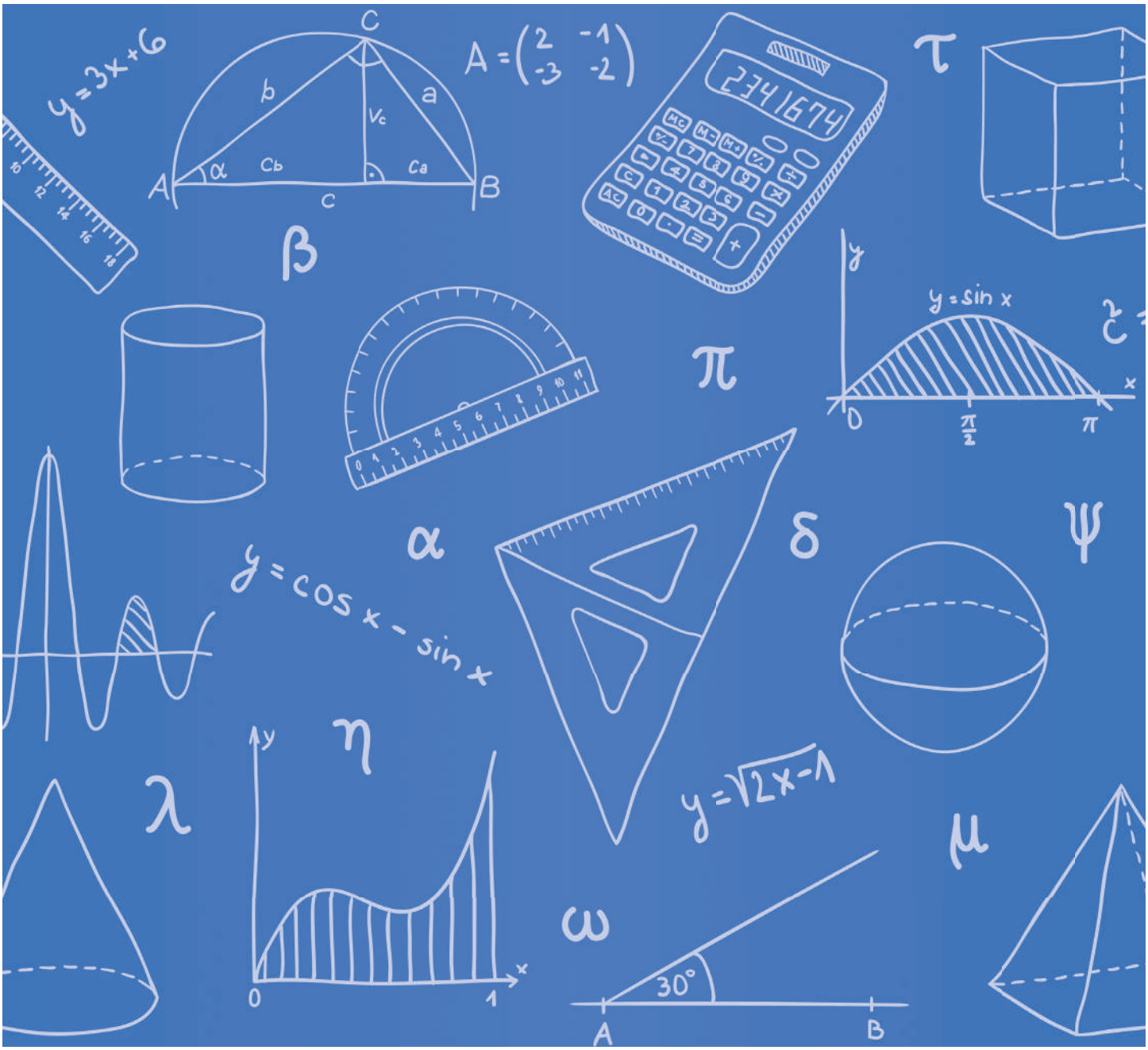
GRADE
5

LESSONS FOR LEARNING

FOR THE COMMON CORE STATE STANDARDS IN MATHEMATICS



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M0910

Fifth Grade – Standards

1. **Developing fluency with addition and subtraction of fractions, developing understanding of the multiplication of fractions and of division of fractions in limited cases (unit fractions divided by whole numbers and whole numbers divided by unit fractions)** – Students apply their understanding of fractions and fraction models to represent the addition and subtraction of fractions with unlike denominators as equivalent calculations with like denominators. They develop fluency in calculating sums and differences of fractions, and make reasonable estimates of them. Students also use the meaning of fractions, of multiplication and division, and the relationship between multiplication and division to understand and explain why the procedures for multiplying and dividing fractions make sense. (Note: this is limited to the case of dividing unit fractions by whole numbers and whole numbers by unit fractions.)
2. **Extending division to 2-digit divisors, integrating decimal fractions into the place value system and developing understanding of operations with decimals to hundredths, and developing fluency with whole number and decimal operation** – Students develop understanding of why division procedures work based on the meaning of base-ten numerals and properties of operations. They finalize fluency with multi-digit addition, subtraction, multiplication, and division. They apply their understandings of models for decimals, decimal notation, and properties of operations to add and subtract decimals to hundredths. They develop fluency in these computations, and make reasonable estimates of their results. Students use the relationship between decimals and fractions, as well as the relationship between finite decimals and whole numbers (i.e., a finite decimal multiplied by an appropriate power of 10 is a whole number), to understand and explain why the procedures for multiplying and dividing finite decimals make sense. They compute products and quotients of decimals to hundredths efficiently and accurately.
3. **Developing understanding of volume** – Students recognize volume as an attribute of three-dimensional space. They understand that volume can be quantified by finding the total number of same-size units of volume required to fill the space without gaps or overlaps. They understand that a 1-unit by 1-unit by 1-unit cube is the standard unit for measuring volume. They select appropriate units, strategies, and tools for solving problems that involve estimating and measuring volume. They decompose three-dimensional shapes and find volumes of right rectangular prisms by viewing them as decomposed into layers of arrays of cubes. They measure necessary attributes of shapes in order to solve real world and mathematical problems.

MATHEMATICAL PRACTICES

1. **Make sense of problems and persevere in solving them.**
2. **Reason abstractly and quantitatively.**
3. **Construct viable arguments and critique the reasoning of others.**
4. **Model with mathematics.**
5. **Use appropriate tools strategically.**
6. **Attend to precision.**
7. **Look for and make use of structure.**
8. **Look for and express regularity in repeated reasoning.**

OPERATIONS AND ALGEBRAIC THINKING

Write and interpret numerical expressions.

5.OA.1 Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.

5.OA.2 Write simple expressions that record calculations with numbers, and interpret numerical expressions without evaluating them. *For example, express the calculation "add 8 and 7, then multiply by 2" as 2 × (8 + 7). Recognize that 3 × (18932 + 921) is three times as large as 18932 + 921, without having to calculate the indicated sum or product.*

Analyze patterns and relationships.

5.OA.3 Generate two numerical patterns using two given rules. Identify apparent relationships between corresponding terms. Form ordered pairs consisting of corresponding terms from the two patterns, and graph the ordered pairs on a coordinate plane. *For example, given the rule "Add 3" and the starting number 0, and given the rule "Add 6" and the starting number 0, generate terms in the resulting sequences, and observe that the terms in one sequence are twice the corresponding terms in the other sequence. Explain informally why this is so.*

NUMBER AND OPERATIONS IN BASE TEN

Understand the place value system.

5.NBT.1 Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left.

5.NBT.2 Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.

5.NBT.3: Read, write, and compare decimals to thousandths.

a. Read and write decimals to thousandths using base-ten numerals, number names, and expanded form, e.g., 347.392 = 3 × 100 + 4 × 10 + 7 × 1 + 3 × (1/10) + 9 × (1/100) + 2 × (1/1000).

b. Compare two decimals to thousandths based on meanings of the digits in each place, using >, =, and < symbols to record the results of comparisons.

5.NBT.4 Use place value understanding to round decimals to any place.

Perform operations with multi-digit whole numbers and with decimals to hundredths.

5.NBT.5 Fluently multiply multi-digit whole numbers using the standard algorithm.

5.NBT.6 Find whole-number quotients of whole numbers with up to four-digit dividends and two-digit divisors, using strategies based on place value, the properties of operations, and/or the relationship between multiplication and division. Illustrate and explain the calculation by using equations, rectangular arrays, and/or area models.

5.NBT.7 Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.

NUMBER AND OPERATIONS – FRACTIONS

Use equivalent fractions as a strategy to add and subtract fractions.

5.NF.1 Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. *For example, 2/3 + 5/4 = 8/12 + 15/12 = 23/12. (In general, a/b + c/d = (ad + bc)/bd.)*

5.NF.2 Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers. *For example, recognize an incorrect result 2/5 + 1/2 = 3/7, by observing that 3/7 < 1/2.*

Apply and extend previous understandings of multiplication and division to multiply and divide fractions.

5.NF.3 Interpret a fraction as division of the numerator by the denominator (a/b = a ÷ b). Solve word problems involving division of whole numbers leading to answers in the form of fractions or mixed numbers, e.g., by using visual fraction models or equations to represent the problem. *For example, interpret 3/4 as the result of dividing 3 by 4, noting that 3/4 multiplied by 4 equals 3, and that when*

3 wholes are shared equally among 4 people each person has a share of size 3/4. If 9 people want to share a 50-pound sack of rice equally by weight, how many pounds of rice should each person get? Between what two whole numbers does your answer lie?

5.NF.4 Apply and extend previous understandings of multiplication to multiply a fraction or whole number by a fraction.

a. Interpret the product $(a/b) \times q$ as a parts of a partition of q into b equal parts; equivalently, as the result of a sequence of operations $a \times q \div b$. *For example, use a visual fraction model to show* $(2/3) \times 4 = 8/3$, *and create a story context for this equation. Do the same with* $(2/3) \times (4/5) = 8/15$. *(In general,* $(a/b) \times (c/d) = ac/bd$.*)*

b. Find the area of a rectangle with fractional side lengths by tiling it with unit squares of the appropriate unit fraction side lengths, and show that the area is the same as would be found by multiplying the side lengths. Multiply fractional side lengths to find areas of rectangles, and represent fraction products as rectangular areas.

5.NF.5: Interpret multiplication as scaling (resizing), by:

a. Comparing the size of a product to the size of one factor on the basis of the size of the other factor, without performing the indicated multiplication.

b. Explaining why multiplying a given number by a fraction greater than 1 results in a product greater than the given number (recognizing multiplication by whole numbers greater than 1 as a familiar case); explaining why multiplying a given number by a fraction less than 1 results in a product smaller than the given number; and relating the principle of fraction equivalence $a/b = (n \times a)/(n \times b)$ to the effect of multiplying a/b by 1.

5.NF.6 Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem.

5.NF.7 Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions. (Note: Students able to multiply fractions in general can develop strategies to divide fractions in general, by reasoning about the relationship between multiplication and division. But division of a fraction by a fraction is not a requirement at this grade.)

a. Interpret division of a unit fraction by a non-zero whole number, and compute such quotients. *For example, create a story context for* $(1/3) \div 4$, *and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that* $(1/3) \div 4 = 1/12$ *because* $(1/12) \times 4 = 1/3$.

b. Interpret division of a whole number by a unit fraction, and compute such quotients. *For example, create a story context for* $4 \div (1/5)$, *and use a visual fraction model to show the quotient. Use the relationship between multiplication and division to explain that* $4 \div (1/5) = 20$ *because* $20 \times (1/5) = 4$.

c. Solve real world problems involving division of unit fractions by non-zero whole numbers and division of whole numbers by unit fractions, e.g., by using visual fraction models and equations to represent the problem. *For example, how much chocolate will each person get if 3 people share 1/2 lb of chocolate equally? How many 1/3-cup servings are in 2 cups of raisins?*

MEASUREMENT AND DATA

Convert like measurement units within a given measurement system.

5.MD.1 Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.

Represent and interpret data.

5.MD.2 Make a line plot to display a data set of measurements in fractions of a unit (1/2, 1/4, 1/8). Use operations on fractions for this grade to solve problems involving information presented in line plots. *For example, given different measurements of liquid in identical beakers, find the amount of liquid each beaker would contain if the total amount in all the beakers were redistributed equally.*

Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.

5.MD.3 Recognize volume as an attribute of solid figures and understand concepts of volume measurement.

a. A cube with side length 1 unit, called a "unit cube," is said to have "one cubic unit" of volume, and can be used to measure volume.

b. A solid figure which can be packed without gaps or overlaps using n unit cubes is said to have a volume of n cubic units.

5.MD.4 Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units.

5.MD.5 Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.

a. Find the volume of a right rectangular prism with whole-number side lengths by packing it with unit cubes, and show that the volume is the same as would be found by multiplying the edge lengths, equivalently by multiplying the height by the area of the base. Represent threefold whole-number products as volumes, e.g., to represent the associative property of multiplication.

b. Apply the formulas $V = l \times w \times h$ *and* $V = b \times h$ for rectangular prisms to find volumes of right rectangular prisms with whole-number edge lengths in the context of solving real world and mathematical problems.

c. Recognize volume as additive. Find volumes of solid figures composed of two non-overlapping right rectangular prisms by adding the volumes of the non-overlapping parts, applying this technique to solve real world problems.

GEOMETRY

Graph points on the coordinate plane to solve real-world and mathematical problems.

5.G.1 Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., x-axis and x-coordinate, y-axis and y-coordinate).

5.G.2 Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

Classify two-dimensional figures into categories based on their properties.

5.G.3 Understand that attributes belonging to a category of two-dimensional figures also belong to all subcategories of that category. *For example, all rectangles have four right angles and squares are rectangles, so all squares have four right angles.*

5.G.4 Classify two-dimensional figures in a hierarchy based on properties.

Spin and Race

Common Core Standard:

Use equivalent fractions as a strategy to add and subtract fractions

5.NF.1 Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. For example, 2/3 + 5/4 = 8/12 + 15/12 = 23/12. (In general, a/b + c/d = (ad + bc)/bd.)

Additional/Supporting Standards:

5.NF.2 Use equivalent fractions as a strategy to add and subtract fractions

Standards for Mathematical Practice:

2. Reason abstractly and quantitatively
6. Attend to precision
8. Look for and make use of repeated reasoning

Student Outcomes:

- I can use common denominators to add fractions including mixed numbers
- I can compare fractions to determine which is largest

Materials:

- Spin and Race Fraction Spinners (1 spinner sheet per group)
- Paper clips (1 per group)
- Spin and Race Recording Sheet (one half sheet per student)

Advance Preparation:

- Copy the Spin and Race Fraction Spinners
- Gather paper clips
- Copy the Spin and Race Recording Sheet
- Consider how you will group students
- Students should be able to add fractions with unlike denominators, including mixed numbers

Directions:

1. This game provides practice for adding fractions.
2. Students should play in pairs or groups of 3.
3. To play each student spins both spinners and records the fractions in the chart. To complete their turn, they record the sum of the two fractions.
4. After each player takes five turns, each student should add their five sums to get a Final Score. Most Final Scores can be represented as mixed numbers.
5. The student with the largest Final Score wins the game.

Questions to Pose:

Before:

- Which strategy for adding fractions with unlike denominators do you prefer? Why?

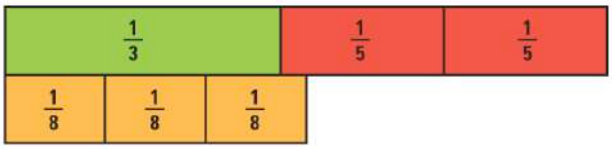
During:

- Which strategy are you using? Why did you choose that strategy?
- Why do you need to use common denominators when adding fractions?
- How did you decide which denominator to use?

After:

- What did you do when your answer was greater than one? Explain your reasoning.
- Which denominators did you use frequently? Why do you think these denominators were more common?

Possible Misconceptions/Suggestions:

Possible Misconceptions	Suggestions
Student has trouble finding equivalent fractions and/or common denominators	Students should work with models such as pattern blocks, fraction strips, fraction circles, and number lines to explore equivalent fractions. For example 1 trapezoid (1/2) is equivalent to 3 triangles (3/6). Record many examples and help the student observe how multiplication is related to equivalent fractions.
Student adds both the numerator and denominator. For example $\frac{1}{3} + \frac{2}{5} = \frac{3}{8}$	Using a fraction model such as bars, strips, or circles demonstrate the following:  Therefore $\frac{1}{3} + \frac{2}{5} \neq \frac{3}{8}$ Ask the student to explain how this model proves that adding both the numerators and denominators does not accurately determine the sum.

Special Notes:

- To practice subtracting fractions, students should subtract fractions 1 and 2 from the Recording Sheet. At the end they will still need to add their five differences to receive a Final Score.
- Games should be played multiple times to increase fluency
- Discussion with students during and after the game should focus on why it is important to use common denominators, how common denominators can be quickly determined, and strategies for efficiently adding fractions, including mixed numbers.

Solutions: NA

Spin and Race Recording Sheet

Fraction 1	Fraction 2	Total for this turn

Directions: On each turn spin both spinners. Then add both fractions. After 5 turns, add all your totals to get your Final Score. The winner is the person with the largest Final Score.

FINAL SCORE: _____

Spin and Race Recording Sheet

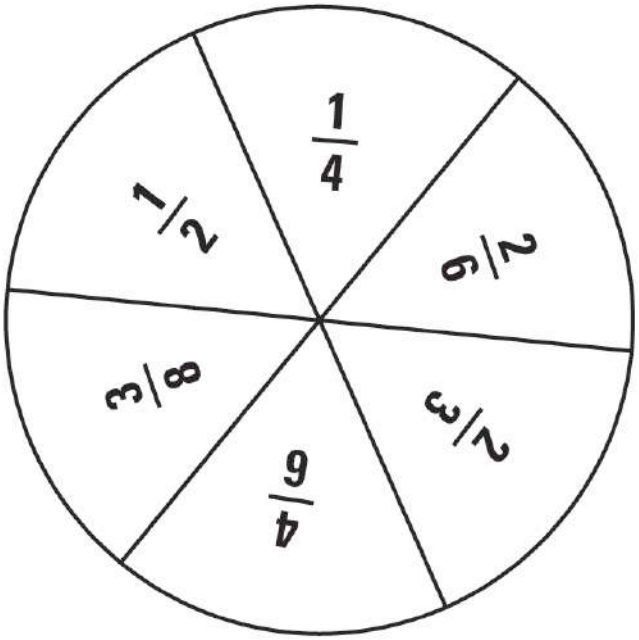
Fraction 1	Fraction 2	Total for this turn

Directions: On each turn spin both spinners. Then add both fractions. After 5 turns, add all your totals to get your Final Score. The winner is the person with the largest Final Score.

FINAL SCORE: _____

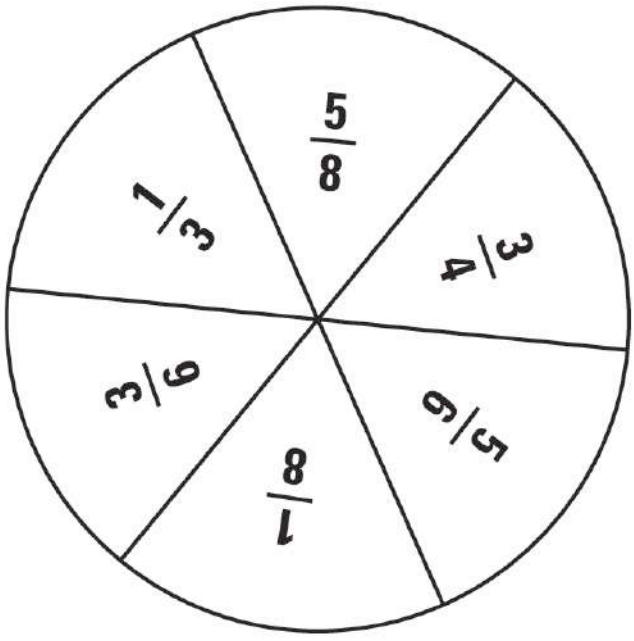
Spin and Race
Fraction Spinners

Fraction 1



To use the spinners, you will need a paper clip and a pencil. Put the paper clip down with one end on the center of the spinner. Put the point of the pencil inside the paper clip at the center. Use your fingers to spin the paper clip.

Fraction 2



Building Powers of Ten

Common Core Standard:

Understand the place value system.

5.NBT.2 Explain patterns in the number of zeros of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.

Additional/Supporting Standards:

5.NBT.1, **5.NBT.3** Understand the place value system.

5.NBT.5 Perform operations with multi-digit whole numbers and with decimals to hundredths.

Standards for Mathematical Practice:

2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
7. Look for and make use of structure

Student Outcomes:

- I can make models of several powers of ten
- I can demonstrate the meaning of exponential form
- I can make conjectures about patterns in powers of ten

Materials:

- Base-ten blocks
- Powers of Ten Sheet (one per student)

Advance Preparation:

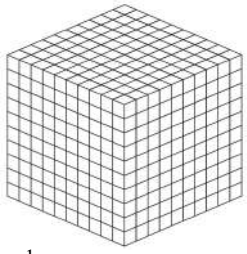
- Make copies of the Powers of Ten Sheet
- Gather base-ten blocks
- Consider how you will pair students
- Students should be familiar with base-ten blocks and have a strong understanding of place value to 100,000
- Students should have experience multiplying with tens
- Students should have experience building square arrays such as 3^2
- Students should be familiar with square numbers

Directions:

1. "How could you represent 10 x 10?" Allow many student suggestions. If no one suggests a base-ten block, ask how these blocks could be used to show 10 x 10
2. Show students the flat base-ten block (sometimes called a "hundreds block"). "What shape is this block?" "Why does it make sense that it is a square?"

3. Distribute base-ten blocks to each student. Have the students use their blocks to prove that 10 x 10 = 100 and that this array forms a square. Students make need to share materials and work together.

4. On the board write the following: $10 \times 10 = 10^2$
   Tell students that 10^2 is read "ten squared." Ask the class to explain how it might have gotten that name (the array for 10 x 10 is a square).
5. Distribute the Powers of Ten chart to each student. Point out that they have just worked on the first row.
6. Ask students to use their blocks to build 10 x 10 x 10. Have students share their strategies. Did they recognize that this could be rewritten as 10 x 100 and could be built as ten hundreds blocks stacked into a cube?
7. On the board write the following: $10 \times 10 \times 10 = 10^3$
   Tell the class that 10^3 is read "ten cubed." Ask the class to explain how it might have gotten that name (the base-ten blocks form a cube of 10 flats).



8. Continue the chart by working with 10^1. Allow students to debate with one another how this might be written and built. Help the students make connections between the number of tens being multiplied and the number used in the exponent.
   10 x 10 multiplies two tens, so the exponent is a 2
   10 x 10 x 10 multiplies three tens so the exponent is a 3
   10^1 has an exponent of one, so it must have only one 10
9. Explain to the students that 10^1 tells us that we are working with one ten. On the board write the following: $10 = 10^1$
   Students can use a tens block (rod) to show 10^1
10. Challenge students to try the next row in their chart with a neighbor. Allow the students ample time to struggle with the work. As you circulate, listen to see if students are making connections to the exponents that they have already explored.
11. When most have finished invite students to share their thinking about 10^4. The students are likely to have a variety of answers. Engage a lively debate by asking students to justify their thinking and explain their reasoning. Students may question one another. They may use blocks, observations, patterns, and logic to prove their answer.
12. At a reasonable stopping point, help students see that 10^4 is written as 10 x 10 x 10 x 10
    This might be written in words as "ten to the fourth power." A picture is not necessary here.
    Write on the board: $10 \times 10 \times 10 \times 10 = 10^4$
13. For the final row of the chart, have students work with their partner. Then engage the class in another discussion of reasoning.
14. To summarize, ask students to complete the "I Discovered That…" section of the recording sheet. Ask students, "What pattern do you notice?" Students should see that each the number of zeros is changing. Ask students to explain why this pattern makes sense.

Questions to Pose:

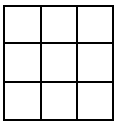
As Students Work

- How did you figure out that…?
- How could you represent that with blocks?
- How could you represent that with multiplication?

In Class Discussion

- Why might some people think that $10^4 = 40$? Where is the error in their reasoning?
- What patterns do you notice in the standard notations?
- Why does this pattern make sense?

Possible Misconceptions/Suggestions:

Possible Misconceptions	Suggestions
Students think of the exponents as factors. For example: $10^3 = 10 \times 3$ $10^1 = 10 \times 1$	• Students should build square arrays and record them as exponents. For example:  $3 \times 3 = 3^2$ • Return to $10 \times 10 = 100$. Use the flat base-ten block to show that 10×10 creates a square array. Explain that mathematicians shortened 10×10 to 10^2. Observe that 10^2 is not the same as 10×2, but that it represents 10×10. Make note of the location and size of the exponent. Connect these observations with other exponents.

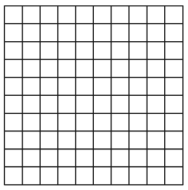
Special Notes:

- Before this lesson, students should conduct an investigation of square numbers using arrays. See the suggestions in above table.
- A follow up lesson should support students as they apply their understanding of powers of ten to create scientific notations such as $4 \times 10^3 = 4{,}000$

Solutions: Note – Students may also use the phrase "ten to the power of ____"

Multiplication Expression	Words and/or Pictures	Exponential Notation	Standard Notation
10 x 10 x 10	 ten cubed	10^3	1,000
10		10^1	10
10 x 10 x 10 x 10	ten to the fourth power	10^4	10,000
10 x 10 x 10 x 10 x 10	ten to the fifth power	10^5	100,000

Building Powers of 10

Multiplication Expression	Words and/or Pictures	Exponential Notation	Standard Notation
10 x 10	 ten squared	10^2	100
10 x10 x 10			
		10^1	
		10^4	
		10^5	

I Discovered That:

10^1 = _____

10^2 = _____

10^3 = _____

10^4 = _____

10^5 = _____

Decimal Clue Conundrum

Common Core Standard:

Understand the place value system.

5.NBT.3 Read, write, and compare decimals to thousandths.

- Read and write decimals to thousandths using base-ten numerals, number names, and expanded form, e.g., 347.392 = 3 × 100 + 4 × 10 + 7 × 1 + 3 × (1/10) + 9 × (1/100) + 2 × (1/1000).
- Compare two decimals to thousandths based on meanings of the digits in each place, using >, =, and < symbols to record the results of comparisons.

Additional/Supporting Standard:

5.NBT.4 Understand the place value system

Standards for Mathematical Practice:

2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
7. Look for and make use of structure

Student Outcomes:

- I can compose decimals that are in between two numbers
- I can use comparison and place value to compose decimals
- I can represent decimals in many ways

Materials:

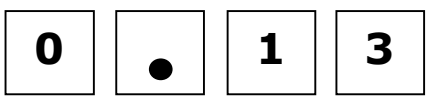
- Number cards 0-9 (one set per student)
- Decimal point and direction cards (one of each per student)
- Decimal Clue cards (one set per group)

Advance Preparation:

- Copy and cut number, direction, and decimal cards.
- Consider how you will group students
- Students should have ample experience representing decimals in many ways
- Students should have some experience comparing decimals

Directions:

1. Students work in groups of 3.
2. Each student needs number cards 0-9, a decimal point card, and a directions card.
3. Each group of students needs a stack of Decimal Clue cards to share.
4. Groups should set the Decimal Clue cards face down in the center of their group.
5. Each student should take one Decimal Clue card. The student should use their number cards to Decimal Clue that according to the clue on the card.

   For example: "Build a number between 0.1 and 0.2" 

6. When everyone in the group has built their decimal, they should take turns sharing their Decimal Clue card and explaining how their decimal fits the clue on the card. Group members should discuss whether they agree or disagree.
7. Now the students should put their 3 clues together and try to create one decimal that fits all 3 clues.
8. Once they find a decimal that fits the clues, they should write their decimal on a record sheet or white board using 3 additional representations. Possible representations include: as a fraction, in words, as a picture, on a number line, or in expanded form.
9. When the group has finished, the students should raise their hands to indicate that they are ready to share their work with the teacher. As you examine student work, pose the questions listed below.
10. When the teacher is finished examining the student work, the group may draw 3 new cards and repeat the process:
    1. Build a number that fits *your clue*
    2. Share with your group
    3. As a group build a number that fits all 3 clues
    4. Represent the decimal in 3 additional ways
    (If it is impossible to build a number that meets all 3 clues, explain why.)

Questions to Pose:

- How did you figure out that this decimal fits the clue?
- How can you prove that this decimal makes sense?
- How could your answer be different if this clue was removed?
- Create a clue you could add to the set that would make the decimal impossible.

Possible Misconceptions/Suggestions:

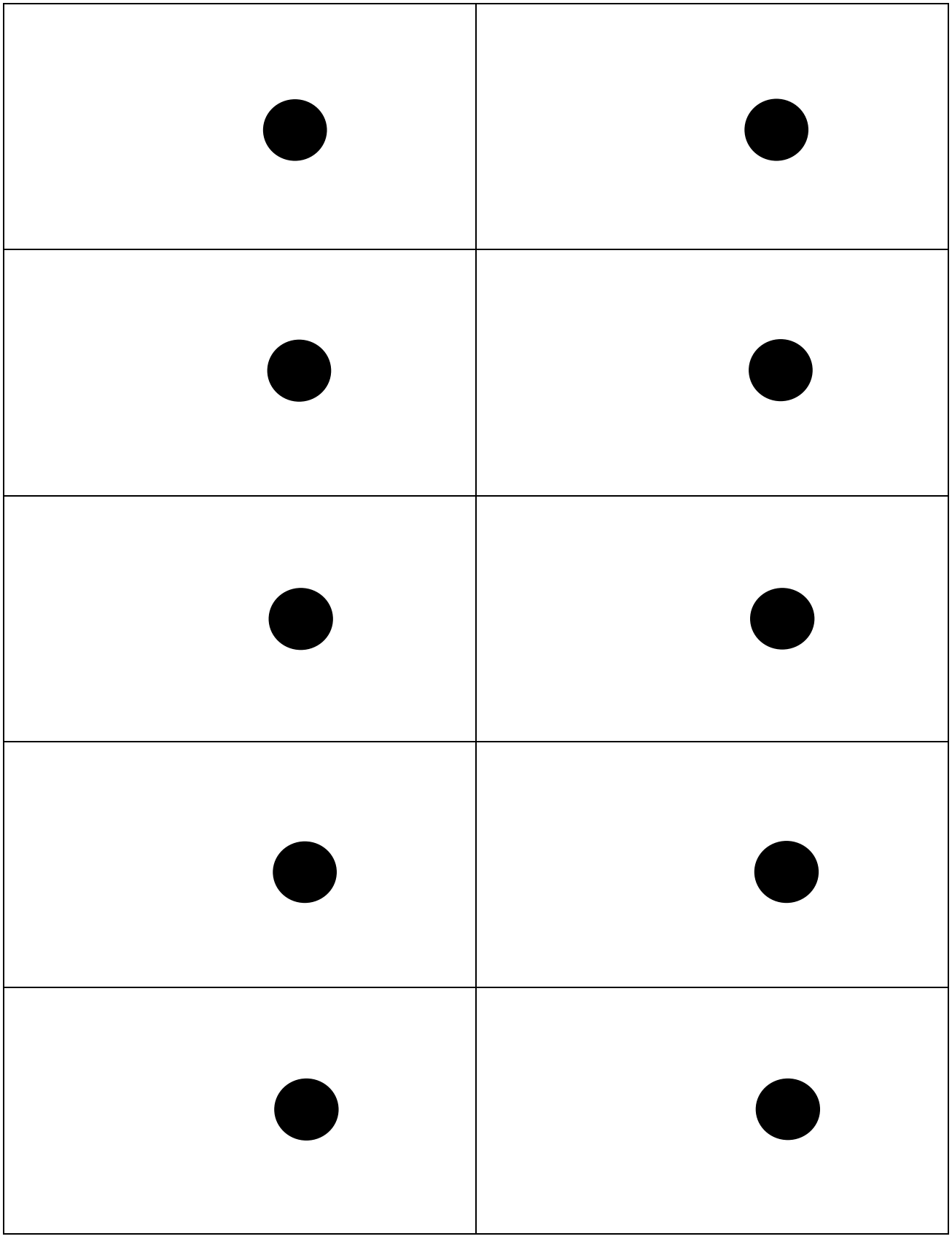
Possible Misconceptions	Suggestions
Student has difficulty comparing decimals	Student should have ample experience building decimals with blocks, shading on decimal grids, and using number lines. Use one of these models to represent two decimals. Now the student can make a visual comparison.
Student has difficulty representing the decimal in 3 ways	Make a list of possible representations on the board for the students to refer to during the task Suggest that the student focus on three models: shade on a grid, write in expanded form, and place on a number line. These representations are especially helpful for strengthening student understanding of decimals.

Special Notes:

- This task can be adapted to include cards with scientific notation
- During this task, students will work more cooperatively if they are grouped with others of similar ability.

Solutions: NA

5	0
9	1
7	2
8	3
6	4



Decimal Clue Conundrum Directions 1. Build a number that fits your clue 2. Share with your group 3. As a group build a number that fits all 3 clues 4. Represent the decimal 3 other ways **If it is impossible to build a number that meets all 3 clues, explain why.**	**Decimal Clue Conundrum Directions** 1. Build a number that fits your clue 2. Share with your group 3. As a group build a number that fits all 3 clues 4. Represent the decimal 3 other ways **If it is impossible to build a number that meets all 3 clues, explain why.**
Decimal Clue Conundrum Directions 1. Build a number that fits your clue 2. Share with your group 3. As a group build a number that fits all 3 clues 4. Represent the decimal 3 other ways **If it is impossible to build a number that meets all 3 clues, explain why.**	**Decimal Clue Conundrum Directions** 1. Build a number that fits your clue 2. Share with your group 3. As a group build a number that fits all 3 clues 4. Represent the decimal 3 other ways **If it is impossible to build a number that meets all 3 clues, explain why.**

Decimal Clue Cards

Build a number between zero and one-half	Build a number between 0.2 and 0.4
Build a number with 5 in the tenths place	Build a number with 3 in the hundredths place
Build a number greater than the value of two dimes	Build a number less than the value of one nickel
Build a number less than the value of a quarter and two dimes	Build a number greater than the value of three nickels and one penny
Build a number between the value of a quarter and two dimes	Build a number between the value of three nickels and one dime

Build a number greater than 0.75	Build a number where the digit in the ones place is half the size of the digit in the tenths place.
Build a number with an 8 in the thousandths place	Build a number that is between one and two
Build a number in which the digit in the tenths place is larger than the digit in the thousandths place	Build a number where the digit in the hundredths place is three times the digit in the ones place
Build a number with an odd digit in the hundredths place	Build a number with a digit in the tenths place that is less than 5
Build a number less than two where the sum of the digits is 9	Build a number with an even digit in the thousandths place

Introduction to Dividing with Fractions

Common Core Standard:

Apply and extend previous understandings of multiplication and division to multiply and divide fractions.

5.NF.7 Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions

Additional/Supporting Standard:

5.NBT.6 Perform operations with multi-digit whole numbers and with decimals to hundredths.

Standards for Mathematical Practice:

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
4. Model with mathematics
6. Attend to precision
7. Look for and make use of structure

Student Outcomes:

- I can create a visual representation for division
- I can relate division with whole numbers to division with fractions
- I can justify my reasoning when developing a strategy for division

Materials:

- Paper and markers for student posters

Advance Preparation:

- Consider how you will pair students
- Students should have abundant experience dividing with whole numbers
- Students should have a strong understanding of fractions as parts of a whole

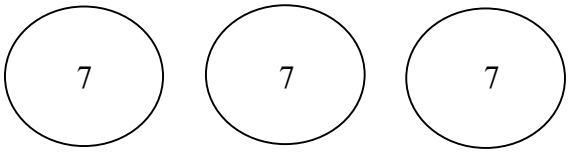
Directions:

1. The focus of this lesson should be on exploring the meaning of division by fractions. At no time should students use the "invert and multiply" method or find the reciprocal.

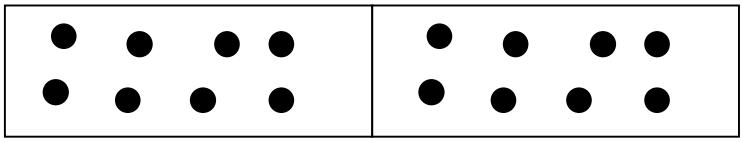
2. Stimulate student thinking about division by asking them to draw their own models for these problems:
    - Jimmy has 16 inches of ribbon. He is making bows for his sister's birthday gifts. If each bow requires 8 inches of ribbon, how many bows can he make?
    - Mary and her 2 friends go on a hike together. They plan to collect 21 leaves for a scrapbook. How many leaves should each person collect so they share the work equally?

3. After students have time to create their drawings, invite them to share their work with a neighbor. Then, ask a few students to share their representations with the whole class. Be sure to include models such as:

21 ÷ 3



16 ÷ 8



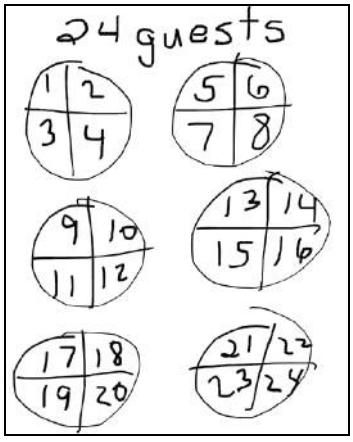
4. Use student work from these problems to facilitate a whole group discussion about the meaning of division. When we see a problem like 12 ÷ 4, today we will think about "*How many groups of 4 can be found in 12*?"

5. Tell students that today they will be applying their knowledge of division to fractions. Share this task: You are going to a birthday party. From the Sweet Tooth Ice Cream Factory, you order 6 pints of ice cream. If you serve ¼ of a pint of ice cream to each guest, how many guests can be served?

6. Allow students to struggle with this task since dividing with fractions is brand new to them. Encourage them to use whatever method makes the most sense to them. Circulate as they work independently and observe how students approach the problem.

7. Now pair students and instruct them to share their strategies. Encourage them to explain the mathematics they used and the reasoning behind their approaches. Each pair should agree on one strategy that they want to display for the class.

8. Each pair should create a poster on blank paper, chart paper, or poster board. Their poster should clearly show a representation of how they solved the problem. For example:



9. When students finish, display the posters and facilitate a discussion about the strategies students used. Do all the strategies make sense? How are the strategies similar to one

another? How are they different? How do these representations connect to dividing with whole numbers?

10. Finally, ask students why we would write this problem as 6 ÷ ¼. Students should see that we are asking "*How many groups of ¼ can be found in 6*?" Note that: When we divide with whole numbers, the answer is *smaller*. However, when we divide a whole number by a fraction, the answer is *larger*. How can this be?

Questions to Pose:

Before:

- What do we mean when we say "divide?"

During:

- How did you decide on this strategy?
- How did you show the 6 pints of ice cream? How did you show fourths?
- What answer did you get? How can you tell if your answer makes sense?

After:

- Did everyone get the same answer?
- Do all the strategies make sense?
- How are the strategies similar to one another? How are they different?
- How do these representations connect to dividing with whole numbers?
- Why is our answer a ***larger*** number even though we divided these numbers?

Possible Misconceptions/Suggestions:

Possible Misconceptions	**Suggestions**
Students attempt to divide by 4 rather than ¼	Refer to the context. Remind students that each party guest receives ¼ of a pint, rather than 4 pints.
Student attempts to use "invert and multiply"	Encourage the student to draw a representation of the problem. Suggest that the student examine the visual models used in the division problems with whole numbers.
Student has trouble understanding how the answer to a division problem could be a larger number.	Relate 6 ÷ ¼ to the context, "How many ¼ portions are found in 6 pints?" Refer to the visual models to show that each whole has 4 ¼ portions.

Special Notes:

This is an introductory lesson to be used when students are unfamiliar with division by fractions. At no time should students use the "invert and multiply" method or find the reciprocal. The focus of this lesson should be on exploring the meaning of division by fractions.

Solutions:

Students will use many different strategies to show that 6 ÷ ¼ = 24.

Adapted from Teaching Student-Centered Mathematics, Grade 3-5. *Van de Walle and Lovin (2006).*

Multiplying Whole Numbers by Decimals

Common Core Standard:

Perform operations with multi-digit whole numbers and with decimals to hundredths.
5.NBT.7 Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.

Additional/Supporting Standard: 5.NBT.3

Standards for Mathematical Practice:

1. Make sense of problems and persevere in solving them
4. Model with mathematics
5. Use appropriate tools strategically
7. Look for and make use of structure

Student Outcomes:

- I can reasonably estimate the product of a whole number and a decimal
- I can use multiple strategies to find the product of a whole number and a decimal

Materials:

- Decimal Grids Sheet (one for each student)
- Paper or journals for student responses

Advance Preparation:

- Copy Decimal Grids Sheet
- Gather paper or student journals
- Consider how you will to pair or group students
- Students should be familiar with adding and subtracting decimals
- Students should be familiar with estimating
- Students should be comfortable struggling with a task and explaining their reasoning
- Students should be able to use a decimal grid to model a decimal to the hundredths place

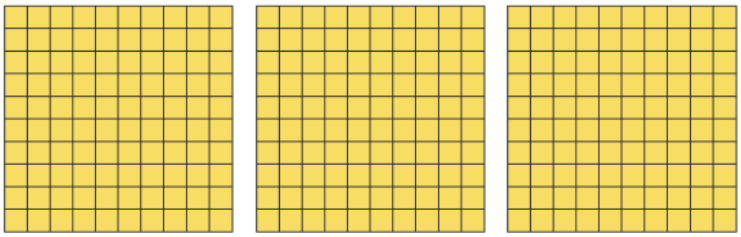
Directions:

1. Pose the following question and write it on the board: A farmer fills each jug with 1.4 liters of cider. If you buy 3 jugs of cider, how much cider will you have?
2. Begin with a class discussion of student estimates. Students explain their reasoning for their estimations (It is bigger than 3. It is less than 6.).
3. Allow students to individually solve the problem using strategies that make sense to them. When most have finished, students should share their strategy and reasoning to a partner or small group.
4. Initiate a whole group discussion of the different strategies. Some will use repeated addition: 1.4 + 1.4 + 1.4. Others will multiply 3 x 1, and then add in 0.4 + 0.4 + 0.4. A wide range of other reasonable strategies may be used. As students explain their thinking, record their methods for all to see.

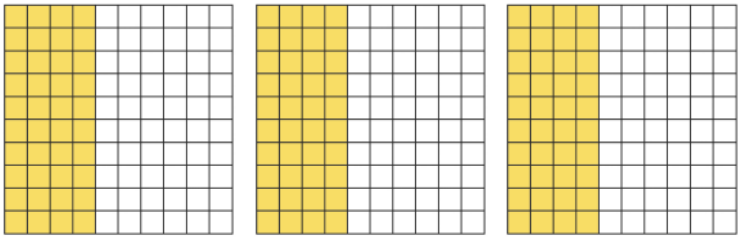
5. Repeat this process with problems using nice fractional parts such as 2.5 x 4 and 2 x 3.25
    - Ask a student to verbalize a word problem for the expression
    - Conduct a class discussion of student estimates
    - Students solve the problem independently
    - Students share their strategies with a partner or small group
    - Teacher facilitates whole group discussion
6. Distribute decimal grids. Students choose one of the previous multiplication problems to solve using the decimal grid. Students should working in pairs or small groups
7. Allow students to struggle with this task. Students may not know how to use the grids to solve the problem. Encourage students to use the grids in a way that makes sense to them.

    Possible solutions for 3 x 1.4:

    Solution 1

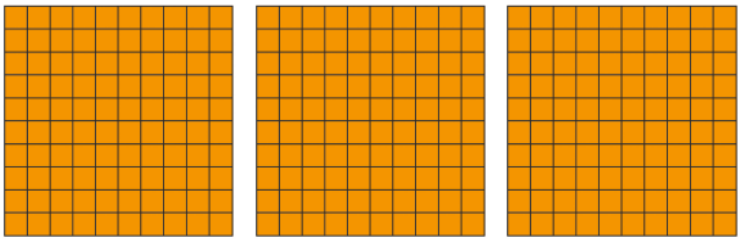


3 x 1

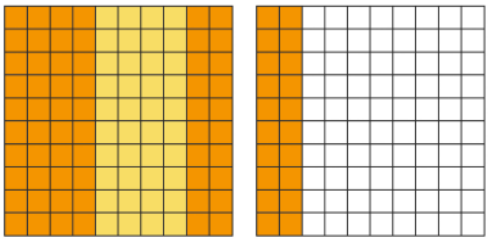


3 x .4

    Solution 2



3 x 1



3 x .4

8. Invite a few pairs or groups to share their solution with the class. Challenge the students to defend their reasoning. Why does the method you used work?
9. As students share their solutions, ask students make connections between the different strategies. How are these strategies alike? How are they different? Do they all make sense?
10. Now have students make connections across problems. Could each of these solutions work for all three problems?

11. To close the lesson write the following journal prompt on the board. Before students write in their journal, ask them to briefly talk with a partner about the two strategies they plan to describe. *Describe two strategies you can use when multiplying a whole number by a decimal.*

Questions to Pose:

As students work together:

- What did you think about first?
- Why did you decide to…..?
- What could you do it you did not have enough grids?

During class discussion:

- What connections do you see with ways you multiply whole numbers?
- How did estimating help your thinking?
- Which strategy worked best for you? Why was this one the best?

Possible Misconceptions/Suggestions:

Possible Misconceptions	Suggestions
• Students make unreasonable estimates	• Students should use various representations to model decimals. They should make generalizations about their magnitude. For example, "I can tell that seven tenths is more than one half." • Students can practice estimating decimal sums and differences since addition and subtraction are more familiar.
• Students have difficulty modeling decimals on a grid • Relating decimals as parts of a whole	• Practice building decimals with base ten blocks and transferring these representations to a grid. Use number lines to explore the magnitude of decimals and how they connect to whole numbers. • Connect these models with numerical representations of decimals.

Special Notes:

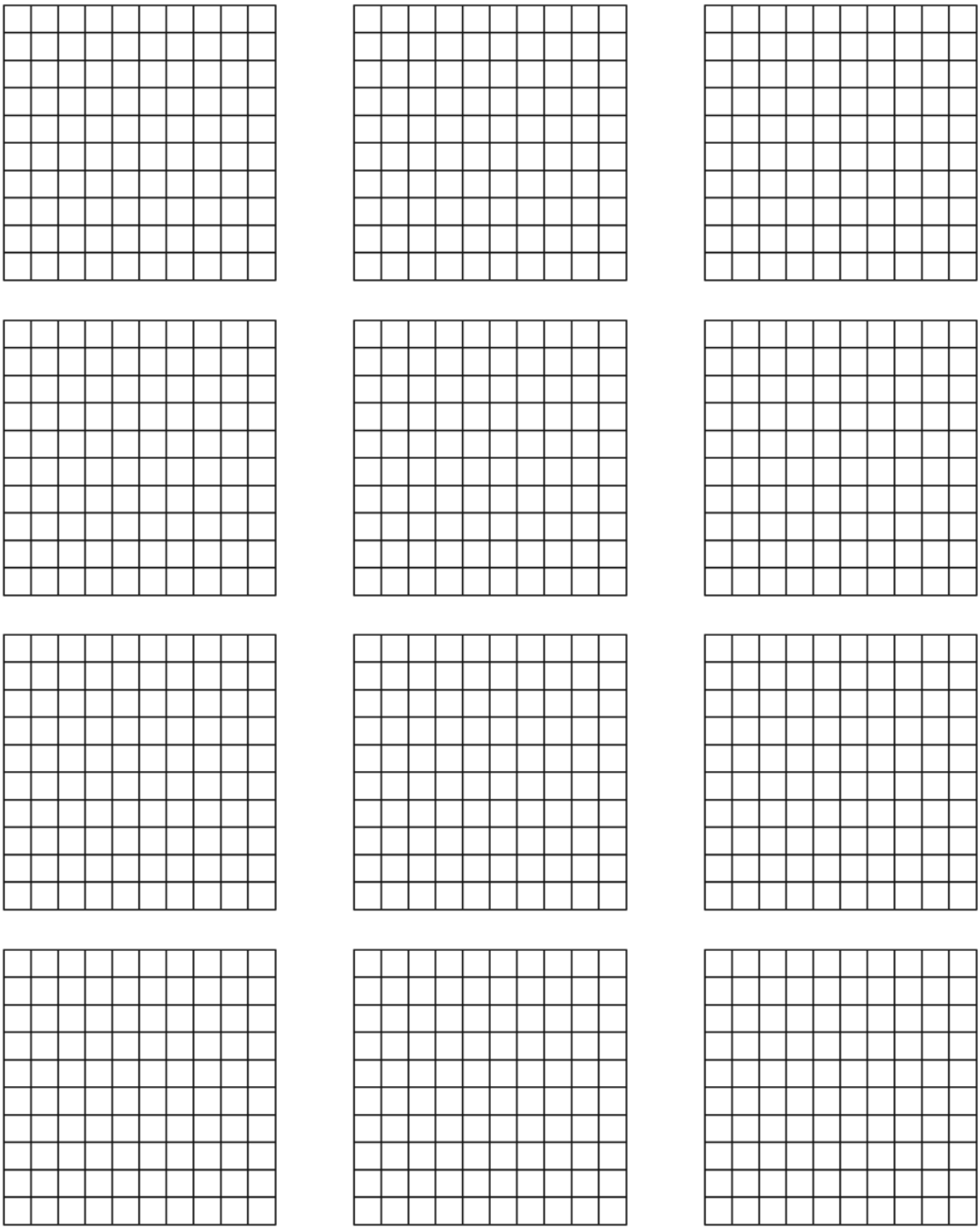
- This lesson should be used first in a study of multiplication with decimals.
- Follow-up lessons should consider multiplying a decimal by another decimal.

Solutions for Problems Used in This Lesson:

3 x 1.4 = 4.2 2.5 x 4 = 10 2 x 3.25 = 6.5

Adapted from Teaching Student-Centered Mathematics, Grades 3-5. *Van de Walle and Lovin (2006).*

Decimal Grids



Window Time

Common Core Standard:

Perform operations with multi-digit whole numbers and with decimals to hundredths.
5.NBT.7 Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.

Additional/Supporting Standard:

5.NBT.5 Perform operations with multi-digit whole numbers and with decimals to hundredths.

Standards for Mathematical Practice:

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
5. Use appropriate tools strategically
6. Attend to precision

Student Outcomes:

- I can use my understanding of decimal operations to solve problems
- I can use clear notations to show my solution strategies

Materials:

- Window Time task sheet (one per student)
- Base-ten blocks, decimal grids, and grid paper

Advance Preparation:

- Copy the Window Time sheet
- Set aside a place in the classroom for base-ten blocks, decimal grids, and grid paper in case students want to use them
- Consider how you will pair students
- Students should be able to add and multiply decimals to the hundredths place
- Students should be familiar with area and perimeter

Directions:

1. This task provides practice with adding and multiplying decimal numbers:
   Your neighbor, Mrs. Jones, has asked for your help with a project. She wants to put a new window in her living room. Her new window will be 3.4 feet wide and 4.65 feet tall. Mrs. Jones needs your help figuring out how many feet of framing she should buy for the window. She also needs to know how many square feet of glass she should purchase.
2. Distribute the task to students. Read the task together and ensure that students understand the directions.
3. Dismiss students to work on the task in pairs.
4. Provide any materials that might be helpful including blank decimal grids, base-ten blocks, and grid paper. Encourage the students to use these materials to support their thinking.

5. Circulate as students work. Observe student strategies and pose the questions listed below.
6. Allow students to struggle. Resist the urge to step in and help to quickly.
7. When most students have finished the task, lead a class discussion about the following questions: "What mathematics did you use today?" "How did you decide what to do?" "What strategies worked best for you today? Why were they so helpful?"

Questions to Pose:

Before:

- How could drawing a picture help you solve this problem?
- How might you use the base-ten blocks, grid paper, or decimal grids?

During:

- Which part of the problem are you working on? How are you approaching this part?
- What challenges are you running into? What are you doing to help you with these challenges?
- How did you decide to use….?

After:

- What mathematics did you use today?
- How did you decide what to do?
- What strategies worked best for you today? Why were they so helpful?

Possible Misconceptions/Suggestions:

Possible Misconceptions	Suggestions
Students have difficulty applying their knowledge of area and perimeter	Set up an array to reinforce the concepts of area and perimeter. Relate these to the window frame and glass. Allow the student to show how area and perimeter would be found using the array. Relate this process to the window task.
Students have difficulty multiplying and/or adding decimals	Students need ample practice using the four operations with decimals. Use grid paper, blocks, and other models to make connections with meaning and procedure.

Special Notes:

- If many students are struggling with the task, you may want to ask the students to pause and share their strategies with the entire class.
- This problem can be extended by asking the students to write letters to Mrs. Jones explaining their reasoning and mathematics.
- Students may also wish to find the cost of multiple windows.

Solutions: Amount of framing needed: 16.1 feet
Amount of glass needed: 15.81 square feet

Extra Challenge: Cost of framing and glass: $27.02

Window Time

Your neighbor, Mrs. Jones, has asked for your help with a project. She wants to put a new window in her living room. Her new window will be 3.4 feet wide and 4.65 feet tall. Mrs. Jones needs your help figuring out how many feet of framing she should buy for the window. She also needs to know how many square feet of glass she should purchase.

Extra Challenge: Each foot of framing costs $0.50. Window glass costs $1.20 per square foot. How much will Mrs. Jones pay for her new window?

Measurement Mania

Common Core Standard

Convert like measurement units within a given measurement system.

5.MD.1 Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.

Additional/Supporting Standard:

5.NBT.1, **5.NBT.2** Understand the place value system

Standards for Mathematical Practice:

6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

Student Outcomes:

- I can convert measures within the same system
- I can explain why my answers make sense

Materials:

- One game board, set of cards, and answer sheet for each group of 3 students
- One die for each group of 3 students
- Items to use as markers for each group of students

Advance Preparation:

- Copy the game board and set of cards. Laminating them on cardstock will help the materials last longer. Cut out each set of 20 cards and store in a baggie.
- Copy an answer sheet for each group
- Place markers for each group in the baggie of cards
- Consider how you will group students
- Students should have ample experience exploring the meanings of cm, m, km, g, kg, ml, L, oz, lb, in, ft, and yd.
- Students should be familiar with strategies for converting measures within the same system.

Directions:

This game provides practice for converting measures. There are two options for game play:

Option 1

3 students play the game with one serving as the Answer Person and the other two solving the problems. The answer person uses the Measurement Mania Answers sheet and acts as supervisor. The Answer Person does not roll the die or move a marker.

Option 2

3 students play the game. The students take turns being the Answer Person and using the Answer Person, switching to a new person on each turn.

Questions to Pose:

Before:

- What strategies can you use for converting measures?
- How are cm, m, and km related? How are oz and lb related?
- How can you make sure that your answer makes sense?

During:

- What strategy did you use to convert the measures?
- How can you tell that your answer makes sense?
- What error did you make? How can you prevent this error in the future?

After:

- What strategies worked especially well for you? Why were they so effective?
- What errors did you make frequently? How can you prevent these errors in the future?
- How might it help to visualize the unit in your mind?
- How might it help to use a benchmark?
- How might it help to think about 10s, 100s, and 1000s?

Possible Misconceptions/Suggestions:

Possible Misconceptions	Suggestions
Students have difficulty remembering how the units are related to one another.	Use objects and measuring tools to explore the base units. For instance, on a meter stick how many centimeters are equivalent to a meter? Engage the students in activities to establish benchmarks. What can they use to remember the size of a gram? Through classroom tasks, develop a chart to explore how measures are related. For instance 2 m = 200 cm and 3 m = 300 cm, therefore meters are 100 times the size of centimeters.

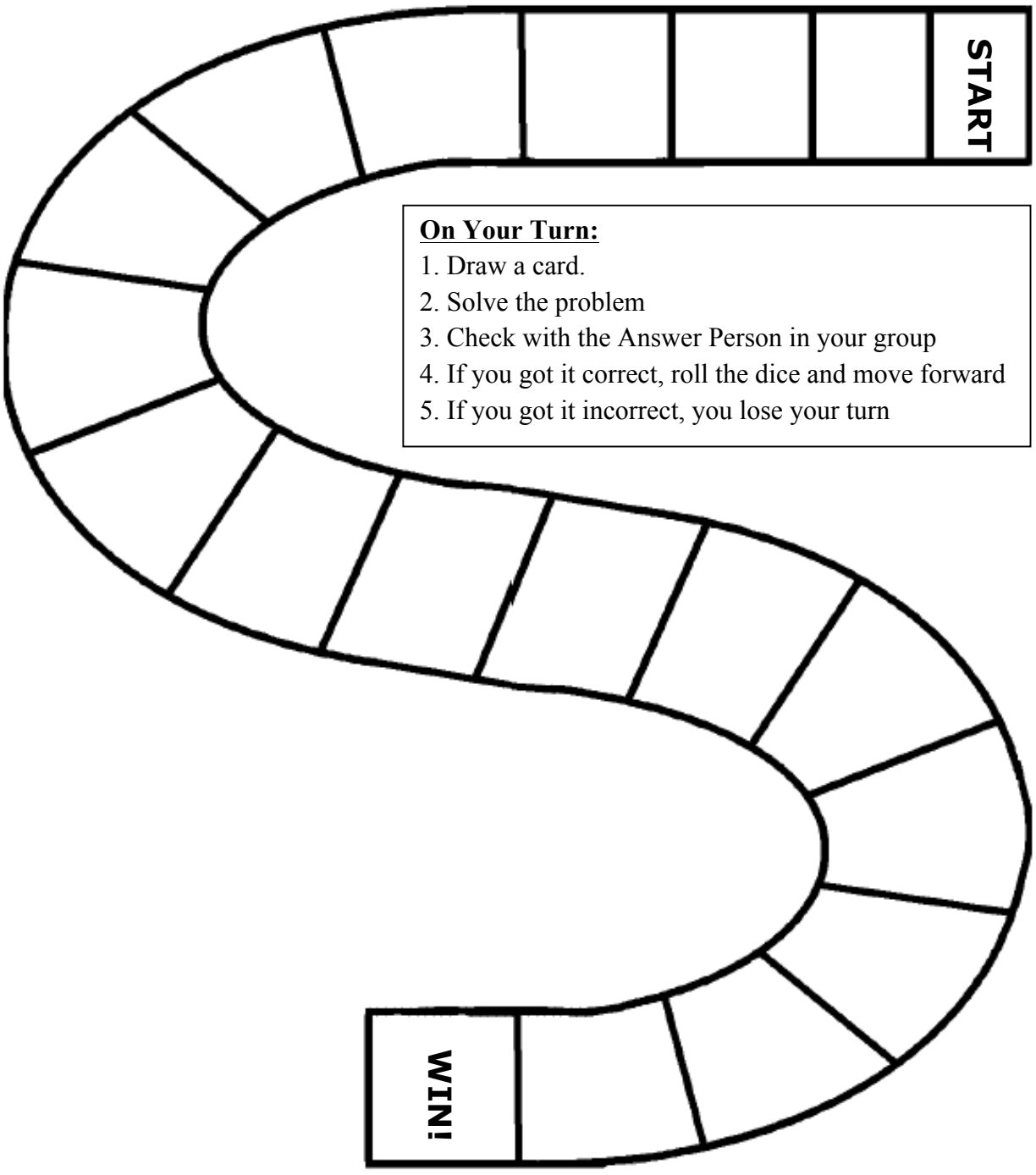
Special Notes:

This game is intended for practice. Students should not practice the procedures for conversion until they have had ample opportunities to explore measurement units and relationships.

Solutions:

See Measurement Mania Answers

Measurement Mania



#1. 1 cm = ____ m	#2. 1 kg = _____ g
#3. 1 m = _____ cm	#4 1 L = _____ ml
#5 100 cm = ____ m	#6 1 km = ____ m
#7 1000 m = ____ km	#8 1 lb = ____ oz
#9 3 ft = ____ in	#10 9 yd = ____ ft

#11 4.2 m = ____ cm	#12 3000 ml = ____ L
#13 32 oz = ____ lb	#14 5 cm = ____ m
#15 200 m = ____ km	#16 500 g = ____ kg
#17 45.6 cm = ____ m	#18 36 in = ____ ft
#19 150 ft = ___ yd	#20 3.2 kg = ____ g

Measurement Mania Answers

1. 1 cm = 0.01 m
2. 1 kg = 1000 g
3. 1 m = 100 cm
4. 1 L = 1000 ml
5. 100 cm = 1 m
6. 1 km = 1000 m
7. 1000 m = 1 km
8. 1 lb = 16 oz
9. 3 ft = 36 in
10. 9 yd = 27 ft
11. 4.2 m = 420 cm
12. 3000 ml = 3 L
13. 32 oz = 2 lb
14. 5 cm = 0.05 m
15. 200 m = 0.2 km
16. 500 g = 0.5 kg
17. 45.6 cm = 0.456 m
18. 36 in = 3 ft
19. 150 ft = 30 yd
20. 3.2 kg = 3200 g

Filling Boxes

Common Core Standard:

Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.

5.MD.3 Recognize volume as an attribute of solid figures and understand concepts of volume measurement.

- A solid figure which can be packed without gaps or overlaps using *n* unit cubes is said to have a volume of *n* cubic units.

Additional/Supporting Standards:

5.MD.4, **5.MD.5** Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.

Standards for Mathematical Practice:

1. Make sense of problems and persevere in solving them
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
8. Look for and express regularity in repeated reasoning

Student Outcomes:

- I can develop and implement a strategy for determining volume
- I can determine the volume of a figure by using only a small number of cubes
- I can make observations about the structure of cubic units

Materials:

- A variety of small empty boxes such as shoe boxes and tissue boxes (at least one per pair)
- Small same-size cubes (enough for each pair to complete only 1-3 layers of a box)

Advance Preparation:

- Gather a collection of small boxes such as shoe boxes and tissue boxes. The boxes should be a variety of sizes.
- Gather small cubes. Unifix or Snap Cubes work best. Each pair of student will need enough cubes to make 1-3 layers in a box, but not enough to fill the whole thing. Test a few boxes to determine how many cubes they will need.
- Consider how you will pair students
- Students should understand the concept of volume, but *not* the formula l x w x h
- Students should have some experience creating solid figures with cubes

Directions:

1. Display your collection of boxes. Ask the students to predict which box has the largest volume. Ask which has the least. Have students justify their reasoning. Think about the height, width, and length of each box.

2. Tell the students that they will be determining each box's volume by using cubic blocks. Their task is to figure out how many cubes will fill each box completely. Note that they will not be given all the cubes that will fit. For instance, they may only have 30 cubes even though their box can hold 100. They will need to develop a strategy for finding the total number of cubes that will completely fill their box.

What is the total number of cubes that will completely fill your box?

3. Give each pair of students one box and a collection of same-size cubes. This is a great opportunity to ask students why it is important to use same-size cubes.

4. Circulate as students work. Some students will determine how many cubes fit in one layer of the box and then determine the number of layers. Others may line up the blocks along the edges and multiply. Still others will try to physically move the blocks so that they fill in the space. Be sure to ask questions including those listed below.

5. About half way through the work time ask the students to pause. Invite several groups to share a strategy that *did not* work for them. Then invite a few pairs to share a strategy that *is working*. This discussion will especially support groups that are struggling with the task.

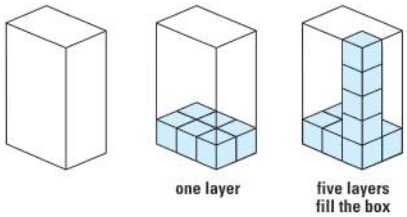
6. When a group has finished working with one box, they should trade boxes with another group that has finished and start again. Some groups may finish 2 or 3 boxes, while others will only complete one.

7. When each pair has completed at least one box bring the group back together to discuss their strategies and observations.

8. Discuss the following questions: What strategies worked best for your group? What strategies did not work? What made one strategy more effective than another? What problems did you run into?

9. If students do not point out the potential problems of accidentally leaving gaps or overlapping the blocks, be sure to bring this topic up in discussion.

10. Ask the students how they might get the most precise measure of volume for each box. Many students will point out that you could fill the box completely with cubes. Guide the students to see that the layers of the box can be seen as arrays. These arrays are repeated with each layer.



If students make the connection to multiplication, guide their thinking by asking "What numbers would you multiply to find the volume?" If students *do not* make the connection to multiplication, help them see how we can use multiplication or repeated addition to find the precise volume.

11. To summarize the lesson, show students one additional box. Ask the students to describe to a neighbor the steps they would take to find the volume if they only had 20 blocks.

Questions to Pose:

Before:

- Predict which box will have the largest volume? Explain your reasoning.
- Predict which box will have the smallest volume? Explain your reasoning.
- How could you use the cubes to figure out the volume of your box, even though you will not have enough to fill up the whole box?

During:

- What strategy are you using? Is it working well? How can you tell?
- What problems are you running into? How could you adjust your strategy so you have fewer problems?
- What will you do next?
- How can you tell if you are leaving any gaps? How can you tell if you are overlapping the cubes?

After:

- What strategy worked best for you? Why did it work so well?
- What problems did you encounter? How did you address them?
- How could thinking about layers help you determine a figure's volume?
- How could multiplication be related to a figure's volume?

Possible Misconceptions/Suggestions:

Possible Misconceptions	Suggestions
Students have difficulty recognizing that a strategy is problematic. Their strategy may overlap the cubes, leave gaps, or be incomplete.	Form a cube with 8 blocks. Guide the student to recognize that the volume of this cube is 8 cubic units and that there are no gaps or overlaps. Reinforce the concept that the current task requires the student to find out how many cubic units would completely fill the entire box.
Students have difficulty keeping track of their progress and/or how many cubes they have used.	Provide paper for students to record the number of cubes used. Suggest that student make marks on their box to keep track of their progress.

Special Notes:

- The focus of this lesson is to explore concepts of volume and help students discover volume's connection to multiplication.
- Rather than using pre-made boxes, you might have the students create several boxes from nets. Be sure to use large nets that will accommodate many cubes. You may want to copy the nets on cardstock so that they stay together as they are manipulated.

Solutions: NA

Candy Boxes

Common Core Standard:

Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.

5.MD.4 Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units.

Additional/Supporting Standard(s):

5.MD.3, **5.MD.5** Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.

Standards for Mathematical Practice:

2. Reason abstractly and quantitatively
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision

Student Outcomes:

- I can demonstrate the meaning of volume
- I can determine the dimensions of a rectangular prism
- I can relate the dimensions of a figure to its volume

Materials:

- Unifix cubes, connecting cubes, 1" blocks
- Yummy Candy Boxes Recording sheet

Advance Preparation:

- Gather 36 cubes per student
- Copies of recording sheet per student
- Consider partnering students for sharing of strategies

Directions:

1. Teacher presents the task to the class:
   The Yummy Candy Company makes fudge cut into pieces that are one cubic inch in volume. That is, each piece is one inch long, one inch wide, and one inch deep. The company wants to make a package that holds 36 pieces of fudge. Investigate the different dimensions for three different boxes the company could use to package the fudge.

2. Using 36 cubes each (fudge pieces), students work to create multiple representations of organizing the cubes into rectangular prisms 'box'. After completing a representation of a box, students record the dimensions with a visual, words or numbers on the recording sheet.

3. Students continue to build 'boxes'. Once students have built and recorded 3 'boxes', they share work with a partner justifying their thinking.

4. Teacher facilitates a whole class discussion. Students share box dimensions. Teacher or student records their representation for class to see. As students share, bring out vocabulary such as length, width, and height of their box. What do you notice about how the height, width and length help you with the volume? If students cannot connect to L x W x H, ask follow up questions such as: How does the length, width, height relate to addition? Multiplication?

5. Students discuss which box the Yummy Candy Company would choose to package their fudge pieces. There is not one right answer, but students need to justify their thinking.

6. Students record which box they chose and explain their thinking in their journal.

Questions to Pose:
As students work individually or with a partner:

- What is the area of the bottom of your box?
- If the area of the bottom of your box is 18, how many layers would you have?
- If you have a bottom area of 5, what would your box look like?
- What would your box look like if you had 50 cubes?

During class discussion:

- What do you notice about how the height, width and length help you with the volume?
- Which size box would the Yummy Candy Company choose? Explain your thinking.
- What is volume?
- How does the length, width, height relate to addition? Multiplication?

Possible Misconceptions/Suggestions:

Possible Misconceptions	Suggestions
• Student has difficulty constructing a box that is a rectangular prism.	• Provide multiple examples of boxes for student to examine then build with cubes. Make a connection to rows and columns.

Special Notes:
This is an introductory lesson for exploring the meaning of volume. Students need time to create their own prisms and explore their properties. Students develop their own way of finding the volume.

Solutions: Multiple solutions

Yummy Candy Boxes

Box	Dimensions
Box 1	
Box 2	
Box 3	
Box 4	

Growing Sumandas

Common Core Standard:

Graph points on the coordinate plane to solve real-world and mathematical problems.

5.G.2 Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

Additional/Supporting Standards:

5.G.1 Graph points on the coordinate plane to solve real-world and mathematical problems

5.OA.3 Analyze patterns and relationships

Standards for Mathematical Practice:

2. Reason abstractly and quantitatively
4. Model with mathematics
5. Use appropriate tools strategically
7. Look for and make use of structure

Student Outcomes:

- I can model and extend a pattern
- I can represent a pattern using models, drawings, words, tables, and graphs
- I can make connections between a pattern and a graph

Materials:

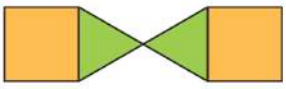
- Pattern blocks (at least 15 squares and 5 triangles per student or pair of students)
- Growing Sumandas sheet (1 for each student)

Advance Preparation:

- Gather pattern blocks
- Copy the Growing Sumandas sheet
- Consider whether students will work in pairs or as a class for this task
- If students are working in pairs, they should have some experience with patterns, including working with tables
- If students are working pairs they should have experience using a table to plot points on a coordinate grid.

Directions:

1. Distribute pattern blocks.
2. Present the following scenario to the students:
   During your scientific exploration to a newly discovered rainforest you encounter a new creature called a sumanda.

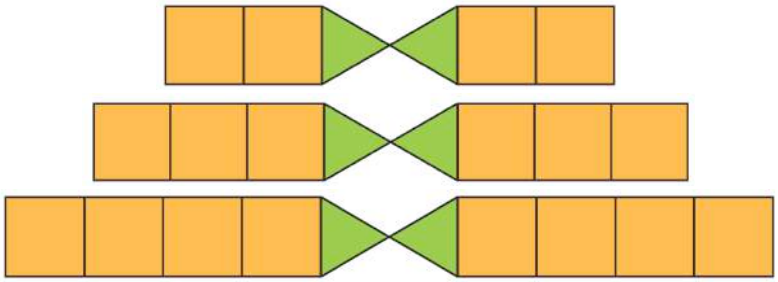


3. Invite students to build the sumanda with their blocks. Tell them that this is the sumanda at 1 year old.
4. Tell students that they will observe the sumanda's growth. Demonstrate and have students build years 2, 3, and 4 beneath year one:

2 years old

3 years old

4 years old



5. Use the Growing Sumandas sheet to guide your instruction. Ask students to complete one section at a time, then elicit student answers and model the component. *However:* If students have experience with this process, have them work in pairs with much less teacher guidance.
6. To close, extend student thinking by asking the questions below.

Questions to Pose:

As students work in pairs:

- How did you decide to draw your table? How does your table relate to the blocks?
- What surprised you about the graph? Why was it surprising?
- What challenges are you running into? What are you doing to help you face them?

After:

- What do you notice about the shape of the graph? Why does this shape make sense?
- How does the graph help you describe the sumanda's growth?
- How can the graph help you predict the sumanda's future growth?
- What does this point on the graph tell you about the sumanda?

Possible Misconceptions/Suggestions:

Possible Misconceptions	Suggestions
Students have difficulty placing the attribute on the axis (number of years on the x-axis and number of blocks on the y-axis).	Have the students examine a collection of simple line graphs. Ask them to draw conclusions about the type of data listed on each axis. Note that the x-axis shows the data you are changing. The y-axis should show the data being *measured.*

Special Notes:

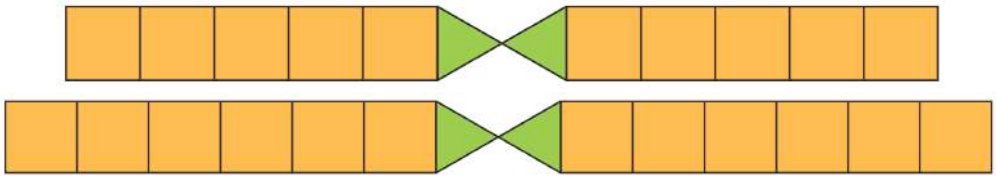
A follow up task should follow this process with 2 patterns. The patterns should be graphed on the same coordinate grid and analyzed (5.OA.3).

Solutions:

Extend the Pattern:

5 years old

6 years old



Words: Student words will vary. One example is - Each year, the sumanda grows one square on each side.

Table: Function tables may be set up horizontally or vertically. One example is –

Years old (n)	1	2	3	4	5	6
Number of blocks	4	6	8	10	12	14

Number of blocks at the 10^{th} stage: 22

Pattern Rule: Student answers may vary. Some examples are –

- There are twice as many squares as the age of the sumanda. There are always 2 triangles.
- Add 2 blocks to the previous year
- Multiply the age by 2 then add 2 more
- Number of blocks $= 2n + 2$
- Number of blocks $= (2 \times n) + 2$

Coordinate points: (1,4) (2,6) (3,8) (4,10) (5,12) (6,14)

Adapted from Partners for Mathematics Learning, 2008

Growing Sumandas, side 1

<table>
<tr><td colspan="2">Based on this pattern, draw and extend the sumanda for 2 more years:

5 years old

6 years old</td></tr>
<tr><td>Use words to describe the pattern</td><td>Create a table to describe the pattern</td></tr>
<tr><td>Draw and describe the
10th stage of the pattern</td><td>Write a rule for this pattern</td></tr>
</table>

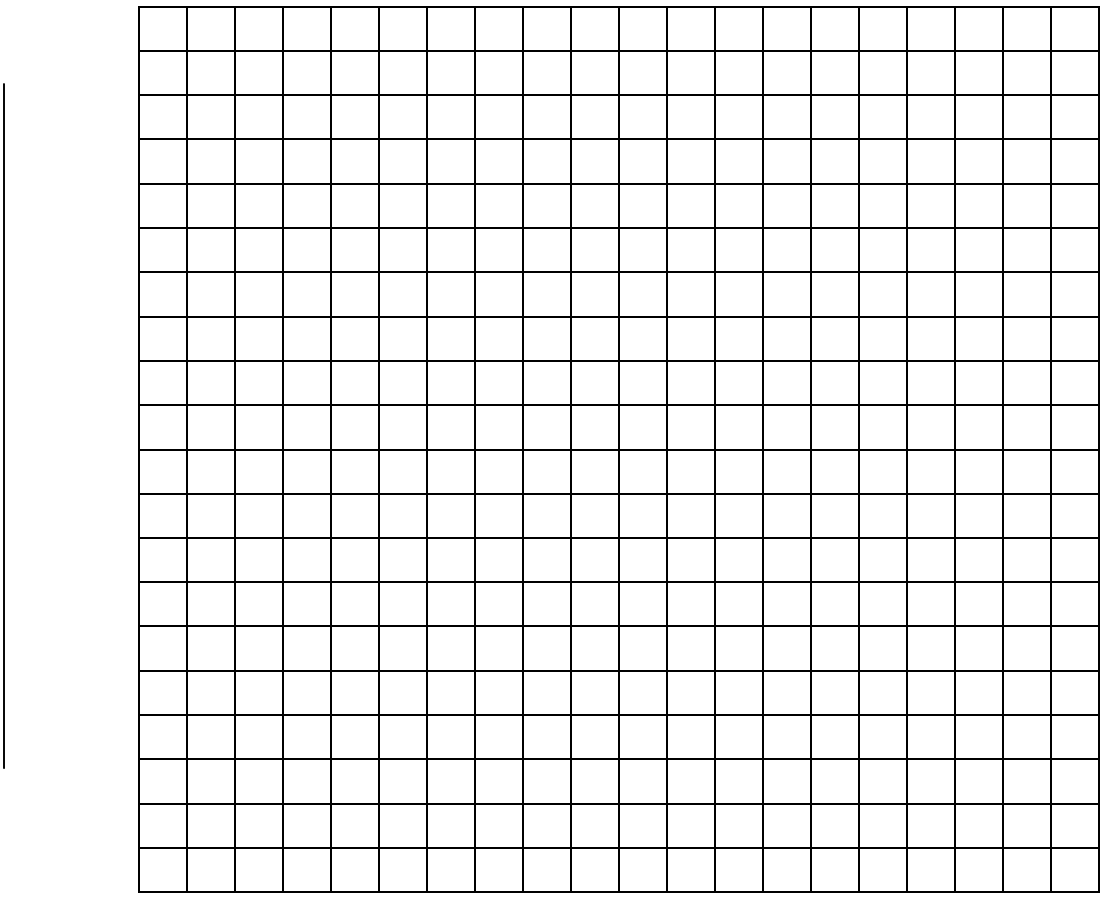
Adapted from Partners for Mathematics Learning, 2008

Growing Sumandas, side 2

Use the table to write the coordinate points for this pattern:

Plot the coordinate points on the graph below. Should these points be connected to form a line graph? How do you know?

Title _____



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Adapted from Partners for Mathematics Learning, 2008