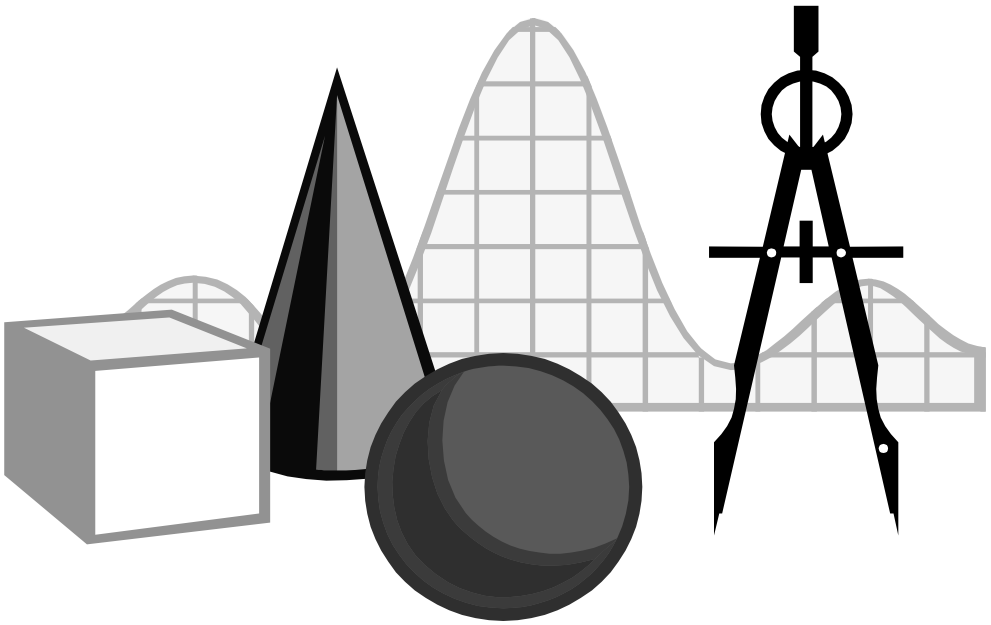
MATHEMATICS STANDARDS OF LEARNING ENHANCED SCOPE AND SEQUENCE

Grade 4



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Introduction

The *Mathematics Standards of Learning Enhanced Scope and Sequence* is a resource intended to help teachers align their classroom instruction with the Mathematics Standards of Learning that were adopted by the Board of Education in October 2001. The Mathematics Enhanced Scope and Sequence is organized by topics from the original Scope and Sequence document and includes the content of the Standards of Learning and the essential knowledge and skills from the Curriculum Framework. In addition, the Enhanced Scope and Sequence provides teachers with sample lesson plans that are aligned with the essential knowledge and skills in the Curriculum Framework.

School divisions and teachers can use the Enhanced Scope and Sequence as a resource for developing sound curricular and instructional programs. These materials are intended as examples of how the knowledge and skills might be presented to students in a sequence of lessons that has been aligned with the Standards of Learning. Teachers who use the Enhanced Scope and Sequence should correlate the essential knowledge and skills with available instructional resources as noted in the materials and determine the pacing of instruction as appropriate. This resource is not a complete curriculum and is neither required nor prescriptive, but it can be a valuable instructional tool.

The Enhanced Scope and Sequence contains the following:

- Units organized by topics from the original Mathematics Scope and Sequence
- Essential knowledge and skills from the Mathematics Standards of Learning Curriculum Framework
- Related Standards of Learning
- Sample lesson plans containing
    - Instructional activities
    - Sample assessments
    - Follow-up/extensions
    - Related resources
    - Related released SOL test items.

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Organizing Topic Whole Numbers: Representations, Relationships, Operations, Estimation, Addition, Subtraction, Multiplication, Division

Standards of Learning

4.1 The student will
a) identify (orally and in writing) the place value for each digit in a whole number expressed through millions;
b) compare two whole numbers expressed through millions, using symbols (>, <, or =); and
c) round whole numbers expressed through millions to the nearest thousand, ten thousand, and hundred thousand.

4.5 The student will estimate whole-number sums and differences and describe the method of estimation. The student will refine estimates, using terms such as *closer to, between*, and *a little more than*.

4.6 The student will add and subtract whole numbers written in vertical and horizontal form, choosing appropriately between paper and pencil methods and calculators.

4.7 The student will find the product of two whole numbers when one factor has two digits or fewer and the other factor has three digits or fewer, using estimation and paper and pencil. For larger products (a two-digit numeral times a three-digit numeral), estimation and calculators will be used.

4.8 The student will estimate and find the quotient of two whole numbers, given a one-digit divisor.

Essential understandings, knowledge, and skills	Correlation to textbooks and other instructional materials
The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to	
• Identify and communicate, both orally and in written form, the place value for each digit in whole numbers expressed through the one millions place.	_____
• Read whole numbers through the one millions place that are presented in standard format, and select the matching number in written format.	_____
• Write whole numbers through the one millions place in standard format when the numbers are presented orally or in written format.	_____
• Identify and use the symbols for *greater than*, *less than*, and *equal to*.	_____
• Compare two whole numbers expressed through the one millions, using symbols >, <, or =.	_____

- Round whole numbers expressed through the one millions place to the nearest thousand, ten thousand, and hundred-thousand place. _____
- Estimate whole-number sums and differences, using rounding, front-end strategies, and compatible number strategies. Describe the method of estimation used. _____
- Refine estimates by adjusting the final amount, using terms such as *closer to, between*, and *a little more than*. _____
- Determine the sum or difference of two whole numbers, each 999,999 or less, in vertical form with or without regrouping. _____
- Determine the sum or difference of two whole numbers, each 999,999 or less, in horizontal form with or without regrouping. _____
- Find the sum or difference of two whole numbers, each 999,999 or less, using paper and pencil. _____
- Find the sum or difference of two whole numbers, each 999,999 or less, using a calculator. _____
- Estimate the products of two whole numbers when one factor has two digits or fewer and the other factor has three digits or fewer. _____
- Find the product of two whole numbers when one factor has two digits or fewer and the other factor has three digits or fewer, using paper and pencil and calculators. _____
- Estimate the quotient of two whole numbers, given a one-digit divisor and a two- or three-digit dividend. _____
- Find the quotient of two whole numbers, given a one-digit divisor and a two- or three-digit dividend. _____

Estimation Game

Reporting category Computation and Estimation

Overview Students estimate and calculate actual amounts spent for groceries for a week.

Related Standard of Learning 4.5

Objectives

- The student will estimate whole-number sums and differences and describe the method of estimation.
- The student will use the terms *closer to* and *a little more than.*

Materials needed

- Paper and pencils
- Sales flyers from local newspapers
- Calculators

Instructional activity

1. Use this shopping activity to help the students develop estimation skills. Divide the class into teams of two students each, and give each team a copy of a sales flyer from a local grocery store. Tell each team that they have $20.00 with which to buy groceries for a week, based on what is listed on sale. Remind them that they are expected to spend as much of their money as possible, but that they will not be getting any more money in addition to the $20.00! Give the teams 10 minutes to decide on their purchases and *estimate* the amount that they are spending.
2. Have students share the strategies they used in step 1. Then have them spend $100.00 and take 15 minutes to estimate. This will provide an assessment of whether students who had no strategy for estimation the first time learned from other students who shared their strategies, or whether any students tried a new strategy.
3. Next, ask students to use their calculators to figure the actual total cost of their purchases.
4. Have the students compare their estimates with the actual costs. How good were the teams' estimation skills? Which team came closest to $100.00 in actual expenditures? Did anyone spend more than $100.00? Did anyone spend exactly $100.00?

Sample assessment

- Have students describe their estimation methods in writing, and then hold a class discussion on this topic. Did students use compatible numbers that are easy to add and subtract mentally? For example, one estimation strategy may have been to replace the actual numbers with compatible numbers, e.g., 52 + 74 becomes 50 + 75. The estimated sum is very close to the actual sum. (125 versus 126)

Follow-up/extension

- Have students use estimation skills to plan an end-of-the-year party for the class. Have them gather prices for party foods and decorations, determine how much money will be available, and estimate whether the money will cover the expenses. Then have them compute the actual cost and compare their estimate with the actual cost.

- Explain that estimates are used in making budgets for business, industry, and education. However, estimates often fall short of actual costs. If the amount of money available is based on an estimate and the actual cost proves to be more than the estimate, what happens? Encourage students to discuss the pros and cons of estimation.

Location, Location, Location!

Reporting category Number and Number Sense

Overview Students name the place value of each digit and describe its place on a period chart.

Related Standard of Learning 4.1

Objectives

- The student will construct a chart that shows place value.
- The student will correctly identify the place values in a "hundred-millions" number.

Materials needed

- Index cards with a variety of large numbers written on them
- Paper and pencils
- A set of 11 index cards — nine cards with one numeral, 1–9, written very large on each, plus two cards with a comma written large on each
- A clothesline and eleven spring-type clothespins
- A copy of the "Periods Place-Value Chart" for each student

Instructional activity

1. *Setting the Scene:* Explain to students that when we understand place value, we also develop an understanding of really big numbers. Write the number 134,276,983 on the board, and ask the students to write a description of the number on their papers. Their description should include a reference to the value of the number and to the importance of the place of each numeral. Ask for volunteers to read what they have written. Tell the students that you want them to understand the "place" of each numeral. To make this more readily understandable, explain to them that a "periods place-value chart" is a helpful tool for understanding large numbers.
2. Draw the "Periods Place-Value Chart," shown on the handout, on the board. Be sure to make each column the same width so as not to make some columns visually "larger" than others. Write each numeral in the number 134,276,983 in its proper place under the proper heading:

Hundred Millions – 1	Hundred Thousands – 2	Hundreds – 9
Ten Millions – 3	Ten Thousands – 7	Tens – 8
Millions – 4	Thousands – 6	Ones – 3

3. Distribute to each student a "Period Place-Value Chart" and an index card with a hundred-millions number written on it. (Each hundred-millions number should be different.)
4. Ask students to write each numeral of their number under the correct heading in their chart, just as you did at the board. There should be only one numeral under each heading. Tell students to exchange index cards and repeat the activity. Then have them exchange again but with a different person and repeat. Each student will then have placed three "hundred-millions" numbers on his or her periods chart.
5. Extend the lesson by asking two students to hold up a clothesline and distributing the set of 11 index cards (see "Materials needed" above) and 11 spring-type clothespins to 11 students. Display the number 943,721,856 so that the other students in the class can see it but the 11 students holding the cards cannot. Tell the students who received the cards to clip their numerals/commas on the

clothesline one by one to make the "secret" number as the other students answer the following questions aloud. Ask the class the following:

- What numeral is in the hundred-thousands place? (7)
- What numeral is in the thousands place? (1)
- What numeral is in the hundreds place? (8)
- What is used to separate the hundreds place and the thousands place? (,)
- What numeral is in the hundred-millions place? (9)
- What numeral is in the ten-thousands place? (2)
- What numeral is in the ten-millions place? (4)
- What numeral is in the millions place? (3)
- What is used to separate the hundred-thousands and the millions place? (,)
- What numeral is in the ones place? (6)
- What numeral is in the tens place? (5)
- Have the student read the number once it is displayed.

6. Verify that all numerals have been placed in the right places — i.e., that their place values are correct.
7. Repeat the activity with a different number and 11 other students. If time permits, give every student an opportunity to participate as a "clipper."

Sample assessment

- Observe student accuracy in placing numerals in the correct locations as they write the numerals on the periods chart or clip them on the clothesline. Listen for accuracy in student descriptions of their numbers.

Follow-up/extension

- Ask students to write their numbers in expanded format.
- Ask students to identify any patterns that they see in the place-value system.

Periods Place-Value Chart

Millions Period			Thousands Period			Ones Period		
Hundred-Millions	**Ten-Millions**	**Millions**	**Hundred-Thousands**	**Ten-Thousands**	**Thousands**	**Hundreds**	**Tens**	**Ones**

Modeling Addition and Subtraction

Reporting category Computation and Estimation

Overview Students use base-10 blocks to model addition and subtraction problems.

Related Standard of Learning 4.6

Objectives

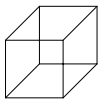
- The student will use base-10 blocks to develop understandings about regrouping.
- The student will understand that regrouping is used in addition and subtraction.

Materials needed

- Base-10 blocks
- Blank base-10 chart
- Paper and pencils
- Calculators

Instructional activity

1. *Setting the Scene:* Explain to students that regrouping is used in both addition and subtraction. To model this with manipulatives, have the class use base-10 blocks to represent addition and subtraction.
2. Review with students the names of the base-10 blocks that they will use: cube = 1,000; flat = 100; rod = 10; unit = 1. Use a blank base-10 chart similar to the one displayed below:

			
1,000	100	10	1
cube	flat	rod	unit

3. Distribute base-10 blocks to all students. Instruct them to construct the following numbers with the blocks, using the fewest possible number of blocks: 675 (6 flats, 7 rods, and 5 units); 846 (8 flats, 4 rods, and 6 units).
4. Ask students to add the two numbers together, represent the sum with the fewest blocks, and describe in their narratives what happened in the addition. Ask them to include drawings of the addition. Ask the following questions:
   - What happens to 5 units and 6 units? (They become 1 rod and 1 unit.)
   - What happens to 7 rods and 4 rods? (They become 11 rods or 1 flat and 1 rod.)
   - What happens to 6 flats and 8 flats? (They become 14 flats or 1 cube and 4 flats.)
   - What is the total? (1 cube [1,000], 5 flats [500], 2 rods [20], and 1 unit)
5. Have the students perform the addition with paper and pencil.
6. Next, have them use a calculator. Are all the answers the same? (Yes: 1,521)

7. For the next example, have the students use the base-10 blocks to construct the numbers 675 and 846, using the fewest number of blocks. Have the students use the blocks to subtract 675 from 846.
   - 5 ones subtracted from 6 ones equals 1 unit.
   - 7 rods subtracted from 4 rods will not work, so we will regroup and "borrow" 10 rods (or a flat) from 8 flats, changing the 8 flats to 7 flats. Now 7 rods can be subtracted from 14 rods, equaling 7 rods.
   - Finally, 6 flats subtracted from 7 flats equals 1 flat.
   - What is the total? 1 flat (100), 7 rods (70), and 1 unit
8. Have the students perform the subtraction with paper and pencil.
9. Next, have them use a calculator. Are all the answers the same? (Yes: 171).
10. Provide additional math problems for students to solve, using base-10 blocks.
11. Give students opportunities to move from the manipulative (base-10 blocks), to the representational (drawings), to the abstract (vertical and horizontal addition and subtraction/ calculator computation).
12. Instruct students to write about what they did during the subtraction activity, and include drawings of the base-10 blocks.

Sample assessment

- Observe students as they manipulate the base-10 blocks. Watch for grouping for both addition and subtraction. Also, make sure that their written descriptions and drawings of base-10 blocks correlate.

Multiplying and Trading

Reporting category Computation and Estimation

Overview Students use base-10 blocks to model multiplication of two-digit numbers.

Related Standard of Learning 4.7

Objective

- The student will solve a multiplication problem by using a manipulative and a calculator.

Materials needed

- Overhead base-10 blocks
- Classroom set of base-10 blocks
- Paper and pencils
- Calculators
- A "Multiplication Using Base-10 Blocks" worksheet for each student

Instructional activity

1. Using base-10 blocks, demonstrate an array to show the product of 5 times 6. Choose one student to model a solution on the overhead. Explain that today they will be exploring the area of a rectangle that has dimensions that are larger factors.
2. Ask students to discuss how they could use the area model to find the product of 13 and 34. Have students share their suggestions.
3. Demonstrate to students how to build a 13-by-34 rectangle with the base-10 blocks. Begin with 13, representing it with 1 rod and 3 units placed on the overhead to represent the length of the rectangle. Then represent 34 with 3 rods and 4 units placed to represent the width of the rectangle. Remind students that they were able to find the product of 5 and 6 by completing a rectangle that was 5 units wide and 6 units long and that the same process can be used to find the product of two-digit factors. Ask students what blocks should be used to complete the rectangle, using the fewest blocks. Have them start with the largest blocks, the flats. Model placing the 3 flats in the rectangle. Ask students how many rods will fit in the remaining area? Then ask how many units will fit in the remaining area? At this point, students should have created a rectangle containing 3 flats, 13 rods, and 12 units. Trading in units for rods and rods for flats should give students a final value of 4 flats, 4 rods, and 2 units.
4. Have students work with a partner to find the product of 25 and 32, using the same process.
5. Explain to students that they will be recording the results of several problems in a table and will be looking for the patterns that occur with the number of flats, vertical rods, horizontal rods, and units. Distribute the worksheet that has the example of the first problem represented. Review the results listed in the table. Ask students to record the information in the second row of the table for the product of 25 and 32. Discuss the patterns that students observe. Ask students to share any other observations.

Sample assessment

- Use the third and fourth problems on the "Multiplication Using Base-10 Blocks" worksheet and the students' written responses to the prompts.

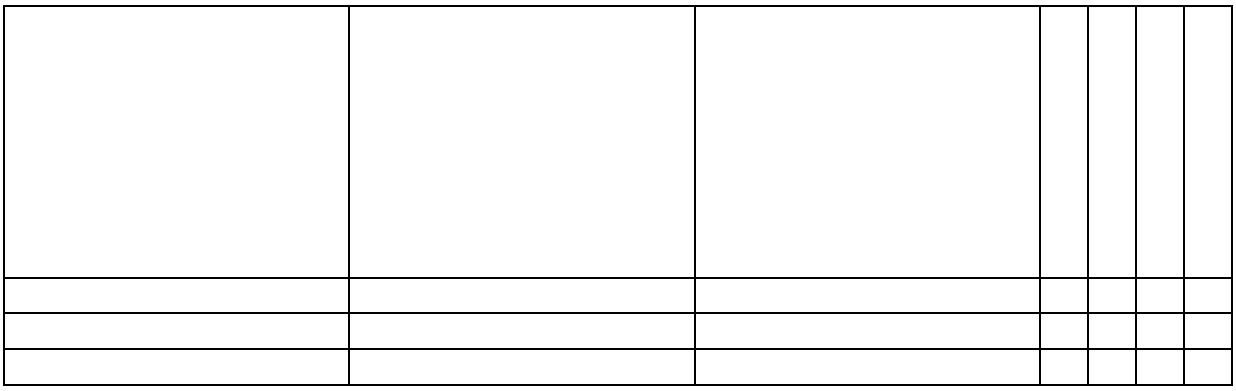
Multiplication Using Base-10 Blocks

We can represent the product of 13 and 34 as shown below. We can use trading to get the correct final answer.

1. Represent 13 vertically. (The length of the rectangle equals the first factor.)
2. Represent 34 horizontally. (The width of the rectangle equals the second factor.)
3. Use as few base-10 blocks as possible to fill in the rectangle.

Width = 34 = 3 rods and 4 units

Length = 13 = 1 rod and 3 units



4. The sum of the value of these blocks after trading is the desired product.

Use this technique to find the following products. Fill in the following table for each product.

Problem	# Flats	# Vertical Rods	# Horizontal Rods	# Units	Product
13 × 34	3	4	9	12	442
25 × 32					
12 × 23					
16 × 13					

5. Refer to the table above. How could you find the number of flats in the rectangle in the original problem?
6. Refer to the table above. How could you find the number of vertical rods in the rectangle in the original problem?
7. Refer to the table above. How could you find the number of horizontal rods in the rectangle from the original problem?
8. Refer to the table above. How could you find the number of units in the rectangle from the original problem?

Use the pattern you just discovered to find the following products mentally:

1. 31 × 22
2. 41 × 12
3. 52 × 45
4. 28 × 36
5. Why does this work?

Pears in a Basket

Reporting category Computation and Estimation

Overview Students use base-10 blocks to model division and the process of finding equal groups or equal shares.

Related Standard of Learning 4.8

Objectives

- The student will use division to create equal groups.
- The student will model division, using base-10 blocks.

Materials needed

- Base-10 blocks
- Paper and pencils for each student

Instructional activity

1. *Setting the Scene:* "Ann has a pear tree in her back yard. The tree produces beautiful pears each year, and Ann likes to share the pears with her three neighbors. So, Ann picked a basketful of pears, 57 in all! She decided not to keep any for herself this time, but to use all the pears to make pear baskets for her neighbors. She decided to put the same number of pears in each basket." Tell the class that they are going to find out how many pears each neighbor received.
2. First, ask the students to estimate how many pears each neighbor will get.
3. Then, tell the students that they may use a variety of manipulatives, such as color tiles, unifix cubes, and/or base-10 blocks. Observe students as they use the selected manipulatives. Have students explain their various models and solutions.
4. Ask students to write and illustrate how they used their manipulatives. Did anyone's estimation result in there being any pears left over?
5. Finally, have the students compare their estimate to the actual number of pears that each neighbor will receive. How close was their estimate?

Sample assessment

- Observe students as they construct their models. Also, look for details in the narrative and illustrations to indicate understanding of the division process, e.g., equal shares.

Follow-up/extension

- Use different numbers, and ask students to create problems that relate to the numbers.

Sample resources

http://standards.nctm.org/document/chapter5/numb.htm#bp1 – NCTM Principals and Standards for School Mathematics chapter on the Number and Operations Standard for Grades 3–5.

http://www.linkslearning.org/Teachers/1_Math/6_Learning_Resources/1_Illustrated_Lessons/3_Place_Value/index.html – Students work with place value using whole numbers as well as decimals. This interactive, computer-based lesson includes activities and assessments.

http://www.arcytech.org/java/b10blocks/description.html – Visual representations of base-10 place value and multi-digit operations, a valuable tool for teachers to use in class or for students to use on their own.

http://edweb.sdsu.edu/courses/edtec670/Cardboard/Card/N/NumberClub.html – Instructions for a card game that reinforces place-value concepts.

http://www.naturalmath.com/mult/ – A tutorial to help students learn the multiplication facts.

Released SOL test items

1 The difference of 21,234 − 19,078 is best described as —

A a little more than 1,000
B a little more than 1,500
C a little more than 2,000
D a little more than 2,500

5

$$\begin{array}{r} 82 \\ \times\ 69 \\ \hline \end{array}$$

A 5,558
B 5,658
C 6,238
D 12,030

12 The table below shows the number of tickets sold to different events at the county fair.

Event Tickets Sold

Event	Number Sold
Dog Show	2,260
Craft Booth	3,031
Whirly Ride	928
Ferris Wheel	1,415

What was the total number of tickets sold for these four events?

F 7,634
G 7,624
H 6,634
J 6,524

2 $56\overline{)1,234} =$

F 22 R2
G 34 R9
H 38 R6
J 42 R2

8 $381 + 245 + 579 = ?$

F 1,105
G 1,195
H 1,205
J 1,295

15 Which digit goes in the space to make the statement below true?

4,837,206 > 4,8__5,379

A 2
B 4
C 6
D 9

13 For her report on dinosaurs, Rita rounded the weight of one kind of dinosaur to the nearest thousand. If the weight to the nearest thousand pounds was 8,000 pounds, which of the following could have been the weight before rounding?

A 7,489 pounds
B 8,293 pounds
C 8,609 pounds
D 9,512 pounds

9 The picture below shows a copy of four different magazines. The number under each magazine is the total number of copies that magazine sold last year.

Which magazine sold a number of copies that has a 4 in the ten-thousands place?

A All Sports
B Teenage
C Music Time
D Young People

Organizing Topic Decimals: Representations, Relationships, Operations, Estimation, Addition and Subtraction

Standards of Learning

4.2 The student will
- c) relate fractions to decimals, using concrete objects.

4.4 The student will
- a) read, write, represent, and identify decimals expressed through thousandths;
- b) round to the nearest whole number, tenth, and hundredth; and
- c) compare the value of two decimals, using symbols (<, >, or =), concrete materials, drawings, and calculators.

4.9 The student will
- b) add and subtract with decimals through thousandths, using concrete materials, pictorial representations, and paper and pencil; and
- c) solve problems involving addition and subtraction with fractions having like and unlike denominators of 12 or less and with decimals expressed through thousandths, using various computational methods, including calculators, paper and pencil, mental computation, and estimation.

Essential understandings, knowledge, and skills	Correlation to textbooks and other instructional materials
The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to	
• Represent fractions for halves, fourths, fifths, and tenths as decimals through thousandths, using concrete objects (e.g., demonstrate the relationship between the fraction $\frac{1}{4}$ and its decimal equivalent 0.25).	
• Relate fractions to decimals, using concrete objects (e.g., 10-by-10 grids, meter sticks, number lines, decimal squares, money [coins]).	
• Investigate the ten-to-one place-value relationship for decimals through thousandths, using base-10 manipulatives (e.g., place-value mats/charts, decimal squares, base-10 blocks, money).	
• Represent and identify decimals expressed through thousandths, using base-10 manipulatives, pictorial representations, calculators, and numerical symbols (e.g., relate the appropriate drawing to 0.005).	
• Read and write decimals expressed through thousandths, using base-10 manipulatives, drawings, calculators, and numerical symbols. Any decimal less than 1 will include a leading zero (e.g., 0.125).	
• Round decimals to the nearest whole number, tenth, and hundredth.	

- Compare the value of two decimals, using the symbols >, <, =. _____
- Add and subtract with decimals through thousandths, using concrete materials, pictorial representations, and paper and pencil. _____
- Solve problems that involve adding and subtracting with decimals through thousandths. _____

Reading and Writing Decimals

Reporting category Number and Number Sense

Overview Students use various materials to read and write decimals through the thousandths place.

Related Standard of Learning 4.4

Objective

- The student will read, write, represent, and identify decimals through the thousandths.

Materials needed

- Base-10 blocks: large cube (thousands), flats (hundreds), rods (tens), units (ones)
- A copy of the "Decimal Grids" handout for each students
- Crayons
- Place-value charts
- Meter stick
- A set of 10 digit (0–9) cards and a decimal card for each student
- Calculator

Instructional activity

1. Use base-10 blocks to review with students the ten-to-one relationship of whole numbers. After you are certain that students are comfortable reading and representing whole numbers with base-10 blocks, ask them what is to the right of the ones place. This should also be review, as students were introduced to decimal concepts in third grade. Relate decimals to money, fractions, and being part of a whole (less than one).
2. Give students a situation involving a decimal number, and ask them how they can use base-10 blocks to model that number. The flat (hundred) is usually used for one whole. Would the rod (ten) be larger or smaller? What would be smaller? Focus the students again on the ten-to-one relationship of our base-10 system. The flat can be broken into how many rods? (10) The rod can be broken into how many units? (10)
3. Ask the students to name the places used with whole numbers (ones, tens, hundreds, thousands, ten-thousands, hundred-thousands, and millions place) and record these on the chalkboard. Remind the students that the first place to the right of the decimal is called the "tenths" place. Record this also. Ask students to look closely at the chart and see if any can predict the next smaller place (hundredths). Again, ask students to predict the next few places until they see the pattern. Point out that in our place-value system, the ones place is the line of symmetry, not the decimal.
4. Ask students to brainstorm which base-10 block belongs in each place if the flat goes in the ones place. Challenge students to explain why they put each piece in that place.
5. Leave the place-value chart and the base-10 pieces displayed as students create their own numbers with the base-10 pieces. Read and model writing numbers as the students use their base-10 pieces. Include numbers greater than one if there are enough available pieces. For example, say, "Show me two hundredths," and write "0.02." Say, "Show me 65 thousandths," and write ".065." Ask students to justify how they know their models are correct.
6. After students become comfortable modeling numbers and can state why their models are correct, challenge them to write the number down before you do, and see if they are correct. Also, describe

numbers for the students to model. For example, say, "I am thinking of a number greater than 5 that has a 6 in the tenths place." (Note: Keep in mind that there is more than one right answer for this.) Focus on the value of the number so students know where the digit belongs. For example, say, "My number has a value of 5 thousandths and 30 in it." Have students create their own number and clues for other students to guess.

7. Repeat the same activities by having students color the appropriate decimal on the "Decimal Grids" handout and record the number. Also, have students read and write down the number you have colored in on the thousandths decimal grid. Use these decimal grids to compare and round decimals in the following lessons.
8. Review the place-value chart with whole numbers and decimals, and have students create their own. Repeat the earlier lesson reading and describing numbers. This time have students model the number both with pieces and with their digit and decimal cards. Having students read back the number they have chosen will also give them practice in reading decimal numbers.
9. Dueling Decimals Game: Provide each student with a set of 10 digit (0–9) cards and a decimal-point card. Have students play with a partner, as follows:
   - Each player shuffles his/her digit cards and lays them in a pile face down in front of him/her. Each player keeps the decimal card in front of him/her to use.
   - When both players are ready, they turn over their top four digit cards and arrange them to make a number close to the target number for that round. (See target numbers in table below.) Each player reads the number he/she created.
   - Whoever is closer to the target number scores a point.
   - Both players return the cards to the deck and reshuffle them.
   - The first round ends when players have "dueled" five times.
   - Play for the following numbers (or choose your own):

Round #	Target #
1	**0**
2	**5**
3	**10**
4	**50**
5	**100**

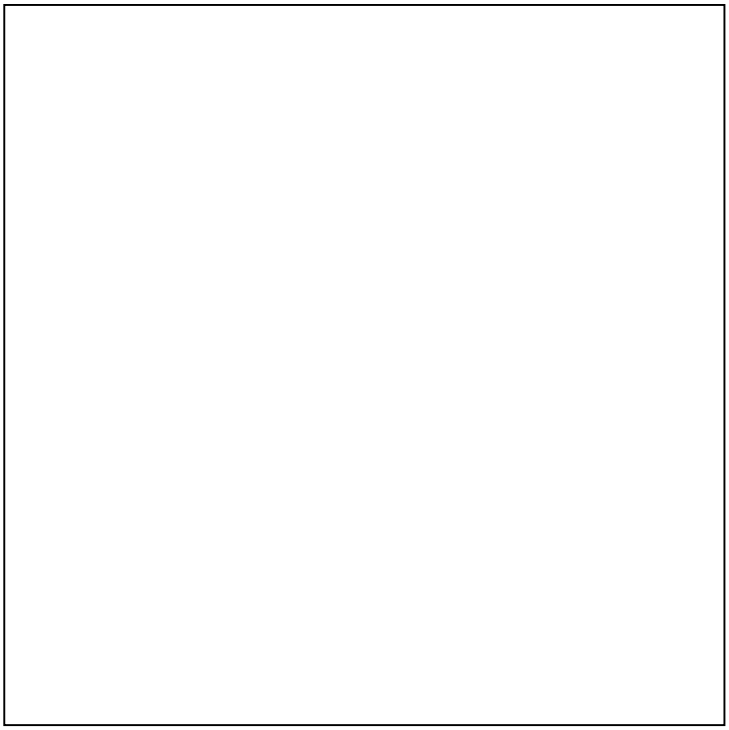
Sample assessment

- Have students read, write, and model various numbers with whole numbers and decimals.

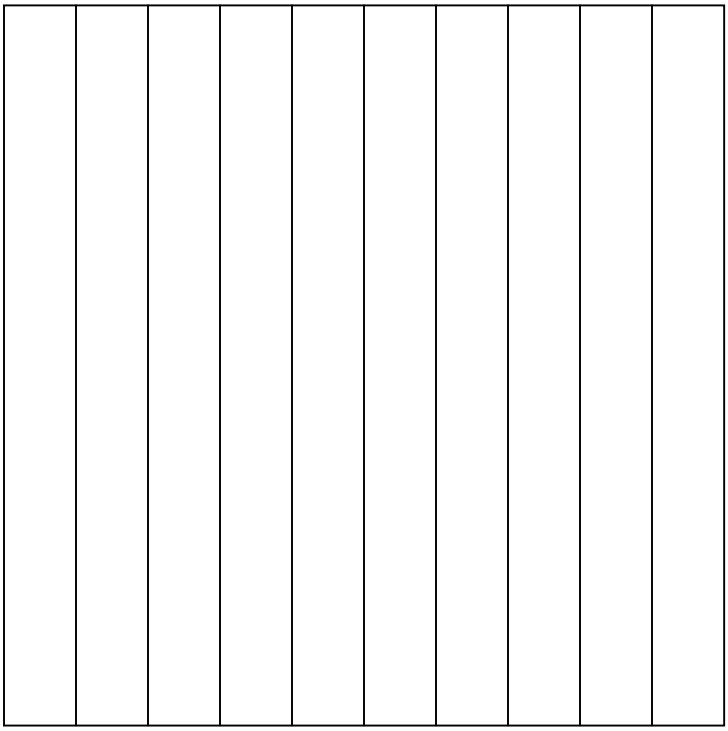
Decimal Grids

Name _____ **Date** _____

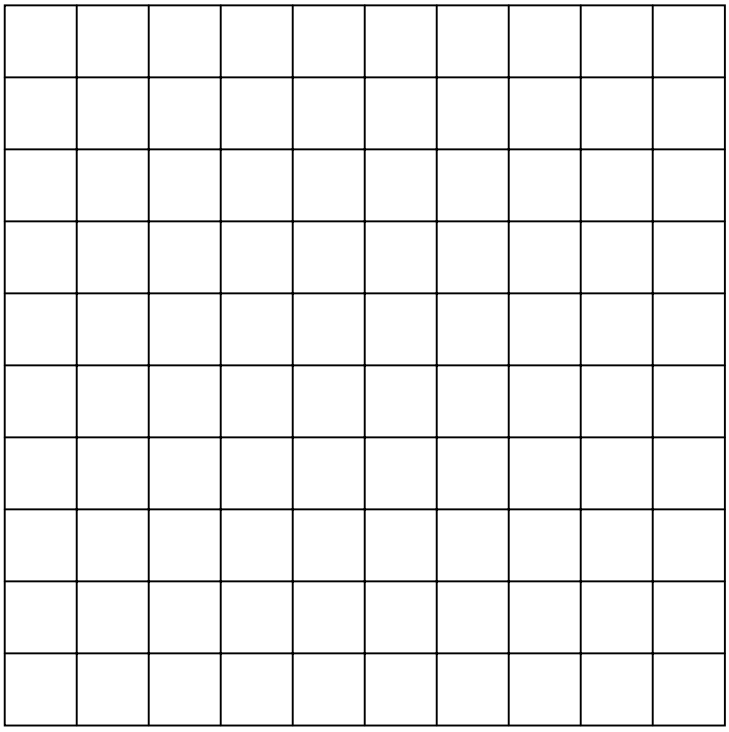
ONE WHOLE

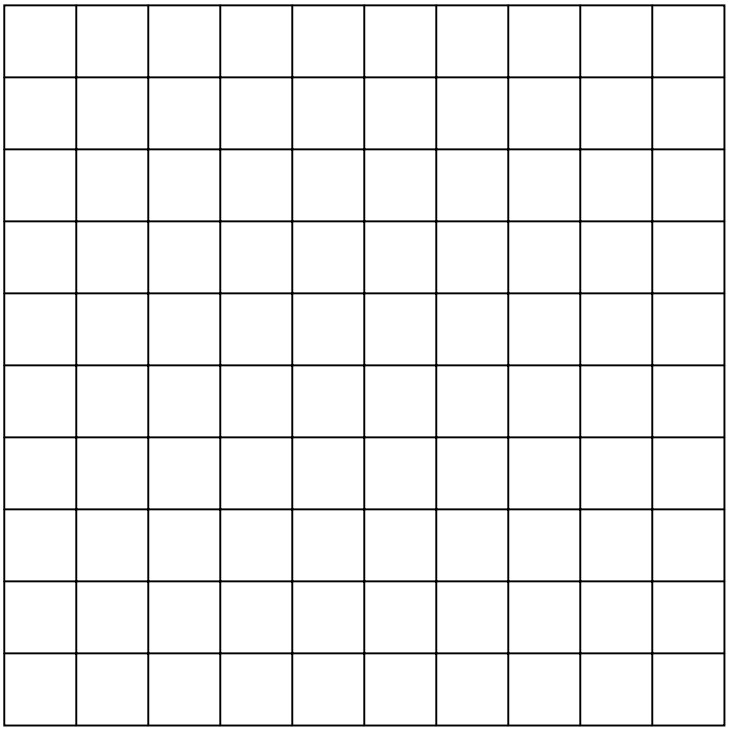


TENTHS



HUNDREDTHS

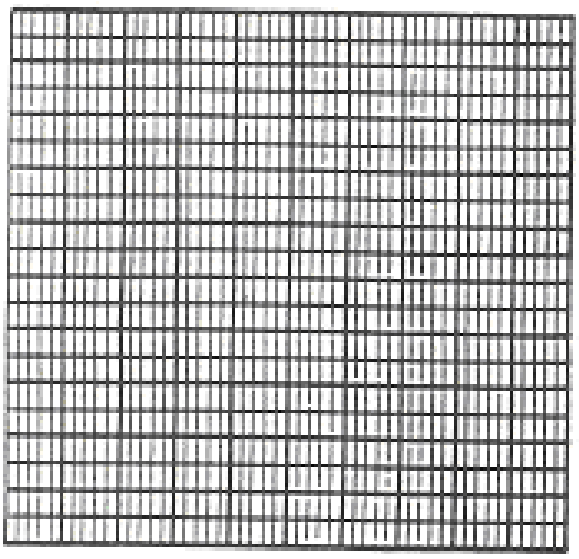


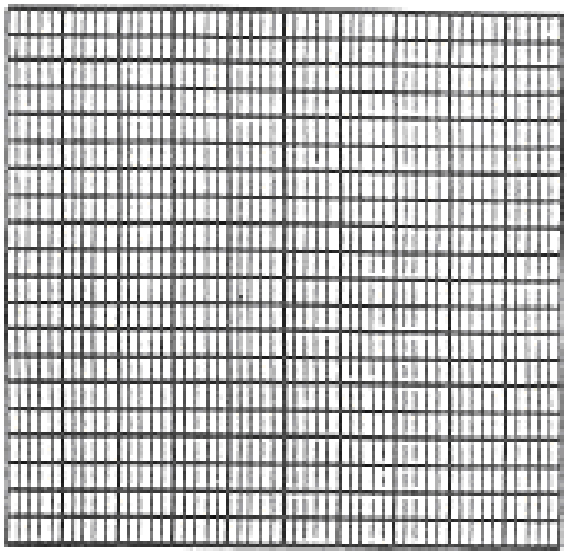


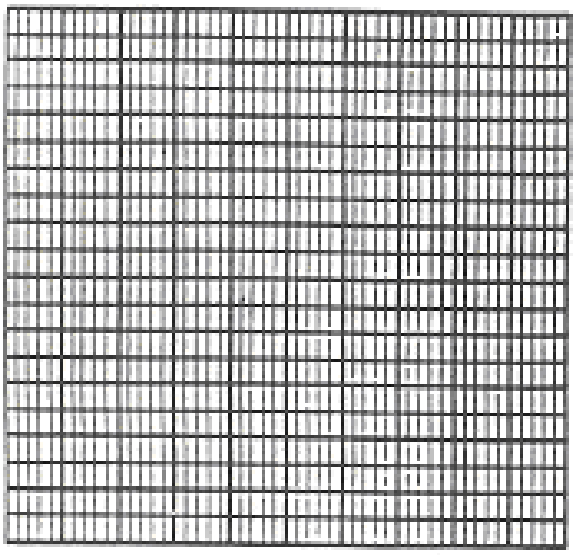
Decimal Grids

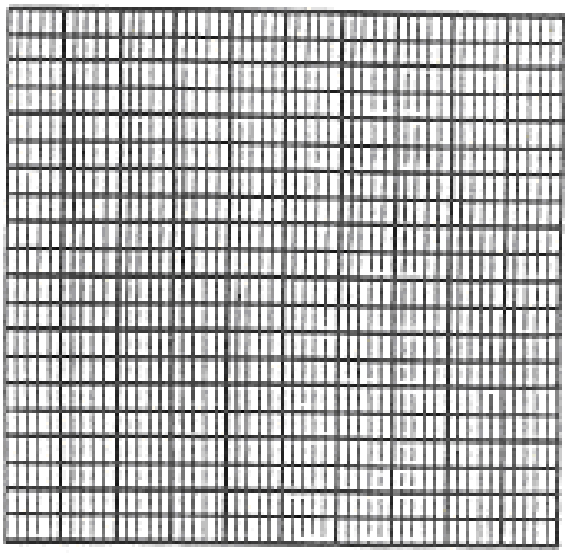
Name _____ **Date** _____

THOUSANDTHS









Comparing Decimals

Reporting category Number and Number Sense

Overview Students use various materials to compare the value of two decimals.

Related Standard of Learning 4.4c

Objective

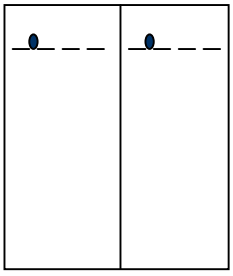
- The student will compare the value of two decimals, using symbols, concrete materials, drawings, and calculators.

Materials needed

- Base-10 blocks: large cube (thousands), flats (hundreds), rods (tens), units (ones),
- Decimal grids (See the "Reading and Writing Decimals" activity above.)
- Place-value charts
- Digit and decimal cards
- Calculators
- Dice

Instructional activity

1. Have student partners use base-10 blocks and place-value charts to model different decimal fractions or mixed numbers. Each partner writes down in words the number he/she modeled. One partner then writes the appropriate symbol, <, >, or =, while the other partner writes a sentence to describe the relationship between the two numbers: for example, "Two and sixty-four hundredths is greater than two hundred sixty-four thousandths." Have the students use the place-value chart to check. Then have them discuss how the models and the charts helped them compare the decimals.
2. Repeat the same activity, using the decimal grids and place-value charts. Give students grids already colored in and let them compare them. Remind them to always use the symbol and write the sentence. This helps to continue practicing reading and writing decimals. Use the place-value chart, and let partners use digit cards or dice to select digits randomly. This makes practice more of a game. Focus on comparing the digits with the greatest value. Many students may think that 0.217 is greater than 0.22 because it has more digits. Have students identify what 0.217 and 0.22 have in common (they both have 2 tenths) and how they are different. Partners can also work together, each typing a numbers into his/her calculator and then comparing the two numbers.
3. Have student partners play The Greatest Decimal Game. One sheet of paper is split in half vertically. Each student takes a half and makes four short, horizontal lines to show the places for each digit. The partners choose where the decimal will be placed before the game begins. Each player takes turns rolling a die and choosing where to put the digit shown. After each partner has completed his/her number, the person with the greatest number wins one point. If a student correctly reads his/her number, he/she wins an additional point.



Sample assessment

- Have students compare decimals shown on a calculator or written down. Make sure they are using the correct symbol and writing a sentence to explain what the symbol means.

Decimal Rings

Reporting category Number and Number Sense

Overview Students use decimal rings to find the equivalent decimals for fractions.

Related Standard of Learning 4.2

Objective

- The student will explore relationships between fractions and decimals, using decimal rings.

Materials needed

- Fraction circles
- A copy of the "Fraction-Decimal Equivalence" worksheet for each student
- Decimal Rings (can be ordered from ETA Cuisenaire)

Instructional activity

1. *Initiating Activity:* Show a picture of something divided in half, e.g., a pizza, a pan of brownies. Ask students to describe it. Ask, "Who remembers what decimal is equivalent to the fraction $\frac{1}{2}$? How can you prove it?"
2. Pass out fraction circles and decimal rings. Ask, "What do you observe about the rings?"
3. Ask student to take out the $\frac{1}{2}$ piece. (Note: This is a good opportunity to review the meaning of numerators and denominators.)
4. Show the students how to use the decimal rings: Line up the beginning of the fraction piece with the 0; the other end of the fraction gives the decimal equivalent.
5. Have the students find the decimal equivalent for $\frac{1}{4}$, using the ring. (0.25) Discuss their findings, and ask them to predict what the decimal equivalent for $\frac{2}{4}$ will be.
6. Have the students find the decimal equivalent for $\frac{2}{4}$, using the ring. Ask the students what they notice about the decimals for $\frac{1}{4}$ and $\frac{2}{4}$. Lead the students toward the idea that the decimal for $\frac{2}{4}$ is double the amount of the decimal for $\frac{1}{4}$. Since $\frac{2}{4}$ is also equivalent to $\frac{1}{2}$, the decimals for $\frac{1}{2}$ and $\frac{2}{4}$ would be equivalent.
7. Have students complete the sheet, using the ring. Discuss their findings, and ask them what they notice about the decimals.

Sample assessment

- Assign items similar to those on the "Fraction-Decimal Equivalence" worksheet.

Fraction-Decimal Equivalence

Name _____ **Date** _____

Use the fraction circles and decimal ring to find the decimal equivalent for each fraction.

$\frac{1}{2} =$

$\frac{1}{4} =$

$\frac{2}{4} =$

$\frac{3}{4} =$

$\frac{1}{5} =$

$\frac{2}{5} =$

$\frac{3}{5} =$

$\frac{4}{5} =$

$\frac{9}{10} =$

$\frac{1}{10} =$

$\frac{2}{10} =$

$\frac{3}{10} =$

$\frac{4}{10} =$

$\frac{5}{10} =$

$\frac{6}{10} =$

$\frac{7}{10} =$

$\frac{8}{10} =$

Decimal Sums and Differences

Reporting category Computation and Estimation
Overview Students use various strategies to add and subtract decimals.
Related Standard of Learning 4.9b

Objective

- The student will use pictures, mental math, estimation strategies, and calculators to add and subtract decimals.

Materials needed

- Base-10 blocks: large cube (thousands), flats (hundreds), rods (tens), units (ones),
- Decimal grids (See the "Reading and Writing Decimals" activity above.)
- Calculators

Instructional activity

1. Present the following scenario to the class. "You want to figure out how far you drove in two days. The first day you drove 120 miles. The second day you drove 19 miles. How far did you drive both days?" Have the students estimate the answer.
2. Next, have students figure out this scenario. "You want to figure out exactly how far you walked in two days. The first day you walked 1.2 miles, and the second day you walked 0.19 miles. How far did you walk both days?" After the students have had a minute to think about the problem, ask for some estimates of the answer. Stress *estimating* the answer first. After estimates have been given, ask the students to compare the two problems.
3. Have students use base-10 blocks or decimal grids to show each number in the second problem and combine them.
4. Discuss how they might solve the problem by using pencil and paper to line up the decimal points and get the sum of 1.39.
5. Have students write and exchange their own story problems involving decimal sums and differences. Have them use calculators to check for correct answers.
6. Have students solve more examples like the one above. Remember to use decimals including tenths, hundredths, and thousandths, e.g., 3.9 + 2.046. Discuss how estimating helps you know if your answer is reasonable. Allow students to use calculators to check their answers.
7. Give students story problems involving decimals to add or subtract.

Sample assessment

- Have students respond to the following written prompt: "How is adding whole numbers similar/different to adding numbers with decimals?"

Estimating Decimal Sums and Differences

Reporting category Computation and Estimation

Overview Students round decimals when they are added or subtracted to estimate the sum or difference.

Related Standard of Learning 4.9c

Objective

- The student will round decimals to the nearest whole number to estimate the sum and difference of two decimals.

Materials needed

- Overhead projector or flip chart

Instructional activity

1. Present the following scenario to the class. "You are in the grocery store and need to buy bread, lunchmeat, and chips to make your lunch. You only have a ten-dollar bill so you are worried that you won't have enough money. The bread is $1.82, the lunchmeat is $4.93, and the chips are $2.03. Without writing anything down, will you have enough money to buy all three items?" After students have some time to think about the answer, have them vote yes or no. Talk about the strategies they used to *estimate* the total.
2. Discuss as a class other examples in which you would need to estimate decimals instead of finding the exact answer (e.g., calculating distances ran or driven, calculating cooking ingredients).
3. Discuss the fact that rounding each decimal to the nearest whole number and then adding or subtracting gives a valid whole-number estimate. Also talk about using benchmarks when estimating (e.g., Is the number closer to 0 or 1?).
4. Provide students with practice estimating addition and subtraction problems involving decimals. Make sure to include in the problems decimals to tenths, hundredths, and thousandths (e.g., 3.9 + 2.046) to emphasize rounding the closest whole number. Put a problem on the overhead, turn it on for about five seconds, and then turn it off. Alternatively, display the problem on a flip chart for about five seconds, and then flip it over. Have the students estimate the answer mentally and write only the answer on a sheet of paper. Ask individual students for their estimate and have them explain how they figured it out.
5. If time permits, have students write and exchange their own story problems involving estimating decimals sums and differences.

Fraction Grids

Reporting category Number and Number Sense
Overview Students explore the relationship between fractions and decimals.
Related Standard of Learning 4.2

Objective

- The student will explore relationships between fractions and decimals, using a hundreds grid.

Materials needed

- A copy of the "Fraction-Decimal Equivalence" worksheet for each student

Instructional activity

1. Ask each student to shade in $\frac{1}{2}$ of the first grid with a pencil. Observe students as they work to figure out $\frac{1}{2}$ of the first grid.
2. Discuss what students did to find $\frac{1}{2}$. Ask, "How did you figure that out?" Make sure that all students have shaded in their grids correctly.
3. Reinforce what a row and a column are. Ask, "How many rows are in the grid?" (10) How many columns?" (10) "How many rows or columns are colored in?" (5) "How would you write that in fraction form?" ($\frac{5}{10}$)
4. Show the students how to write $\frac{5}{10}$ in decimal form. (0.5). Ask, "How do you say this decimal?" (five-tenths) Emphasize for the students that the decimal and the fraction are said the same way. Also, review that the first place after the decimal point is called the "tenths" place.
5. Ask, "How many little boxes are in the grid?" (100) "How many of those boxes are shaded in?" (50) "How would you write this in fraction form?" ($\frac{50}{100}$)
6. Show the students how to write $\frac{50}{100}$ in decimal form (0.50), reviewing with them that the second place after the decimal is called hundredths.
7. Ask the students to go through this same process with the second grid. Tell them to use what they learned in working on the first grid to shade in the fraction and then write the equivalent decimal for the second grid.
8. The fractions with a denominator of 5 are a little more difficult. One technique is to color every fifth square, which forms a visual pattern. Some students will be able to reason that $\frac{1}{10}$ is equivalent to one row on the grid, so two rows are equivalent to $\frac{2}{10}$ or $\frac{1}{5}$. Another technique is to try to make 5 equal groups out of the 100 squares.

9. Have students complete the worksheet. Discuss their findings and ask them to note any relationships.

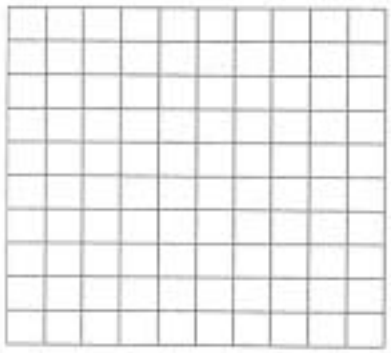
Sample assessment

- Have students create their own grids, and have partners work together to find decimal equivalents.

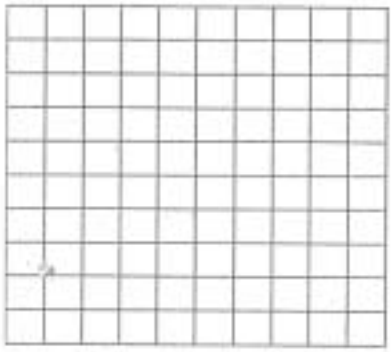
Fraction-Decimal Equivalence

Name _____ **Date** _____

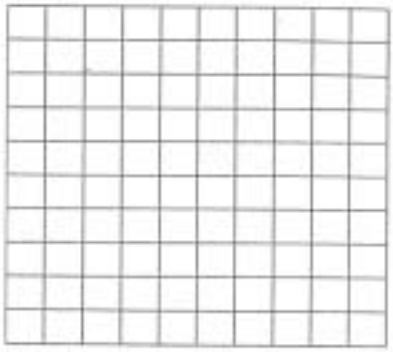
Shade in each grid below to represent the fraction shown below it. Use the grid to help you figure out the equivalent decimal for each fraction. Write the decimal next to the fraction.



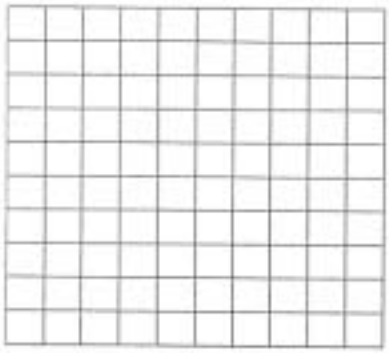
$\frac{1}{2}$ =



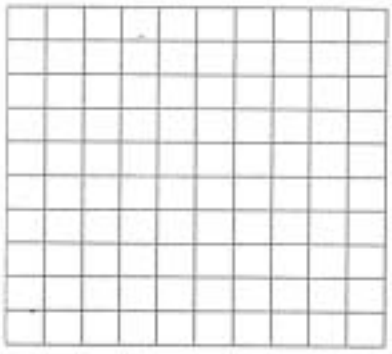
$\frac{1}{4}$ =



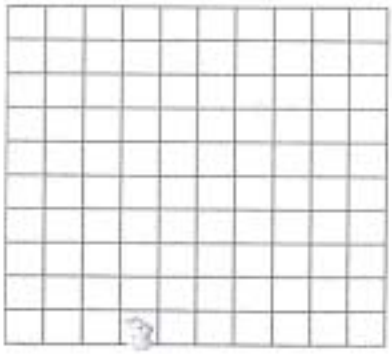
$\frac{3}{4}$ =



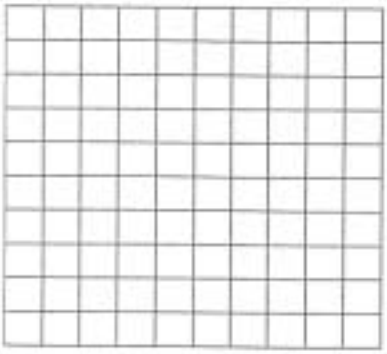
$\frac{1}{5}$ =



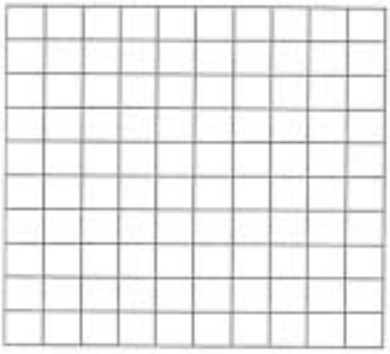
$\frac{2}{5}$ =



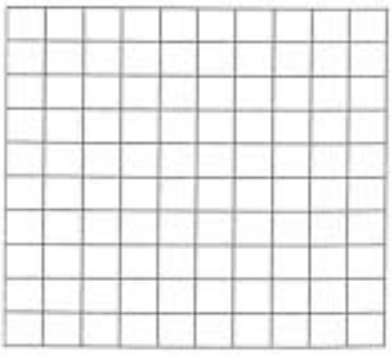
$\frac{3}{5}$ =



$\frac{4}{5}$ =



$\frac{3}{10}$ =



$\frac{7}{10}$ =

Rounding Decimals

Reporting category Number and Number Sense

Overview Students round numbers to the nearest whole number, tenth, and hundredth.

Related Standard of Learning 4.4b

Objective

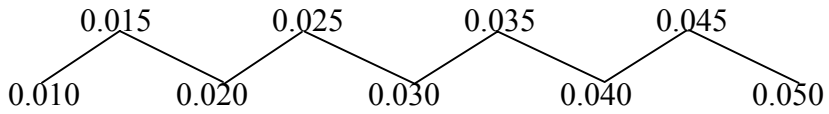
- The student will round numbers to the nearest whole number, tenth, and hundredth.

Materials needed

- Base-10 blocks: large cube (thousands), flats (hundreds), rods (tens), units (ones)
- Decimal grids (See the "Reading and Writing Decimals" activity above.)
- Decimal cards (See the "Reading and Writing Decimals" activity above.)

Instructional activity

1. Have students begin by creating base-10 models or decimal grids of some numbers containing decimals. Have students use the models or pictures to tell what whole number, what tenth, and what hundredth the decimal is closest to. You may need to review place value and writing decimals. Have students write out the decimal they created and again tell what whole number, what tenth, and what hundredth the decimal is closest to. Have students use the pictures or models to help them remember the rules of rounding.
2. Use the decimal cards, if you wish, to have students randomly choose decimals to round to the given place.
3. If students are still having difficulty with rounding, refer to SOL 4.2 for more ideas. A picture of a rounding mountain also helps some students. Locate the desired number on the mountain. If it lands on a slope, it will fall down to the nearest number. If it lands exactly on the top, it will roll over to the right side.



Sample assessment

- Have students round numbers to the nearest whole, tenth, and hundredth.

Sample resources

http://standards.nctm.org/document/chapter5/numb.htm#bp1 – NCTM Principles and Standards for School Mathematics chapter on the Number and Operations Standard for Grades 3–5.

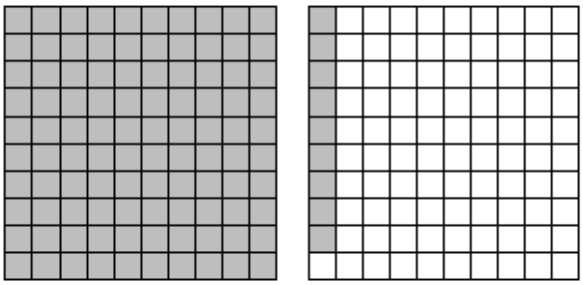
http://funbrain.com/football/index.html – Power Football provides interactive practice with the decimal concepts.

http://askeric.org/cgi-bin/printlessons.cgi/Virtual/Lessons/Mathematics/Number_Sense/NUS0200.html An activity in which students physically arrange themselves into decimal numbers, this lesson can be used to assess students' understanding about decimals.

Thinking Rationally about Fractions, Decimals, and Percent: Instructional Activities for Grades 4 through 8 – Lesson plans available from VDOE at http://www.pen.k12.va.us/VDOE/Instruction/Math/FractionsDecimalsPercent.pdf.

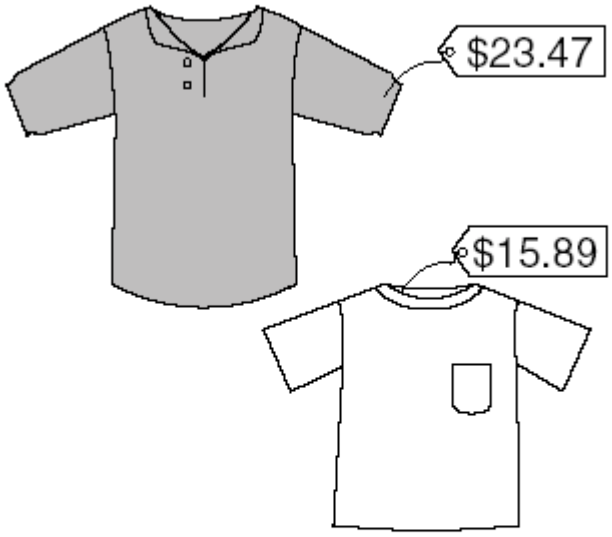
Released SOL test items

8 What number is represented by the shaded part of the figure below?



F 0.19
G 1.09
H 1.19
J 2.09

3 Lark bought the two shirts shown below.



If the prices shown include tax, what was the total cost of the two shirts?

A $39.26
B $39.36
C $40.26
D $40.36

4 Last week Drew worked 7.9 hours. This week he worked 8.6 hours. How many more hours did he work this week than last week?

F 1.7
G 1.3
H 0.7
J 0.3

14 Which is read "fifty-five and twenty-one thousandths"?

F 5,521,000
G 55,210
H 55.21
J 55.021

17 What digit goes in the space to make the number sentence below true?

1.6238 < 1._017

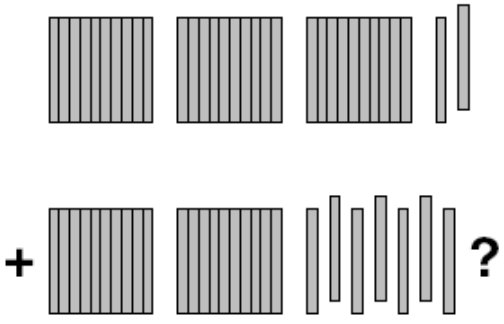
A 4
B 5
C 6
D 7

13 A piece of wood is 2.27 centimeters thick. What is that measurement rounded to the nearest tenth of a centimeter?

A 2.1
B 2.2
C 2.3
D 2.5

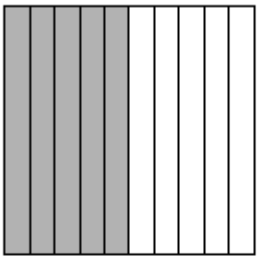
19 **This is one.** **This is one-tenth.**

What is



A 1.5
B 3.9
C 5.9
D 9.5

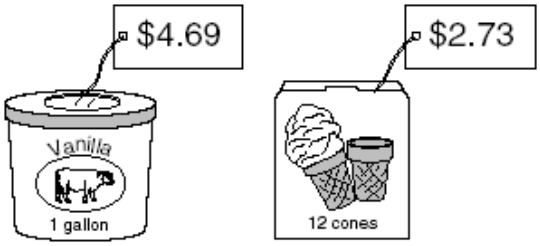
The figure below is shaded to represent a decimal.



How many of the hearts below must be shaded to represent the fraction with the same value as the decimal represented above?

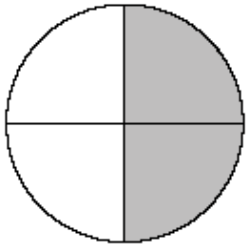
F 1
G 2
H 3
J 4

1 What would be the cost of 2 gallons of ice cream and 2 boxes of ice cream cones?



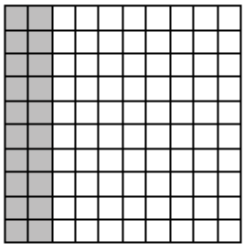
A $12.64
B $12.84
C $14.64
D $14.84

14 A fraction of this circle is shaded.

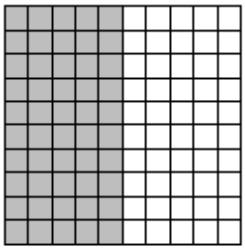


Which is shaded to represent a decimal with the same value as the fraction?

F



G



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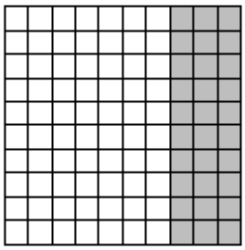

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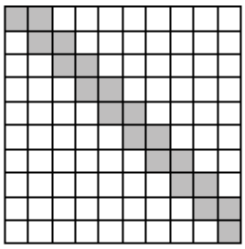
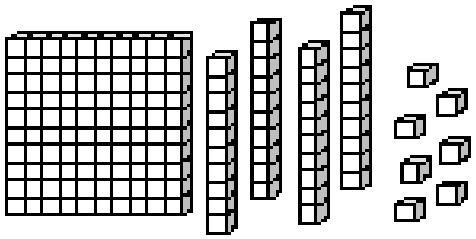


5 What number is represented by the model shown below?



A 1.47
B 1.74
C 10.47
D 14.07

A box of cherries weighs 3.082 pounds. What is that rounded to the nearest hundredth of a pound?

F 3.0 pounds
G 3.1 pounds
H 3.09 pounds
J 3.08 pounds

Which is true?

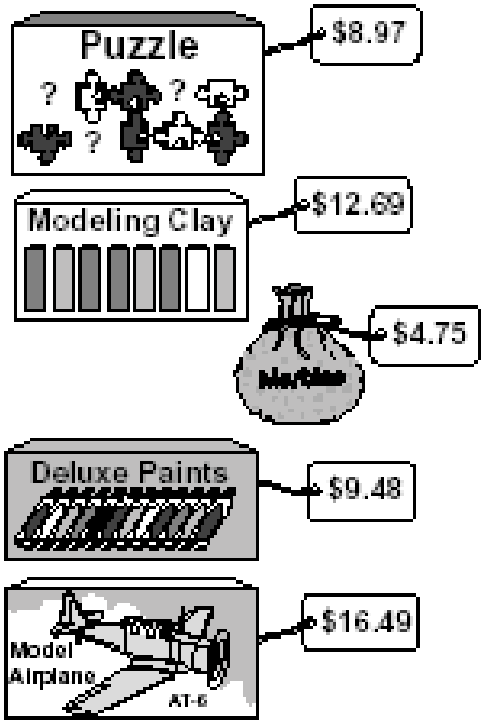
F 1.0254 > 1.24
G 1.1763 > 1.199
H 1.978 > 1.8979
J 1.3046 > 1.3106

9

Sarah bought these flowers. If she gave the clerk $10.00, how much change should she have received?

A $2.72
B $2.37
C $1.72
D $1.63

10



Lynette has $25 to spend. If she wants to buy the deluxe paint set, which of the following could she also buy?

F 1 model airplane
G 4 bags of marbles
H 1 puzzle and 1 box of clay
J 1 bag of marbles and 1 puzzle

Organizing Topic Fractions: Representations, Relationships, Estimation and Operations

Standards of Learning

4.2 The student will
- a) identify, model, and compare rational numbers (fractions and mixed numbers), using concrete objects and pictures;
- b) represent equivalent fractions; and
- c) relate fractions to decimals, using concrete objects.

4.3 The student will compare the numerical value of fractions (with like and unlike denominators) having denominators of 12 or less, using concrete materials.

4.9 The student will
- a) add and subtract with fractions having like and unlike denominators of 12 or less, using concrete materials, pictorial representations, and paper and pencil;
- b) add and subtract with decimals through thousandths, using concrete materials, pictorial representations, and paper and pencil; and
- c) solve problems involving addition and subtraction with fractions having like and unlike denominators of 12 or less and with decimals expressed through thousandths, using various computational methods, including calculators, paper and pencil, mental computation, and estimation.

Essential understandings, knowledge, and skills	**Correlation to textbooks and other instructional materials**
The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to	
• Identify, model, and compare fractions and mixed numbers through twelfths, using ° region/area models (e.g., fraction circles, pattern blocks, geoboards, color tiles, graph paper); ° set models (e.g., two-sided counters, chips); and measurement models (e.g., cuisenaire rods, unifix cubes, fraction strips, number lines).	
• Represent fractions for halves, fourths, fifths, and tenths as decimals through thousandths, using concrete objects (e.g., demonstrate the relationship between the fraction $\frac{1}{4}$ and its decimal equivalent 0.25).	
• Relate fractions to decimals, using concrete objects (e.g., 10-by-10 grids, meter sticks, number lines, decimal squares, money [coins]).	
• Identify and represent equivalent fractions through twelfths, using region/area models, set models, and measurement models.	

- Compare two fractions having denominators of 12 or less, using manipulative models and drawings, such as
  - region/area models (e.g., fraction circles, pattern blocks, geoboards, color tiles, graph paper, drawings);
  - set models (e.g., two-sided counters, chips, drawings); and
  - measurement models (e.g., cuisenaire rods, unifix cubes, fraction strips, rulers/number lines, drawings).
- Compare two fractions with like denominators by comparing numerators (e.g., $\frac{1}{5} < \frac{3}{5}$).
- Compare two fractions having unlike denominators of 12 or less by comparing the fractions to common benchmarks (e.g., $\frac{1}{2}$ or 1) to determine their relationship or by finding a common denominator.
- Use the symbols >, <, and = to compare the numerical value of two fractions having denominators of 12 or less.
- Add and subtract with fractions having like denominators of 12 or less, using concrete materials, pictorial representations, and paper and pencil.
- Add and subtract with fractions having unlike denominators of 12 or less, using concrete materials pictorial representations and paper and pencil.
- Solve problems that involve adding and subtracting with fractions having like and unlike denominators of 12 or less.

Register Tape Fractions

Reporting category Number and Number Sense

Overview Students fold different lengths of paper (register tape) to see the relative size of fractions.

Related Standards of Learning 4.2, 4.3

Objectives

- The student will review the meaning of the term *one-half*.
- The student will understand that the relative size of a fraction will depend on the size of the whole.

Material Needed

- One piece of paper (register tape) for each student; each piece a different length

Instructional activity

1. *Initiating Activity*: Brainstorm with students what *one-half* means. Ask, "How do you know when you have one-half? Can you have a 'bigger half'?"
2. Pass out varying lengths of register tape (or other kind of paper). Ask students to fold their piece in half.
3. Have a few volunteers come to the front of the classroom. Ask the volunteers to show their wholes, and then ask them to show their halves. Ask the remaining members of the class to describe what they see. Lead a discussion of the sizes of halves. Ask, "Does everyone have the same size half?" (No) Ask, "If she has one-half, and he has one-half, then why are the two halves different sizes? (They started with different size wholes.)
4. You can also bring use different-size pans of brownies to model this concept. Ask, "Is one-half of a large pan of brownies more than one-half of a small pan of brownies?" (Yes) Students should see that the size of the half depends on the size of the whole.
5. Distribute various sizes of bags of small candies that can illustrate the set model. Follow the same process, having students figure out what represents half of the set and comparing the amounts found in the various sizes of bags.
6. Follow the same process with tiles, which can be used to represent the area model. Have students create arrays with the tiles and find half of the area. Ask students to observe what happens to the "part" as the size of the array is increased.
7. Continue the lesson in the same manner but with different fractions, such as one-third and one-fourth.

Sample assessment

- During the activity, walk around the room and observe whether the students know how to create one-half with their piece of paper. Assess during the discussion whether they understand the concept.
- At the end of this activity, have the students respond in their math journals to the following questions: "What process did you use to find a fractional part of your paper, your set of candy, and your array of tiles? How were the processes alike? What was different?"

Follow-up/extension

- Have students look for examples of fractions at home, e.g., two out of six pairs of pants are black, one-half of the bottle of ketchup is left.

Circle Fractions

Reporting category Number and Number Sense

Overview Students work with an area model (fraction circles) to understand the meaning of numerators and denominators, as well as the concept of equal-size pieces.

Related Standards of Learning 4.2, 4.3

Objectives

- The student will identify $\frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{5}, \frac{1}{6}, \frac{1}{8}, \frac{1}{10}$, and $\frac{1}{12}$ with fraction circles.
- The student will recognize that the bottom number of the fraction names the size of the fraction and the top number counts the number of fraction pieces.
- The student will understand that fractional pieces must be equal in size.
- The student will recognize and identify improper fractions and mixed numbers.

Note: Students are not being introduced to the vocabulary terms of *denominator* and *numerator* yet. The objective is for them to understand the concepts first before introducing the vocabulary.

Materials needed

- Two sets of fraction circles for every pair of students

Instructional activity

1. Ask students to take out the whole/complete circle. Then ask them to take out a half. Write "$\frac{1}{2}$" on the board. Ask, "How do you know it's half?" (Two equal-size pieces make a whole, and this is one piece.) Ask them to take out another half. Ask, "How would we write this?" Make sure students are explaining their thinking as they explain how to write this. Write "$\frac{2}{2}$" on the board.
2. Ask the students to take out another half. (This is why they need two sets.) Ask them how to write this. Write "$\frac{3}{2}$" on the board.
3. Ask the students to take out another half. Ask them how to write it. Write "$\frac{4}{2}$" on the board.
4. Ask students to point to their pieces and count "one half, two halves, three halves, four halves." Ask, "How many whole circles do you have?" (2)
5. As you do this activity, be sure to show the students how to write the fraction in mixed-number form as well as improper-fraction form. Emphasize that the size of the piece always refers back to the whole, as well as how many parts the whole has been divided into.
6. Talk about the top numbers and the bottom numbers. Ask the students, "Did you notice a pattern in the top numbers as we counted halves?" (It increased by 1 each time.) Ask the students, "What did you notice about the bottom number as we counted?" (It did not change at all.)
7. Repeat this activity with fourths, fifths, sixths, eights, tenths, and twelfths.

Sample assessment

- Observe the students' ability to count and identify fractions as you conduct the lesson.

Follow-up/extension

- Have students draw pictures of area models of fractions. For example, ask them to draw $\frac{4}{3}$.

Fraction Strips

Reporting category Number and Number Sense

Overview Students fold and label equal-length strips of paper to make individual sets of fraction manipulatives.

Related Standards of Learning 4.2, 4.3, 4.9

Objectives

- The student will create his/her own set of fraction strips by cutting strips into specific parts: $1, \frac{1}{2}, \frac{1}{3}, \frac{1}{4}, \frac{1}{6}, \frac{1}{8}, \frac{1}{12}$.
- The student will visually compare fractions, using fraction strips. (The fraction $\frac{1}{10}$ will be addressed in lessons on decimals.)

Materials needed

- Seven equal-size strips of different-colored construction paper for each student
- Scissors
- Pencils or markers
- Sticky notes
- Chart paper
- A letter-size, three-hole-punched envelope for each student to hold strips for future projects

Note: For easier management, put the set of seven paper strips, a pair of scissors, and a marker in a plastic storage bag for each student.

Instructional activity

1. *Initiating Activity:* Brainstorm with the students what ideas they have about fractions — what they remember from previous grades or from experiences outside of school. Have students record their ideas on sticky notes and place them on a sheet of chart paper. (Students may put their initials on the back of the sticky notes, and these may be used later for individual assessment of prior knowledge.) Accept all responses. At the end of the activity, students may examine each idea and verify whether they are correct or incorrect.
2. Show students a completed set of fraction strips, and model how they can be used to solve a simple problem.
3. Distribute seven strips of colored construction paper, a pair of scissors, and a marker to each student. Explain that they will be creating their own set of fraction strips. As you work though the steps below, model each step with your own strips.
4. Ask students to label one strip "1".
5. Have the students fold a second strip in half, and talk about the two equal-size parts that result, demonstrating by folding that the two parts are congruent. Have students label each part "$\frac{1}{2}$" and

then cut on the fold. Ask the students how many of the $\frac{1}{2}$ strips it will take to cover the 1 strip. Have them place the two $\frac{1}{2}$ strips on the 1 strip to prove their answer.

6. Model the same procedures for fourths, choosing a different-colored strip. At each step, discuss how many of the $\frac{1}{4}$ strips it takes to cover the 1, and how many of the $\frac{1}{4}$ it takes to cover the $\frac{1}{2}$. After modeling each step for the students, have them repeat the step.
7. Model the same procedures for eighths, choosing a different-colored strip. At each step, talk about how many of the $\frac{1}{8}$ strips it takes to cover the 1, the $\frac{1}{4}$, and the $\frac{1}{2}$.
8. Model the same procedures for thirds, choosing a different-colored strip. This step takes a little more practice to fold the strip into three equal-size parts, or students may use a ruler to mark the strip into thirds. At each step, talk about how many of the $\frac{1}{3}$ strips it takes to cover the 1, or whole. Ask how many of the $\frac{1}{3}$ strips it will take to cover the $\frac{1}{2}$. Students will discover that thirds will not cover the half exactly.
9. Model the same procedures for sixths, choosing a different-colored strip. Model procedures to use this strip to make three $\frac{1}{3}$ strips and then fold them in half and cut on the folds to get six equal-size parts. Label each part "$\frac{1}{6}$." Ask the students how many $\frac{1}{6}$ strips it will take to cover the 1, the $\frac{1}{2}$, and the $\frac{1}{4}$. Students will discover that sixths will not cover the fourth exactly.
10. At this point, you may want the students to explore twelfths and share with their partners how they would create the $\frac{1}{12}$ strips.
11. Have the students write their name on all their fraction strips, place them in their three-hole-punched envelope, and store the envelopes in their binders.

Note: This activity should help the students visualize fractions and begin to conceptualize the relationships between the common fractions. The process of folding and cutting, however, is not an exact one, and the handmade strips may lead to incorrect comparisons.

12. *Closing Activity:* Refer back to the sticky notes from the beginning of the activity. Help students reflect on the concepts that were demonstrated in the activity. Ask students to verbalize the concepts learned in this activity, including pictorial representations, if applicable. The concepts should include:
    a. A fraction is a way of representing part of a whole or part of a group.
    b. A fraction is used to name a part of one thing.
    c. Wholes can be broken into equal-size parts, and the parts can be reassembled into wholes.
    d. Equal-size parts have special names: *halves, thirds, fourths* or *quarters, sixths, eighths, twelfths*.
13. Organize the sticky notes on a wall chart by having the students indicate in which of two columns ("Correct" or "Need More Information") the ideas should be placed.

Sample assessment

- During the activity, walk around the room and check for understanding. At the end of the activity, students may respond to the following prompts in their math journals:
  - "What did you notice that was the same when you created the $\frac{1}{2}$ and the $\frac{1}{8}$ strips?"
  - "What did you notice that was different when you created the $\frac{1}{2}$ and the $\frac{1}{8}$ strips?
- To see if students understand the concept that fractions divide areas into equal-size parts, ask, "If you fold your strips to create $\frac{1}{5}$, how do you know they are fifths?" (There should be 5 equal-size parts.)

Follow-up/extension

- Have the students use their fraction strips in numerous activities involving fractions, such as comparing fractions, finding equivalent fractions, and adding and subtracting fractions.
- Have the students share the strips with their family and explain the mathematics lessons that they learned today.

Egg-Carton Fractions

Reporting category Number and Number Sense

Overview Students use an egg carton to model and understand the part-whole concept of fractions.

Related Standards of Learning 4.2, 4.3

Objectives

- The student will represent fractions by dividing an egg carton (whole) into equal-size parts (denominator) and filling the specified sections (numerator) with plastic eggs or counters.
- The student will compare egg-carton fractions to determine equivalence.

Materials needed

- An egg carton for each student
- Yarn or string cut in lengths of 10 to 12 inches
- Plastic eggs, colored tiles, counters, cubes, or other manipulatives to use as "eggs"
- Multiple copies of the "Egg-Carton Record Sheet" handout for each pair of students

Instructional activity

1. *Initiating Activity:* Distribute egg cartons, "eggs," and six lengths of yarn to each student or pair of students. Ask them to model the fraction $\frac{1}{2}$ with their materials. The models will reveal ways in which the students perceive the meaning of fractions. Ask them to show their models and explain their reasoning. Some of the responses may include the following:
   - They may divide the egg carton into two equal-size parts and fill one of the parts with eggs. This is the "part-whole" concept of fractions, which this activity reinforces.
   - They may place six eggs in the carton, but explain it as putting in "one egg for every two spaces." This is a "ratio" concept of fractions.
   - They may select a whole that is smaller than 12 spaces and fill one-half of this different whole — e.g., select four spaces as the whole and fill two of them. This is not invalid as long as they clearly understand the whole and part.
   - They may concentrate on finding one-half of the total number of eggs and may fill *any* six of the 12 spaces in the carton.
   - They may demonstrate their misconceptions with incorrect models — e.g., they may divide the carton into two parts that are *not* equal and fill one of the parts.
2. Clarify students' perceptions by modeling a fraction and then having the students model other fractions. Ask each pair to model $\frac{3}{4}$ by dividing the carton into four equal-size parts with yarn, and filling three of the parts with eggs or cubes.
3. Use the part-whole concept to complete the activity. In an egg-carton fraction, the denominator represents the number of equal-size parts or divisions of the egg carton (marked with yarn), and the numerator represents the number of these parts that should be filled with eggs.

4. Ask each pair of students to model $\frac{2}{3}$ in one carton and $\frac{4}{6}$ in the other carton. Using the models, ask the following questions about both fractions:
   - "How many eggs represent the 'whole' carton?" (12)
   - "When you modeled $\frac{2}{3}$ of the carton, how many eggs did you use?" (8) Encourage students to see it as 8 out of 12 so they are constantly aware of the whole.
   - "When you modeled $\frac{4}{6}$ of the carton, how many eggs did you use?" (8)
   - "How do the fractions $\frac{2}{3}$ and $\frac{4}{6}$ compare?" (They are equivalent.)
5. Depending on the prior experience of your class, call for responses, or lead the students to understand that *as long as the entire carton represents the whole*, fractions that have the same number of egg cups filled will be equivalent.
6. Distribute copies of the "Egg-Carton Record Sheet," and ask students to model and record (draw) all of the possible fractions that can be made from a dozen eggs. Each fraction should be listed in all of its equivalent forms. The fractions that you might expect students to list are shown in the chart under "Follow-up/extension."
7. *Closing Activity:* Call for answers, and allow students to ask questions. Model any fraction that creates discussion. Clear up misconceptions if they exist.

Sample assessment

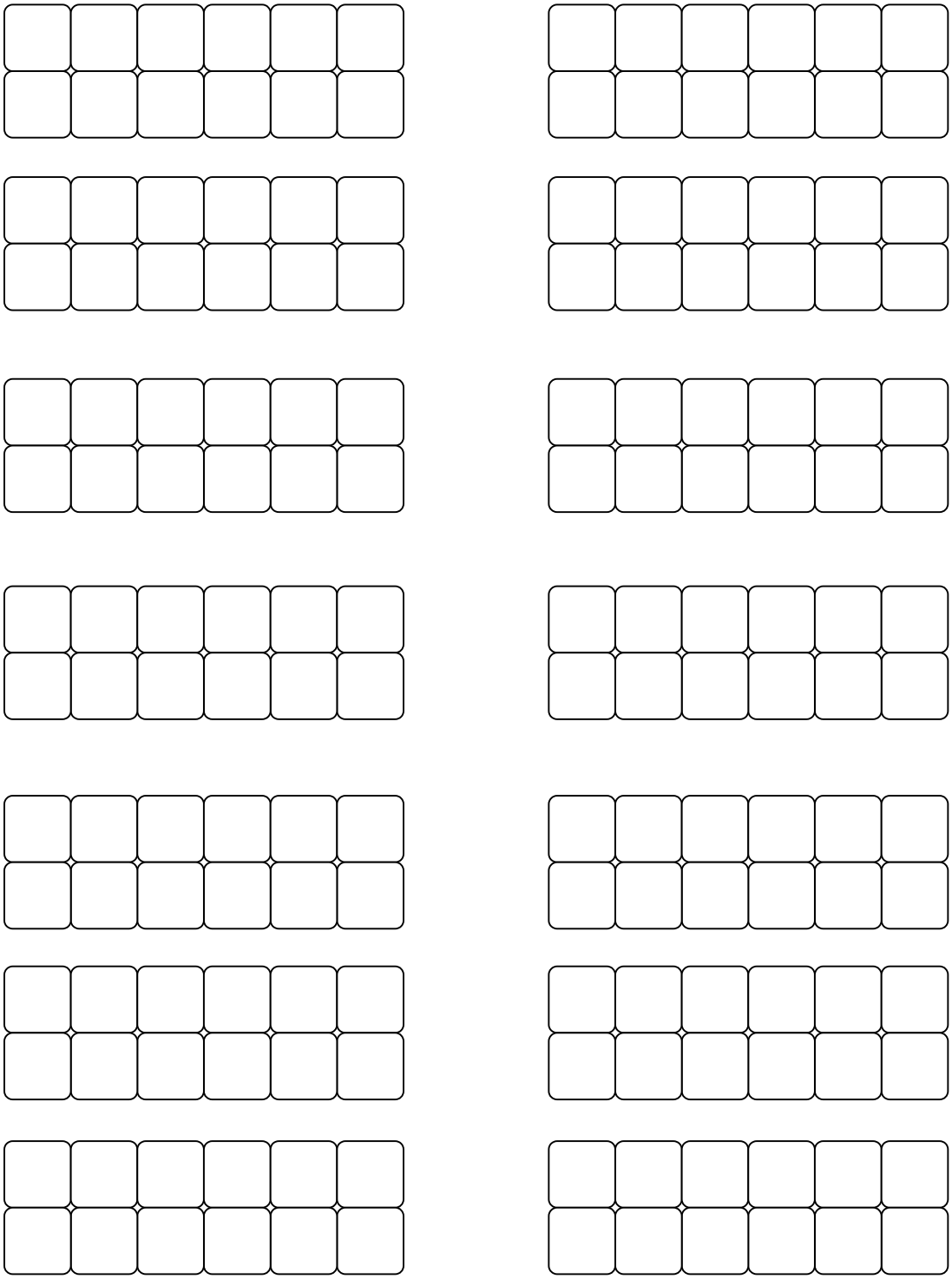
- Examine the students' record sheets either as the students are drawing them or at the conclusion of the activity. Use them to pinpoint individual weaknesses, and address those.

Follow-up/extension

- The egg cartons can be used to solve real-life problems and to add or subtract with fractions.

Number of Eggs Sections Filled	Equivalent Fractions Formed					
0	$\frac{0}{1}$	$\frac{0}{2}$	$\frac{0}{3}$	$\frac{0}{4}$	$\frac{0}{6}$	$\frac{0}{12}$
1	$\frac{1}{12}$					
2	$\frac{1}{6}$			$\frac{2}{12}$		
3	$\frac{1}{4}$			$\frac{3}{12}$		
4	$\frac{1}{3}$		$\frac{2}{6}$		$\frac{4}{12}$	
5	$\frac{5}{12}$					
6	$\frac{1}{2}$		$\frac{2}{4}$	$\frac{3}{6}$	$\frac{6}{12}$	
7	$\frac{7}{12}$					
8	$\frac{2}{3}$		$\frac{4}{6}$		$\frac{8}{12}$	
9	$\frac{3}{4}$			$\frac{9}{12}$		
10	$\frac{5}{6}$			$\frac{10}{12}$		
11	$\frac{11}{12}$					
12	$\frac{1}{1}$	$\frac{2}{2}$	$\frac{3}{3}$	$\frac{4}{4}$	$\frac{6}{6}$	$\frac{12}{12}$

Egg-Carton Record Sheet



Pattern Block Fractions

Reporting category Number and Number Sense

Overview Students determine the fractional sizes of pattern blocks, using a pre-drawn figure.

Related Standards of Learning 4.2, 4.3

Objectives

- The student will determine the fractional sizes of pattern block pieces.
- The student will understand that pattern blocks can have different fractional sizes depending on the figure being used.
- The student will understand the meaning of *numerator* and *denominator*.
- The student will understand the concept of equal-size pieces for fractions.

Materials needed

- A "Pattern Block" worksheet for each student
- Pattern blocks

Instructional activity

1. Pass out pattern blocks and "Pattern Block" worksheet to students.
2. Students need to figure out which blocks will work in each figure to make fractions.
3. Do the first problem, which consists of two hexagons, together as a class. Ask the students to put hexagons in the figure. Ask, "How many hexagons does it take to make the whole figure? (2) So, what fraction is each hexagon?" ($\frac{1}{2}$) Repeat this process with triangles, trapezoids, and rhombi.

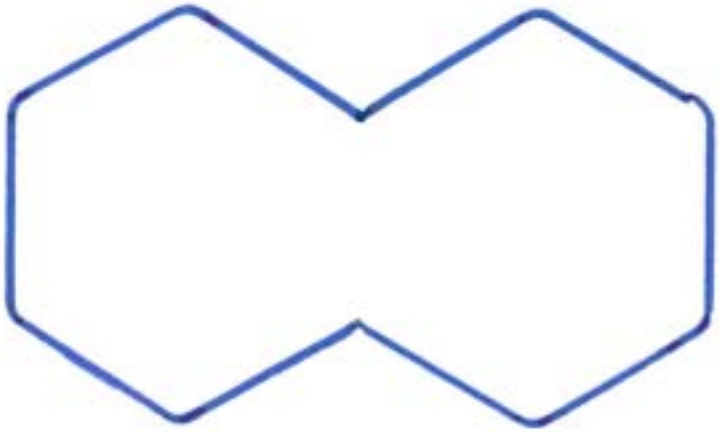
   Make sure students understand that they cannot put a hexagon and triangles in the same figure — they are not equal-size pieces.
4. Have students do problems 2 and 3 on their own or with a partner, filling them with different shapes and indicating what fraction of the whole figure each shape is.
5. Discuss with the whole class the results of problems 2 and 3. Ask the students, "Does anyone know a different name for the top number in a fraction?" (*numerator*) Ask, "Does anyone know a different name for the bottom number of a fraction?" (*denominator*) From this point on, use this vocabulary consistently to teach the mathematical names. You may wish to share with the students the following mnenomic devices:
   - numerator = up; denominator = down; or
   - denominator tells into how many equal pieces something's been divided; numerator tells the number of pieces being described.
6. Have students complete problem 4. Discuss findings with class.

Sample assessment

- During the activities, observe students' ability to create fractions, using equal parts. Also, observe students' ability to figure how many pieces are needed to create a whole. The worksheets will serve as a way to check students' understanding.

Pattern Block Worksheet

1.



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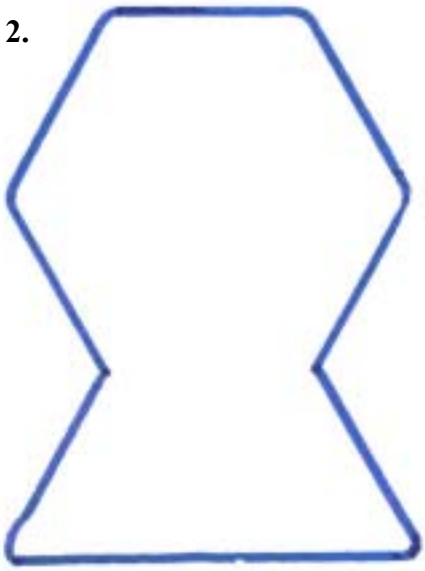

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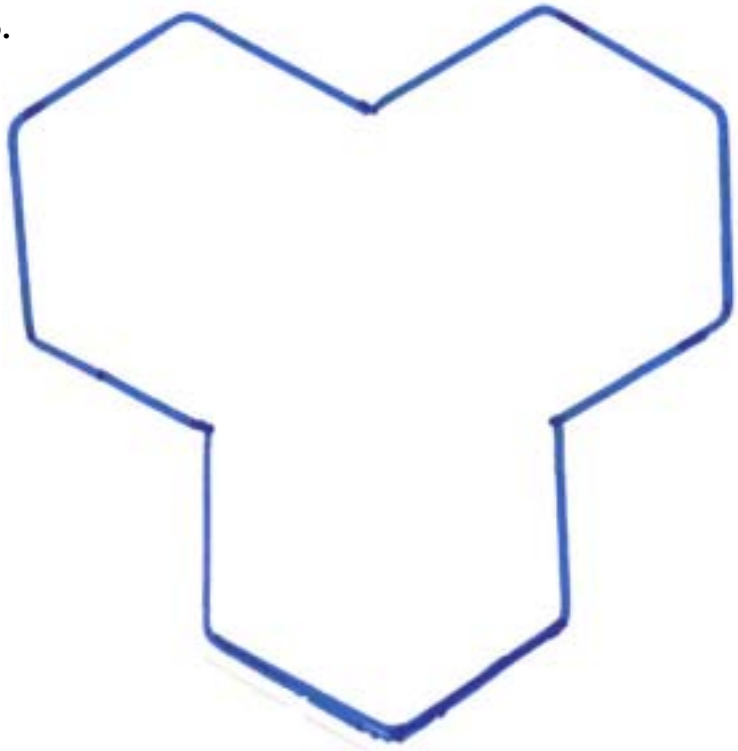


4.

Build the Whole

Reporting category Number and Number Sense
Overview Students create a whole when given a fractional part.
Related Standards of Learning 4.2, 4.3

Objective

- The student will make a whole when given a fractional part.

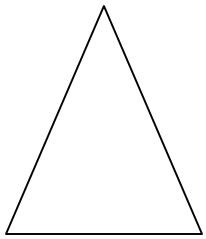
Materials needed

- Copies of the "Build the Whole" worksheets for each student
- Pattern blocks

Instructional activity

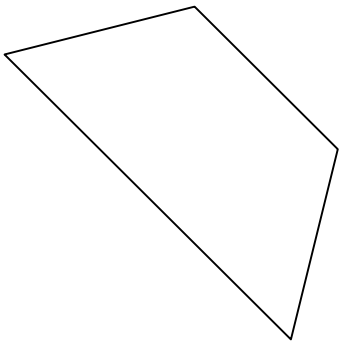
1. *Initiating Activity:* Review the meaning of the terms *numerator* and *denominator*.
2. Build the first whole on the worksheet together. Indicate to the students that the little triangle represents $\frac{1}{4}$, and ask the questions, "What do you think this means? If one triangle is $\frac{1}{4}$, then how many would you need to make one whole?"
3. This should be a review of the meaning of the top and bottom numbers in a fraction. Students should remember that when the top and bottom numbers are the same numbers, the fraction equals one whole. You may need to lead them in this direction if they are struggling with this concept.
4. Make sure the students "build" the whole on their paper by tracing the original part and then drawing in the required number of additional parts, using the tracing. Demonstrate the need to have all the parts touch or share a side. Ask the students what they notice about their drawing compared to another student's drawing. (The parts may be drawn in a different arrangement.)
5. Have the students write an explanation of how their arrangement equals one whole. For example, "One piece is $\frac{1}{4}$, so 4 pieces will equal 1 whole."
6. After you have modeled the first example for the students, let them work in partners to complete the other three.
7. Discuss the students' findings and explanations at the end of the lesson.

Build the Whole



If this piece is $\frac{1}{4}$, build the whole and trace it.

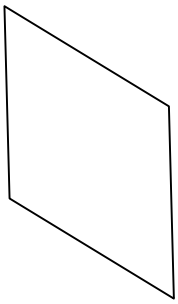
Write an explanation.



If this piece is $\frac{1}{3}$, build the whole and trace it.

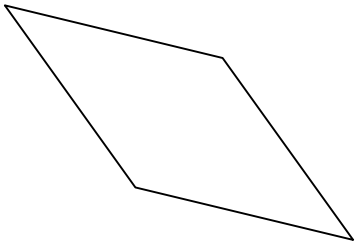
Write an explanation.

Build the Whole



If this piece is $\frac{1}{5}$, build the whole and trace it.

Write an explanation.



If this piece is $\frac{1}{4}$, build the whole and trace it.

Write an explanation.

Pattern Block Fraction Game

Reporting category Number and Number Sense

Overview Students play different versions of a game to demonstrate their knowledge of fraction sense.

Related Standards of Learning 4.2, 4.3

Objectives

- The student will represent fractions with pattern blocks.
- The student will use fraction language and connect it to symbolic and concrete representations.
- The student will understand that different fractional pieces can be combined to make a whole, but the fractional part retains its name.
- The student will trade for equivalent fractional parts to build up to six wholes.
- The student will trade for equivalent fractional parts to subtract from six wholes.

Materials needed

- A "Pattern Block Fraction Game" game board for each student
- Pattern blocks
- Cubes (dice) with the numbers 1, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{3}$, $\frac{1}{6}$, $\frac{1}{6}$ written on the faces, or a spinner

Instructional activity

Version #1

1. Distribute a game board to each student.
2. Roll cube or dice. Take the pattern block that represents that fraction (the hexagon is always a whole), name it, and place it on one of the hexagon "frames" on the game board.
3. Once you have started filling in a hexagon with a particular color, it must be filled in completely with that color.
4. Each time students add a piece to their game board, they must tell what fractional part of the hexagon is covered and record it on their record sheet.
5. Near the end of the game, if you roll a fraction and cannot use it, you lose that turn.
6. The first player to fill all the hexagons on the game board is the winner.

Version #2

1. Game is played same as above, except players may place different colored pieces on the same hexagon.
2. After the game, students can be asked to write equations representing the fractional parts that make up each hexagon.

Versions #3

1. Game is played same as above, except students work on building and finishing one hexagon at a time.

2. If students roll $\frac{1}{2}$ and have $\frac{1}{6}$ left to fill in a hexagon, they may take $\frac{1}{2}$ as $\frac{3}{6}$, or as $\frac{1}{6}$ and $\frac{1}{3}$.
3. Students may finish one hexagon and begin another on the same turn.
4. After each turn, students may announce the total covered on the board ($3\frac{2}{3}$).
5. At the end of the game, students can be asked to write equations to match the hexagons on their boards.

Version #4

1. Game is played as in version #3, except game starts with the board covered with yellow hexagons.
2. On each roll, students must subtract the equivalent fraction. The winner is the first one to remove all pieces from the board.

Sample assessment

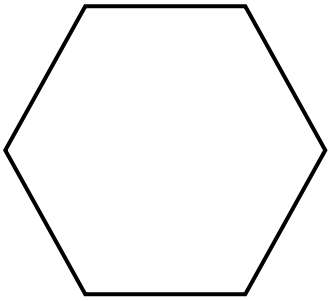
- Observe students playing games. Have students discuss the various ways they traded pattern blocks. Have students create an organized list of the equivalent parts.

Follow-up/extension

- Have students find all the possible ways to cover a hexagon.

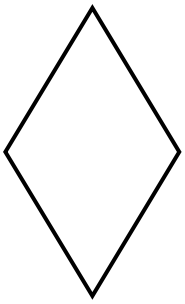
Pattern Block Fraction Game

1 whole

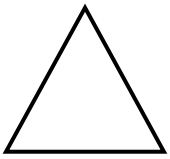


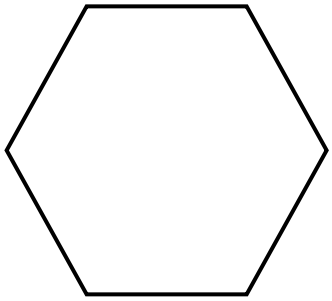
$\frac{1}{2}$

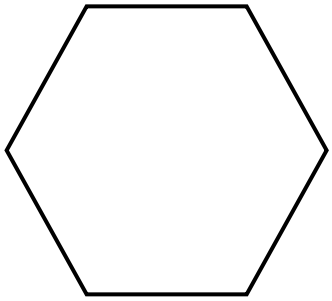
$\frac{1}{3}$

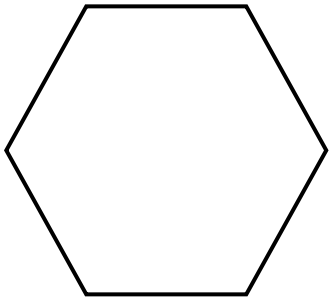


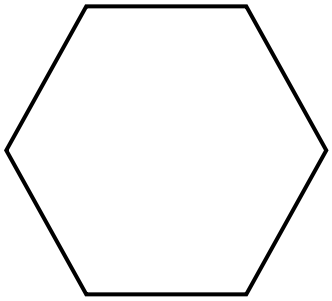
$\frac{1}{6}$

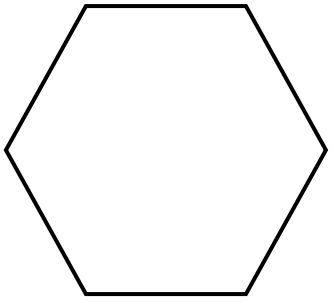


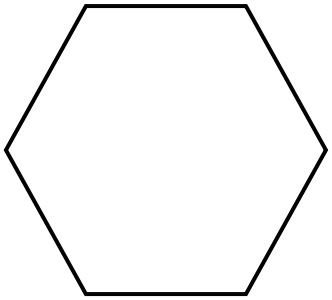












Comparing Fractions

Reporting category Number and Number Sense
Overview Students compare fractions without using models and benchmarks.
Related Standards of Learning 4.2, 4.3

Objectives

- The student will compare two fractions with like denominators.
- The student will compare two fractions with unlike denominators.

Materials needed

- Fraction cards, if desired
- Fraction circles or rods, if desired
- A number line from 0 to 1, showing halves, fourths, eighths, fifths, and tenths
- A copy of the "Which is More?" worksheet for each student

Instructional activity

1. *Initiating Activity*: Review with students what fractions are equivalent to $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{1}{3}$.
2. Have students compare the following fractions, using fraction circles or fraction rods.
   a. $\frac{3}{4}$ and $\frac{1}{4}$
   b. $\frac{1}{8}$ and $\frac{4}{8}$
   c. $\frac{3}{6}$ and $\frac{1}{6}$

   Discuss these problems with the students. Ask, "Could you figure out these problems without fraction circles or rods to help you? If so, how?" Lead students to see that if the same-size piece is used (denominators are the same), then one needs to compare only the numerators.
3. Have students compare the following fractions, using fraction circles or rods.
   d. $\frac{4}{5}$ and $\frac{4}{8}$
   e. $\frac{6}{10}$ and $\frac{6}{8}$
   f. $\frac{3}{5}$ and $\frac{3}{6}$

   Discuss these problems with the students. Ask, "Could you figure out these problems without fraction pieces to help you? How?" Lead students to see that if the numerators are the same, then one needs to compare only the denominators — i.e., the larger the denominator, the smaller the piece. So, $\frac{4}{8}$ is less than $\frac{4}{5}$ because the four pieces in $\frac{4}{5}$ are larger than the four pieces in the $\frac{4}{8}$.

4. Have students compare the following fractions, using fraction circles or rods.

   g. $\frac{2}{6}$ and $\frac{5}{8}$

   h. $\frac{4}{6}$ and $\frac{3}{8}$

   i. $\frac{5}{12}$ and $\frac{6}{10}$

   Ask, "Could you compare these fractions without using fraction pieces? If so, how?" Lead students to recognize that each of these fractions is close to $\frac{1}{2}$. One needs to figure out which of the fractions is *greater than* and which is *less than* $\frac{1}{2}$. For example, in g, $\frac{2}{6}$ is $\frac{1}{6}$ *less than* $\frac{1}{2}$, and $\frac{5}{8}$ is $\frac{1}{8}$ *greater than* $\frac{1}{2}$, so $\frac{5}{8}$ is larger.

5. Have students compare the following fractions, using fraction circles or rods.

   j. $\frac{3}{4}$ and $\frac{9}{10}$

   k. $\frac{8}{9}$ and $\frac{7}{8}$

   Ask, "Could you compare these fractions without using fraction pieces? If so, how?" For example, in j, $\frac{3}{4}$ is $\frac{1}{4}$ away from 1, and $\frac{9}{10}$ is $\frac{1}{10}$ away from 1. Using a number line, lead the students to see that the $\frac{1}{10}$ is a smaller distance away from 1 than $\frac{1}{4}$ is, so $\frac{9}{10}$ is larger. The same process applies to k.

Sample assessment

- Have student complete the "Which Is More?" worksheet.
- During the activity, walk around the room and observe whether the students can compare the fractions with the fraction pieces. Also note their ability to apply the new strategies to the next set of fractions.

Follow-up/extension

- Give the students a set of fractions, and ask them to compare pairs of them without using fraction pieces.

Which Is More?

Name _____ **Date** _____

There are several candy bars, cookies, and pizzas for you and your friends to share. However, in each case, you must choose which fractional part you want. Assuming you want the larger portions, work with your partner to find out which fractions are greater. You may not use the procedures of cross multiplication or finding common denominators, nor may you use models or benchmarks. Circle the fraction that is greater:

1. $\frac{1}{3}$ or $\frac{1}{4}$
2. $\frac{3}{4}$ or $\frac{3}{8}$
3. $\frac{2}{5}$ or $\frac{1}{5}$
4. $\frac{2}{3}$ or $\frac{1}{4}$

What rules or generalizations have you discovered that can help you decide which fraction is greater?

- _____
- _____
- _____

As you continue, write down how you decided which fraction is greater. You may use the rules you created to help you, but you may not use formal procedures or algorithms.

5. $\frac{4}{5}$ or $\frac{13}{12}$
6. $\frac{5}{6}$ or $\frac{9}{10}$
7. $\frac{17}{8}$ or $\frac{17}{10}$
8. $\frac{1}{3}$ or $\frac{3}{12}$
9. $\frac{6}{4}$ or $\frac{11}{8}$
10. $\frac{4}{3}$ or $\frac{14}{12}$

When you are done, check over your explanations. Can you find any exceptions to your rules? You may revise your rules and write down any new rules.

Which Is Closer?

Reporting category Computation and Estimation

Overview Students use common fractions, decimals, and benchmarks in a game context to estimate the sum of chosen fractions and determine if the sum is closer to 0, 1, or 2.

Related Standards of Learning 4.2, 4.3, 4.9

Objectives

- The student will estimate fraction and decimal sums.
- The student will compare decimal and fraction sums to the benchmarks 0, 1, and 2.

Materials needed

- A copy of the "Game Cards—Fractions" and the "Game Cards—Decimals" handouts for each group of students
- A "Which Is Closer? Sum Cards" handout for each student
- Scissors
- Fraction strips or hundredths strips and hundredths grids
- Calculators

Note: This game should follow introductory work with fraction strips or other manipulatives. By the time the students undertake this activity, they should have a working knowledge of common fractions, such as $\frac{1}{2}$, $\frac{3}{4}$, $\frac{1}{3}$, and should know how to represent them as parts of a whole unit.

Instructional activity

1. *Initiating Activity:* Pose a sample question, such as, "Is the sum of $\frac{1}{4}$ and $\frac{7}{8}$ greater than or less than 1?" Ask the students to estimate the answer. Students may respond with the thought process that there are two $\frac{1}{8}$s in $\frac{1}{4}$, so $\frac{7}{8}$ and one more $\frac{1}{8}$ would be 1, and thus the answer is greater than 1. They may also say that $\frac{1}{4}$ is closer to $\frac{1}{2}$ and $\frac{7}{8}$ is closer to 1. Once they have determined that the sum is greater than 1, ask if it is closer to 1 or to $1\frac{1}{2}$. Do not introduce rules or algorithms at this point. Instead, encourage students to use fraction manipulatives and common benchmarks (0, $\frac{1}{2}$, or 1) or drawings to explore and reason.
2. Divide the students into groups of two-to-four players. Give each player a "Sum Cards" handout and each group a "Game Cards—Fractions" handout. Ask the students to cut out all their cards. Assign one player per group the task of calculating the sums for the game.
3. Instruct all players to hold their personal sum cards in their hands and to place their group's game cards face down in a pile in the center of the table. Model the following rules of the game for one round to make sure the students understand the play:
   a. The first player draws two cards from the game cards pile and turns them up in the center of the table. Each player estimates the sum of the two fractions shown on the game cards (using

fraction strips if necessary), and decides if the sum is closer to 0, 1, or 2. Each student then places the corresponding sum card (0, 1, or 2) face up on the table.

b. After each player has placed his/her sum card on the table, the assigned player uses the calculator or some other method to determine the sum.

c. The first player who puts the correct sum card down collects the two game cards. If there is a tie, each player gets one game card. If necessary, they draw cards from the pile.

d. Each player who put down the wrong sum card must return one of his/her game cards to the bottom of the pile if he/she has any game cards.

e. Play continues with the winner of the round turning over two more game cards from the pile.

f. When all the game cards have been used, or there is only one left, the game ends. The winner is the player with the most game cards.

4. *Closing Activity:* Give each player a chance to describe the estimation strategies that worked best. You may choose to call on each group to describe one of its strategies.

Which Is Closer? Game Cards—Fractions

$\frac{1}{5}$	$\frac{2}{3}$	$\frac{1}{4}$	$\frac{1}{6}$	$\frac{2}{5}$
$\frac{3}{8}$	$\frac{1}{8}$	$\frac{3}{10}$	$\frac{1}{2}$	$\frac{7}{8}$
$\frac{7}{10}$	$\frac{1}{10}$	$\frac{3}{8}$	$\frac{9}{10}$	$\frac{3}{2}$
$\frac{5}{3}$	1	$\frac{3}{4}$	$\frac{4}{5}$	$\frac{5}{8}$
$\frac{4}{3}$	$\frac{7}{5}$	$\frac{3}{5}$	$\frac{5}{4}$	$\frac{7}{4}$

Which Is Closer? Game Cards—Decimals

0.5	**1.5**	**2**	**0.25**	**0.75**
1.25	**1.75**	**0.33**	**0.67**	**1.33**
0.1	**0.2**	**0.3**	**0.4**	**0.6**
0.7	**0.8**	**0.9**	**1.1**	**1.2**
1.8	**1.9**	**0.125**	**0.375**	**0.625**

Which Is Closer? Sum Cards

0	1	2
0	1	2
0	1	2
0	1	2
0	1	2
0	1	2

Fraction-Strip Addition

Reporting category Computation and Estimation

Overview Students work together to add two fractions, using sets of fraction strips (or fraction tiles).

Related Standards of Learning 4.2, 4.9

Objective

- The student will add two fractions, using his/her sets of fraction strips, and interpret the answers in equivalent forms.

Materials needed

- Individual sets of fraction strips (made in the "Fraction Strips" activity or made from the fraction strip sheet templates on the following pages)
- A "Fraction Sum Sheet" handout for each student

Note: Copy each template of fraction strip sheets onto a different color of cardstock or paper. Be sure to precede the activity with the "Fraction Strips" activity above. Students who experience difficulty with the unlike denominators (steps 2c and 2d) may need additional examples.

Instructional activity

1. *Initiating Activity:* Each student should have a complete set of fraction strips, one each for the whole (1 unit), halves, thirds, fourths, sixths, eighths, tenths, and twelfths. These can be overlapped to work problems and will probably be easier to use in this format. If a student does not understand the overlapping process, the strip sheets may be cut apart.
2. Use the "Fraction Sum Sheet" to model several problems for the class, for example:
   a. Say, "Add the fractions $\frac{1}{2}$ and $\frac{1}{4}$ on your unit strip. What is the sum?" ($\frac{3}{4}$.)
   b. Ask, "How many $\frac{1}{8}$ pieces does it take to cover your answer?"(6) Ask, "What is another way to express $\frac{3}{4}$ as a fraction?" ($\frac{6}{8}$)
   c. Say, "Add $\frac{3}{4}$ and $\frac{3}{8}$. What is a good estimate of the sum?" Students may need help at this point, since the answer is more than one. Encourage them to put two whole cards together and continue the same process. They should be able to tell you that the answer is equivalent to 9 eighths, or to 1 whole and 1 eighth.
   d. Say, "Add $\frac{2}{3}$ and $\frac{3}{4}$. What is a good estimate of the sum?" Students may not be able to give this answer, as neither thirds nor fourths will fit exactly. Encourage them to experiment with their other fraction strips until someone discovers that twelfths will work. Make sure that all groups understand that 17 twelfths, or 1 whole and 5 twelfths, will fit this sum exactly. On a transparency, model $\frac{2}{3}$ as $\frac{8}{12}$ and $\frac{3}{4}$ as $\frac{9}{12}$. Transparent copies of the fraction strips might help to do this. Do not mention rules for addition unless students bring them up. The emphasis

here should be on the physical visualization of the fraction sum and the visualization of an equivalent sum.

3. Give each pair of students a copy of the handout "Fraction Sum Sheet" and several of the following fraction exercises. Alternatively, you might give them a handout of all eight problems or write the problems on the board one at a time. Ask them to work with their fraction strips to find the sums and to record the equivalent fractions they used in the process. (See answers below.) Have students describe problem situations with these number sentences.

a. $\frac{5}{12}+\frac{1}{3}=$ _____ b. $\frac{1}{8}+\frac{1}{4}=$ _____ c. $\frac{5}{8}+\frac{7}{8}=$ _____

d. $\frac{2}{3}+\frac{5}{6}=$ _____ e. $\frac{7}{10}+\frac{1}{2}=$ _____ f. $\frac{5}{6}+\frac{2}{3}=$ _____

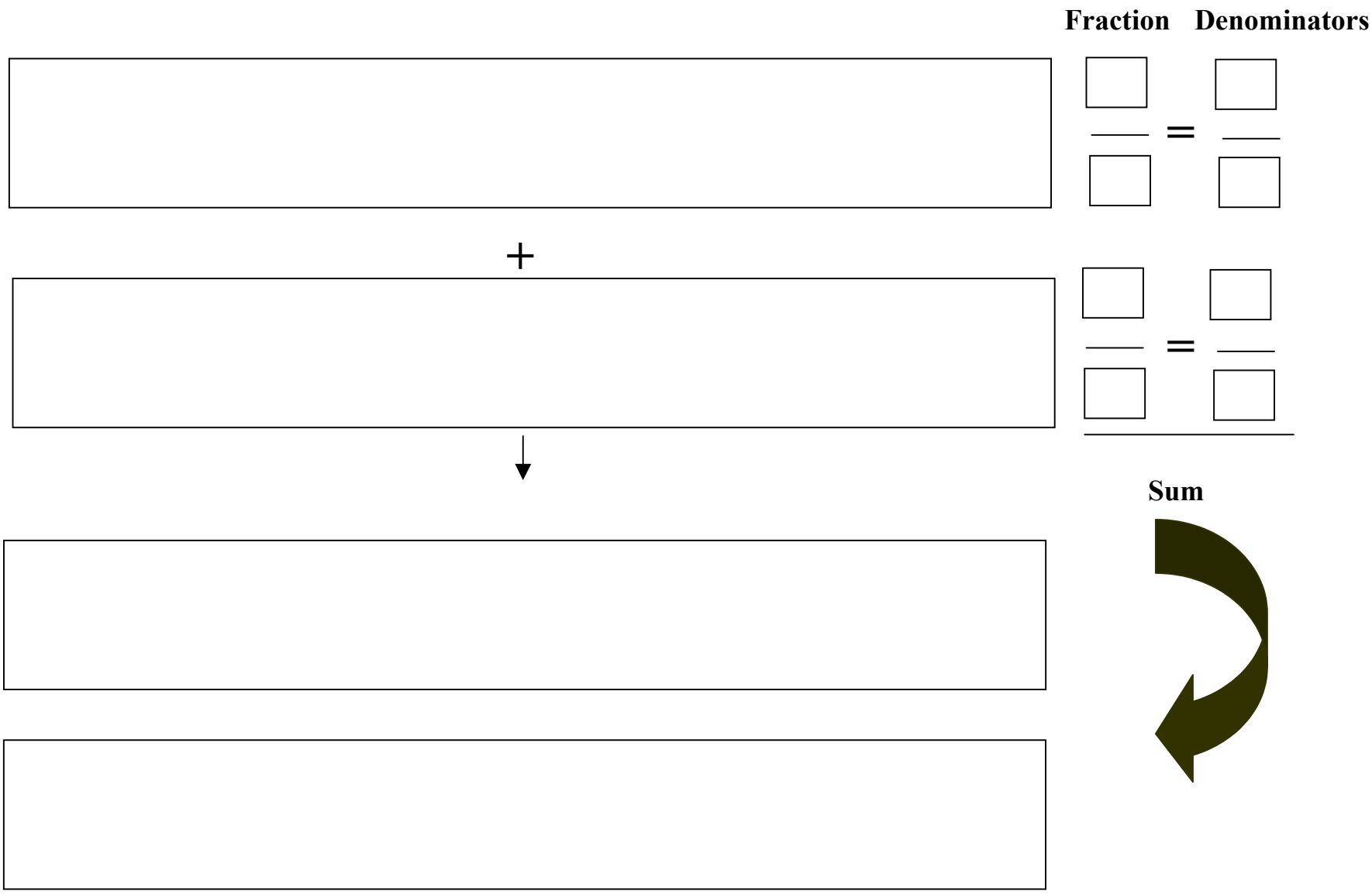
4. *Closing Activity:* Ask each group to discuss the strategies they used, and have them look for patterns. Write the problem $\frac{3}{4}+\frac{7}{8}=$ ___ on the board or overhead. Ask each student to find the answer and write a short paragraph justifying the answer. Also create a problem situation to match the number sentence. Encourage drawings or diagrams. Call for responses from students, or allow each group time to discuss their answers.

Answers to the fraction exercises

a. $\frac{9}{12}$ or $\frac{3}{4}$ b. $\frac{3}{8}$ c. $\frac{12}{8}$ or $\frac{3}{2}$ or $1\frac{1}{2}$

d. $\frac{9}{6}$ e. $\frac{12}{10}$ or $\frac{6}{5}$ or $1\frac{1}{5}$ f. $\frac{9}{6}$ or $\frac{3}{2}$ or $1\frac{1}{2}$

Fraction Sum Sheet



Fraction Strips — One Whole

1
1
1
1
1

Fraction Strips — Halves

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

Fraction Strips — Fourths

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

Fraction Strips — Eighths

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

Fraction Strips — Tenths

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

Fraction Strips — Thirds

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

Fraction Strips — Sixths

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

Fraction Strips — Twelfths

$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$
$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$
$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$
$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$
$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{1}{12}$

Fraction-Strip Subtraction

Reporting category Computation and Estimation

Overview Students subtract fractions from a whole unit, using sets of fraction strips.

Related Standards of Learning 4.3, 4.9

Objectives

- The student will subtract fractions, using fraction strips.
- The student will recognize equivalent forms of fractions, using fraction strips.

Materials needed

- Individual sets of fraction strips
- Fraction spinner or random fraction cards from the activity "Which Is Closer?"

Instructional activity

Note: The activities and problems in this activity can be done quite easily with fraction squares or circles, with egg cartons, or with other fraction manipulatives.

1. *Initiating Activity:* Give each student a complete set of fraction strips. Hold up the unit (1) strip and ask, "What does this represent? (one unit or one whole) Ask, "How many fourths make up this unit? (4) Say, "Place the unit and the four fourths from your set of strips in front of you on the desk. If this whole unit represents a candy bar, and I give $\frac{1}{4}$ of it to Sue, how much of the candy bar remains?" ($\frac{3}{4}$) Then ask, "If I give an additional $\frac{3}{8}$ of the candy bar to Joe, how much of the original candy bar will be left for me?" Encourage students to explore with the one-eighth strips to discover this answer. ($\frac{3}{8}$) Continue with more examples, allowing sufficient time for students to explain their reasoning.
2. Once the students understand the process of using fraction strips to subtract from a whole unit, group the students into pairs or small groups to play the game "Take One." Give each group a set of fraction cards from the "Which Is Closer?" activity or other source. Model the activity for the class, using overhead fraction strips. Start with the unit piece. Subtract $\frac{1}{3}$. Ask for the result. Subtract $\frac{1}{4}$ from that answer, using twelfths pieces. Answer any questions that arise.

DIRECTIONS FOR THE GAME "TAKE ONE"

a. Begin with the whole unit or two halves. Draw a fraction card from the center of table and remove the amount shown from the whole or two halves.
b. Keep track of what is left with the fraction strips.
c. Substitute equivalent fractions as needed.
d. Alternate turns, with each player drawing a card and subtracting.
e. The first player with a blank board wins.

3. Ask the pairs of students to place in front of them on the desk fraction strips to represent $\frac{7}{8}$ and $\frac{1}{2}$. Ask, "Which is bigger?" ($\frac{7}{8}$) Ask them, "How much bigger?" Following their previous work with addition of strips, pairs should line up the two fractions, one under the other, and fit fraction strips to represent the difference. Call on volunteers to model their work. If necessary, model the problem yourself on the overhead with transparent fraction strips to show that the difference is $\frac{3}{8}$.

4. Ask the groups to model the following problems one at a time and record their models by drawing on paper. Ask the students also to write the fraction next to the representation of each problem. Students need to connect the model with the written problem. Have them demonstrate and explain correct solutions on the overhead projector. Students can also create problem situations for these number sentences.

   a. $\frac{2}{3} - \frac{1}{9} =$ _____ b. $\frac{3}{4} - \frac{5}{8} =$ _____

   c. $\frac{10}{12} - \frac{3}{6} =$ _____ d. $\frac{4}{5} - \frac{4}{10} =$ _____

   e. $\frac{1}{2} - \frac{1}{6} =$ _____

5. *Closing Activity:* Ask each student to model a solution to the following problem, record a diagram or picture of their model, and write an explanation of their solution: "Brad has $\frac{3}{4}$ of a pound of fudge, and Julie has $\frac{7}{8}$ of a pound. Together do they have enough fudge to serve 12 people $\frac{1}{8}$ of a pound of fudge each?" Solutions will vary in appearance, but all students should come to an understanding that Brad and Julie have a total of $\frac{13}{8}$ pounds of fudge — enough to serve 13 people $\frac{1}{8}$ of a pound each. Students who find writing an explanation to be difficult may explain orally to the teacher.

Follow-up/extension

- The use of a ruler is important in science for making measurements. This activity could be tied to subtracting lengths — given in halves, fourths, and eighths of an inch or tenths of a centimeter — from a starting length. For example, groups might be given a yard or meter of adding machine tape and asked to cut as many $6\frac{3}{4}$-in. or $5\frac{7}{10}$-cm lengths as possible from it, recording the result at each step. This would reinforce subtraction as well as set the stage for division. Each group could cut a length of a different size and make comparisons between the cut lengths.

Four in a Row

Reporting category Computation and Estimation

Overview Students add and subtract fractions with fraction strips, as well as paper and pencil, in a game format.

Related Standard of Learning 4.9

Objective

- The student will add and subtract common fractions, using fraction strips and paper and pencil.

Materials needed

- Fractions strips (made in the "Fraction Strips" activity)
- Copies of the handouts "Four-in-a-Row Fraction Chart" and "Four-in-a-Row Game Board" for each group
- Beans of two colors or other board markers
- Paper to record the problem

Instructional activity

1. Begin the activity with the following problem using fractions: "One half of the students in Mr. Joy's class bought lunch yesterday. Three-eighths of the class brought their lunch. The remainder of the class went home before lunch. What fractional part of the class went home before lunch?" Have the students work in pairs
2. After the problem has been solved and discussed, use the same problem to model the game on the overhead. Let a pair of students also model another problem.
3. Four-in-a-Row Game:
    a. Let each pair of students decide who goes first.
    b. Player One chooses from the "Four-in-a-Row Fraction Chart" two fractions that can be added or subtracted to get one of the answers on the "Four-in-a-Row Game Board." Player One must first demonstrate the problem with the fraction strips (or another manipulative), after which he/she may cover the answer with a bean or marker.
    c. Students should record the problem and solution on paper.
    d. Each fraction may be used only once. A bean on a fraction indicates it has been used.
    e. Player Two now takes a turn.
    f. Play continues until someone covers four fractions in a row — horizontally, vertically, or diagonally.

Four-in-a-Row Fraction Chart

$\frac{7}{8}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{3}$
$\frac{2}{5}$	$\frac{2}{3}$	$\frac{3}{4}$	$\frac{2}{4}$
$\frac{1}{8}$	$\frac{5}{8}$	$\frac{3}{6}$	$\frac{6}{8}$
$\frac{3}{5}$	$\frac{4}{5}$	$\frac{3}{8}$	$\frac{1}{5}$
$\frac{9}{10}$	$\frac{7}{12}$	$\frac{3}{10}$	$\frac{5}{12}$

Four-in-a-Row Game Board

$\frac{1}{4}$	$\frac{3}{8}$	$\frac{2}{3}$	$\frac{1}{2}$
$\frac{3}{4}$	$\frac{1}{12}$	$\frac{7}{8}$	$\frac{1}{8}$
$\frac{5}{8}$	$\frac{1}{12}$	$\frac{11}{8}$	$\frac{3}{2}$
$\frac{13}{10}$	$\frac{9}{8}$	$\frac{5}{4}$	0

Fraction Riddles

Reporting categories Number and Number Sense, Computation and Estimation

Overview Students continue their practice of adding and subtracting fractions, using region/area models. (Note: This is not intended to be a complete lesson.)

Related Standards of Learning 4.2, 4.9

Objectives

- The student will estimate and compare fraction values in order to make reasonable choices of fractions used in solving riddles.
- The student will add or subtract two fractions, using sets of fraction strips.

Materials needed

- Individual sets of fraction strips or another region/area model
- A copy of the "Fraction Chart" handout for each pair of students

Instructional activity

1. *Initiating Activity:* Give each pair of students a set of fraction manipulatives and a copy of the handout "Fraction Chart." Each pair might use a different fraction manipulative. Pose the following riddles to the class one at a time. Ask the pairs to find as many *different* solutions to the riddles as they can, using only fractions from the "Fraction Chart." Display responses on the overhead or chart paper. After Riddle 1, students should share their reasoning for the different choices.

RIDDLES	
Riddle 1:	I have two fractions whose sum is more than $\frac{1}{2}$ but less than 1. What two fractions from the chart might I have?
Riddle 2:	I have two fractions whose difference is less than $\frac{1}{2}$. What two fractions from the chart might I have?

2. Have each student choose two fractions from the chart and either add or subtract them. Then have each student tell his/her partner the result of the addition or subtraction, and have the partner guess the original fractions. Choose several pairs to share their solutions with the class. It is important that students are making reasonable choices and not just guessing. Listening to their reasoning will help determine if they are thinking or just guessing.
3. Have each student make up a riddle using fractions from the chart and then challenge his/her partner to solve it.

Follow-up/extension

- To make this more challenging, students could take turns answering each riddle and cross out the fractions as they use them.

Fraction Chart

$\frac{7}{8}$	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{3}$
$\frac{2}{5}$	$\frac{2}{3}$	$\frac{3}{4}$	$\frac{2}{4}$
$\frac{1}{8}$	$\frac{5}{8}$	$\frac{3}{6}$	$\frac{6}{8}$
$\frac{3}{5}$	$\frac{4}{5}$	$\frac{3}{8}$	$\frac{1}{5}$
$\frac{9}{10}$	$\frac{7}{12}$	$\frac{3}{10}$	$\frac{5}{12}$

Sample resources

Thinking Rationally about Fractions, Decimals, and Percent: Instructional Activities for Grades 4 through 8 – Lesson plans available from VDOE at http://www.pen.k12.va.us/VDOE/Instruction/Math/FractionsDecimalsPercent.pdf.

http://math.rice.edu/~lanius/Patterns/ – Students use pattern blocks to investigate and build relations among fractions.

http://mathforum.org/paths/fractions/e.fraclessons.html – Extensive list of lesson plans and software related to fraction concepts.

http://www.col-ed.org/cur/math/math19.txt – Students construct words based on the fractional parts of other words in order to create a clue for a hidden candy bar.

http://mathcentral.uregina.ca/RR/database/RR.09.95/hanson4.html – This lesson plan uses pattern blocks to help students understand fractions and operations on fractions.

http://www.teachnet.com/lesson/math/fractioncity.html – This lesson provides instructions for an in-class activity in which students compare fractional parts.

Released SOL test items

$$6\frac{11}{12}$$
$$-\ \frac{5}{6}$$
$$\_\_\_\_\_$$

F $6\frac{1}{12}$

G $6\frac{3}{4}$

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

J $5\frac{2}{5}$

Which of the following has a value greater than $\frac{5}{6}$?

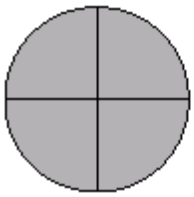
F $\frac{5}{9}$

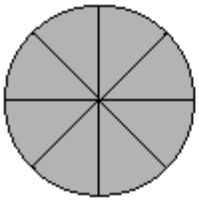
G $\frac{2}{3}$

H $\frac{11}{12}$

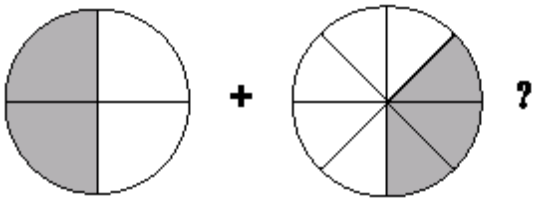
J $\frac{10}{12}$

This is 1. **This is also 1.**





What is



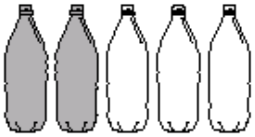
F $\frac{1}{4}$

G $\frac{2}{5}$

H $\frac{2}{3}$

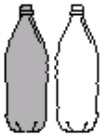
J $\frac{7}{8}$

A fraction of the group of bottles below is shaded.

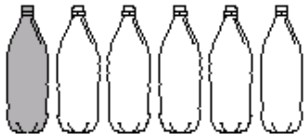


Which of the following groups is shaded to show a fraction with the same value?

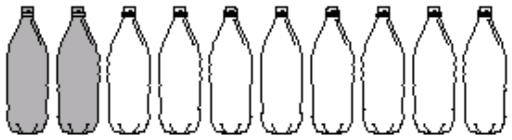
F



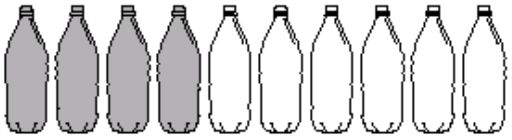
G



H



J



Organizing Topic Measurement: Length, Weight/Mass, Volume (Liquid), Perimeter, Area, Volume

Standards of Learning

4.10 The student will
- a) estimate and measure weight/mass, using actual measuring devices, and describe the results in U.S. Customary/metric units as appropriate, including ounces, pounds, grams, and kilograms;
- b) identify equivalent measurements between units within the U.S. Customary system (ounces and pounds) and between units within the metric system (grams and kilograms); and
- c) estimate the conversion of ounces and grams and pounds and kilograms, using approximate comparisons (1 ounce is about 28 grams, or 1 gram is about the weight of a paper clip; 1 kilogram is a little more than 2 pounds). *

**The intent of this standard is for students to make ballpark comparisons and not to memorize conversion factors between U.S. Customary and metric units.*

4.11 The student will
- a) estimate and measure length, using actual measuring devices, and describe the results in both metric and U.S. Customary units, including part of an inch (1/2, 1/4, and 1/8), inches, feet, yards, millimeters, centimeters, and meters;
- b) identify equivalent measurements between units within the U.S. Customary system (inches and feet; feet and yards; inches and yards) and between units within the metric system (millimeters and centimeters; centimeters and meters; and millimeters and meters); and
- c) estimate the conversion of inches and centimeters, yards and meters, and miles and kilometers, using approximate comparisons (1 inch is about 2.5 centimeters, 1 meter is a little longer than 1 yard, 1 mile is slightly farther than 1.5 kilometers, or 1 kilometer is slightly farther than half a mile). *

** The intent of this standard is for students to make ballpark comparisons and not to memorize conversion factors between U.S. Customary and metric units.*

4.12 The student will
- a) estimate and measure liquid volume, using actual measuring devices and using metric and U.S. Customary units, including cups, pints, quarts, gallons, milliliters, and liters;
- b) identify equivalent measurements between units within the U.S. Customary system (cups, pints, quarts, and gallons) and between units within the metric system (milliliters and liters); and
- c) estimate the conversion of quarts and liters, using approximate comparisons (1 quart is a little less than 1 liter, 1 liter is a little more than 1 quart).*

** The intent of this standard is for students to make ballpark comparisons and not to memorize conversion factors between U. S. Customary and metric units.*

4.13 The student will
- a) identify and describe situations representing the use of perimeter and area; and
- b) use measuring devices to find perimeter in both standard and nonstandard units of measure.

Essential understandings, knowledge, and skills	Correlation to textbooks and other instructional materials
The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to	
• Determine an appropriate unit of measure (e.g., ounce, pound, gram, kilogram) to use when measuring everyday objects in both metric and U.S. Customary units.	
• Measure objects in both metric and U.S. Customary units (e.g., ounce, pound, gram, or kilogram) to the nearest appropriate measure, using a variety of measuring instruments.	
• Record the mass of an object including the appropriate unit of measure (e.g., 24 grams).	
• Estimate conversions between U.S. Customary and metric units, using ballpark comparisons, such as ° 1 ounce is about 28 grams; ° 1 nickel has the mass of about 5 grams; and ° 1 kilogram is a little more than 2 pounds.	
• Determine an appropriate unit of measure (e.g., inch, foot, yard, millimeter, centimeter, and meter) to use when measuring everyday objects in both metric and U.S. Customary units.	
• Estimate the length of everyday objects (e.g., books, windows, tables) in both metric and U.S. Customary units of measure.	
• Measure the lengths of objects in both metric and U.S. Customary units, measuring to the nearest inch ($\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$), foot, yard, millimeter, centimeter, or meter, and record the length including the appropriate unit of measure (e.g., 24 inches).	
• Compare estimates of the length of objects with the actual measurement of the length of objects.	
• Identify equivalent measures of length between U.S. Customary measurements and between metric measurements.	
• Estimate conversions between the U.S. Customary and metric units, using ballpark comparisons, such as ° 1 inch is about 2.5 centimeters; ° 1 meter is a little longer than 1 yard; ° 1 mile is slightly farther than 1.5 kilometers; and ° 1 kilometer is slightly farther than half a mile.	

- Determine an appropriate unit of measure (cups, pints, quarts, gallons, milliliters, or liters) to use when measuring liquid volume in both metric and U.S. Customary units.
- Estimate the liquid volume of containers in both metric and U.S. Customary units of measure to the nearest cup, pint, gallon, milliliter, or liter.
- Measure the liquid volume of everyday objects in both metric and U.S. Customary units, including cups, pints, quarts, gallons, milliliters, and liters, and record the volume including the appropriate unit of measure (e.g., 24 gallons).
- Identify equivalent measures of volume between U.S. Customary and metric measurements.
- Estimate conversion between U.S. Customary and metric units, using ballpark comparisons, such as 1 quart is a little less than 1 liter, and 1 liter is a little more than 1 quart.
- Identify and describe situations where the perimeter of an object should be found (e.g., the distance around the edge of walls of the classroom; the length of fencing needed to enclose a playground).
- Identify and describe situations in which the area should be found (e.g., laying tile for the floor of the classroom).
- Measure the perimeter of an object, using nonstandard units of measure (e.g., unsharpened pencil, board eraser, toothpick, chalk, crayon, paper clip) and record the perimeter including the nonstandard unit of measure used (e.g., 24 paper clips).
- Measure the perimeter of concrete objects in both metric and U.S. Customary units of measure to the nearest inch, foot, yard, millimeter, centimeter, or meter.
- Determine the perimeter of an object or pictorial representation of an object and label it with the appropriate standard or nonstandard unit of measure.

Don't Fence Me In!

Reporting category Measurement

Overview Students design a fence that encloses the maximum amount of space and that represents an understanding of perimeter.

Related Standard of Learning 4.13

Objectives

- The student will identify the most efficient use of area.
- The student will determine the perimeter of an area in metric measurements and identify the equivalent in U.S. Customary measurements**.**

Materials needed

- Rulers – U.S. Customary and metric
- Pencils
- Scissors
- 1-cm grid paper and plain paper
- String cut into 40-cm lengths, one for each student

Instructional activity

1. *Setting the Scene:* Jane's father just completed installing a fence around their farm, and he had 40 meters of fencing left over. Jane asked if she could have it to make a pen for her pet goat, Nanny.
2. Tell the students that they are each going to help Jane with the fencing design. While they will not actually have 40 meters of fencing to work with, they can simulate that length by working with a piece of string and some grid paper
3. Distribute to each student a 40-cm length of string, a sheet of grid paper, a ruler, and a pencil. Explain that the piece of string represents the piece of fence, and that they should arrange the string on the grid paper until they get the design that they think will be best for Nanny.
4. Students may work in pairs or groups of four to experiment with the string on the grid paper to find the best pen for Nanny. Each pair or group should draw a picture of the design they select.
5. Compare students' designs. Which shape pen gives Nanny the most space? Which shape had the greatest perimeter?
6. Display the variety of solutions that the teams designed. Ask the team to show the perimeter on the design by labeling it.

Sample assessment

- Observe students as they work in teams, noting cooperation and collaboration. Listen for creative approaches to solving the fencing problem. Note how students transfer their designs to paper on which they have included their narrative. Look for details in the descriptions.

Follow-up/extension

- Discuss additional situations in which this kind of decision-making can be used. Is this a practical method?
- Have the students find the equivalent measurements in U.S. Customary measurements.

- Use geoboards and rubber bands as additional tools for constructing designs.
- Have the students count the squares of the space. Talk about the *size* of the space as the *area*.

Kiddy Pool

Reporting category Measurement

Overview Students conduct a measurement experiment to determine how much water has collected in a kiddy pool.

Related Standards of Learning 4.11, 4.12

Objectives

- The student will use U.S. Customary and non-standard measuring tools to measure the water in the kiddy pool.
- The student will explore length, width, depth, perimeter, area, and capacity.

Materials needed

- A small, hard-plastic, rectangular swimming pool
- Notebooks or journals for recording estimates and actual measurements
- Pencils, crayons, markers
- A variety of measuring devices, including measuring cups, liter containers, tape measures, meter sticks, and string, and other measurement tools as suggested by students.

Instructional activity

1. *Setting the Scene:* Mrs. Smith has placed a small, rectangular, plastic swimming pool in the school yard so that rain water will collect in it. The rain water is used in the classroom to water the plants in the science area. There has been a lot of discussion among the students about how much water collects in the pool during a rain shower. So, Mrs. Smith has decided that the class will measure the rainwater to get an accurate account. Prior to this activity, Mrs. Smith measured the amount of water in the pool so that she could compare her data with that of the students when the activity is complete.
2. Tell the students that they are going to conduct a measuring experiment to find out how much water fell in the pool during the rain storm last night (Of course, this activity will have to be conducted when rain has actually fallen.) Alternatively, you could put water in the pool before the students arrive at school and tell them to pretend that an unexpected shower happened during the previous night.
3. Discuss with the students the ways to determine how much water is in the pool. Ask them to write in their journals what they would do to measure the water. Be sure to ask for their "estimates" of how much water they think is in the pool. What tools will they use? Are those tools appropriate for measurement? Ask them to draw pictures in their journals of the procedures that they would follow. Have students explain their estimates.
4. Discuss what dimensions the students will measure. Possible dimensions include depth of the water, length and width of the pool, depth of the pool. Will the final measurements be accurate? What kinds of things could keep the measurement from being accurate? (Spillage, evaporation, debris in the pool, inaccurate measuring, etc.)
5. Divide the class into cooperative learning groups of four students each. Tell the students that each group may use the measuring devices of their choice, but that there must be consensus within the group about what is to be used. For instance, one group may decide to use U. S. Customary measuring cups. Another group may use metric measuring devices. Another group may want to

use a non-standard measuring device. Allow for creativity, but encourage students to be realistic about their measurement tools. For example, if one group insists on using measuring spoons, reserve that group for last, out of consideration for the other students. This should be discouraged as a realistic device for this large amount of water.

6. After each group has chosen their measuring tool, the group should record their estimate.
7. Each group will then conduct their measurements, record the measurements, and pour the water back into the pool, if they removed it. Later, discuss how the pouring may affect the accuracy of the measurement.
8. As each group completes its measurement, ask them to share it with the class. Include additional comments in their journals, answering the following questions: "Did the measurement go as they had expected? Did anything unusual happen?"
9. Compare the measurements of water from each group on the board. Discuss whether or not the totals are the same. Should they be? If not, why aren't they? This is a very open-ended activity, but it allows students to see that measurements may be conducted in a variety of ways. Finally, the teacher will reveal the actual measurement of the original amount of water and compare this measurement to those of the groups.

Sample assessment

- Observe groups as they discuss their plans for measurement and their choice of measuring device(s). Watch for realistic plans. Also, check student journals for details and descriptions that indicate understanding and accuracy of measurement.

Follow-up/extension

- Compare the amount of water that the students measured in the pool with the amount that the pool is capable of holding. Have them find out how much more water the pool could hold in addition to the amount presently in it.
- Ask the students to brainstorm additional unusual "bodies of water" that could be measured but typically are not, e.g., puddles in the school yard, water in a bath tub, water in a birdbath, and water in an aquarium.

This Fruit is a Mass!

Reporting category Measurement

Overview Students collect a variety of fruits and determine the mass of each fruit and the total mass

Related Standard of Learning 4.10

Objectives

- The student will weigh a variety of fruits to determine the mass of each.
- The student will estimate the total weight and compare the estimate with the actual weight.

Materials needed

- A variety of fruits, including if possible, bananas, apples, oranges, pears, kiwis, grapes, cantaloupes, and plums
- Balances and gram weights for each team of two students
- Paper and pencils for recording weights
- A "This Fruit Is a Mass!" recording sheet for each team of two students

Instructional activity

1. *Setting the Scene:* John loves fruit! Everybody in fourth grade knows that fruit is John's favorite food. He eats fruit all the time. And, anyone who brings fruit in his or her lunchbox always gives the fruit to John. John is always grateful! Unfortunately, John also enjoys four-wheeling! He recently wrecked on his four-wheeler and will have to be in the hospital for several days. John's classmates want to do something nice for him, so they are going to prepare a nice basket of mixed fruit to take to the hospital. They know that John's doctor will let him have only 5 kilograms of fruit, so they want to prepare a basket of fruit that weighs exactly 5 kilograms. Since a grape weighs approximately 1 gram, it should be possible to put together a basket of fruit that meets the doctor's restrictions.
2. Have the class estimate how much fruit will weigh close to 5 kilograms. Allow the class to weigh one apple to help them make a better estimate. They could discuss the size of a banana and of a plum. After the class decides what fruit should be purchased, the teacher could buy the fruit, or the students may volunteer to bring fruit.
3. Note that a grape weighs approximately 1 gram, and that a kilogram is approximately 2 pounds.
4. Divide the class into teams of two members each to facilitate weighing and recording. Have each team weigh each piece of fruit, using the balance and gram weights, record the weights, and decide on the number of pieces of each kind of fruit that will go into the basket that the classmates will take to John.
5. Have the whole class compare their conclusions about the combinations of fruits. Ask, "How many fruit combinations can be made?"
6. Use the recording sheet to show a list of fruits that total 5 kilograms.
7. Encourage students to try to please John in their combinations of fruit for the basket. While a grape weighs approximately 1 gram, John would prefer not to receive a basket with 1,000 grapes!

Sample assessment

- Observe students as they weigh the fruits. Watch for accurate use of gram weights, careful recording of weights, and adding weights to make a total of 5 kilograms. Look for creative combinations of fruits to reach the desired weight. Note discussions and conversations, listening for appropriate mathematical vocabulary and noting correct use of balances and gram weights.

Follow-up/extension

- Discuss the following: "Do all fruits of the same kind weigh the same?" Have the students estimate the weight of each piece of fruit, record the estimate, and compare the actual weight with the estimated weight.

This Fruit Is a Mass! Recording Sheet

Name of Fruit	Weight of One Piece	Number of Pieces Used

Sample resources

Curriculum and Evaluation Standards for School Mathematics, NCTM publication, 1989.

Principles and Standards for School Mathematics, NCTM publication, 2000.

Learning and Teaching Measurement: 2003 Yearbook with Classroom Activities Companion Booklet, NCTM, 2003 Information related to measurement and activities that go beyond the content.

http://standards.nctm.org/document/chapter5/meas.htm – Information on measurement from Principles and Standards for School Mathematics.

http://mathforum.org/paths/measurement/inchbyinch.html – A lesson from the Math Forum that uses literature to explore the concept of length.

http://mathforum.org/paths/measurement/e.measlessons.html – Ideas and resources for teaching measurement that includes lesson plans, materials, common questions, and software.

http://www.aimsedu.org/Activities/minimetrics/mini-metrics.pdf – A Mini-Metric Olympics activity from the AIMS organization.

www.funbrain.com/poly/ – Activities involving area and perimeter.

www.shodor.org/interactivate/lessons/lpa.html – This lesson is designed to examine the mathematical concepts of length, perimeter, and area. These activities and discussions may be used to develop students' understanding of these mathematical concepts.

www.mste.uiuc.edu/users/carvell/rectperim/RectPerim2.html – Interactive Web site that examines the relationship between area and perimeter.

www.mathgoodies.com/lessons/vol1/area_rectangle.html – Lessons and problems involving area and perimeter.

http://its.guilford.k12.nc.us/webquest/areaperim/areaperim.htn– A Webquest, using area and perimeter to design a "Fun House."

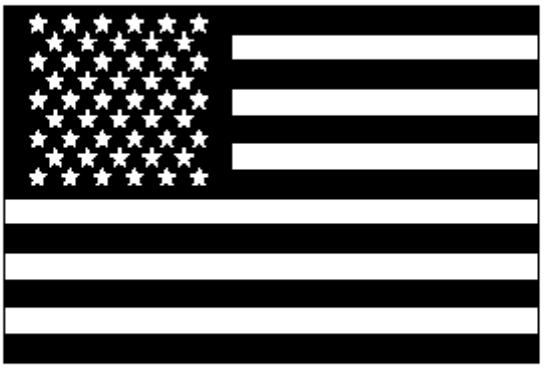
Released SOL test items

21 Caroline put 1 inch of water in the bottom of a pot. Which is *closest to* 1 inch?

A 2.5 centimeters
B 25 centimeters
C 2.5 meters
D 25 meters

22 Use your inch ruler to help you answer this question.

What is the perimeter of the picture of the United States flag shown below?



F 5 inches
G 6 inches
H 8 inches
J 10 inches

25 Which of the following describes a figure that has an area of 28 square centimeters?

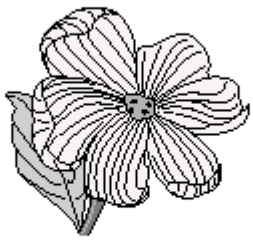
A A rectangle with length of 9 centimeters and width of 5 centimeters

B A rectangle with length of 7 centimeters and width of 4 centimeters

C A square with length of 7 centimeters and width of 7 centimeters

D A triangle that has 2 sides 10 centimeters long and 1 side 8 centimeters long.

27 Which unit would *most often* be used to determine the mass of one dogwood flower?



A Gram

B Kilogram

C Meter

D Liter

32 A recipe calls for 25 grams of sugar. This amount is closest to —

F 1 pound

G 1 ounce

H 10 pounds

J 10 ounces

Organizing Topic Geometry: Two-Dimensional (Plane), Three-Dimensional (Solid), Transformations, Spatial Relationships

Standards of Learning

4.14 The student will investigate and describe the relationships between and among points, lines, line segments, and rays.

4.15 The student will
a) identify and draw representations of points, lines, line segments, rays, and angles, using a straightedge or ruler; and
b) describe the path of shortest distance between two points on a flat surface.

4.16 The student will identify and draw representations of lines that illustrate intersection, parallelism, and perpendicularity.

4.17 The student will
a) analyze and compare the properties of two-dimensional (plane) geometric figures (circle, square, rectangle, triangle, parallelogram, and rhombus) and three-dimensional (solid) geometric figures (sphere, cube, and rectangular solid [prism]);
b) identify congruent and noncongruent figures; and
c) investigate congruence of plane figures after geometric transformations such as reflection (flip), translation (slide) and rotation (turn), using mirrors, paper folding, and tracing.

4.18 The student will identify the ordered pair for a point and locate the point for an ordered pair in the first quadrant of a coordinate plane.

Essential understandings, knowledge, and skills	Correlation to textbooks and other instructional materials
The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to	
• Differentiate among a point, line, line segment, and ray by using the definitions to compare.	
• Investigate and describe the relationships between and among points, lines, line segments, and rays.	
• Identify points, lines, line segments, rays, and angles, using their definitions.	
• Draw representations of lines, line segments, rays, and angles, using a straightedge, ruler, or angle ruler.	
• Identify lines that are parallel, intersecting, or perpendicular, using their definitions.	
• Draw representations of intersecting, parallel, and perpendicular lines.	
• Identify and describe the properties of squares, rectangles, triangles, parallelograms, rhombi, and circles.	

- Identify and describe the properties of spheres, cubes, and rectangular solids (prisms).
- Identify congruent and noncongruent figures.
- Analyze and compare the properties of
  - circles and spheres;
  - squares and cubes; and
  - rectangles and rectangular solids (prisms).
- Recognize the congruence of plane figures resulting from geometric transformations such as translation, reflection, and rotation.
- Identify the ordered pair for a point in the first quadrant of a coordinate plane, given the coordinates (x, y).
- Locate points in the first quadrant on a coordinate grid, given the coordinates (x, y).

Simple Pictures

Reporting category	Geometry
Overview	Students use a simple picture to discuss and label geometric figures.
Related Standards of Learning	4.14, 4.15, 4.16

Objectives

- Students will investigate and describe the relationships between and among points, lines, line segments, and rays.
- The student will identify, describe, and draw points, lines, line segments, rays, and angles.
- The student will identify and draw representations of intersecting, parallel, and perpendicular lines.

Materials needed

- "Simple House" drawing without labels
- "Simple House" drawing with points labeled
- Blank paper
- Popsicle sticks
- String
- A "Multiple Paths" activity sheet for each student

Instructional activity

1. Show students the "Simple House" drawing. Have them talk about things they see in the picture. Ask questions to encourage them to begin using geometric terms to discuss the picture, for example, "Do you see a rectangle in the picture? Where is a line segment?"
2. Help students identify points (doorknob), lines (road in front of house), line segments (sides of the house, roof), rays (sun's rays), and angles (corners of house and roof).
3. Discuss any confusion about exactly which line segment or angle the students are talking about. Discuss the importance of labeling each point and the way to identify lines.
4. Help the students label the main points, showing how to write the points correctly.
5. Illustrate a similar set of instructions on the board or overhead, asking students to help.
6. Have students create their own picture based on your instructions:
    - Draw 2 line segments.
    - Add 1 angle to the picture.
    - Add 4 lines.
    - Add 3 rays.
    - Label 6 points on your picture.
7. Compare pictures for similarities and differences.
8. To review, have students use their hands to model a point (closed fist), line (both arms out, open hands), line segment (both arms out, closed fists), ray (both arms out, one hand open, one closed fist), and angle (both arms out, not necessarily in a straight line).

9. Again, look at the "Simple House" drawing, focusing on the angles and how lines or line segments intersect with each other. Look for any angles that are right angles (make square corners). What do the lines look like that form those angles? (Make a plus sign with your hands.) These are called *perpendicular lines*. What about angles that aren't right angles? (roof, chimney) These are just called *intersecting lines*. Do perpendicular lines intersect? (Yes) Show intersecting lines by crossing your arms. Which lines go on forever and never touch? What do these look like? (Make two horizontal lines with your arms.) How would you write and label these? (Note to teachers: Parallel lines lie in the same plane and never touch. If two lines go on forever and never touch but do not lie in the same plane, they are not parallel. They are called *skew lines*. For example, the line formed by the wall and floor meeting on the east side of the room and the line formed by the ceiling and the wall meeting on the north side of the room are skew lines.)
10. Have pairs of students use popsicle sticks to model all three types of lines. Have students glue down the sticks and label all of the different types of line segments.
11. Lead students to state that the shortest distance between two points is a straight line by doing the following: Give student pairs a piece of string, and have them move to one spot on the playground. Have the pairs hold their string between them, each partner holding one end. The teacher moves away from the group and tells one partner from each pair to walk toward you as quickly as possible while holding their string tightly. Tell the students to look at the path that the strings created. Have the students go back to the beginning spot, while the teacher moves to a new spot. Again have the students walk to you as quickly as possible while holding one end of the string. Ask, "What do you know about the string? Why didn't you go to the first spot and then to the teacher?"

Sample assessment

- Have students complete the "Multiple Paths" activity sheet
- Hold a class discussion about the completed activity sheet, and note students' use of language and level of understanding.

Multiple Paths Activity Sheet

Name _____ **Date** _____

Directions: Color the shortest path to each destination the required color.

BLUE: The shortest path from the moon to the cube.

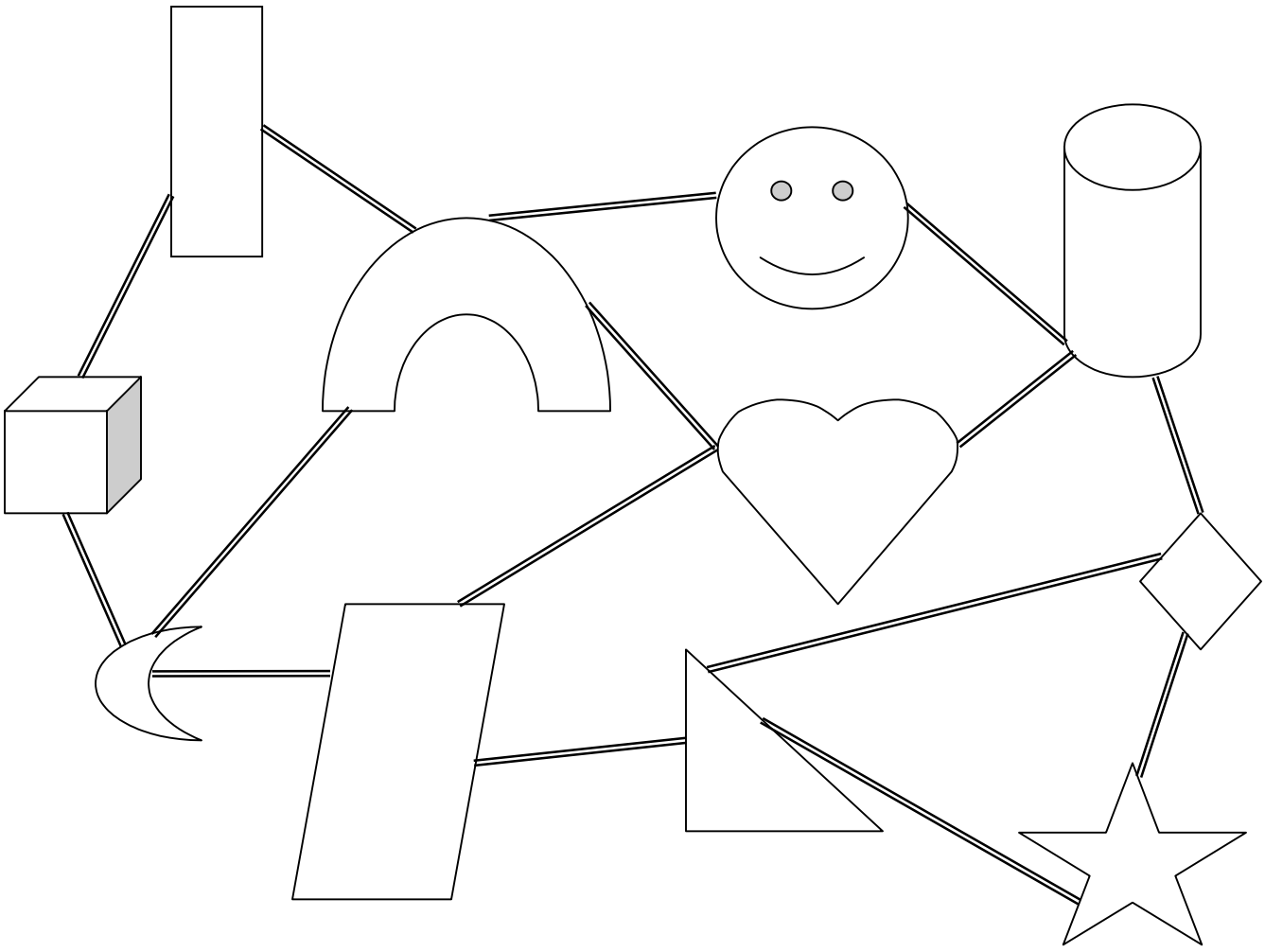
RED: The shortest path from the cylinder to the parallelogram.

GREEN: The shortest path from the star to the smiley face.

YELLOW: The shortest path from the rectangle to the heart.

ORANGE: The shortest path from the triangle to the rhombus.

BROWN: The shortest path from the rainbow to the smiley face.



Multiple Paths Activity Sheet — Answer Key

Directions: Color the shortest path to each destination the required color.

BLUE: The shortest path from the moon to the cube.

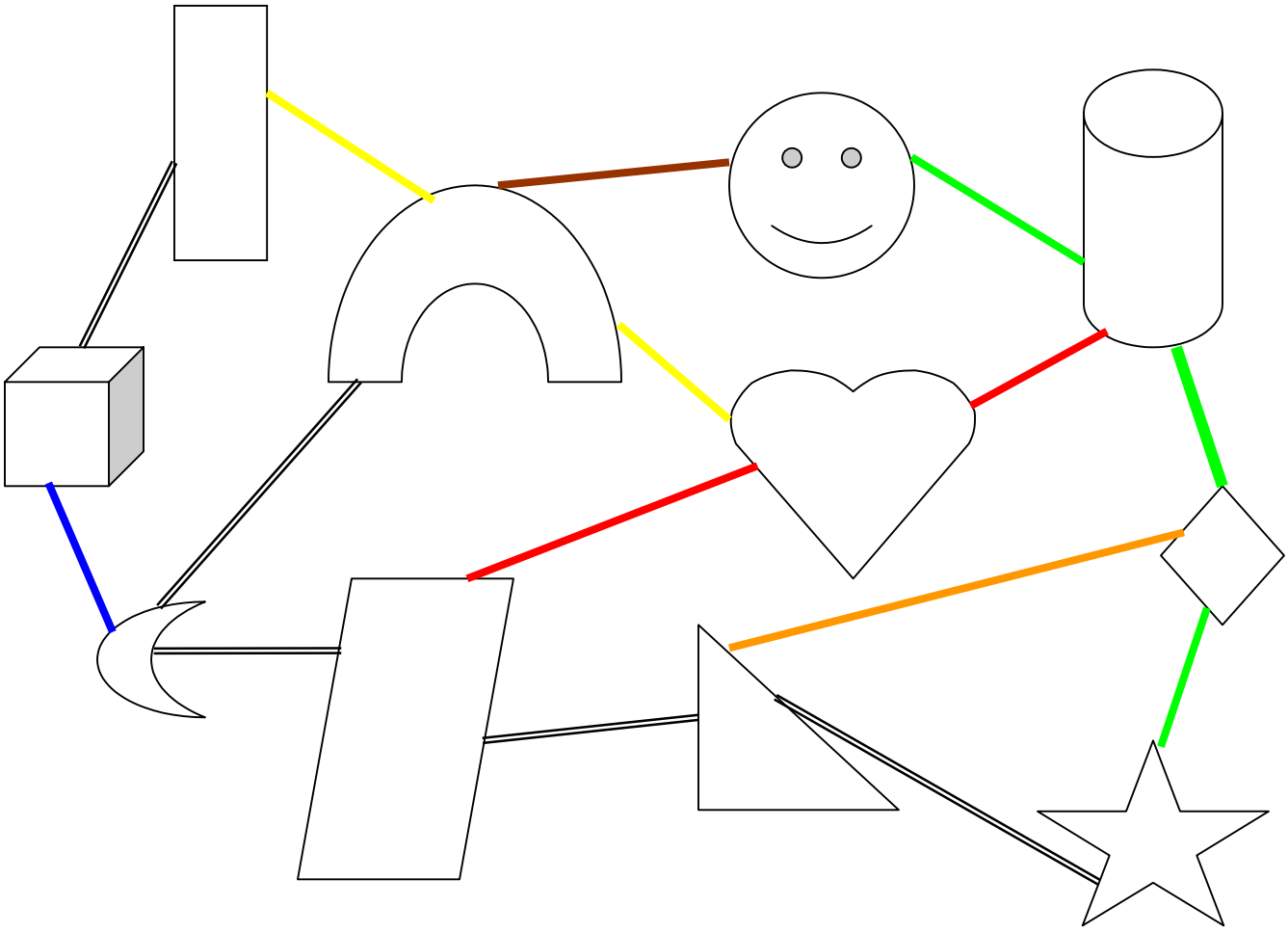
RED: The shortest path from the cylinder to the parallelogram.

GREEN: The shortest path from the star to the smiley face.

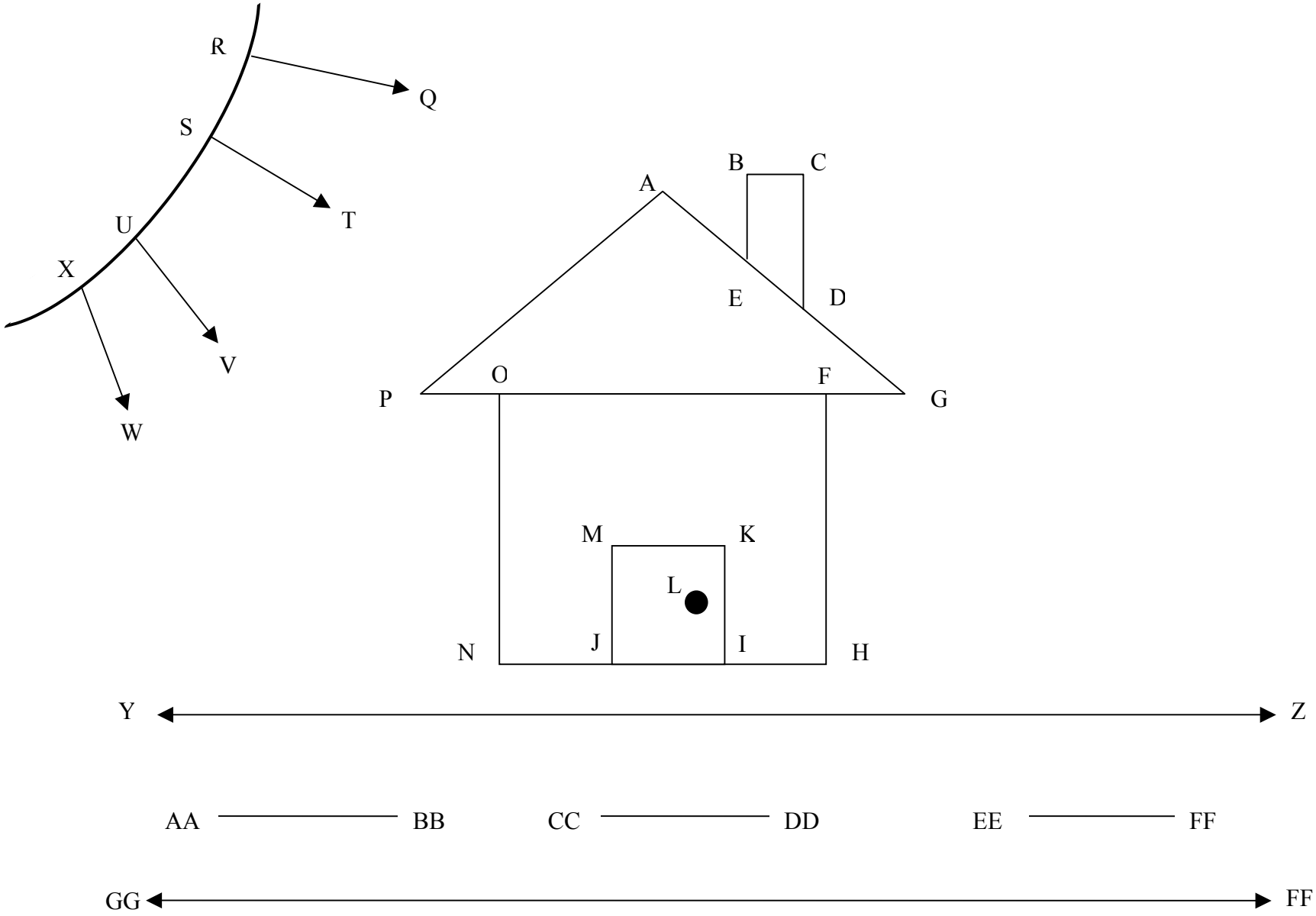
YELLOW: The shortest path from the rectangle to the heart.

ORANGE: The shortest path from the triangle to the rhombus.

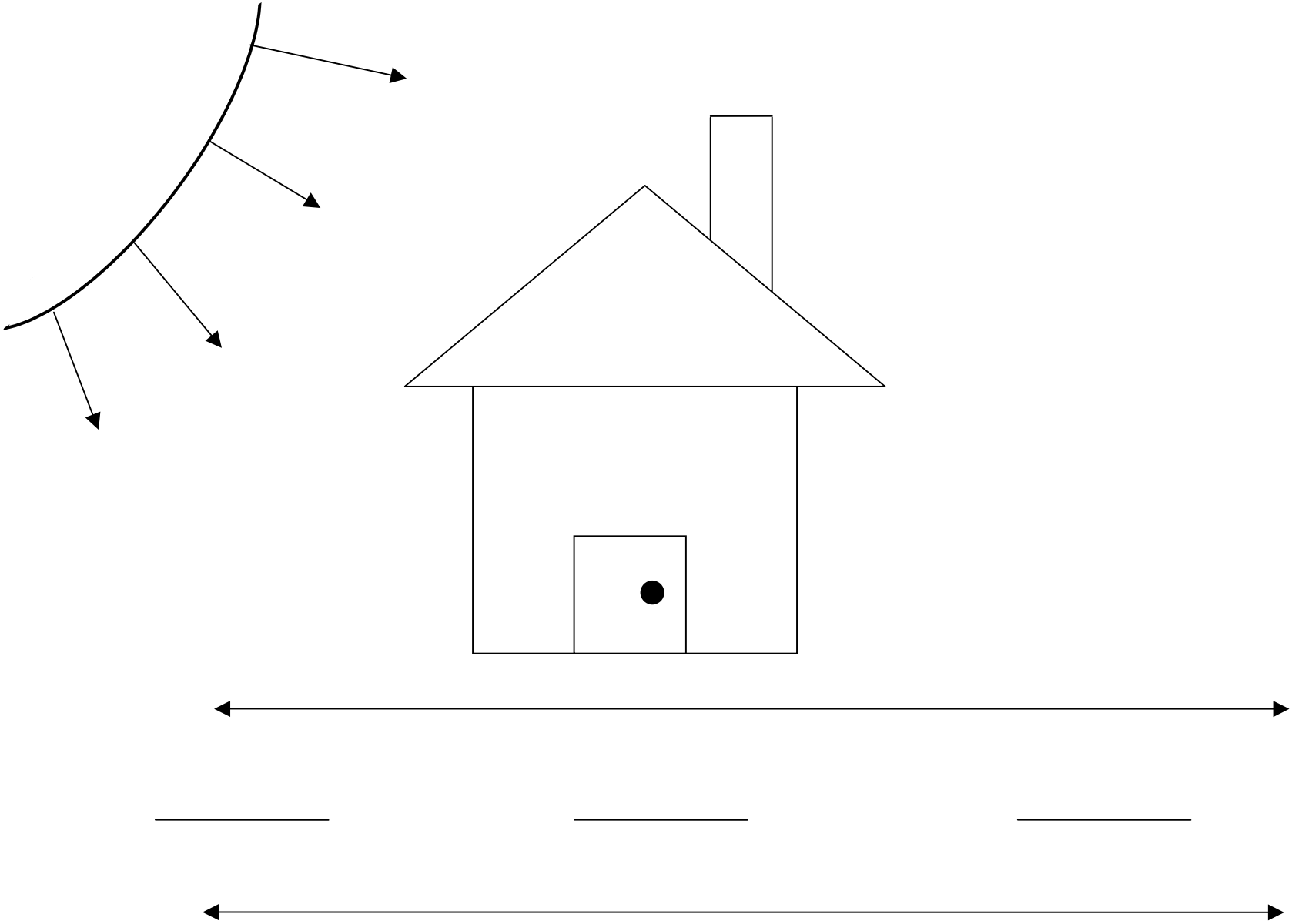
BROWN: The shortest path from the rainbow to the smiley face.



Simple House Picture (Points Labeled)



Simple House Picture



Geometric Figures

Reporting category Geometry

Overview Students use basic two-dimensional and three-dimensional geometric figures to determine the properties of each figure.

Related Standard of Learning 4.17a

Objectives

- The student will identify and describe the properties of the following two-dimensional geometric figures: square, rectangle, triangle, circle, rhombus, and parallelogram.
- The student will identify and describe the properties of the following three-dimensional geometric figures: sphere, cube, and rectangular solid (prism).
- The student will analyze and compare the properties of two-dimensional and three-dimensional geometric figures.

Materials needed

- Plane (two-dimensional) geometric figures for each group of students
- A "Plane Geometric Figures" activity sheet for each group
- A "Plane Geometric Figures Sort" activity sheet for each student
- A "Properties of Plane Geometric Figures" activity sheet for each student
- Solid (three-dimensional) geometric figures for each group
- A "Solid Geometric Figures" activity sheet for each student
- A "Comparing Plane and Solid Geometric Figures" activity sheet for each student

Instructional activity

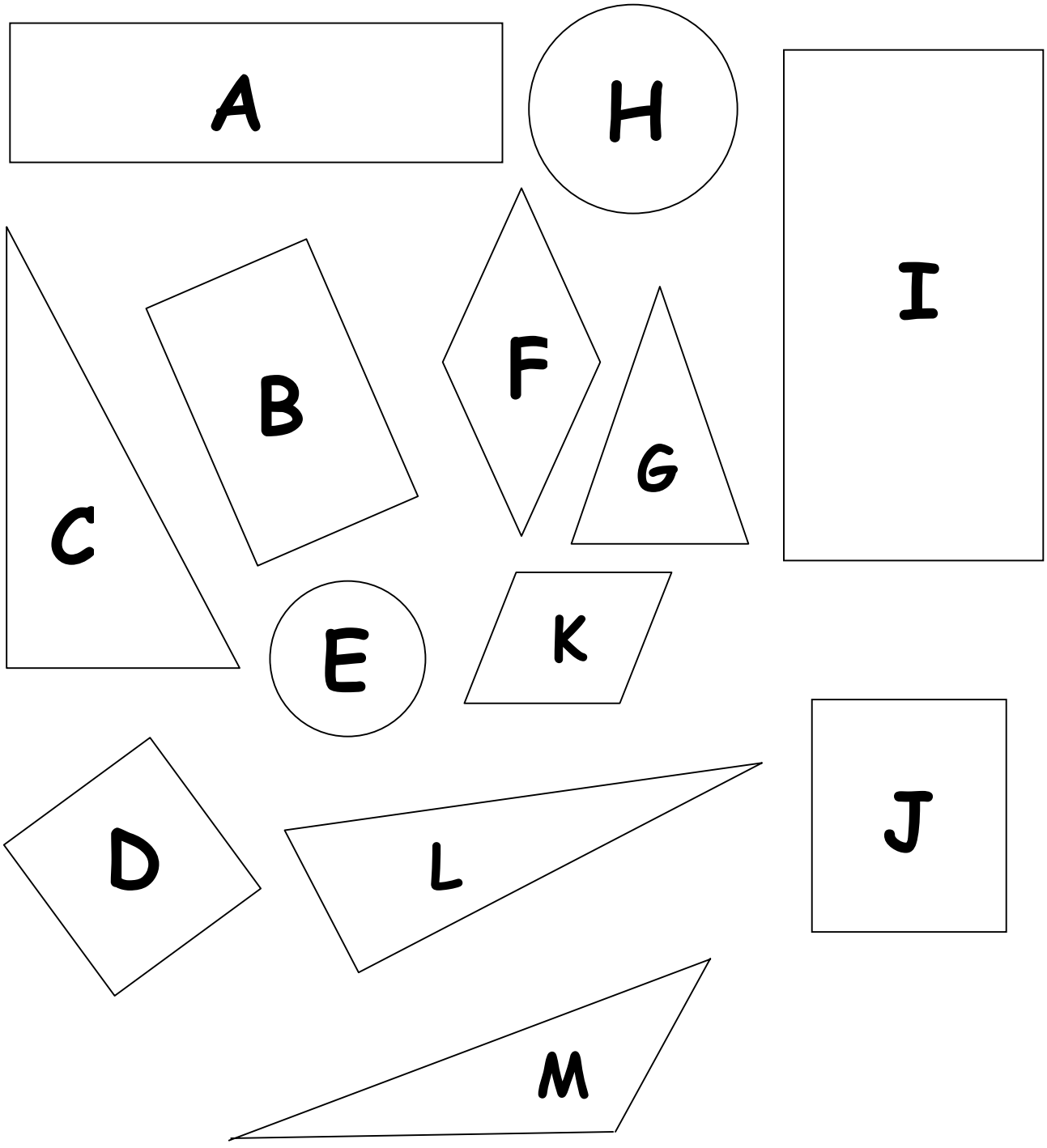
1. Initiate the activity by displaying two-dimensional (plane) geometric figures and asking students to describe some of them. Then ask some students to share ways that two selected figures are alike and ways they are different. Have students work with partners or in a small group. Hand each group a bag containing a set of two-dimensional figures, a "Plane Geometric Figures" activity sheet, and a "Plane Geometric Figures Sort" activity sheet. Ask each group to complete their chart, using the figures in the bag.
2. After the charts have been completed, have students talk about what they notice about figures H and E, and have them answer the first question. Next, ask the students, "What are figures G, C, and L called? Do any of the triangles have a right angle?" As an extension, ask, "Can a triangle have more than one right angle?" Then ask, "What do you notice about figures J and D? What are they called?"
3. Have the students work individually through the "Plane Geometric Figures Sort" activity. Then hand out the "Properties of Plane Geometric Figures" activity sheet, and have the students name each figure. Encourage students to list ideas that describe that figure specifically. Some ideas are included on the answer key.
4. Distribute three-dimensional (solid) figures, and engage students in a dialogue about ways they are like and ways they are different from plane figures. Be sure the students make connections.
5. Next, use the solid figures and the "Solid Geometric Figures" activity sheet for students to explore the properties of the sphere, cube, and rectangular solid (prism). You can have students make a

sphere easily by balling up a sheet of paper. Have students work with partners or in groups to fill out the chart on the "Solid Geometric Figures Activity Sheet." Explain to students that the term *vertices* means points and *edges* means line segments. After groups of students have completed the chart, have them write down what they noticed. Sample ideas are included on the answer key.

Sample assessment

- Have students compare the two- and three-dimensional figures, using the "Comparing Plane and Solid Geometric Figures" activity sheet.

Plane Geometric Figures Activity Sheet



Plane Geometric Figures Sort Activity Sheet

Name _____ **Date** _____

Directions: Look carefully at each figure on the "Plane Geometric Figures Activity Sheet." Check all the columns that apply to each figure. Based on the chart, answer the questions that follow.

FIGURE	no sides	three sides	four sides	at least one right angle	all sides equal	opposite sides equal	opposite sides parallel
A							
B							
C							
D							
E							
F							
G							
H							
I							
J							
K							
L							

1. Figures with no sides or line segments and with all points on the figure the same distance from a center point are called _____.

2. Figures with three sides are called _____.

3. Can figures with three sides have a right angle? _____

4. Figures with four equal sides and four right angles are called _____.

5. Figures with four right angles and opposite sides equal are called _____.

6. Figures with all equal sides and any types of angles are called _____.

7. Figures with two sets of parallel sides are called _____.

Plane Geometric Figures Sort Answer Key

Directions: Look carefully at each figure on the "Plane Geometric Figures Activity Sheet." Check all the columns that apply to each figure. Based on the chart, answer the questions that follow.

FIGURE	no sides	three sides	Four sides	at least one right angle	all sides equal	opposite sides equal	opposite sides parallel
A			X	X		X	X
B			X	X		X	X
C		X		X			
D			X	X	X	X	X
E	X						
F			X		X	X	X
G		X					
H	X						
I			X	X		X	X
J			X	X	X	X	X
K			X			X	X
L		X		X			

1. Figures with no sides or line segments and with all points on the figure the same distance from a center point are called <u>circles</u>.

2. Figures with three sides are called <u>triangles</u>.

3. Can figures with three sides have a right angle? <u>Yes</u>

4. Figures with four equal sides and four right angles are called <u>squares</u>.

5. Figures with four right angles and opposite sides equal are called <u>rectangles</u>.

6. Figures with all equal sides and any types of angles are called <u>rhombi</u>.

7. Figures with two sets of parallel sides are called <u>parallelograms</u>.

Properties of Plane Geometric Figures Activity Sheet

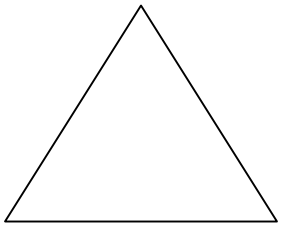
Name _____ **Date** _____

Directions: Look carefully at each figure. Name each figure and list at least three properties that describe that figure.

_____

_____

_____



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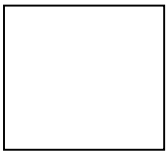

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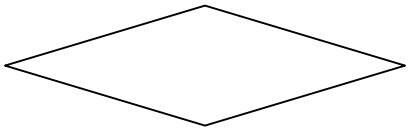

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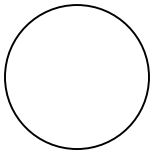

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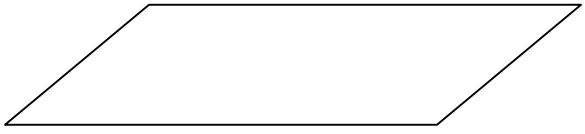

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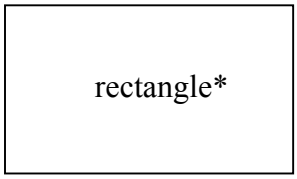
Properties of Plane Geometric Figures Answer Key

Directions: Look carefully at each figure. Name each figure and list at least three characteristics that describe that figure.

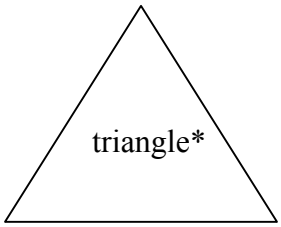


four right angles

opposite sides equal

opposite sides parallel

*This could also be named a *quadrilateral* or *parallelogram*, but these terms are not in the fourth-grade SOL.

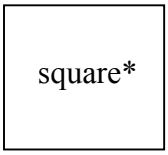


three sides

three angles

can have one right angle

*This can have no, two, or three sides of the same length.

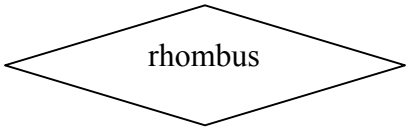


four right angles

four equal sides

opposite sides parallel

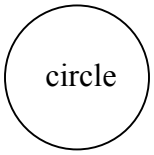
*This could also be named a *quadrilateral, parallelogram, rectangle,* or *rhombus.*



four equal sides

opposite sides parallel

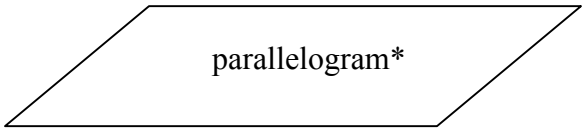
can have right angles, but doesn't have to



no line segments

all points are same distance from center point (5th grade)

diameter goes through the center point to connect two points on the circle (5th grade)



two sets of parallel sides

opposite sides equal

opposite sides parallel

*This can also be named a *quadrilateral*.

Solid Geometric Figures Activity Sheet

Name _____ **Date** _____

Directions: Look carefully at each figure. Fill out the chart for each figure. Write two conclusions based on this chart.

Figure	Number of Faces	Number of Vertices	Number of Edges	Type of Faces
Sphere				
Cube				
Rectangular Solid (Prism but not a Cube)				

1. One thing we noticed was _____

_____

_____

_____

2. Another thing we noticed was _____

_____

_____

_____

Solid Geometric Figures Answer Key

Directions: Look carefully at each figure. Fill out the chart for each figure. Write two conclusions based on this chart.

Figure	Number of Faces	Number of Vertices	Number of Edges	Type of Faces
Sphere	0	0	0	none
Cube	6	8	12	squares
Rectangular Solid (Prism but not a Cube)	6	8	12	rectangles (some may be squares)

1. One thing we noticed was that the sphere has no faces, vertices, or edges because it does not have any line segments.

2. Another thing we noticed was that the cube and the rectangular solid (prism) have exactly the same number of faces, vertices, and edges. The only difference is that the rectangular solid (prism) that is not a cube has rectangular faces instead of all square faces.

Note: A cube is a special type of rectangular solid (prism).

Comparing Plane and Solid Geometric Figures Activity Sheet

Name _____ **Date** _____

1. Draw a picture of a circle.

Draw a picture of a sphere.

List two ways the circle and sphere are alike.

_____

_____

List two ways the circle and sphere are different.

_____

_____

2. Draw a picture of a square.

Draw a picture of a cube.

List two ways the square and cube are alike.

_____

_____

List two ways the square and cube are different.

_____

_____

3. Draw a picture of a rectangle.

Draw a picture of a rectangular prism.

List two ways the rectangle and rectangular prism are alike.

_____

_____

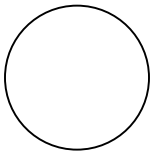
List two ways the rectangle and rectangular prism are different.

_____

_____

Comparing Plane and Solid Geometric Figures Answer Key

1. Draw a picture of a circle.

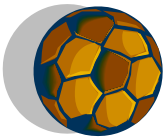


List two ways the circle and sphere are alike.

No line segments

All points on the figure are same distance from center point

Draw a picture of a sphere.

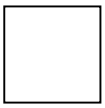


List two ways the circle and sphere are different.

Circle is flat (two dimensional)

Sphere can roll

2. Draw a picture of a square.

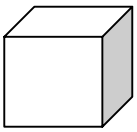


List two ways the square and cube are alike.

All angles are right angles

All sides are equal

Draw a picture of a cube.



List two ways the square and cube are different.

Cube is three dimensional

Square has only one face

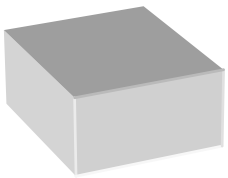
3. Draw a picture of a rectangle.

List two ways the rectangle and rectangular prism are alike.

All angles are right angles

Both are parallelograms

Draw a picture of a rectangular prism.



List two ways the rectangle and rectangular prism are different.

Rectangle is two dimensional (flat)

Rectangular prism can have squares and rectangles

Congruent Figures

Reporting category Geometry

Overview Students find congruent and noncongruent figures and identify translations, rotations, and reflections.

Related Standards of Learning 4.17b, 4.17c

Objectives

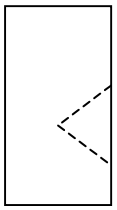
- The student will identify congruent and noncongruent figures.
- The student will investigate congruent figures after they have been translated, rotated, or reflected.

Materials needed

- Scraps of paper
- Rectangle templates of various sizes for each student
- A "Congruent Figures" worksheet for each student
- Patty paper (tracing paper)

Instructional activity

1. Give each student a template of a rectangle, and ask students use it to draw a rectangle. Then ask them to draw another rectangle at another place on the same page, but to turn the template a different way so that the rectangles appear different. Now ask them to use another smaller or larger rectangular template to draw a third rectangle. Then ask students to describe the three rectangles that are drawn on the same piece of paper. This discussion should lead to the understanding of the word (*congruent*) that means same size and same shape, as well as the meaning of the word (*noncongruent*) that describes two figures that are not the same size and the same shape. Have students cut a rectangle out of scrap paper. Have them prove it is a rectangle — i.e., it has four right angles, and its opposite sides are equal. Then have the students cut a small notch or triangle out of the rectangle.



2. Ask students to trace the original rectangle at the very top of their paper and then trace another congruent rectangle below it. Encourage students to turn and flip the rectangle to make it difficult to tell if it really is congruent. Have students trace a few congruent rectangles and a few noncongruent rectangles. When they are done, have them trade papers.
3. After the papers have been traded, give students a minute to guess which figures are congruent to the one at the top of the paper. After students have guessed, hand out the patty paper (tracing paper). Have students trace the original rectangle at the top. Then have them turn and flip the patty paper figure to identify the rectangles that are exactly the same (congruent). Ask the students to circle the congruent rectangles.
4. Have students use the patty paper to prove which figures are congruent on the "Congruent Figures" worksheet.

5. Next, have students use the original rectangular template or make a new one. This time, have students trace the rectangle on a sheet of paper and label it "original." Next, have them slide the rectangular template slowing in any direction and trace it again. Label this rectangle "translation (slide)." Then have them turn the rectangular template on one point, trace it, and label the drawing "rotation (turn)." Finally, have the students flip the rectangular template over, trace it, and label the drawing "reflection (flip)." While these figures are being traced, students should be discussing with the teacher why they are being labeled with these terms.

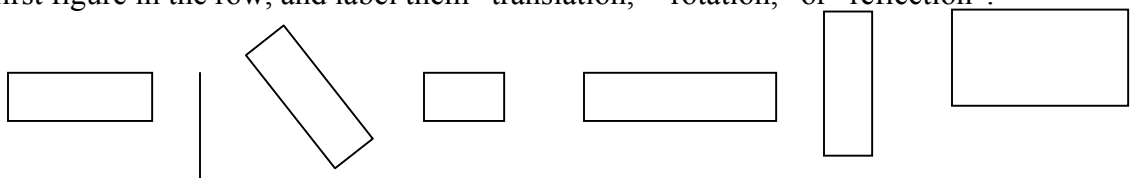
original **translation** **rotation** **reflection**

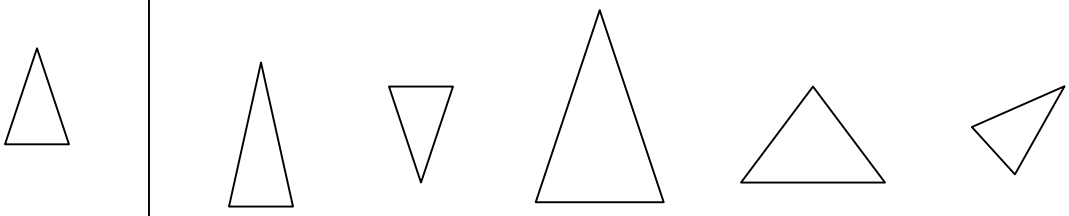
6. After you have talked about the terms, have students go back to the "Congruent Figures Worksheet." For each figure they said was congruent, have students label how it was moved, using one of the three terms *translation, rotation,* or *reflection*.

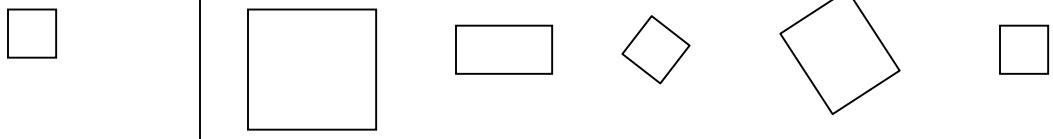
Congruent Figures Worksheet

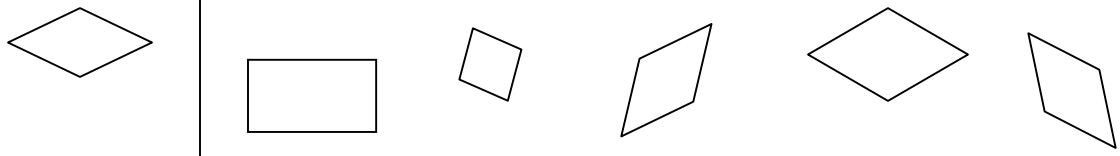
Name _____ **Date** _____

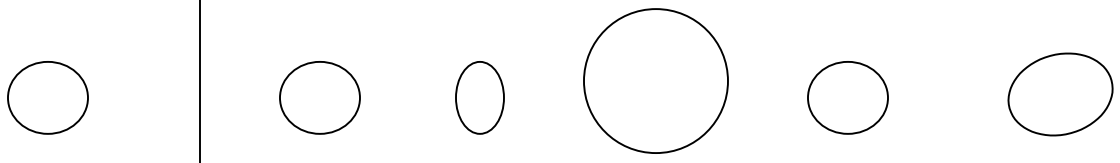
Directions: Look carefully at each figure in each row. Circle the figures in that row that are congruent to the first figure in the row, and label them "translation," "rotation," or "reflection".

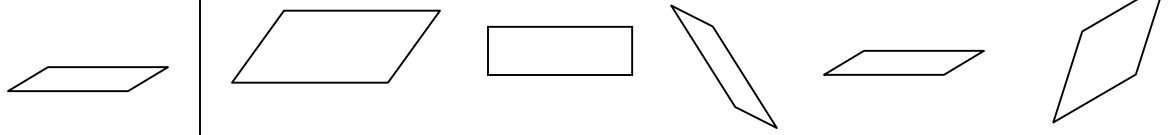
1. 

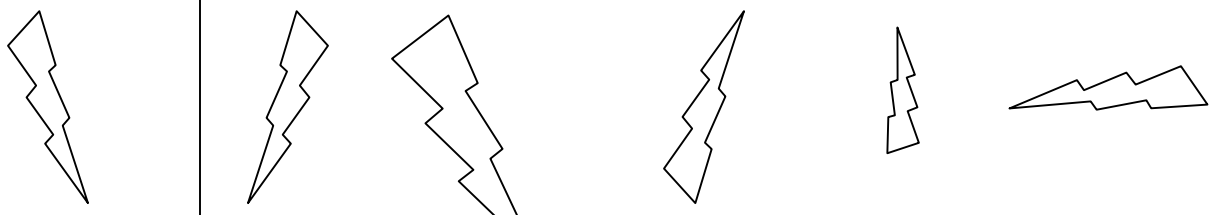
2. 

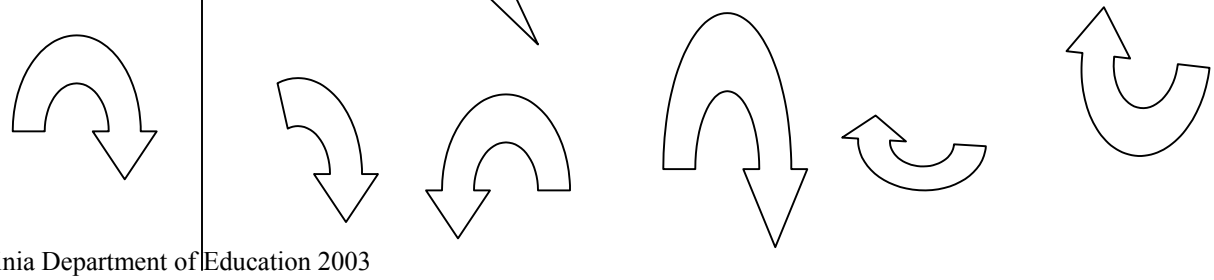
3. 

4. 

5. 

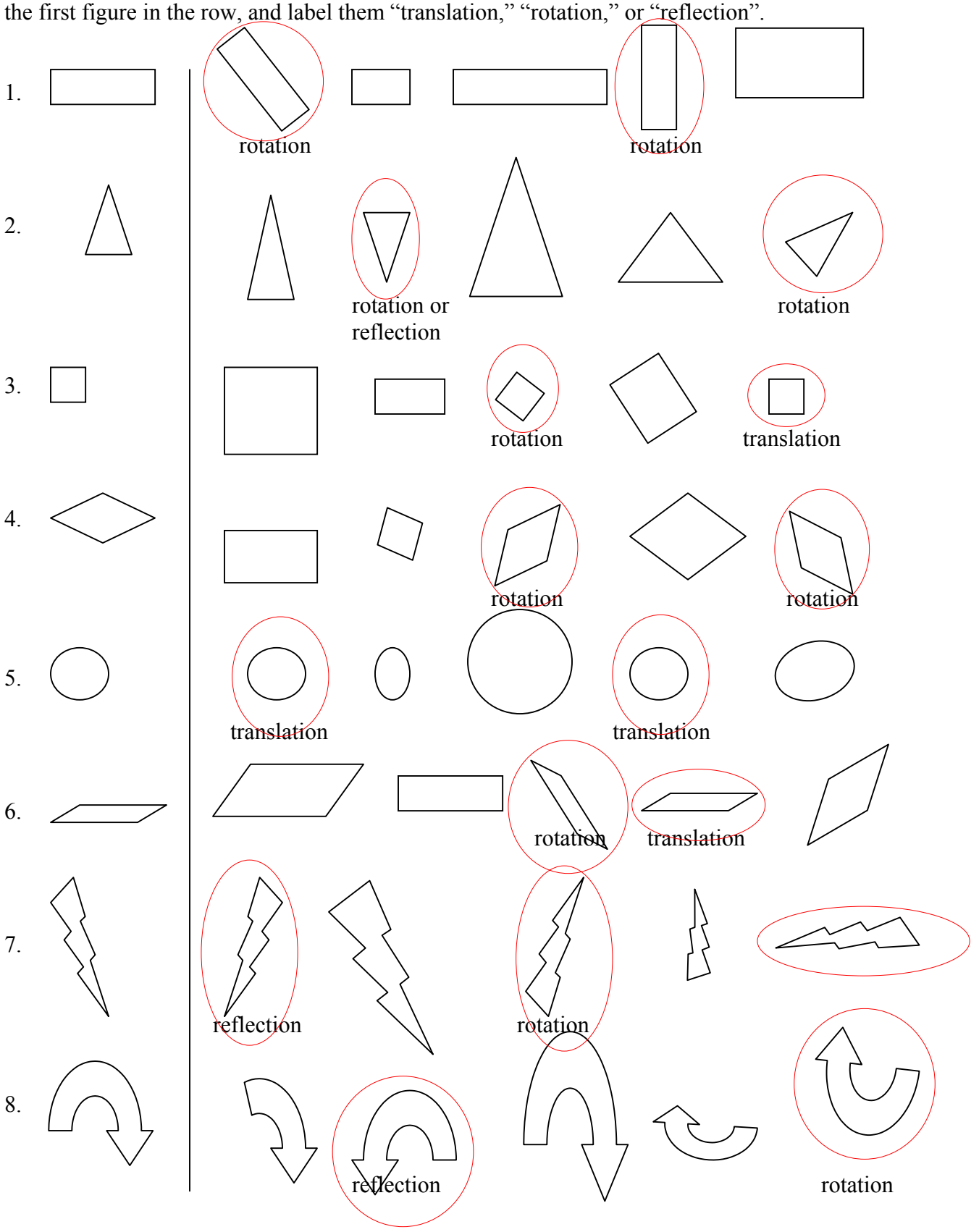
6. 

7. 

8. 

Congruent Figures Worksheet Answer Key

Directions: Look carefully at each figure in each row. Circle the figures in that row that are congruent to the first figure in the row, and label them "translation," "rotation," or "reflection".



Coordinate Points

Reporting category Geometry
Overview Students identify points on a coordinate grid.
Related Standard of Learning 4.18

Objective

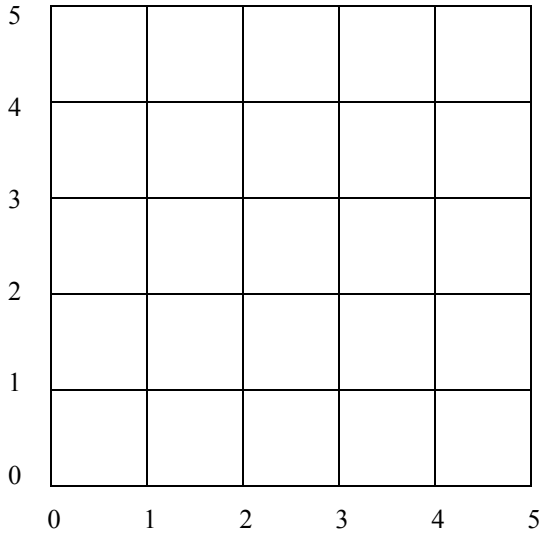
- The student will identify points on a coordinate grid.

Materials needed

- Square tiles on floor
- Masking tape (not duct tape, which leaves a residue)
- Wall map with coordinate lines
- Index cards with coordinate points written on them
- A "Coordinate Points" worksheet for each student

Instructional activity

1. Before class begins, mark a coordinate grid on the floor with tape, as shown at right, and display a large map on the wall.
2. When students enter the room, ask them how to find a given city on the wall map. Name a city that they are studying, and lead them in recognizing that a city is "located" on maps by using *coordinates*. Brainstorm other reasons you need to plot points.
3. Have all students line up on one of the numbered sides of the floor grid. Give one student an index card, and tell him/her to go and stand with both feet on that point. Talk about how he/she decided where that point is. (over and up) Continue giving out cards and discussing how to find the points.



4. After you have given out a number of cards, call on the observing students to identify the point on which each student is standing. Ask them how they can tell. When a correct set of *coordinate points* is given, have the student standing on that point move off the grid. Continue until all the students are off the grid. Repeat as needed.
5. When students have a good understanding of how to read the grid, have them complete the "Coordinate Points" worksheet to reinforce shapes and coordinate points. Ensure that students understand the meaning of the word *quadrilateral*.

Coordinate Points

Name _____ **Date** _____

Directions: Plot the following points on the coordinate grid provided on the next page. Connect them in order, connecting the last point to the first. Describe in the space provided the figure created.

SET 1: figure: _____
(8, 8) (9, 12) (7, 12)

SET 2: figure: _____
(7, 5) (9, 5) (8, 0) (6, 0)

SET 3: figure: _____
(1, 0) (2, 1) (1, 3) (0,2)

SET 4: figure: _____
(3, 12) (1, 12) (1, 8) (3, 8)

SET 5: figure: _____
(12, 12) (13, 9) (12, 7) (11, 9)

SET 6: figure: _____
(5, 7) (7, 7) (7, 10) (5, 10)

SET 7: figure: _____
(12, 3) (12, 1) (14, 0) (14, 1)

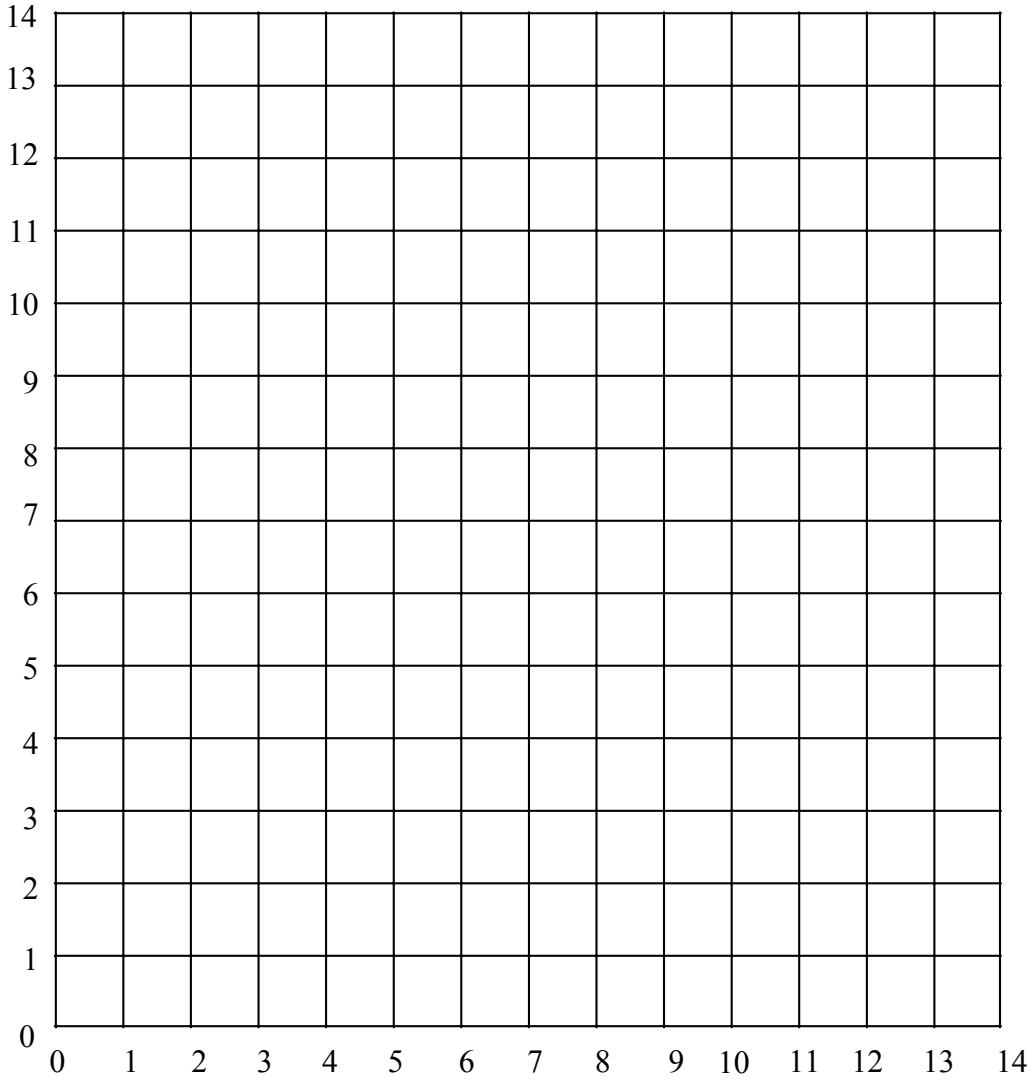
SET 8: figure: _____
(5, 4) (3, 4) (3, 7)

SET 9: figure: _____
(4, 13) (4, 10) (5, 12) (3, 11)

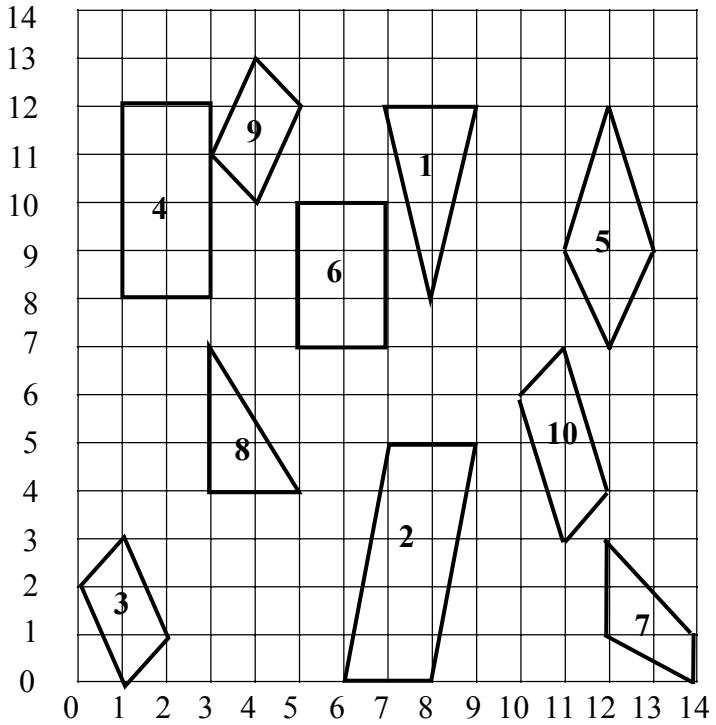
SET 10: figure: _____
(11, 7) (10, 6) (11, 3) (12, 4)

Coordinate Points Grid

Name _____ **Date** _____



Coordinate Points Answer Key



SET 1: figure: triangle
(8, 8) (9, 12) (7, 12)

SET 2: figure: parallelogram or quadrilateral
(7, 5) (9, 5) (8, 0) (6, 0)

SET 3: figure: parallelogram or quadrilateral
(1, 0) (2, 1) (1, 3) (0,2)

SET 4: figure: rectangle, quadrilateral, or parallelogram
(3, 12) (1, 12) (1, 8) (3, 8)

SET 5: figure: quadrilateral (kite)
(12, 12) (13, 9) (12, 7) (11, 9)

SET 6: figure: rectangle, quadrilateral, or parallelogram
(5, 7) (7, 7) (7, 10) (5, 10)

SET 7: figure: quadrilateral
(12, 3) (12, 1) (14, 0) (14, 1)

SET 8: figure: triangle
(5, 4) (3, 4) (3, 7)

SET 9: figure: parallelogram
(4, 13) (4, 10) (5, 12) (3, 11)

SET 10: figure: parallelogram
(11, 7) (10, 6) (11, 3) (12, 4)

Geometry Review

Reporting category Geometry
Overview Students review all Geometry Standards of Learning.
Related Standards of Learning 4.14, 4.15, 4.16, 4.17, 4.18

Objectives

- The student will review all Geometry Standards of Learning.

Materials needed

- A copy of the "Geometry Review" worksheet for each student

Instructional activity

1. Have students complete the "Geometry Review" sheet to review the Standards of Learning for Geometry.
2. After students are finished, have the students share their answers in class discussion. Note any confusion or uncertainty, and reinforce learning in those areas by providing extra practice as needed.

Geometry Review

Name _____ Date _____

1. Draw and label ray AB. How many endpoints does it have? _____

2. Draw and label line CD. How many endpoints does it have? _____

3. Draw and label line segment EF. How many endpoints does it have?_____

4. Draw and label angle ABC.

5. Draw and label point P.

6. Draw a pair of intersecting lines. What do they have in common? _____

7. Draw a pair of parallel lines. Do they intersect? _____

8. Draw a pair of perpendicular lines. Do they intersect? _____ What is the name of the angles formed by the lines? _____

9. The shortest distance between two points is a _____ line.

10. Draw an example of a figure not formed with any line segments. All of its points should be the same distance from a center point. What is it called? _____

11. Draw an example of a square. What are two things it *must* have? _____
_____

12. Give an example of a reflection, translation, and rotation of a rectangle.

_____

13. Draw an example of a cube. It is made up of ___ faces, ___ vertices, and ___ edges.

14. Draw an example of a sphere. It is like a _____.

15. Draw an example of a rectangular solid (prism). It is made up of ___ faces, ___ vertices, __ edges.

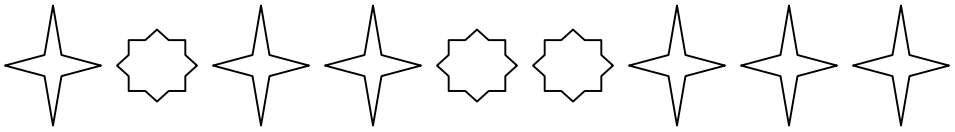
16. A rectangular prism and a cube both have ___ faces, ___ edges, and ___ vertices.

17. List three two-dimensional figures. _____ _____ _____

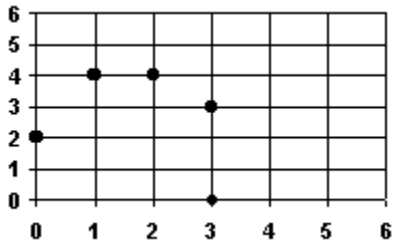
18. List three three-dimensional (solid) figures. _____

_____ _____

19. Complete the next three figures.



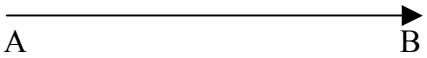
20. Use the graph to answer the following question: "What should you make sure to do on the test tomorrow?"



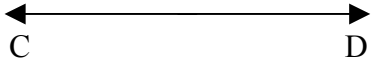
Put the letter A on (2,4).
Put the letter E on (1,4).
Put the letter D on (3,3).
Put the letter R on (0,2).

Geometry Review Answer Key

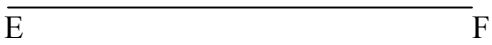
1. Draw and label ray AB. How many endpoints does it have? one



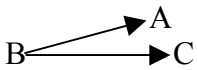
2. Draw and label line CD. How many endpoints does it have? none



3. Draw and label line segment EF. How many endpoints does it have? two

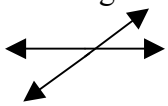


4. Draw and label angle ABC.

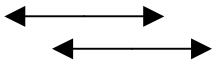


5. Draw and label point P.

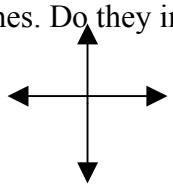
6. Draw a pair of intersecting lines. What do they have in common? one point



7. Draw a pair of parallel lines. Do they intersect? no



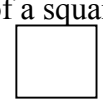
8. Draw a pair of perpendicular lines. Do they intersect? yes. What is the name of the angles formed by the lines? right angles



9. The shortest distance between two points is a straight line.

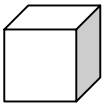
10. Draw an example of a figure not formed with any line segments. All of its points should be the same distance from a center point. What is it called? circle

11. Draw an example of a square. What are two things it *must* have? equal sides and right angles



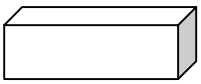
12. Give an example of a reflection, translation, and rotation of a rectangle. (Check for accuracy.)

13. Draw an example of a cube. It is made up of 6 faces, 8 vertices, and 12 edges.



14. Draw an example of a sphere. It is like a circle.

15. Draw an example of a rectangular solid (prism). It is made up of 6 faces, 8 vertices, and 12 edges.

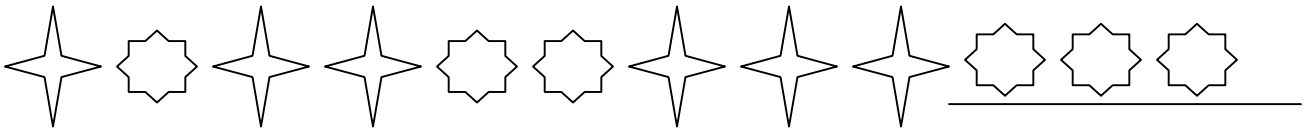


16. A rectangular prism and a cube (which is a special rectangular prism) both have 6 faces, 12 edges, and 8 vertices.

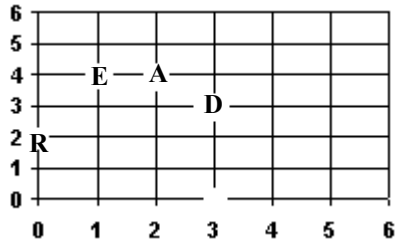
17. List three two-dimensional figures. triangle, rectangle, circle (and other possible answers)

18. List three three-dimensional (solid) figures. cube, sphere, rectangular solid (prism) (and other possible answers)

19. Complete the next three figures.



20. Use the graph to answer the following question: "What should you make sure to do on the test tomorrow?" **READ**



Put the letter A on (2,4).
Put the letter E on (1,4).
Put the letter D on (3,3).
Put the letter R on (0,2).

Sample resources

http://standards.nctm.org/document/chapter5/geom.htm – NCTM Principles and Standards information related to geometry in Grades 3–5.

http://illuminations.nctm.org/imath/3-5/GeometricSolids/index.html – An I-math investigation of geometric solids.

http://standards.nctm.org/document/eexamples/chap5/5.3/index.htm – An interactive exploration of the properties of rectangles and parallelograms.

http://www.learnnc.org/LearnNC/lessonp.nsf/docunid/E59C22A90A8A43F485256831007443D4?opendocument – A lesson plan on congruent figures.

http://ericir.syr.edu/cgi-bin/printlessons.cgi/Virtual/Lessons/Mathematics//Geometry/GEO0200.html – A lesson plan on points, rays, lines, line segments, parallel, perpendicular and intersecting lines.

http://www.learnnc.org/LearnNC/lessonp.nsf/docunid/272DFA – A lesson plan on constructing three-dimensional figures.

http://www.glc.k12.ga.us/BuilderV03/lptools/lpshared/lpdisplay.asp?Session_Stamp=&LPID=15265 – A lesson plan on graphing coordinate points on a grid.

http://artsedge.kennedy-center.org/teaching_materials/curricula/curriculum.cfm?curriculum_id=213&mode=full – Using the context of lighthouses, this lesson plan focuses on the geometric figures required to construct structures.

http://www.learner.org/teacherslab/math/geometry/space/ – Lessons plans that focus on visualization of three-dimensional objects.

VDOE Geometry Instructional Module – Professional development training module that contains activities that can be adapted for student use.

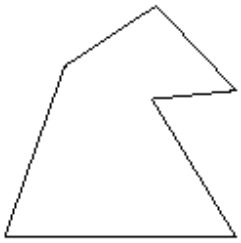
Navigating through Geometry in Grade 3 through Grade 5 – Available from NCTM. Contains additional lessons for geometric activities.

Van Hiele Levels of Geometric Thought CD – Available through the Virginia Department of Education. Contains assessments to determine children's level of geometric thinking.

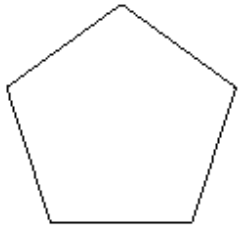
Released SOL test items

Which of the following has at least two sides that appear to be parallel?

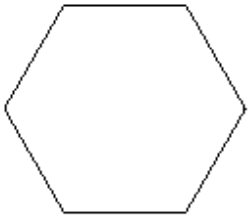
A



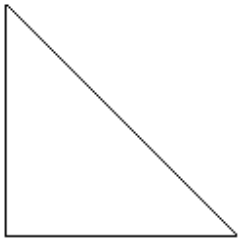
B



C

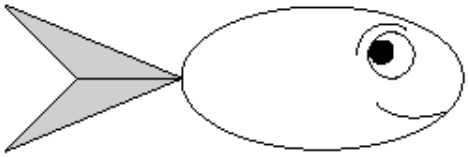


D

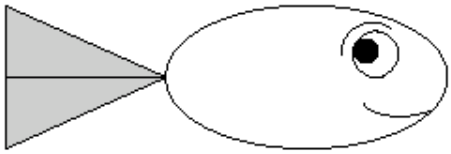


Lynn drew a fish using two right triangles for its tail. Which could be the fish Lynn drew?

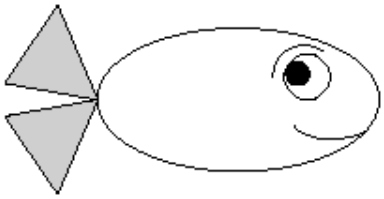
F



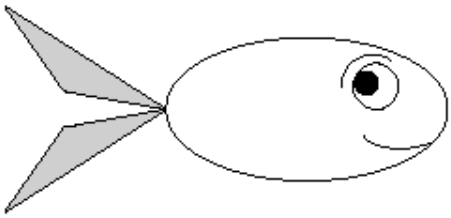
G



H



J



Which of the following describes a figure that has an area of 28 square centimeters?

A A rectangle with length of 9 centimeters and width of 5 centimeters

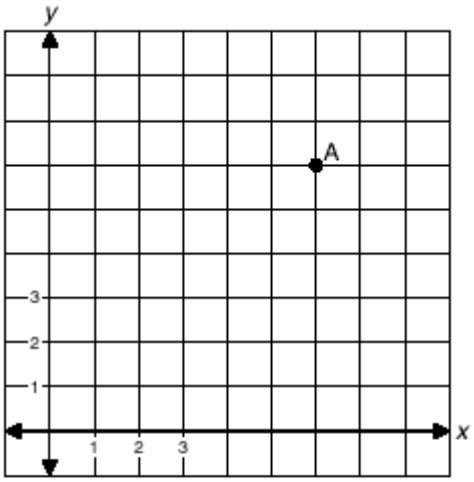
B A rectangle with length of 7 centimeters and width of 4 centimeters

C A square with length of 7 centimeters and width of 7 centimeters

D A triangle that has 2 sides 10 centimeters long and 1 side 8 centimeters long.

Which best describes this figure?

F Angle JK
G Line segment JK
H Ray JK
J Line JK

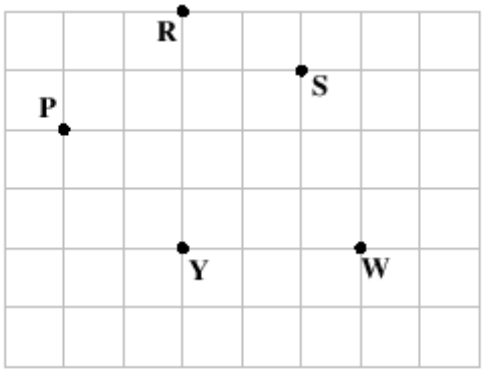


What are the coordinates of Point *A*?

F (7, 7)
G (6, 6)
H (6, 5)
J (5, 6)

Use your ruler as a straightedge to help you answer this question.

On the grid below, connect point P to point Y, then connect point Y to point W. What kind of angle has been formed?



F Obtuse
G Acute
H Right
J Straight

Which is a true statement?

A The length of the radius of a circle is one-fourth the length of the diameter.

B The length of the radius of a circle is the same as the length of the diameter.

C The length of the radius of a circle is one-half the length of the diameter.

D The length of the radius of a circle is two times the length of the diameter.

Organizing Topic Statistics

Standard of Learning

4.20 The student will collect, organize, and display data in line and bar graphs with scale increments of one or greater than one and use the display to interpret the results, draw conclusions, and make predictions.

Essential understandings, knowledge, and skills	Correlation to textbooks and other instructional materials
The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to	
• Collect data, using, for example, observations, measurement, surveys, scientific experiments, polls, or questionnaires.	
• Organize data into a chart or table.	
• Construct and display data in bar graphs, labeling one axis with equal whole-number increments of 1 or more (numerical data) (e.g., multiples of 5, 10, or 100) and the other axis with categories related to the title of the graph (categorical data) (e.g., swimming, fishing, boating, and water skiing as the categories of "Favorite Summer Sports").	
• Construct and display data in line graphs, labeling the vertical axis with equal whole-number increments of 1 or more and the horizontal axis with continuous data commonly related to time (e.g., hours, days, months, years, and age). Line graphs will have no more than four identified points along a continuum for continuous data. For example, growth charts showing age versus height place age on the horizontal axis (e.g., 1 month, 2 months, 3 months, and 4 months).	
• Title the given graph or identify the title in a given graph and label the axes.	
• Analyze information from simple line and bar graphs by describing the characteristics of the data and the data as a whole (e.g., the category with the greatest/least, categories with the same number of responses, similarities and differences, the total number). Data points will be limited to 20 and categories to 4.	
• Interpret the data to answer the question posed, and compare the answer to the prediction (e.g., "The summer sport preferred by most is swimming, which is what I predicted before collecting the data.").	
• Write at least one sentence to describe the analysis and interpretation of the data, identifying parts of the data that have special characteristics, including categories with the greatest, the least, or the same.	

- Select from among four choices a correct analysis of the data presented in a bar or line graph. For example, given a line graph showing the number of soccer players (in millions) in the U.S. over the time period 1980 to 2000 in five-year intervals, select the correct answer response that relates to the graphs, such as, "The greatest increase in number of soccer players occurred between 1985 and 1990."

Sandwich Data

Reporting category Statistics
Overview Students interpret data and compare display of information.
Related Standard of Learning 4.20

Objectives

- The student will interpret graphical representations.
- The student will compare a graph format with a narrative format.

Materials needed

- Copies of the two handouts for each student
- Transparencies of both handouts
- Math journals

Instructional activity

1. Divide the class into two groups, and separate the groups by placing one at the front of the classroom and the other at the back of the classroom.
2. Distribute the "Sandwich Data Handout 1" to the students in the group at the front of the classroom and the "Sandwich Data Handout 2" to those in the group at the back. Place the handouts *face down* on a desk or table. Instruct the students not to turn the papers over until instructed to do so.
3. Tell the two groups that you are going to ask some questions about sandwiches from the information given in the handout you gave them and that you are going to keep track of the people who raise their hands first to answer the questions. Ask the students to turn their papers over and respond to the questions. Begin asking questions. Keep a record of those who answer first, anticipating that those who have the graphical answer will respond first. Ask the following questions. Call on the first person that raises his or her hand to answer the question.
   - What type of sandwich was preferred by the most people?
   - What types of sandwiches were preferred by only two people?
   - What type of sandwich did Oliver prefer?
4. After establishing that one group is doing better than the others in answering the questions quickly, show the entire group a transparency of both types of data displays. Explain that this is an example of the importance of the *way* statistical information is presented.
5. Distribute the alternate handout to the groups so that each person has a copy of both handouts.
6. Lead the students in a discussion of why one handout is easier to understand than the other. They should conclude that the bar graph in H2 is easier to understand than the narrative in H1, i.e., that the data can be quickly read and understood in H2.
7. Instruct students to write about this activity in their math journals.
8. If time permits, make graphs from newspapers, magazines, and textbooks available for students to work in pairs to discuss the way such information is displayed.

Sample assessment

- Observe the two groups as they attempt to respond to the questions. Watch for cooperation, discussion, and sharing of information. Note whether all students are involved in answering the questions.

Follow-up/extension

- Discuss additional situations in which this kind of graphical representation can be used. Discuss why the narrative was so difficult to interpret. Ask, "Where are graphs typically found?" Make a list of locations, e.g., newspapers, consumer magazines, economic reports, and sports writings.

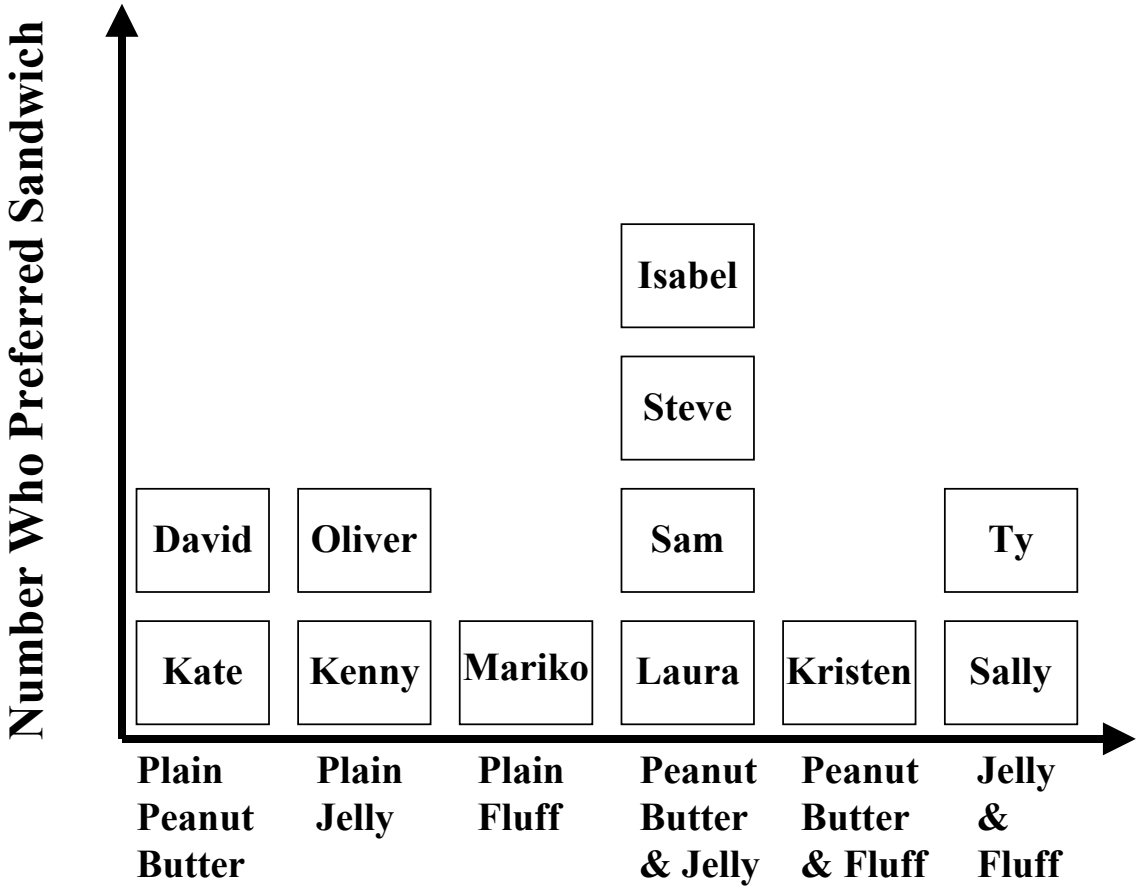
Sandwich Data Handout 1

The Lunch Bunch's Favorites

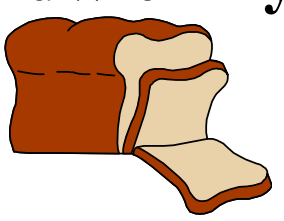
Laura had peanut butter and jelly. Kenny had plain jelly. Oliver also had plain jelly. Katie and David had plain peanut butter. Oh, I forgot to mention that Steven, Isabel and Sam also had peanut butter and jelly. Kristen had peanut butter and fluff. Mariko had plain fluff, while Sally and Ty had jelly and fluff.

Sandwich Data Handout 2

The Lunch Bunch's Favorites



Sandwich Types



Say, "Here!"

Reporting category Statistics

Overview Students collect and organize data over the course of a week and organize that data into a graph.

Related Standard of Learning 4.20

Objectives

- The student will collect and organize data.
- The student will use their data to construct a bar graph.
- The student will interpret the data through class discussion and journal entries.

Materials needed

- An **"**Attendance Board" bulletin board on which students will place their names each day over the course of a week. Board should be entitled "Say, Here!"
- Five different-color index cards per student with student's name written on each card
- Extra blank cards of the same colors
- Tape
- Math journals
- A copy of the "Say, Here! Recording Sheet" for each student

Instructional activity

1. *Setting the Scene:* At the beginning of the week, explain to students that they are going to be part of a data-collection activity that will take the entire week! Each day, as they come to class, they are to put one of their name cards on the Attendance Board to indicate that they are present. They will use the following colors: Monday – blue, Tuesday – orange, Wednesday – pink, Thursday – green, and Friday – yellow. They must affix the cards in a graph format, with one card placed above the other in bar-graph style.
2. Have the students continue this method of recording attendance each day through Friday morning.
3. Discuss with the students what they think about this method of taking attendance. Is it efficient? Does it save time? Is it accurate? Did anyone forget to put his or her card on the Attendance Board? How can you tell? What should we do if someone is absent? Should a blank card be put in that person's place? Is there another place on the chart where we should record absences?
4. Ask the students if this type of graph could be used to record any other class information, for example, lunch boxes vs. tray lunches, food preferences, types of clothes, movies vs. videos.
5. Distribute the "Say, Here! Recording Sheets" and have students fill in the numbers on their sheet and construct a bar graph, using the information.
6. Have students answer the questions that follow the chart.
7. Ask students to write about this activity in their math journals.

Sample assessment

- Supervise students as they record their daily attendance on the chart. Monitor the chart to insure that it is correct. Carefully look at each student's graph to check for correct display, including increments, labeling of axes, and title.

Follow-up/extension

- Discuss additional situations in which this kind data of collection would be helpful.
- Divide class into groups, provide poster board and markers, and instruct students to take the data from the Attendance Board and create a line graph. Critical to this step is that students understand why this data can now be displayed in a line graph showing change over time and change in attendance from day to day.
- Extend the length of time for data collection to two weeks or a month.

Say, Here! Recording Sheet

Name _____ **Date** _____

Transfer the data from the Attendance Board to the following chart:

	Number of Students Present
Monday	
Tuesday	
Wednesday	
Thursday	
Friday	

Use the data from the Attendance Board to answer the following questions:

1. Which day had the most absences? _____ How can you explain this?

_____

2. Did one of the days have the lowest number of absences? _____Why do you think that happened?

_____

_____

3. How did creating the graph give you information about the class's attendance?

_____

_____

4. What other kinds of graphs could you make to show the daily attendance?

_____

_____

Spinning Colors

Reporting category Statistics

Overview Students conduct an experiment with a spinner, tally results, and construct a bar graph to display data**.**

Related Standard of Learning 4.20

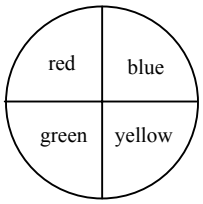
Objectives

- The student will create data by using a spinner.
- The student will convert data to a graphical representation.

Materials needed

- Four-section spinners
- A "Spinning Colors" handout for each student
- Pencils for recording tallies
- Poster board for constructing bar graphs
- Markers
- Math journals

Instructional activity



1. Explain to the class that they are going to use a data-generating manipulative — a spinner — to create data that will be converted into a graph.
2. Divide students into teams of two members each.
3. Give each team a spinner that is divided into four equal sections in which the color words *red, blue, green,* and *yellow* have been written.
4. Instruct each team to spin the spinner and record their spins with tally marks. Do not tell each team how many times to spin the spinner, but instead let them continue for two minutes. Be sure that each spin is recorded with a tally mark and that each color is tallied separately.
5. Next, tell the students to create a bar graph, using the data from the tally marks. The bar graph should show the four colors and the number of spins.
6. When each team has completed its bar graph, they should pass that graph to a neighboring team so that the neighboring team can answer the following questions based on the data displayed in the graph:
   - Approximately how many spins did the team make in all?
   - Did they spin one color approximately twice as many times as another color? If so, which one?
   - What color do you think that team will spin next? Explain your prediction.
7. Conduct a second experiment. This time each team should spin the spinner 30 times. Once again, have the teams record the spins with tally marks and create a new bar graph. Have them compare the results with those of the first experiment.
8. Instruct students to write about this activity in their math journals.

Sample assessment

- Observe the groups as they respond to the questions. Watch for cooperation, discussion, and sharing of information. Note whether all students are involved in answering the questions. Note whether students compare ease of reading data from tally marks to ease of reading bar graphs. Which do they feel is more useful?

Follow-up/extension

- Have the students conduct additional experiments, using different numbers of spins and compare results to previous experiments. As the number of spins increases, ask students to explain what will happen to the bar graph.

Sample resources

Curriculum and Evaluation Standards for School Mathematics, NCTM publication, pp. 54–57.

Principles and Standards for School Mathematics, NCTM publication, 2000.

NCTM Addenda Series, Grade 4.

www.nces.ed.gov/nceskids/Graphing/ – An interactive Web site for students that allows them to create several types of graphs.

http://illuminations.nctm.org/swr/list.asp?Ref=1&Std=4&Grd=3 – List of Web resources reviewed by NCTM containing activities for data and probability.

http://standards.nctm.org/document/chapter5/data.htm – Information from NCTM's Principles and Standards in relation to data analysis for Grade 3 through Grade 5.

Probability and Statistics Professional Development Module available from VDOE Web site – Contains activities related to this strand that can be modified for student use.

Navigating through Data Analysis and Probability in Grade 3 through Grade 5 – Available from NCTM. Contains additional lessons for data analysis activities.

Spinning Colors

Name _____ **Date** _____

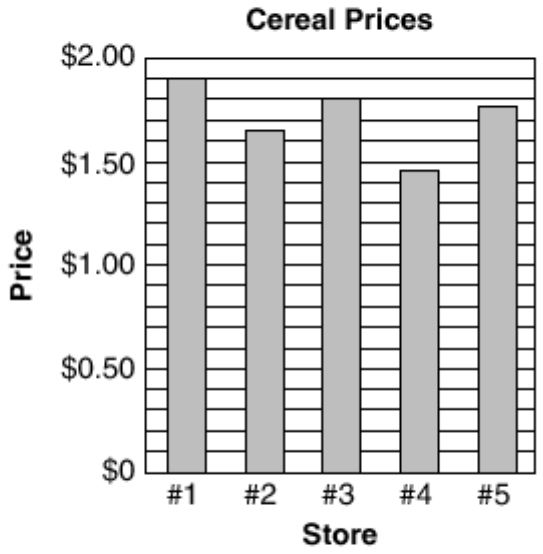
Use tally marks to record each spin

Red	
Yellow	
Green	
Blue	

On the back of this paper, use the tally marks to create a bar graph that shows the number of spins and the four colors.

Released SOL test items

35 For a class project, Anita compared the price of a medium-sized box of Superflakes cereal at five different stores. All the prices were recorded on the same day. The graph below shows the prices she recorded.



Which is *closest* to the price of the box of cereal at Store #2?

A $1.65
B $1.51
C $1.13
D $1.02

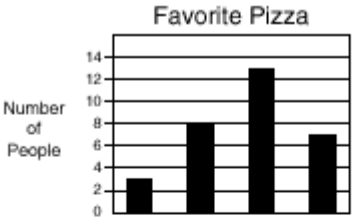
39 Shelby asked some friends to name their favorite kind of pizza. She made this tally chart to show their answers.

Favorite Pizza

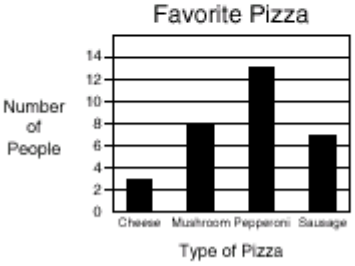
Cheese	𝍸
Mushroom	𝍸 𝍸
Pepperoni	𝍸 𝍸 𝍸
Sausage	𝍸

Which bar graph displays this information correctly?

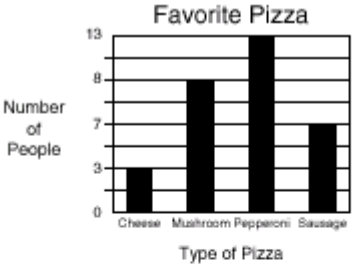
A



B

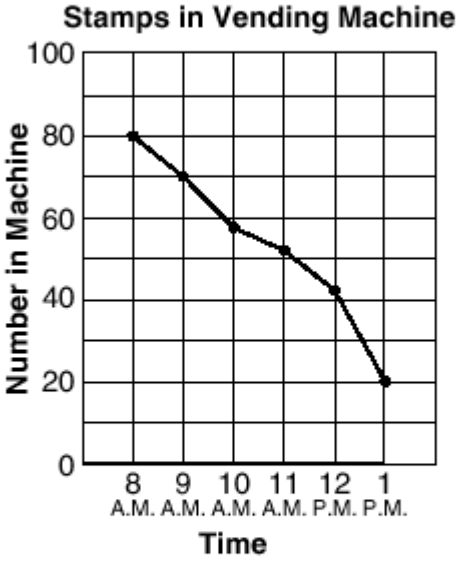


C



D

10 The graph below shows how the number of books of flower stamps in a vending machine changed over a period of hours.



Which is *closest* to the number of books of stamps in the machine at 11 A.M.?

F 41
G 46
H 52
J 59

Organizing Topic Probability

Standards of Learning

4.19 The student will
a) predict the likelihood of outcomes of a simple event, using the terms *certain, likely, unlikely, impossible*; and
b) determine the probability of a given simple event, using concrete materials.

Essential understandings, knowledge, and skills	**Correlation to textbooks and other instructional materials**
The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to	
• Model and determine all possible outcomes of a given simple event where there are no more than 12 possible outcomes, using a variety of manipulatives, such as coins, number cubes, and spinners.	
• Conduct experiments to determine the probability of an event occurring for a given number of trials (no more than 12 trials), using manipulatives (e.g., the number of times "heads" occurs when flipping a coin 10 times; the chance that when the names of 12 classmates are put in a shoebox, a name that begins with *D* will be drawn).	
• Write the probability of a given simple event as a fraction, where the total number of possible outcomes is 12 or fewer.	
• Identify the likelihood of an event occurring and relate it to its fractional representation (e.g., impossible/0; equally likely/$\frac{1}{2}$; certain/1).	

How Certain Are You?

Reporting category Probability

Overview Students classify statements into the following categories: *certain, likely, unlikely,* and *impossible.*

Related Standard of Learning 4.19

Objectives

- The student will determine the likelihood of an event.
- The student will construct a probability line to aid in visualizing the probability of an event.

Materials needed

- A 3-by-16-in. strip of tagboard for each team of two students
- A "Probability Statements" handout for each student
- Scissors
- Glue or tape
- Chart paper and markers

Instructional activity

1. *Setting the Scene:* Display the words *IMPOSSIBLE, UNLIKELY, LIKELY,* and *CERTAIN* on an overhead or chalkboard. Discuss with students that some statements are completely certain or will definitely happen, while other statements can be interpreted as "maybe they will," or "maybe they won't." Other statements will never happen. On chart paper, write the four headings IMPOSSIBLE, UNLIKELY, LIKELY, and CERTAIN at the top of four columns. Make the columns very wide, because you are going to write the students' statements in the columns.
2. Ask students to help you fill the columns with statements that fit, recording the students' suggestions as they are made. (Examples: Under the IMPOSSIBLE heading, "All the boys in the room will have green hair tomorrow." Under the CERTAIN heading, "Everyone in class will take a spelling test today.") Continue until there are two or three statements in each column and students can easily see the differences between the columns. Some of the statements will be silly, but that is okay. This will make the students think critically about and evaluate the statements. Discuss the fact that it is possible to disagree about the category into which a statement fits.
3. Tell the class that they are now going to look at a collection of statements and decide where those statements fit on a "probability line." Distribute a 3-by-16-in. strip of tagboard to each team of two students, and tell them that they are going to make a probability line. Have them divide the strip into fourths, and instruct them to write each of the four headings above, one in each section of the strip.
4. Distribute the "Probability Statements" handouts, and have the students cut out the statements on them. Then, put the students into groups of two, and have the teams decide where each statement fits on the probability line and attach it under the agreed heading. Both students on a team may not agree, but they should come to a consensus.
5. When all probability lines have been completed, ask team members to share their results and discuss the similarities and differences that are observed.

Sample assessment

- Observe students as they work in teams and discuss the categories. Watch for examples of problem solving.

Follow-up/extension

- Change team members and repeat the activity. Compare results with the first trial. Were they the same? Was there as much discussion or problem solving the second time?
- Flip coins to determine the likelihood of heads or tails. Tally each turn.
- Have students locate and share articles in news magazines and newspapers that use vocabulary such as *certain, likely, unlikely,* and *impossible.*
- Listen for phrases such as *more likely* and *less likely* in the daily weather report. Compare the forecasted weather to the actual weather.

Probability Statements

It will rain tomorrow.
Pizza will be served for lunch.
The sun will rise tomorrow.
You will have two birthdays this year.
Your teacher is over 18 years old.
At least two students will be absent tomorrow.
You will ride in a bus before the end of the school year.
It will take you more than one hour to do your homework.
You will have homework tonight.
Your school has a principal.
You will go to bed before 9:00 tonight.
You will go to Disney World sometime.
You will get tails when you flip a coin.
You will throw a 4 on a die.
Your teacher will let you have extra recess.
On your way to school, you will see a live dinosaur.

Looking for a Pet!

Reporting category Probability

Overview Students conduct an experiment, using a spinner, and use the data collected from it to make a decision.

Related Standard of Learning 4.19

Objectives

- The student will model a simple event, using a manipulative.
- The student will write the probability of each possible choice as a fraction.

Materials needed

- A five-section spinner showing numbers 1 through 5, one spinner for each student
- Poster displaying 5 animals (3 dogs and 2 cats) with numbers 1 through 5 drawn on them.
- Paper and pencils for students to record tallies and fractions
- Chart paper and markers

Instructional activity

1. *Setting the Scene:* Sarah and her parents have decided that it is time for her to have a pet. After a lot of discussion, they agree to go to the city pound to "adopt" a pet. When Sarah and her parents arrive at the pound, the supervisor tells them that the pound has 5 animals. The animals include both cats and dogs. All of the animals are so cute and need homes, and it is very hard for Sarah to make a decision. She really wants them all, but her parents tell her that 5 are too many. She will have to choose one! To help Sarah decide which animal to take home, the supervisor assigns a number from 1 to 5 to each of the animals. He then shows Sarah and her parents a spinner that has the numbers 1 through 5 on it. They decide that Sarah will spin the spinner 12 times, tally the number of times the spinner falls on each number, and the number with the most tally marks will tell Sarah which animal to take home with her as her new pet!
2. Tell the students that they are each going to do what Sarah did and use a spinner to decide which animal to take home with them. Display the poster that shows 5 animals with their assigned numbers.
3. Distribute to each student a spinner with the numbers 1 to 5 written on it. Working individually, ask each student to spin his or her spinner 12 times and tally each number as the spinner points to it.
4. Survey the class to determine which animal each student has selected by spinning. Display the results in a chart format by writing the numbers 1 to 5 on chart paper and placing a tally mark beside each number to show how many students selected it. Discuss the results. Was one number selected more than others? Did each number have an equal chance of being selected? Instruct each student to write his or her tallies as fractions. Example: $1 = \frac{2}{12}$, $2 = \frac{4}{12}$, $3 = \frac{2}{12}$, $4 = \frac{1}{12}$, $5 = \frac{3}{12}$.
5. Sarah found that when she spun the spinner, number 2 received the most tally marks, and she took home a little cat because it had the number 2 assigned to it.
6. Discuss with the students if they think this is a fair way to make a decision. Why or why not? If Sarah had repeated the spinning process a second time, would she have chosen the same animal?

Sample assessment

- Observe students as they use the spinners and record their tallies. Be careful to note whether they record their fractions correctly. Ask individual students to explain why the denominator of each fraction is 12.

Follow-up/extension

- Discuss additional situations in which this kind of decision making can be used. Is this a practical method?
- Have the students place four different-color cubes in a bag, draw one cube from the bag, tally it, replace it, and continue until 12 draws have been tallied. Then have them repeat the activity and compare the results.
- Have the students roll a die 12 times and record whether the number is odd or even. Ask, "Is there a better chance of rolling an even number than an odd number?"
- Have the students construct four-section spinners with three colors, thus giving one color a better chance than the others. Have them spin the spinner 12 times and record the colors, using tally marks. Did the color that fills two of the four sections get selected more than each of the other colors?
- Have the students spin an eight-number spinner 12 times and tally each spin. Discuss whether or not each number has an equal chance of the spinner landing on it.
- Construct a spinner on which all colors are equally likely to be spun.

Lucky Sums?

Reporting category Probability

Overview Students predict and then discover the probability of getting certain sums when rolling two number cubes.

Related Standard of Learning 4.19

Objectives

- The student will conduct probability experiments, using number cubes.
- The student will record data from experiments in charts, using two number cubes.
- The student will interpret the results of probability experiments.
- The student will use the data to predict which of two events is more likely to occur if the experiment is repeated.

Materials needed

- One crayon, marker, or bingo stamper for each student
- One sheet of paper and pencil for each student
- Two number cubes for every pair of students

Instructional activity

1. Divide class into pairs, and give each student one sheet of paper and a crayon.
2. Have students fold their paper into twelfths as follows: holding the paper horizontally, fold it in half, like a card. Then fold it in half again. Finally, fold it into equal thirds with two more folds, like a letter. This should result in 12 equal sections, as shown below. Have the students number the sections 1 through 12 at the bottom of each section.

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**

Note: A review of geometry may be done while folding: point out that they begin with a rectangle (have students define this term) and that they still have a rectangle with each fold even though the width becomes less and less. You may also mention fractional parts while they are doing the folding: with the first fold, they are making halves; the second fold results in fourths; and the third and fourth folds yield twelfths. Students can make predictions about what they think is happening with each fold and then check their predictions.

3. Have students predict the sums of the two number cubes for each of the twelve rolls and then use the crayon/marker/bingo stamper to record their predictions on their paper by making a circle for each sum above the corresponding number. Do not give them any hints or suggestions. For example:

		o o			o o			o o			
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**

4. Give pairs of students two number cubes, and have each student roll the two cubes together, add the numbers shown to find the sum, and then mark off the circle above that number on the chart. If a circle was not placed above that number or if there is no circle is left, have the students place a tally above the number so they have a record of what number was rolled.
5. The first person in the pair to mark off all of their circles is the winner.
6. When all or almost all pairs are done, regroup as a whole class to have the students reflect and analyze why they won or lost the game. Have them make theories about strategies they would like to try. As a class, document on the board the probability of rolling each sum. For example:

		Odds/Likelihood That Sum Will Come Up
1	0 percent chance — impossible to roll a one with two dice	0 / 36
2	1 + 1 (unlikely or little chance)	1 / 36
3	1 + 2, 2 + 1 (unlikely or little chance)	2 / 36
4	1 + 3, 2 + 2, 3 + 1	3 / 36
5	1 + 4, 2 + 3, 3 + 2, 4 + 1	4 / 36
6	1 + 5, 2 + 4, 3 + 3, 4 + 2, 5 + 1 (likely or good chance)	5 / 36
7	1 + 6, 2 + 5, 3 + 4, 4 + 3, 5 + 2, 6 + 1 (likely or good chance)	6 / 36
8	2 + 6, 3 + 5, 4 + 4, 5 + 3, 6 + 2 (likely or good chance)	5 / 36
9	3 + 6, 4 + 5, 5 + 4, 6 + 3	4 / 36
10	4 + 6, 5 + 5, 6 + 4	3 / 36
11	5 + 6, 6 + 5 (unlikely or little chance)	2 / 36
12	6 + 6 (unlikely or little chance)	1 / 36

Note: Patterns in interpreting the *odds* or likelihood that something is going to happen and the use of the commutative property (e.g., 3 + 4 and 4 + 3) without naming it should be discussed here as well.

7. Have students discuss and analyze the data. Then have them make a new chart to play the game again at school and/or at home, using their new knowledge.

Sample assessment

- Circulate during the game. Listen to the strategies, rationale for placement of circles, and discoveries as the students are working. Note how quickly the students apply their new knowledge from the first game experience and probability chart on the board to the second game predictions.
- Have students explain in their journal how they plan to beat their opponents when playing this game. Have them explain their strategies and why they believe it will help them to succeed.

Follow-up/extension

- Have students create their own challenges, using number cubes.
- Have students predict how their strategies for the placement of their circles would change depending on the number of number cubes used.
- Have students predict how their strategies would change if the goal were to subtract instead of add the two number cubes. Have them explain this by using a chart. They could then complete the experiment and analyze to see if their predictions were accurate.

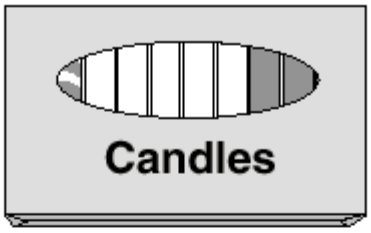
Sample resources

http://standards.nctm.org/document/chapter5/data.htm#bp4 – NCTM's Principles and Standards information about probability at the 3–5 grade levels.

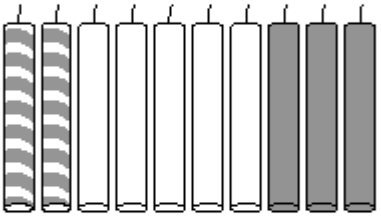
http://www.pbs.org/teachersource/mathline/lessonplans/esmp/chances/chances_procedure.shtm – PBS lesson plan on probability.

Released SOL test items

33 Mitch bought a box of candles.



These are the candles that are in the box.



If Mitch takes out 1 candle without looking, what is the probability that it will be striped?

A $\frac{1}{2}$

B $\frac{2}{8}$

C $\frac{2}{10}$

D $\frac{1}{10}$

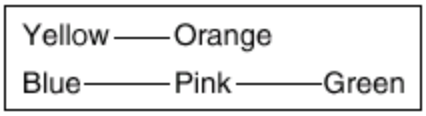
34 Each person attending a meeting will receive a notepad and a ruler. The table below shows the different colors of the notepads and the rulers.

Meeting Supplies

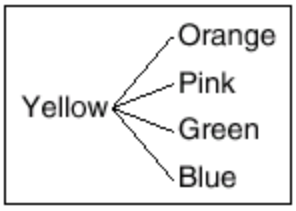
Notepads	Ruler
Yellow	Orange
Blue	Pink
	Green

Which of the following tree diagrams shows all the different combinations of 1 color of notepad and 1 color of ruler?

F

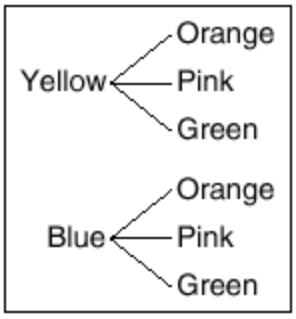


G

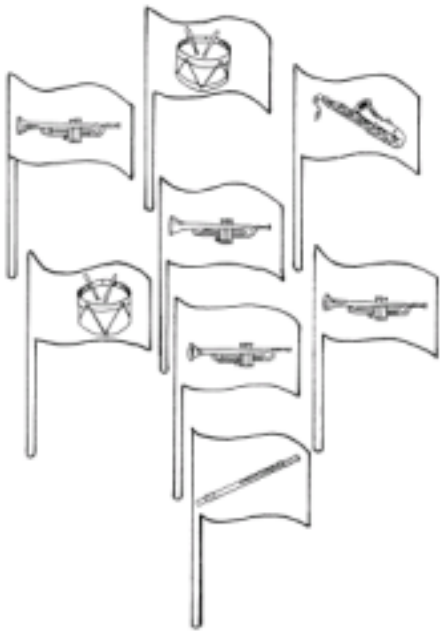


H

J



38 These are the flags that will be carried in front of the marching band.



Which of the following questions about these flags could you use probability to solve?

F How many more flags have trumpets on them than drums?

G If Lionel picks a flag without looking, what kind of flag is he least likely to pick?

H What kind of instrument is on exactly one-half of the flags?

J If 5 people get to pick a flag before Amanda, how many will she have to choose from?

Organizing Topic Patterns, Functions, and Algebra

Standards of Learning

4.21 The student will recognize, create, and extend numerical and geometric patterns, using concrete materials, number lines, symbols, tables, and words.

4.22 The student will recognize and demonstrate the meaning of equality, using symbols representing numbers, operations, and relations [e.g., $3 + 5 = 5 + 3$ and $15 + (35 + 16) = (15 + 35) + 16$].

Essential understandings, knowledge, and skills	**Correlation to textbooks and other instructional materials**
The student will use problem solving, mathematical communication, mathematical reasoning, connections, and representations to	
• Describe geometric and numerical patterns, using tables, symbols, or words.	_____
• Create geometric and numerical patterns, using concrete materials, number lines, tables, and words.	_____
• Extend geometric and numerical patterns, using concrete materials, number lines, tables, and words.	_____
• Recognize that the equals sign (=) relates equivalent quantities.	_____
• Write number sentences to represent equivalent mathematical relationships (e.g., $4 \times 3 = 2 \times 6$).	_____
• Identify number sentences that show appropriate use of the equals sign.	_____

Toothpick, Door, and Staircase Patterns

Reporting category Patterns, Functions, and Algebra

Overview Students use manipulatives to make prescribed shapes that can lead to conclusions about patterns.

Related Standard of Learning 4.21

Objective

- The student will analyze and make predictions about patterns.
- The student will describe patterns, using symbols.

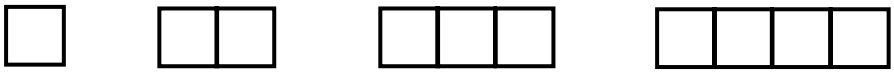
Materials needed

- Toothpicks
- Centimeter cubes
- Overhead projector
- Rainbow cubes
- A copy of the "Building Staircases" handout for each student

Instructional Activities

Toothpicks

1. Distribute toothpicks so that students may create the strip pattern. The first term in the sequence is a square made with the toothpicks. The second term in the sequence is two connected squares. The third term is three connected squares, and so on.



2. Have students organize the data in table form, as shown at right, and predict the number of toothpicks in five connected squares. Record the same information on the overhead or chalkboard.

Number of squares	Number of toothpicks
1	4
2	7
3	10
4	13
5	

3. Before students can understand the meaning of the rule, they must discuss what makes the rule. Have them look at the numbers in the table and come to their own understanding about what happens in the pattern. Then have them predict the number of toothpicks each time a square is added. All fourth graders should not be expected to know the rule, let alone understand it. Listen to student explanations of the pattern.
4. Ask, "How can you determine the number of toothpicks required to make five connected squares? What is the rule?" [$(n \times 3) + 1$]

Staircases

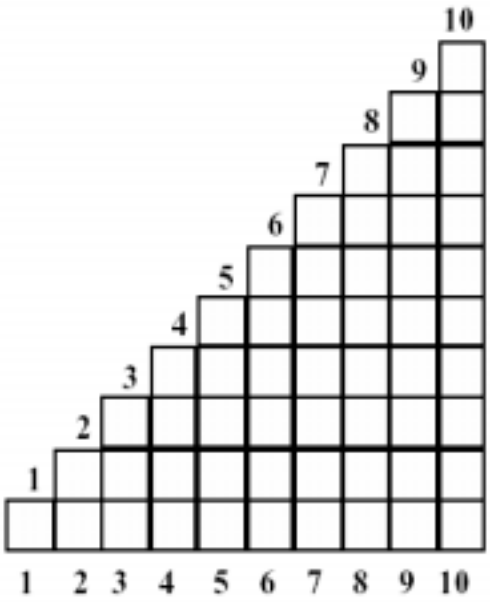
1. On the overhead projector, use centimeter cubes to build a staircase, beginning with one step (cube) and continuing until four steps have been created.
2. As you continue to increase the staircase pattern, ask students, "In this staircase pattern, which step is this? How many centimeter cubes does the pattern have so far? How many centimeter cubes will we need to add to make the next step?"
3. Instruct the students, working with partners, to use centimeter cubes to build staircase models.

4. Encourage students to record the patterns they see.
5. Ask the students, "How many centimeter cubes will you need to build a staircase with one-hundred steps?"
6. Help students explore different possibilities for finding the correct answer.

Sample assessment

- Observe students as they build models and generalize patterns.
- Use the recording sheet "Building Staircases" for skill assessment.

Building Staircases Name: _____



Step	Total Number of Cubes
1	
2	
3	
4	
5	
.	
.	
100	
n	

Weighty Problems

Adapted from Groundworks, Algebraic Thinking and Algebra, Puzzles and Problems *by Greenes and Findell (Creative Publications, 1999). These activity books contain a wealth of ideas for developing algebraic thinking.*

Reporting category	Patterns, Functions, and Algebra
Overview	Students use mathematical reasoning and problem solving to compare the weight of geometric solids and to determine the weight of the solids.
Related Standard of Learning	4.22

Objective

- The student will explore the concepts of equality among variable expressions to develop an understanding of equality or balance.

Materials needed

- Copies of the "Weighty Problems" set for primary grades
- A stationary balance scale
- Geometric solids
- Overhead projector

Instructional activity

1. Use a balance scale to reinforce the concept of equality. Model with real objects the first weighty problem.
2. Next, present the weighty problems to the students, using transparencies on an overhead projector. (Note: You may wish to reproduce the problems as handouts or as laminated problem cards. See teacher questions below. Recognize that concrete experiences with a balance scale can provide the foundation for understanding the concepts of equality and inequality.)
3. Discuss the concepts that students are required to develop, including weight relationships, equality, and equivalent expressions.

Weighty Problem sets

Primary set #1–#11

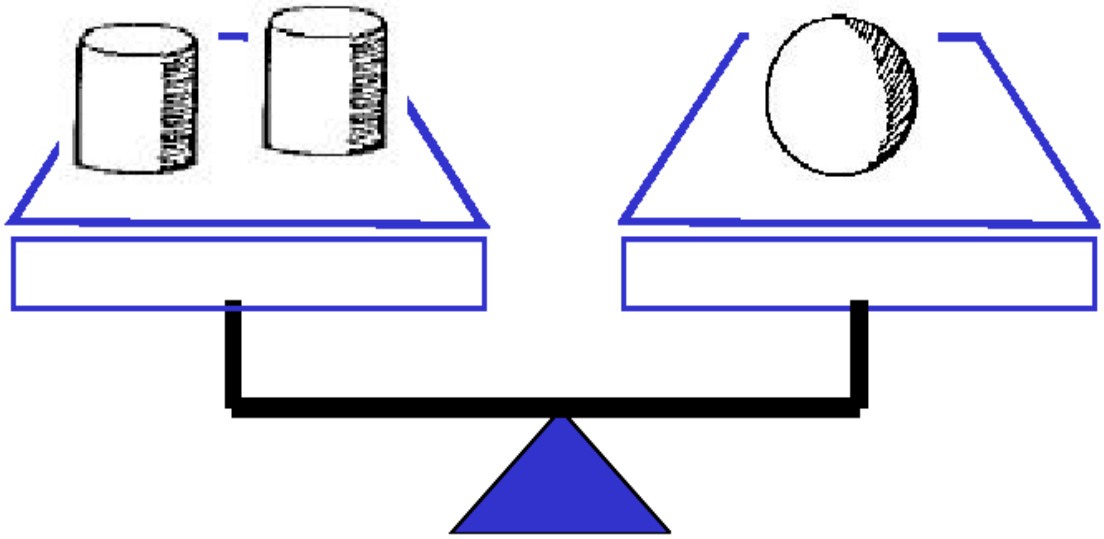
- Objectives
  - Deduce weight relationships.
  - Recognize that a balanced scale represents equality.
- Teacher questions appropriate to the different situations might include
  - What does the scale show?
  - What does the first (or second) scale show?
  - How are the scales alike?
  - How are they different?
  - Which scale would you use first to solve the problem? Why?

- How can you find the weight of the geometric solid (sphere, cylinder, cone)?

Sample assessment

- Have the students develop a few cards of their own. Suggest that they use common objects, such as action figures, cars, beads, shoes, or pictures of toys such as dolls and trucks.

Weighty Problems
Primary #1



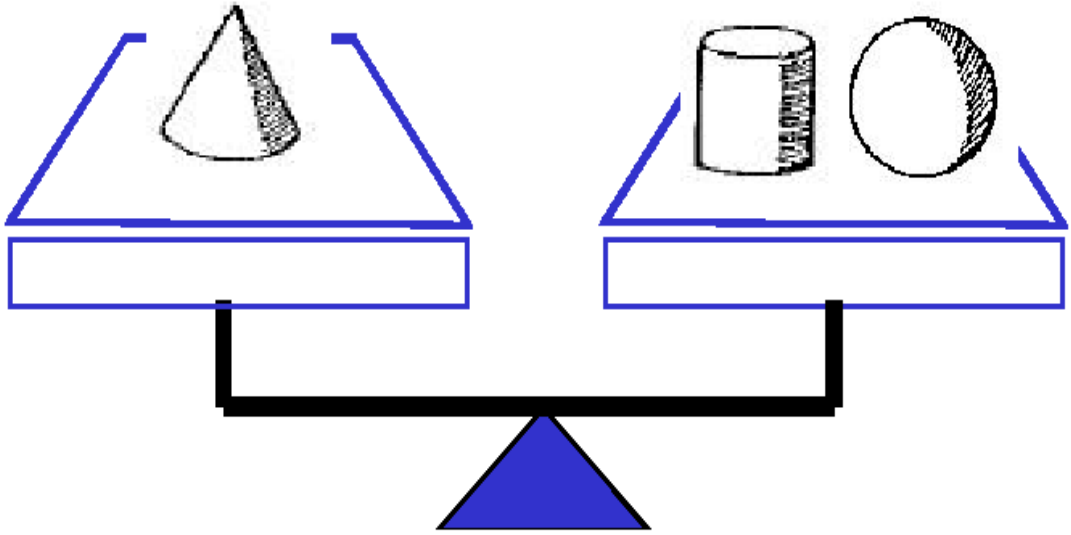
Circle the block that weighs more.

Explain how you know._____

_____

_____

Weighty Problems
Primary #2



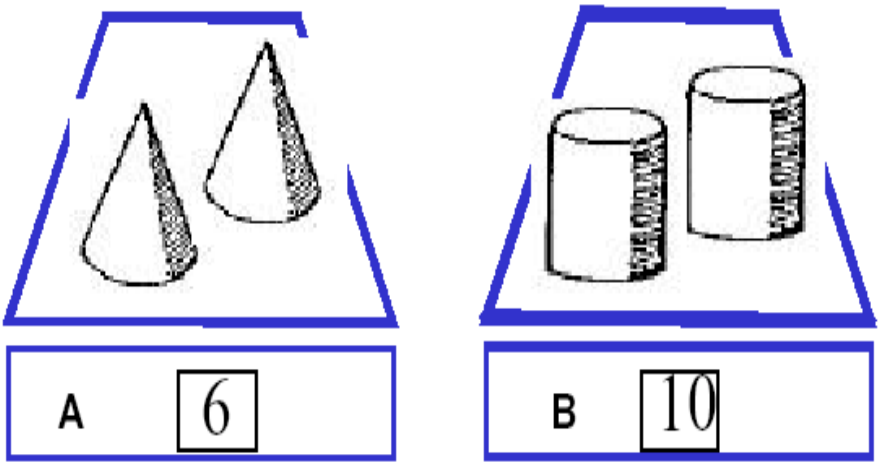
Circle the block that weighs more.

Explain how you know._____

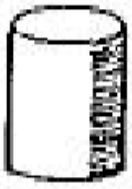
_____

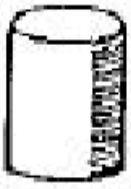
_____

Weighty Problems
Primary #3

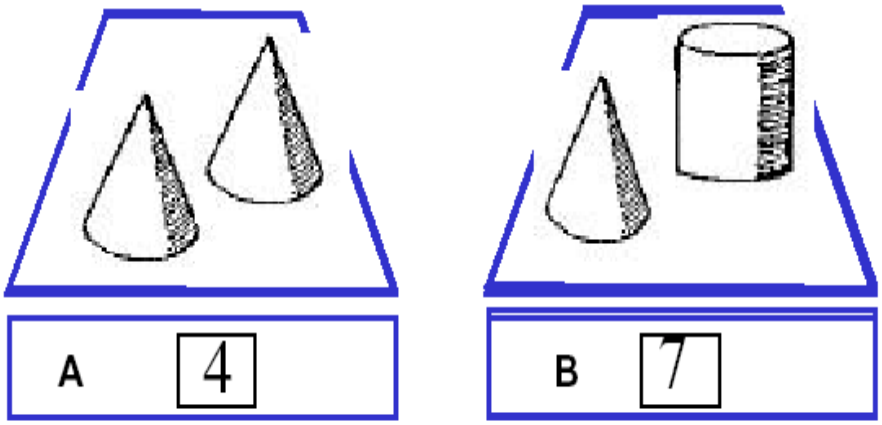


1.  weighs _____ pounds.

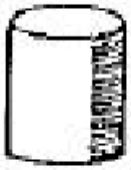
2.  weighs _____ pounds.

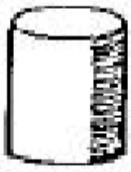
3.  and  weigh _____pounds.

Weighty Problems
Primary #4



1.  weighs _____ pounds.

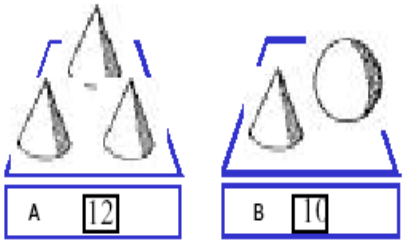
2.  weighs _____ pounds.

3. How did you find the weight of  ? _____

_____

_____

Weighty Problems
Primary #5



1.  weighs _____ pounds.

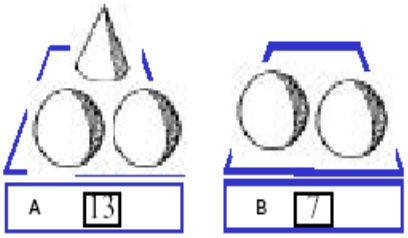
2.  weighs _____ pounds.

3. How did you find the weight of  ? _____

_____

_____

Weighty Problems
Primary #6



1.  weighs _____ pounds.

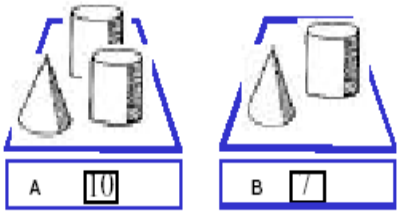
2.  weighs _____ pounds.

3. How did you find the weight of  ? _____

_____

_____

Weighty Problems
Primary #7



1.  weighs _____ pounds.

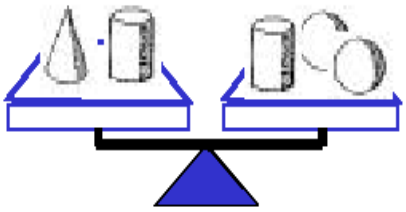
2.  weighs _____ pounds.

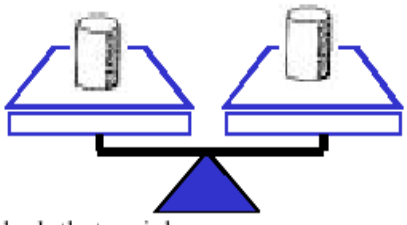
3. How did you find the weight of  ? _____

_____

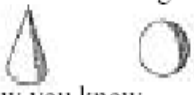
_____

Weighty Problems: Primary #8





Circle the block that weighs more.

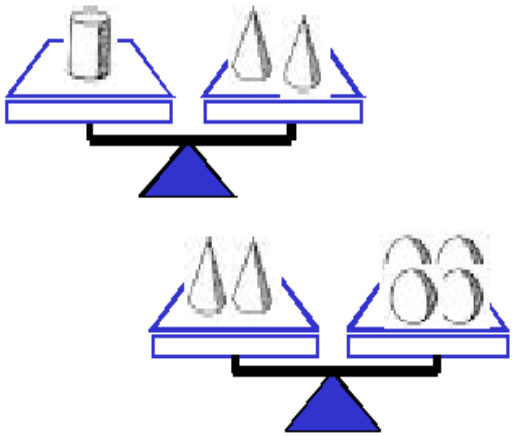


Explain how you know._____

_____

_____

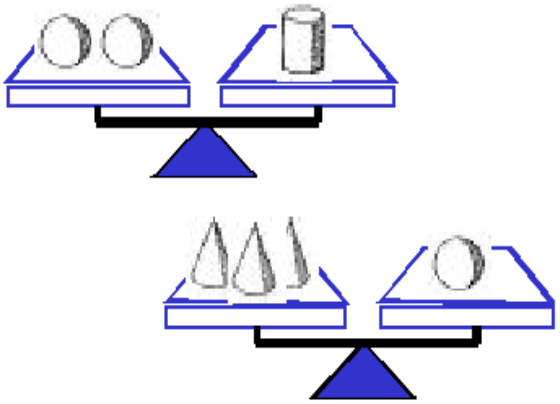
Weighty Problems: Primary #9



Circle the block that weighs the most.
Put a check mark on the one that weighs the least.

Explain how you know._____
_____
_____

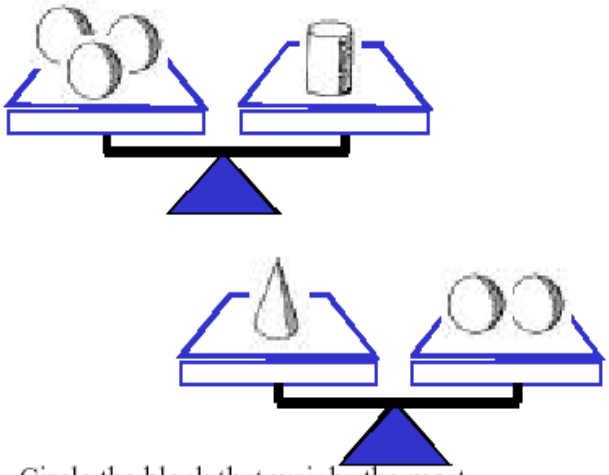
Weighty Problems:Primary #10



Circle the block that weighs the most.
Put a check mark on the one that weighs the least.

Explain how you know._____
_____
_____

Weighty Problems: Primary #11



Circle the block that weighs the most.
Put a check mark on the one that weighs the least.

Explain how you know._____
_____
_____

Balance Beams

Reporting category Patterns, Functions, and Algebra

Overview Students review various types of balance to understand that the = sign relates equivalent quantities.

Related Standard of Learning 4.22

Objective

- Students explore the development of equivalence, using balances.

Materials needed

- A "Balance Beams" handout for each student
- A "Balance Beams" transparency
- Balance scale (optional)

Instructional activity

1. If an actual balance scale is not available, display one on the board or overhead projector. Discuss a sample problem with the students.
2. Have the students individually solve the first balance problem shown on the handout. Discuss why the answer is correct, and write an equation explaining the relationship.
3. Then have the students work with partners to complete the following balances. Each answer should include an equation explaining why the answer is correct.

Answers

A.1. **7**

A.2. $3 + 3 + 1 = \mathbf{7}$
$7 = 7$

B.1. **8**

B.2. $5 + 5 + 2 + 2 = 3 + 3 + \mathbf{8}$
$10 + 4 = 6 + 8$
$14 = 14$

C.1. **8**

C.2. $7 + 6 + 6 + 3 + 3 = 10 + 7 + \mathbf{8}$
$7 + 18 = 17 + 8$
$25 = 25$

D.1. **2**

D.2. $4 + 4 + 2 + 2 + 2 = 5 + 7 + \mathbf{2}$
$8 + 6 = 12 + 2$
$14 = 14$

E.1. **3**

E.2. $10 + 4 + 4 + 4 = 10 + 3 + 3 + 3 + \mathbf{3}$
$10 + 12 = 10 + 12$
$22 = 22$

F.1. **3**

F.2. $9 + 8 + 7 + 5 + 5 + 5 = 2 + 2 + 2 + 6 + 8 + 8 + 8 + \mathbf{3}$
$24 + 15 = 36 + 3$
$39 = 39$

Sample resources

Patterns, Functions, and Algebra Staff Development Module – Available at the VDOE Web site.

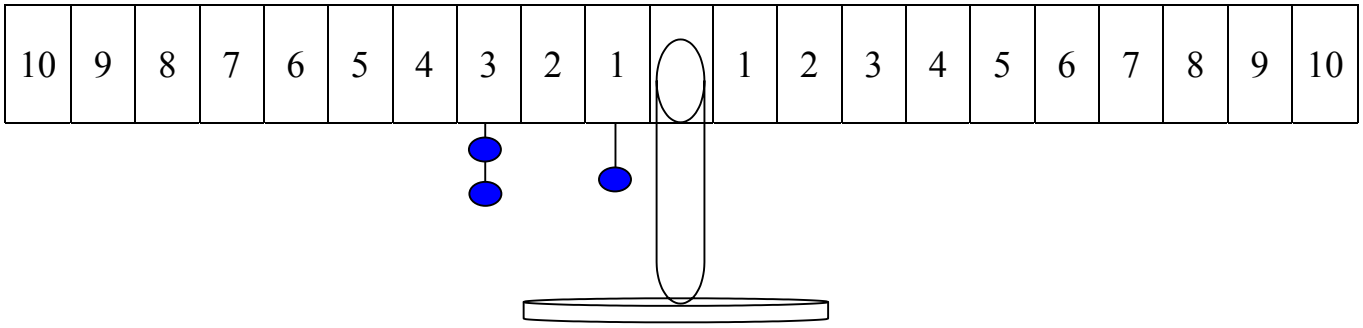
http://standards.nctm.org/document/chapter5/alg.htm#bp1 – NCTM Principles and Standards information related to the Algebra strand in Grades 3–5.

http://www.pbs.org/teachersource/mathline/lessonplans/atmp/snake/snake_procedure.shtm – Students describe, use and extend several stages of an imaginary snake's growth pattern.

http://www.illuminations.nctm.org/lessonplans/3-5/variablemach/index.html – A lesson plan that provides an introduction to the use of variables.

Balance Beams

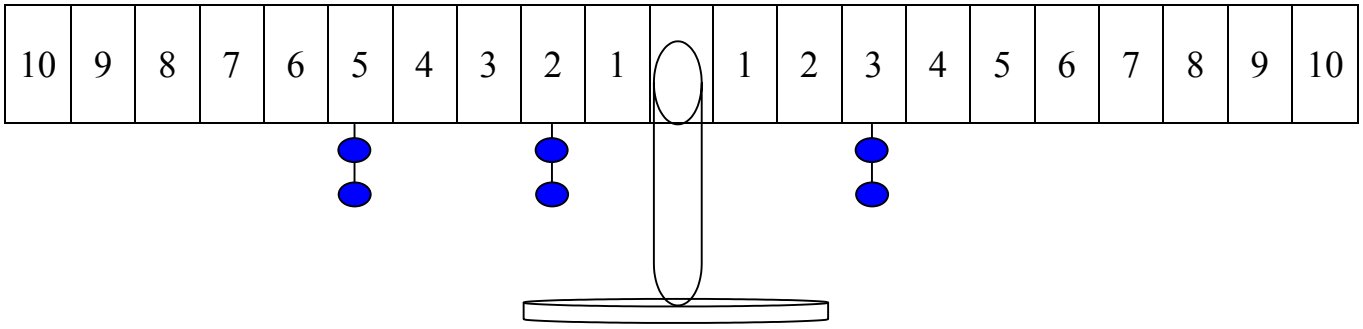
Balance A



Each mass weighs 1 ounce. Put one mass on the right side to make the beam balance.

1. The mass should hang from number _____ on the right side.
2. Give an equation to explain your answer.

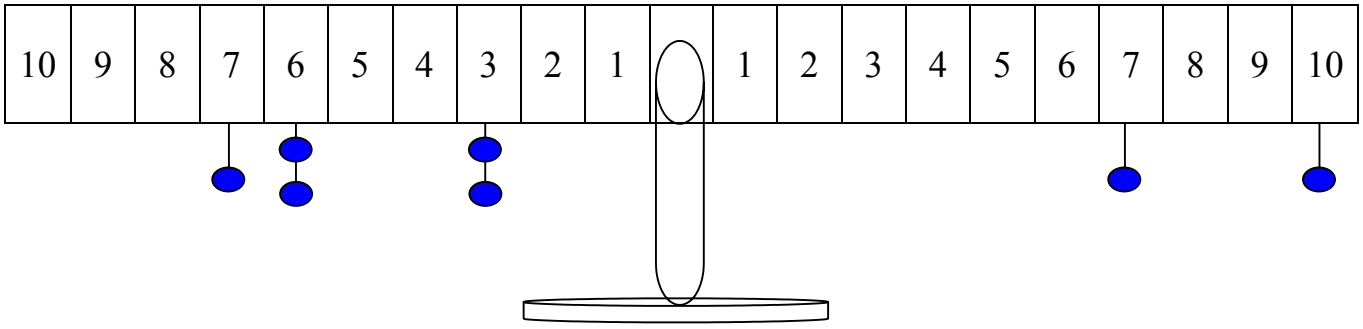
Balance B



Each mass weighs 1 ounce. Put one mass on the right side to make the beam balance.

1. The mass should hang from number _____ on the right side.
2. Give an equation to explain your answer.

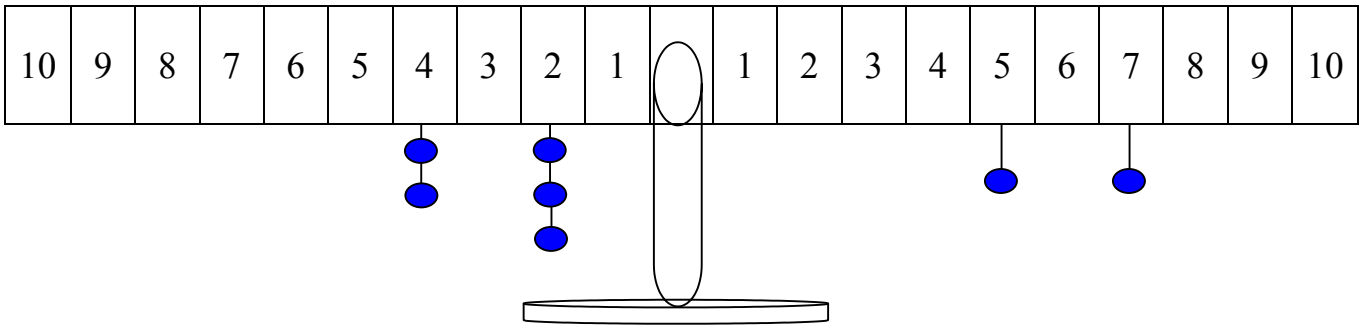
Balance C



Each mass weighs 1 ounce. Put one mass on the right side to make the beam balance.

1. The mass should hang from number _____ on the right side.
2. Give an equation to explain your answer.

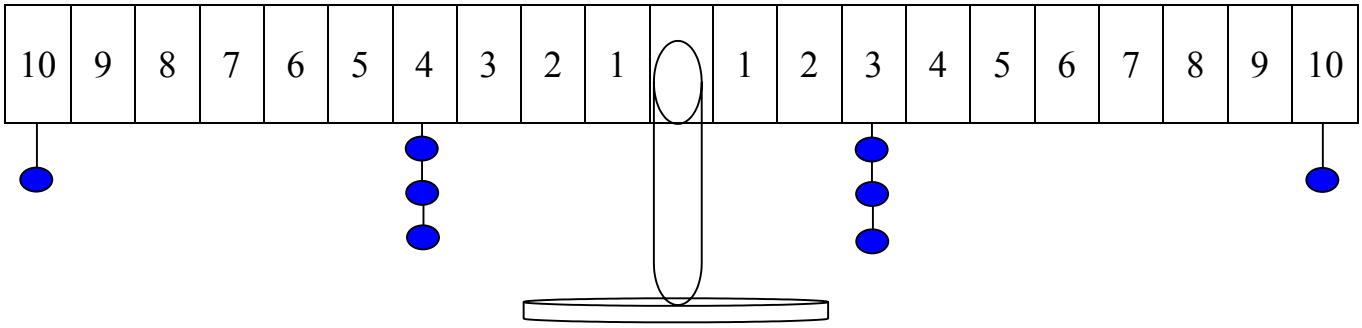
Balance D



Each mass weighs 1 ounce. Put one mass on the right side to make the beam balance.

1. The mass should hang from number _____ on the right side.
2. Give an equation to explain your answer.

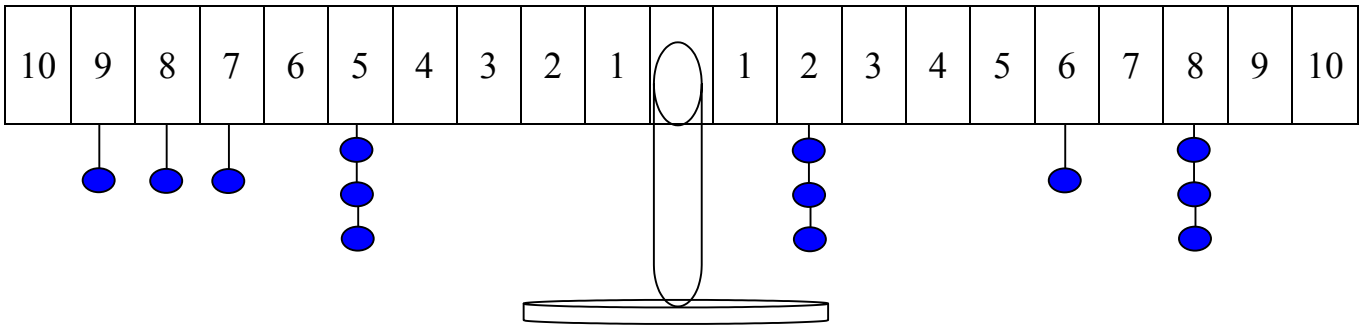
Balance E



Each mass weighs 1 ounce. Put one mass on the right side to make the beam balance.

1. The mass should hang from number _____ on the right side.
2. Give an equation to explain your answer.

Balance F

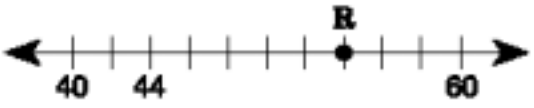


Each mass weighs 1 ounce. Put one mass on the right side to make the beam balance.

1. The mass should hang from number _____ on the right side.
2. Give an equation to explain your answer.

Released SOL test items

41 **Which *best describes* the location of point R on the number line shown below?**



A 49
B 50
C 54
D 58

42 **The table shows the cost of tickets to a museum. The cost per ticket does not change.**

Museum Tickets

Number of Tickets	Total Cost
1	$2.75
2	$5.50
3	?
4	$11.00
5	$13.75

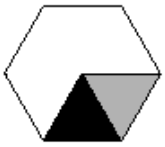
Based on the pattern in the table, what will be the total cost of 3 tickets?

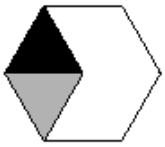
F $7.25
G $7.75
H $8.25
J $8.50

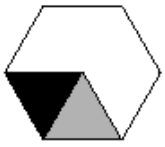
43 **Look at the pattern below.**

If this pattern continues, what will be the next figure?

A 

B 

C 

D 

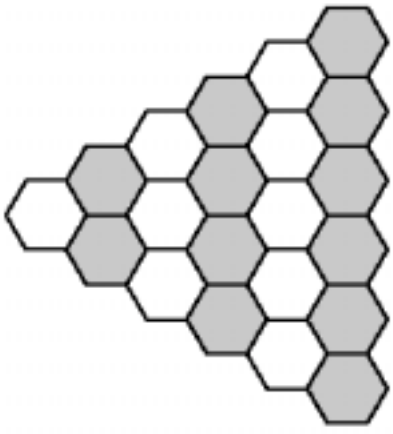
44 Jasper took all the books out of a box and arranged them on two shelves. He put the same number of books on each shelf. If *B* represents the number of books that were in the box, which of the following could be used to find the number of books Jasper put on each shelf?

F $B + 2$
G $B - 2$
H $B \times 2$
J $B \div 2$

46 1, 10, 100, 1,000,
If this pattern of numbers continues, what should be the next number in the pattern?

F 10,000
G 1,110
H 1,100
J 1,001

45 Andi is using white and gray tiles to make the pattern shown below.



If she continues the pattern in the same way, how many tiles will be in the next column of *gray* tiles?

A 7
B 8
C 10
D 12

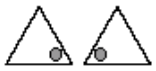
50 Which describes a rule that the number machine could be using?

F Multiply by 4; add 1
G Divide by 4; add 1
H Subtract 7
J Add 7

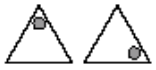
47 Look at the pattern of shapes shown below.

If the pattern continues, what will the next 2 shapes look like?

A 

B 

C 

D 

48 **The table shows the cost of milkshakes at an ice cream store.**

Milkshake Costs

Number of Milkshakes	Total Cost
1	$2.50
2	$5.00
3	$7.50
4	$10.00
5	$12.50
6	?

If the pattern in the table continues, what will be the total cost for 6 milkshakes?

F $15.00
G $14.50
H $13.50
J $13.00

44 **Look at the pattern of shapes below.**

If the pattern continues in the same way, what will be the next shape?

F 

G 

H 

J 

46 **Lexi had 6 fish in he fish tank. Her dad bought her some more fish. After that, Lexi had 14 fish in her tank. How many fish did Lexi's dad buy for her?**

F 8
G 9
H 12
J 20

45 **The table below shows the number of paddles Mr. Watson must order for different numbers of canoes.**

Number of Canoes	2	4	6	8	10
Number of Paddles	4	8	12	16	?

If the pattern in the table continues, how many paddles must be ordered for 10 canoes?

A 17
B 18
C 20
D 23

47 **The table below shows the cost of different numbers of rulers.**

Ruler Costs

Number of Rulers	Total Cost
1	25¢
2	50¢
3	75¢
4	$1.00
5	$1.25
6	?

If the pattern in the table continues, what will 6 rulers cost?

A $1.30
B $1.50
C $1.75
D $2.00

43 **If the pattern shown below continues, what will be the next number?**

8, 13, 11, 16, 14, ...

A 19
B 18
C 12
D 9

42

What number belongs at the position indicated by arrow X?

F 97
G 101
H 102
J 105

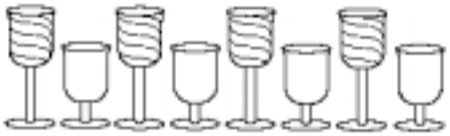
44 **If *B* represents a number, which means "a number divided by 9?"**

F $B + 9$
G $B - 9$
H $9 \div B$
J $B \div 9$

50 **Elizabeth made 3 times as many home runs during baseball season as her friend Tanya. If *R* represents the number of home runs Tanya made, which expression can be used to find the number of home runs Elizabeth made this season?**

F $R + 3$
G $R - 3$
H $R \times 3$
J $R \div 3$

49 **Look at the pattern of shapes below.**



Which of the following shows the same kind of pattern?

A

B

C

D

46

If this pattern continues, what will the *eleventh* shape look like?

F

G

H

J

Sample Problems from the National Assessment of Educational Progress (NAEP)

Here is part of a wall chart that lists numbers from 1 to 100.

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25					

Below is part of the same wall chart. What number should be in the box with the question mark inside?

43
53
?

A. 34
B. 44
C. 54
D. 64

Here is the beginning of the pattern of tiles.

Figure 1 Figure 2 Figure 3

If the pattern continues, how many tiles will be in figure 6?

A. 12
B. 15
C. 18
D. 21

Which pair of numbers follows the rule "Multiply the first number by 5 to get the second number?

A. $15 \rightarrow 3$

B. $6 \rightarrow 11$

C. $11 \rightarrow 6$

D. $3 \rightarrow 15$

These numbers are part of a pattern.

50 , 46 , 42 , 38 , 34 , ...

What do you have to do to get the next number?

Answer: _____

If c - 4 = 7 where c = the number of cars in the parking lot this morning, which of the following is true?

A. There were three cars in the parking lot this morning.

B. After 4 cars arrived there were 7 cars left.

C. After 4 cars drove away there were 7 cars left.

D. After 7 cars arrived there were 4 cars left.

These numbers are part of a pattern.

50 , 46 , 42 , 38 , 34 , ...

What do you have to do to get the next number?

A. Add 4

B. Subtract 2

C. Add 2

D. Subtract 4

These steps are arranged in a pattern.

O Δ O O Δ Δ O O O Δ Δ Δ

Which set of shapes is arranged in the same pattern?

A. ★ □★□★★□□★★□□

B. □★□□★□□□★□□□

C. ★□★★□□★★★□□□

D. □□★★□★□□★★□★

Tanya has read the first 78 pages in a book that is 130 pages long. Which number sentence could Tanya use to find the number of pages she must read to finish the book?

A. 130+78 = □

B. □- 78 = 130

C. 130 ÷ 78= □

D. 130 - 78= □

What do you have to do to each number in Column A to get the number next to it in Column B?

Column A	Column B
10	2
15	3
25	5
50	10

A. Add 8 to the number in Column A.

B. Subtract 8 from the number in Column A.

C. Multiply the number in Column A by 5.

D. Divide the number in Column A by 5.