SOUTH CAROLINA SUPPORT SYSTEMS INSTRUCTIONAL GUID

Content Area	Fifth Grade Mathematics
Recommended Days of Instruction	**Third Nine Weeks**

Standards/Indicators Addressed:

Standard 5-4: The student will demonstrate through the mathematical processes an understanding of congruency, spatial relationships, and relationships among the properties of quadrilaterals.

5-4.5* Predict the results of multiple transformations on a geometric shape when combinations of translation, reflection, and rotation are used. (B2)

5-4.6* Analyze shapes to determine line symmetry and/or rotational symmetry. (B4)

Standard 5-5: The student will demonstrate through the mathematical processes an understanding of the units and systems of measurement and the application of tools and formulas to determine measurements.

5-5.1* Use appropriate tools and units to measure objects to the precision of one-eighth inch. (C3)

5-5.3* Use equivalencies to convert units of measure within the metric system: converting length in millimeters, centimeters, meters, and kilometers; converting liquid volume in milliliters, centiliters, liters, and kiloliters; and converting mass in milligrams, centigrams, grams, and kilograms. (C3)

5-5.4* Apply formulas to determine the perimeters and areas of triangles, rectangles, and parallelograms. (C3)

5-5.5* Apply strategies and formulas to determine the volume of rectangular prisms. (C3)

5-5.6* Apply procedures to determine the amount of elapsed time in hours, minutes, and seconds within a 24-hour period.(C3)

5-5.7* Understand the relationship between the Celsius and Fahrenheit temperature scales. (B2)

5-5.8* Recall equivalencies associated with length, liquid volume, and mass: 10 millimeters = 1 centimeter, 100 centimeters = 1 meter, 1,000 meters = 1 kilometer; 10 milliliters = 1 centiliter, 100 centiliters = 1 liter, 1,000 liters = 1 kiloliter; and 10 milligrams = 1 centigram, 100 centigrams = 1 gram, 1,000 grams = 1 kilogram. (A1)

* These indicators are covered in the following 6 Modules for this Nine Weeks Period.
Teaching time should be adjusted to allow for sufficient learning experiences in each of the modules.

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Module 3-1 Perimeter, Area and Volume			
Indicator	**Recommended Resources**	**Suggested Instructional Strategies**	**Assessment Guidelines**
Module 3-1 Lesson A 5-5.4 Apply formulas to determine the perimeters and areas of triangles, rectangles, and parallelograms. (C3)	**STANDARD SUPPORT DOCUMENT** http://www.ed.sc.gov/agancy/standard-and-learning/academic standards/math/index.html NCTM's Online Illuminations http://illuminations.nctm.org NCTM's Navigations Series 3-5 Teaching Student-Centered Mathematics Grades 3-5 and Teaching Elementary and Middle School Mathematics Developmentally 6th Edition, John Van de Walle Blackline Masters for Van de Walle Series www.ablongman.com/vandewalleseries NCTM's Principals and Standards for School Mathematics (PSSM) NCTM, Mathematics Assessment Sampler: Grades 3-5	See Instructional Planning Guide Module 3-1 Introductory Lesson A	See Instructional Planning Guide Module 3-1 Lesson A Assessing the Lesson

	ETA Cuisenaire, Hands-On Standards: Grades 5-6		
Module 3-1 Lesson B 5-5.5 Apply strategies and formulas to determine the volume of rectangular prisms. (C3)		See Instructional Planning Guide Module 3-1 Introductory Lesson B	See Instructional Planning Guide Module 3-1 Lesson B Assessing the Lesson

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Module 3-2 Plane and Transformational Geometry			
Indicator	**Recommended Resources**	**Suggested Instructional Strategies**	**Assessment Guidelines**
Module 3-2 Lesson A 5-4.5 Predict the results of multiple transformations on a geometric shape when combinations of translation, reflection and rotation are used. (B2)	**STANDARD SUPPORT DOCUMENT** http://www.ed.sc.gov/agancy/standard-and-learning/academic standards/math/index.html NCTM's Online Illuminations http://illuminations.nctm.org NCTM's Navigations Series 3-5 Teaching Student-Centered Mathematics Grades 3-5 and Teaching Elementary and Middle School Mathematics Developmentally 6th Edition, John Van de Walle Blackline Masters for Van de Walle Series www.ablongman.com/vandewalleseries NCTM's Principals and Standards for School Mathematics (PSSM) NCTM, Mathematics Assessment Sampler: Grades 3-5	See Instructional Planning Guide Module 3-2 Introductory Lesson A	See Instructional Planning Guide Module 3-2 Lesson A Assessing the Lesson

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	ETA Cuisenaire, Hands-On Standards: Grades 5-6		
Module 3-2 Lesson B 5-4.6 Analyze shapes to determine line symmetry and/or rotational symmetry. (B4)		See Instructional Planning Guide Module 3-2 Introductory Lesson B	See Instructional Planning Guide Module 3-2 Lesson B Assessing the Lesson

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Module 3-3 Length			
Indicator	**Recommended Resources**	**Suggested Instructional Strategies**	**Assessment Guidelines**
Module 3-3 Lesson A 5-5.1 Use appropriate tools and units to measure objects to the precision of one-eighth inch. (C3)	**STANDARD SUPPORT DOCUMENT** http://www.ed.sc.gov/agancy/standard-and-learning/academic standards/math/index.html NCTM's Online Illuminations http://illuminations.nctm.org NCTM's Navigations Series 3-5 Teaching Student-Centered Mathematics Grades 3-5 and Teaching Elementary and Middle School Mathematics Developmentally 6th Edition, John Van de Walle Blackline Masters for Van de Walle Series www.ablongman.com/vandewalleseries NCTM's Principals and Standards for School Mathematics (PSSM) NCTM, Mathematics Assessment Sampler: Grades 3-5	See Instructional Planning Guide Module 3-3 Introductory Lesson A	See Instructional Planning Guide Module 3-3 Lesson A Assessing the Lesson

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Module 3-4 Equivalencies and Conversions			
Indicator	**Recommended Resources**	**Suggested Instructional Strategies**	**Assessment Guidelines**
Module 3-4 Lesson A 5-5.8 Recall equivalencies associated with length, liquid volume, and mass: 10 millimeters = 1 centimeter, 100 centimeters = 1 meter, 1,000 meters = 1 kilometer; 10 milliliters = 1 centiliter, 100 centiliters = 1 liter, 1,000 liters = 1 kiloliter; and 10 milligrams = 1 centigram, 100 centigrams = 1 gram, 1,000 grams = 1 kilogram. (A1) 5-5.3 Use equivalencies to convert units of	**STANDARD SUPPORT DOCUMENT** http://www.ed.sc.gov/agancy/standard-and-learning/academic standards/math/index.html NCTM's Online Illuminations http://illuminations.nctm.org NCTM's Navigations Series 3-5 Teaching Student-Centered Mathematics Grades 3-5 and Teaching Elementary and Middle School Mathematics Developmentally 6th Edition, John Van de Walle Blackline Masters for Van de Walle Series www.ablongman.com/vandewalleseries NCTM's Principals and Standards for School Mathematics (PSSM) NCTM, Mathematics Assessment Sampler: Grades 3-5	See Instructional Planning Guide Module 3-4 Introductory Lesson A	See Instructional Planning Guide Module 3-4 Lesson A Assessing the Lesson

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measure within the metric system: converting length in millimeters, centimeters, meters, and kilometers; converting liquid volume in milliliters, centiliters, liters, and kiloliters; and converting mass in milligrams, centigrams, grams, and kilograms. (C3)	ETA Cuisenaire, Hands-On Standards: Grades 5-6		

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Module 3-5 Time			
Indicator	**Recommended Resources**	**Suggested Instructional Strategies**	**Assessment Guidelines**
Module 3-5 Lesson A 5-5.6 Apply procedures to determine the amount of elapsed time in hours, minutes and seconds within a 24-hour period. (C3)	**STANDARD SUPPORT DOCUMENT** http://www.ed.sc.gov/agancy/standard-and-learning/academic standards/math/index.html NCTM's Online Illuminations http://illuminations.nctm.org NCTM's Navigations Series 3-5 Teaching Student-Centered Mathematics Grades 3-5 and Teaching Elementary and Middle School Mathematics Developmentally 6th Edition, John Van de Walle Blackline Masters for Van de Walle Series www.ablongman.com/vandewalleseries NCTM's Principals and Standards for School Mathematics (PSSM) NCTM, Mathematics Assessment Sampler: Grades 3-5	See Instructional Planning Guide Module 3-5 Introductory Lesson A	See Instructional Planning Guide Module 3-5 Lesson A Assessing the Lesson

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Module 3-6 Temperature			
Indicator	**Recommended Resources**	**Suggested Instructional Strategies**	**Assessment Guidelines**
Module 3-6 Lesson A 5-5.7 Understand the relationship between the Celsius and Fahrenheit temperature scales. (B2)	**STANDARD SUPPORT DOCUMENT** http://www.ed.sc.gov/agancy/standard-and-learning/academic standards/math/index.html NCTM's Online Illuminations http://illuminations.nctm.org NCTM's Navigations Series 3-5 Teaching Student-Centered Mathematics Grades 3-5 and Teaching Elementary and Middle School Mathematics Developmentally 6th Edition, John Van de Walle Blackline Masters for Van de Walle Series www.ablongman.com/vandewalleseries NCTM's Principals and Standards for School Mathematics (PSSM) NCTM, Mathematics Assessment Sampler: Grades 3-5	See Instructional Planning Guide Module 3-6 Introductory Lesson A	See Instructional Planning Guide Module 3-6 Lesson A Assessing the Lesson

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MODULE 3-1

Perimeter, Area, and Volume

This module addresses the following indicators:

5-5.4 Apply formulas to determine the perimeters and areas of triangles, rectangles, and parallelograms. (C3)
5-5.5 Apply strategies and formulas to determine the volume of rectangular prisms. (C3)

This module contains 2 lessons. These lessons are **INTRODUCTORY ONLY.** Lessons in S^3 begin to build the conceptual foundation students need. **ADDITONAL LESSONS will be required** to fully develop the concepts.

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I. Planning the Module

- **Continuum of Knowledge**

5-5.4

In second grade, students identified and analyzed three-dimensional shapes spheres, cubes, cylinders, prisms, pyramids, and cones according to the number and shape of the faces, edges, corners, and bases of each (2-4.1). In fourth grade, students analyzed the relationship between three-dimensional geometric shapes in the form of cubes, rectangular prisms, and cylinders and their two-dimensional nets (4-4.2).
In fifth grade, students translate between two-dimensional representations and three-dimensional objects.
In seventh grade, students translate between two- and three-dimensional representations of compound figures (7-4.4).

5-5.5

Fifth grade is the first time students are introduced to volume.
In seventh grade, students apply strategies and formulas to determine the surface area and volume of three dimensional shapes (prisms, pyramids and cylinders)

- **Key Concepts/ Key Terms**

These are vocabulary terms that are reasonable for students to know and be able to use. Terms without the * are additional terms for teacher awareness, knowledge and use and conversation for students.

*Perimeter
*Area
*Units^2
*Triangle
*Rectangles
*Parallelogram
*Formulas
*Base
*Height
*Length
*Width
*Volume
*Units^3
*Rectangular prism
Space

II. Teaching the Lessons

1. Teaching Lesson A: Perimeter and Area

In fourth grade students analyzed perimeters of polygons and generated strategies to determine the area of rectangles and triangles. In other words, students have had a variety of concrete experiences with perimeter and area of triangles, rectangles, and parallelograms. As a result, fifth grade students are ready to apply formulas to determine

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area and perimeters of triangles, rectangles, and parallelograms. When applying formulas to determine the area of triangles, focus should be on triangles that have whole number heights and whole even number bases than can be evenly divided. (The formula for area of a triangle is A = ½ base x height. Because students do not multiply fractions until 6th grade, providing whole number heights and whole even number bases eliminates the need to deal with fractions.)

Fifth grade is the first time students are introduced to the concept of volume. However, the expectation is that students will progress from concrete to abstract problem solving situations that involve volume of rectangular prisms. Another important mathematical issue to consider is using the appropriate unit to describe volume versus perimeter or area. For example, when measuring area the unit should be expressed in square units and when measuring volume, cubic units should be used. It is extremely important that students understand when to use the appropriate unit and why that is so.

Students should develop the formulas for determining the areas of triangles, rectangles, and parallelograms. This will aid them in choosing the right formula for the right situation. The first formula developed is the one for finding the area of a rectangle. It is usually given as A = L x W. However, according to John Van de Walle, "an equivalent but more unifying idea might be A = b x h, 'area equals base times height.' The base-time-height formulation can be generalized to all parallelograms (not just rectangles) and is useful in developing the area formulas for triangles and trapezoids. Furthermore, the same approach can be extended to three dimensions, where volumes of cylinders are given in terms of the area of the base time the height. Base times height, then, helps connect a large family of formulas that otherwise must be mastered independently." [Teaching Student-Centered Mathematics, Grades 3-5, p. 282

For this indicator, it is **essential** for students to:

- Understand the properties of triangles, rectangles, and parallelograms
- Add and multiply with fluently
- Identify properties of these shapes when given in pictorial and word form
- Compute area and perimeter in real world situations
- Compute area and perimeter of figures containing more than one of each shape. For example, the figure contains three connected triangles or two connected rectangles, etc..
- Substitute values into formulas

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For this indicator, it is **not essential** for students to:

- Find the area and perimeter of figures that are combinations of these shapes such as triangle combined with rectangles, parallelograms with triangles, etc.

a. *Indicators with Taxonomy*

5-5.4 Apply formulas to determine the perimeters and areas of triangles, rectangles, and parallelograms. (C3)

Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

b. *Introductory Lesson A*

Materials Needed

- rectangles drawn on square grids (variety of whole number dimensions)
- rectangles with whole number dimensions drawn on plain paper
- 1-inch square color tiles (one for each student)
- standard ruler

Possible Literature Connection

Sir Cumference and the Isle of Immeter by Cindy Neuschwander

Sir Cumference returns in this tale that introduces readers to the concepts of perimeter and area. As in the previous books, Neuschwander's characters have names that play with mathematical terminology. In this adventure Per visits his uncle and aunt (Sir Cumference and Lady Di of Ameter). After learning a game involving inners and edges, she and her cousin Radius become embroiled in a mystery with a secret message and a threatening sea serpent. To solve it, the youngsters must travel to the Isle of Immeter and use a series of geometric formulas to tame the sea serpent and bring peace to the area.

Part 1 – Rectangles

Pair students so that they may work together and talk about the math they are learning.

The following sequence of activities is intended to develop the area formula for a rectangle. Treat each step as an opportunity to solve a problem: How can we figure this out?

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1. Have students determine the areas of rectangles drawn on square grids. You may also have students draw rectangles that have specified areas on a grid without giving them the dimensions. Observe students carefully to see how they determine the area (or the dimensions) of their rectangles. Some students may have to count every square, while others will simply multiply to find the total number of squares. Emphasize that because there are two dimensions involved (base and height), the area is noted in units squared.

2. Have students examine rectangles not drawn on a grid that have whole number dimensions. Give students a single color tile and a ruler. Ask them to find the area of the rectangles using just these two tools without drawing in all of the squares or moving their single tile from place to place. Have students share and justify their strategies and answers.

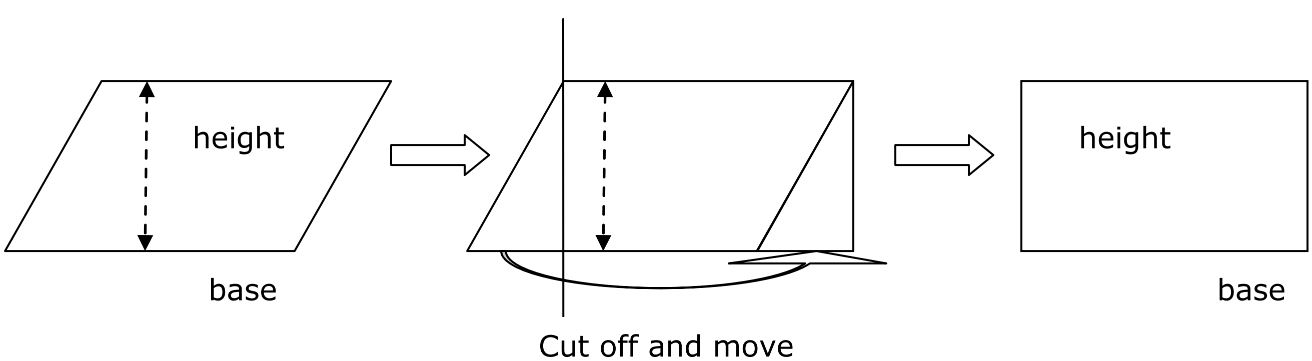
3. Give students with only the dimensions provided and have them determine the area. At this point, they should make the connection to A = b x h.

Part 2 - From rectangles to other parallelograms

Materials Needed

- parallelograms drawn on square grids
- parallelograms drawn on plain paper (whole number dimensions)
- scissors and clear tape
- standard ruler

Teacher Note: Any parallelogram may be transformed into a rectangle with the same base, same height, and same area.



Again, students should work in pairs so that they are able to talk about the math.

To begin, give pairs of students several parallelograms drawn on grid paper and challenge them to find the area of each. The method they develop should work for any parallelogram, not just the ones with which they are working.

If students need a hint, ask them to examine the ways that their parallelograms are like rectangles, or how a parallelogram might be changed into a rectangle. Provide scissors and tape so that they may experiment.

Students should deduce from experimenting with the parallelograms that the base x height formula that works for rectangles also works for all parallelograms.

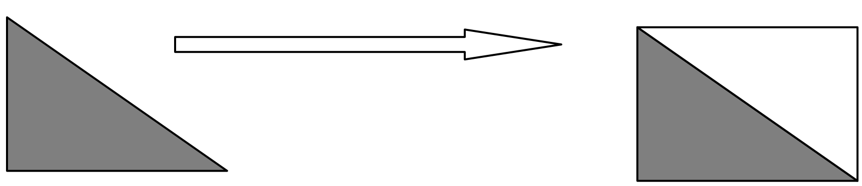
Students may use the plain paper parallelograms to apply the formula they just developed by using the ruler to find the dimensions. Again, emphasize that area is noted in units squared. Since students are using a standard ruler, their areas are in inches^2.

Part 3 - From parallelograms to triangles

Materials Needed

- triangles drawn on grid paper (identical pairs)
- triangles drawn on plain paper (identical pairs)
- clear tape

Teacher Note: Two copies of any triangle will always form a parallelogram with the same base and height. Therefore, the triangle has an area of half of the parallelogram, A = 1/2 (base x height).



Students have developed the area formulas for rectangles and other parallelograms and are now ready to do the same for triangles.

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Give students multiple copies of triangles and challenge them to find a method for determining the area that will work for all triangles.

If students need a hint, suggest they try putting together two identical triangles to make a different shape. They should discover that two congruent triangles can be fitted together to make a parallelogram – and they've already developed a formula for finding that area.

Have them describe the relationship between one of the triangles and the whole parallelogram. This should help them see that the triangle is half the parallelogram. Thus, the area of the triangle is half the area of the parallelogram. So…the formula for the triangle is ½ of the base-times-height, or ½ (base x height).

Following the development of the area formulas, provide meaningful practice for students to apply them. Continue to emphasize the connection between the number of dimensions (two) and the exponent (squared).

c. Misconceptions/Common Errors

Students may confuse the units for volume (cubic) with those for area (square) and perimeter (linear).
That is why it is so important for students to understand the concepts of area and perimeter and to develop the formulas themselves.

d. Additional Instructional Strategies/Differentiation

While additional learning opportunities are needed, no suggestions are included at this time.

e. Technology

Virtual manipulatives should NOT take the place of concrete manipulation of objects/materials. Once conceptual understanding has been reached, you may move to pictorial representations and then virtual manipulatives. Concrete manipulatives should be the focus of learning to build conceptual understanding. Real life situations/representations are critical for conceptual understanding.

There are no specific recommendations for technology for this lesson at this time.

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f. Assessing the Lesson

Formative Assessment is embedded within the lesson through questioning and observation, however, other formative assessment strategies should be employed.

Simply ask students to respond to the following prompts in their journals/notebooks. Then take up the notebooks or responses and review for correct connections and/or misconceptions:

- How do you determine the perimeter of a rectangle or triangle?
- How do you determine the area of a rectangle and triangle?
- What is the relationship between a rectangles area and a parallelograms area?

Math Notebooking: Students respond to this prompt: "What do you know about area, perimeter and volume? (You may use words, symbols and pictures)

2. Teaching Lesson B: Strategies for Volume of Rectangular Prisms

For this indicator, it is **essential** for students to:

- Understand the meaning of volume
- Understand the relationship between area of a rectangular and volume (The volume is the area of the rectangle layered multiple times which is the height)
- Identify the properties of a rectangular prism when given information in word and pictorial form
- Identify the properties of a rectangular prism when the shapes is not oriented upright
- Substitute values
- Use appropriate units (cubic units)

For this indicator, it is **not essential** for students to:

- Compute the volume of other three dimensional shapes

a. Indicators with Taxonomy

5-5.5 Apply strategies and formulas to determine the volume of rectangular prisms. (C3)

Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

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b. Introductory Lesson B

Materials Needed

- empty boxes
- inch cubes
- standard rulers

This lesson is similar in structure to the lesson on developing the formula for the area of rectangles, parallelograms, and triangles. Make a connection between that work and the work they will do now. It should be approached as a problem solving situation and students must communicate and justify their strategies. Even if students have seen or know a formula, they may not rely on a formula to complete the task.

Pair students so that they may work together and talk about the math they are learning.

Give each pair a box, a few cubes, and a ruler. Tell them they must determine how many cubes will fit inside the box. Because it's unlikely that your boxes will have whole-number dimensions, students should ignore any fractional parts of cubes. Tell them not to write on the boxes, so that you may use them more than once.

If students need a hint, suggest they start by determining how many cubes will fit on the bottom of the box. From there, students should figure out that it takes layers of cubes to fill the box, and each layer is the same. Watch and listen carefully as the students work. Students should make the leap that finding out how many layers it takes will get them where they want to go, and make the connection that the number of layers is the height of the box. You may need to guide their thinking in this area.

Students may need to experiment with more than one box to really understand how the pieces – the filling of the bottom and the stacking of the layers – are connected to the formula.

Developing the formula:

- the filling of the bottom of the box = the area of the bottom of the box
- the stacking of the layers = the height of the box

The formula → Volume = the area of the base x the height

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Emphasize that there are three dimensions being measured: the base and height of the **bottom** of the box, and the height of the box. So, volume is noted in units cubed. 3 dimensions → an exponent of 3. Students are using a standard ruler, so the volume of their boxes would be noted in inches^3.

c. Misconceptions/Common Errors

Students may confuse the units for volume (cubic) with those for area (square) and perimeter (linear).

d. Additional Instructional Strategies/Differentiation

While additional learning opportunities are needed, no suggestions are included at this time.

e. Technology

Virtual manipulatives should NOT take the place of concrete manipulation of objects/materials. Once conceptual understanding has been reached, you may move to pictorial representations and then virtual manipulatives. Concrete manipulatives should be the focus of learning to build conceptual understanding. Real life situations/representations are critical for conceptual understanding.
There are no specific recommendations for technology for this lesson at this time.

f. *Assessing the Lesson*

Formative Assessment is embedded within the lesson through questioning and observation; however, other formative assessment strategies should be employed.

Questioning Strategies:
"What strategies did your group use to determine the number of cubes that fit inside the box?"
What ways did knowing the area help your group to determine the number of cubes that fill the box?"
"What reasons might there be for labeling area square units and volume cubic units? (Misconception Assessment)

Have students respond in their notes to the following problem.. then use the popsicle sticks to select a student to share his/her thinking with the class.

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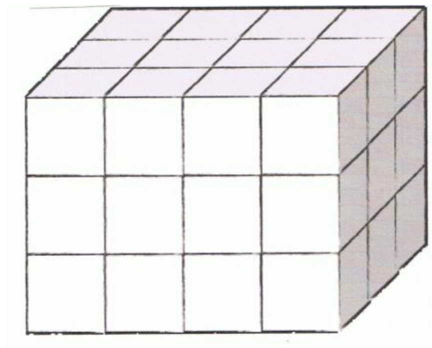
"Victoria was playing around with some sugar cubes she found in the cupboard and built the block shown below. After she built it, she wondered how many cubes she used all together. How could she figure this out without taking them apart and counting?



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III. Assessing the Module

At the end of this module summative assessment is necessary to determine student understanding of the connections among and between the indicators addressed in this module.

5-5.4

The objective of this indicator is apply which is in the "apply procedural" cell of the Revised Taxonomy. The focus of the indicator is to apply; therefore, students should gain computational fluency with finding perimeter and area rectangles, triangles and parallelograms. The learning progression to **apply** requires students to recall and understand the properties of these shapes. To deepen understanding of the formulas, students generalize connections (5-1.6) between concrete/pictorial models and the formulas. They apply the formula in a variety of situations including problems in word form, pictorial form and real world situations. They explain and justify their answers (5-1.3) using correct, clear and complete oral and written language (5-1.6). Students engage in meaningful practice to support retention and understanding of the formulas.

5-5.5

The objective of this indicator is to apply which is in the "apply procedural" knowledge cell of the Revised Taxonomy. To apply is to have the knowledge of steps and the criteria for when to use those steps. The learning progression to use requires students to recall the properties of a rectangular prism. Students explore a variety of problems in order to develop

The objective of this indicator is to apply which is in the "apply procedural" knowledge cell of the Revised Taxonomy. Although the focus of the indicator is to apply, the learning progression should include learning experiences that build both conceptual and procedural knowledge of volume. The learning progression to **apply** requires students to recall the properties of a rectangular prism. They understand the meaning of volume and use concrete models to explore that understanding. As students analyze information (5-1.1) from these experiences, they generate mathematical statements (5-1.4) about the relationships they observe between length, width and height. They explain and justify their understanding (5-1.3) to their classmates and their teachers. They then develop formal relationships using appropriate notation and units of measure. To support retention, students engage in meaningful practice with problems where information is given in word and pictorial form.

The following examples of possible assessment strategies may be modified as necessary to meet student/teacher needs. These examples are not derived from nor associated with any standardized testing.

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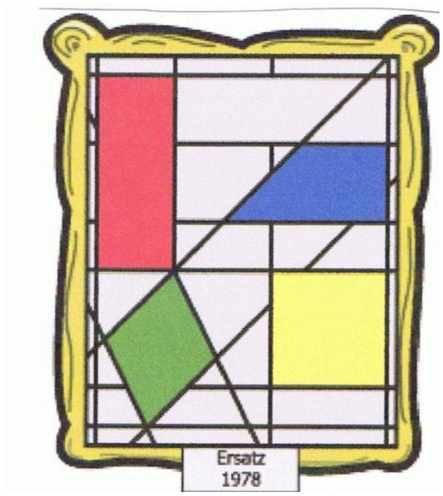
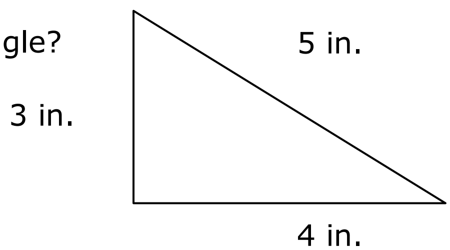
1. The formula for finding the _____________ of a rectangle is length x width.

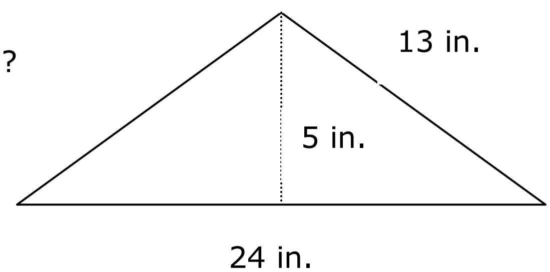
2. Monica is in the gift shop and is thinking about buying one of her favorite paintings. She has a wall that has square wall space for a picture with an area of 9 square feet. Will this 2ft x 3ft picture fit in that space? Explain how you know.



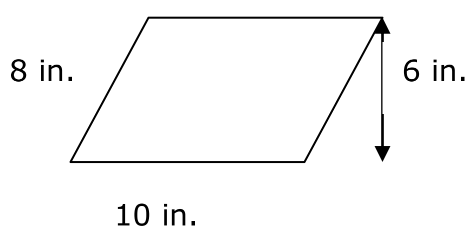
3. What is the area of the triangle?



4. What is the area of the triangle?



5. What is the area of the parallelogram?



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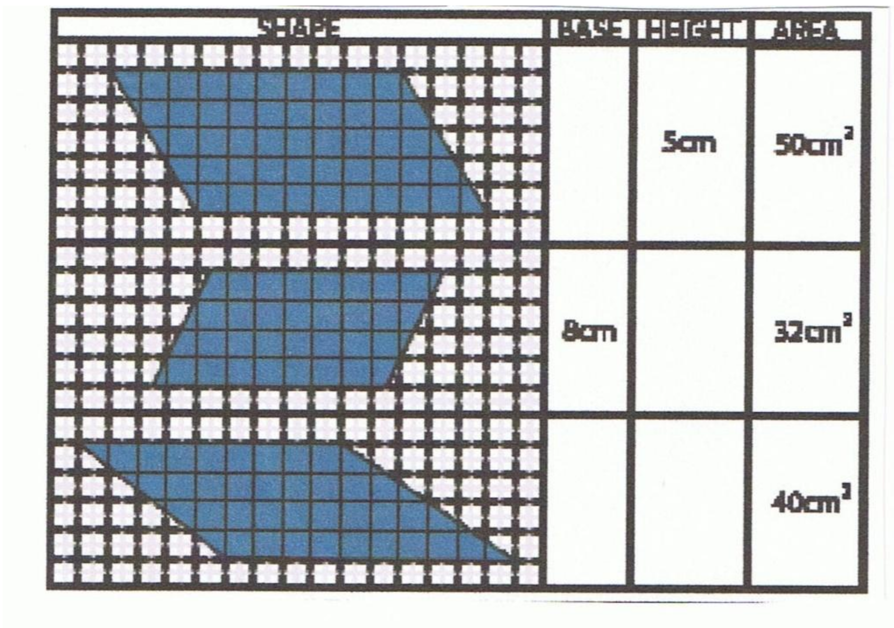
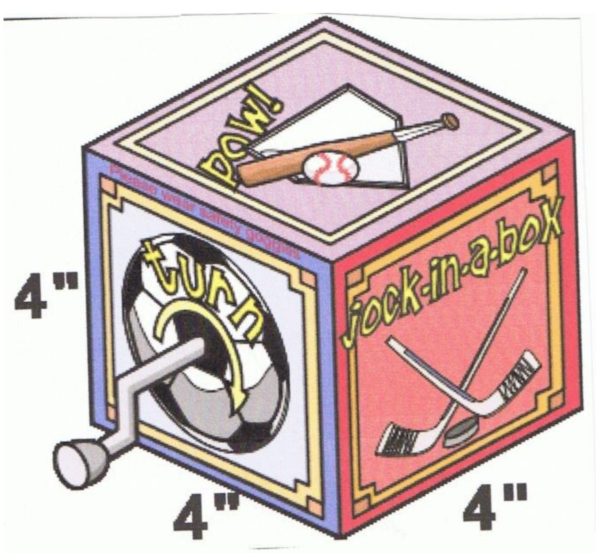
6. Fill in the missing information for each shape in the table below. Then look at the table. Do you notice a connection between the base and height of a parallelogram and its area? Then, write the formula for finding the area of a parallelogram based on your explanation.



SHAPE	BASE	HEIGHT	AREA
		5cm	$50cm^2$
	8cm		$32cm^2$
			$40cm^2$

7. Albert loves to repair broken toys. His baby brother managed to completely dismantle his jack-in-the-box, ripping the jack out entirely. Albert thinks he can fix it and replace the jack, but needs to know the volume of the box before he can do anything. What should Albert keep in mind that would help him? What is the volume of the box?



MODULE

3-2

Plane and Transformational Geometry

This module addresses the following indicators:

5-4.5 Predict the results of multiple transformations on a geometric shape when combinations of translation, reflection, and rotation are used. (B2)
5-4.6 Analyze shapes to determine line symmetry and/or rotational symmetry. (B4)

This module contains 2 lessons. These lessons are **INTRODUCTORY ONLY.** Lessons in S^3 begin to build the conceptual foundation students need. **ADDITONAL LESSONS will be required** to fully develop the concepts.

I. Planning the Module

- **Continuum of Knowledge**

5-4.5

In fourth grade, students have predicted the results of multiple transformations of the same type (4-4.3).

In fifth grade, students predict the results of multiple transformations on a geometric shape when combinations of translation, reflection, and rotation are used (5-4.5).

In sixth grade, students will identify the transformation(s) used to move a polygon from one location to another in the coordinate plane (6-4.5) and explain how transformation affect the location of the original polygon in the coordinate plane (6-4.6) .

5-4.6

In first grade, students identified a line of symmetry (1-4.2). In second grade, students identified multiple lines of symmetry (2-4.2).

For the first time, 5th grade students are introduced to the concept of rotational symmetry. Students will now analyze shapes to determine line symmetry and/or rotational symmetry (5-4.6).

In sixth grade, students generalize the relationship between line symmetry and rotational symmetry for two-dimensional shapes (6-4.3) and construct two-dimensional shapes with line or rotational symmetry (6-4.5).

- **Key Concepts/ Key Terms**

These are vocabulary terms that are reasonable for students to know and be able to use. Terms without the * are additional terms for teacher awareness, knowledge and use and conversation for student.

*Transformation	*Horizontal axis (line)
*Reflection	Degrees
*Rotation	*Line
*Translation	90°
Clockwise	180°
Counterclockwise	270°
*Vertical axis (line)	360°
Line Symmetry	

II. Teaching the Lessons

1. Teaching Lesson A: From Here to There

In 4th grade, students have predicted the results of multiple transformations of the same type, but now they use multiple transformations of different types. "Students should consider three important kinds of transformations: reflections (flips), translations (slides), and rotations (turns). Younger students generally convince

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themselves that two shapes are congruent by physically fitting one on top of the other, but fifth grade students can develop greater precision as they describe the motions needed to show congruence ("turn it 90 degrees or flip it vertically, then rotate it 180 degrees). They should be able to visualize what will happen when a shape is rotated or reflected and predict the result. Students should also explore shapes with more than one line of symmetry. Students often create figures with rotational symmetry, but often have difficulty describing the regularity they see. They should be using language about turns and angles to describe these figures." *(Principles and Standards for School Mathematics, 167-168)*

For the first time, 5^{th} grade students are introduced to the concept of rotational symmetry. A shape that rotates onto itself before turning 360^{o} has rotational symmetry. When rotating shapes, experiences should include clockwise and counterclockwise rotations.

Students' prior experiences have been limited to identification of lines of symmetry. Students will now analyze shapes to determine line symmetry and/or rotational symmetry. It is important to note that all regular polygons have rotational symmetry.

"Students should consider three important kinds of transformations: reflections (flips), translations (slides), and rotations (turns). Younger students generally convince themselves that two shapes are congruent by physically fitting one on top of the other, but fifth grade students can develop greater precision as they describe the motions needed to show congruence (turn it 90 degrees or flip it vertically, then rotate it 180 degrees). They should be able to visualize what will happen when a shape is rotated or reflected and predict the result. Students should also explore shapes with more than one line of symmetry. Students often create figures with rotational symmetry, but often have difficulty describing the regularity they see. They should be using language about turns and angles to describe these figures." *(Principles and Standards for School Mathematics, 167-168)*

For this indicator, it is **essential** for students to:
- Identify the types of transformations (rotation, reflection, translation)
- Understand and identify horizontal and vertical axes
- Understand and identify clockwise and counter clockwise movement
- Perform a series movement involve multiple transformations
- Understand ½ turn, ¼ turn and full turn

For this indicator, it is **not essential** for students to:
None noted

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a. Indicators with Taxonomy

5-4.5 Predict the results of multiple transformations on a geometric shape when combinations of translation, reflection, and rotation are used. (B2)

Cognitive Process Dimension: Understand
Knowledge Dimension: Conceptual Knowledge

b. Introductory Lesson

Materials Needed

- Math notebooks for recording work
- Colored pencils
- *two* right triangle cut outs for each student (pattern included-run on cardstock)

Prior to teaching this lesson, it is VITALLY IMPORTANT that you spend some time practicing transformations yourself. You should develop several examples that you can use in addition to the ones included.

Possible Literature Connections

It Looked Like Spilt Milk by Charles G. Shaw

The white shape silhouetted against a blue background changes on every page. Is it a rabbit, a bird, or just spilt milk? Children are kept guessing until the surprise ending—and will be encouraged to improvise similar games of their own. Children will have fun finding lines of symmetry in their own creations.

Modern Buildings: Identifying BiLateral and Rotational Symmetry and Transformations by Greg Moskal

Examples of symmetry in nature and famous structures from around the workd are explored.

<u>Lesson</u>

Students should be paired so that they may work together and talk about the math they are learning.

NOTE: If you have interactive white boards, your movements will mirror the students. If you use an overhead, and you're facing your students, your movements will be opposite your students' movements. Keep this in mind.

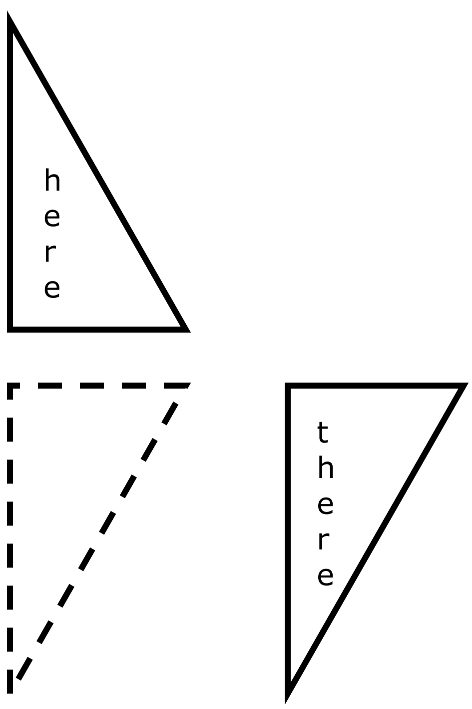
Use the examples to get students started thinking about what combination of transformations it takes to get the shape from the starting position (here) to the ending position (there). The shapes with dotted outlines are the intermediate moves. Don't show those to the students until they have explored the moves on their own. Using dotted lines or a colored pencil to draw intermediate steps is an effective way for students to record their work as they experiment with the examples.

Once students have the idea of how two different transformations affect the position of a shape, let them experiment with multiple transformations of the same type. Then move to having them predict how multiple transformations affect the position of a shape. Students should also use shapes other than the right triangle.

Example 1

Ask: "How might I get from here to there?"

Students should manipulate their own shapes to try to find a solution to the question.



The first transformation is a vertical reflection. The second is a horizontal translation.

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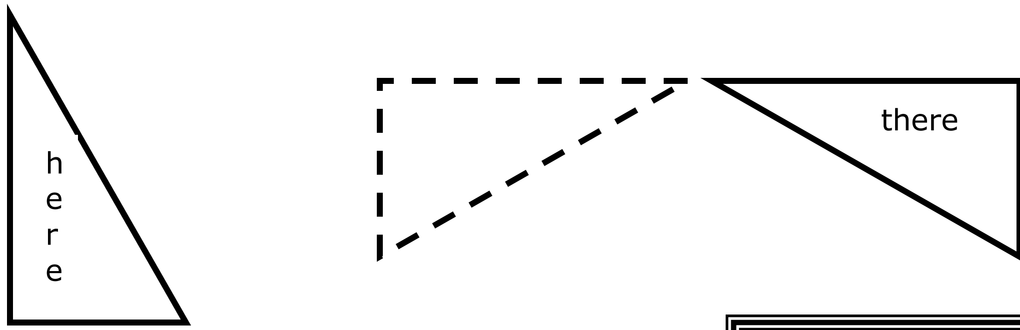

Figure 1

Example 2

Ask: "How might I get from here to there?"

Students should manipulate their own shapes to try to find a solution to the question.

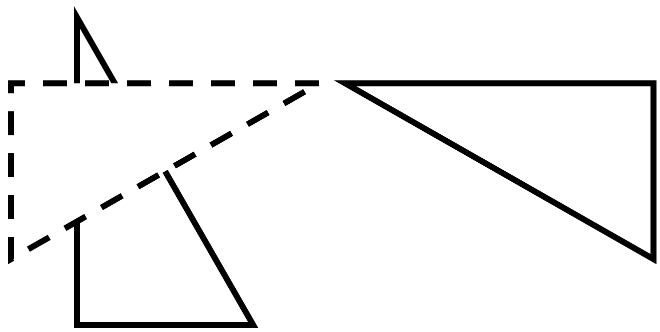

Figure 2

This is a little tricky. The two transformations are a 90° clockwise rotation and a horizontal reflection. Figure 1 actually has a translation after the rotation so that the first step and second step aren't on top of each other in the drawing. Figure 2 does not have the translation after the rotation. This may be too fine a point for students, but it is offered for your consideration.

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Example 3

Ask: "How might I get from here to there?"

Students should manipulate their own shapes to try to find a solution to the question.

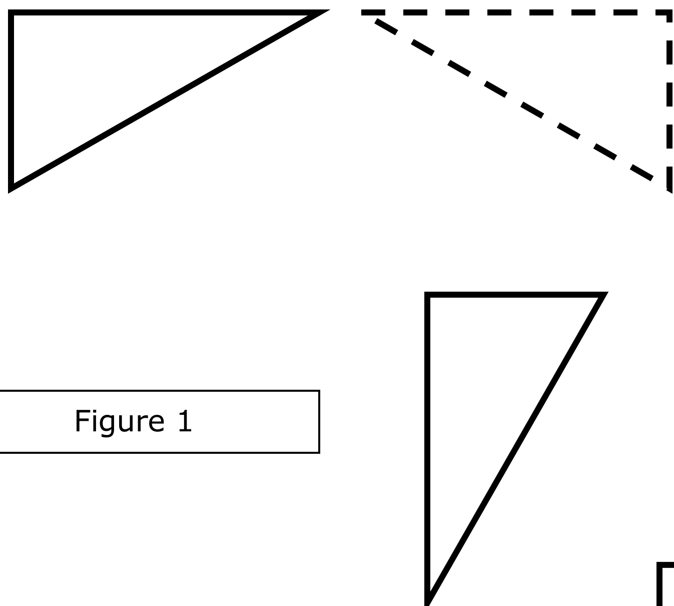

Figure 1

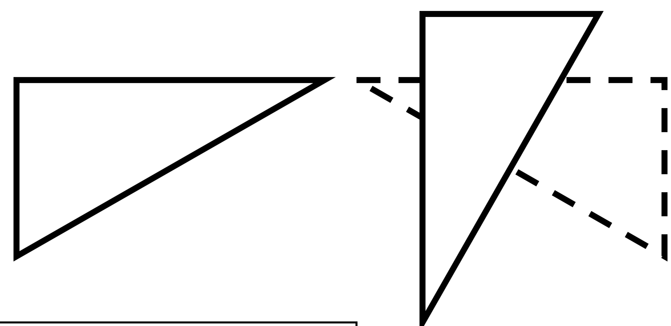

Figure 2

As in the second example, there is a rotation involved. In Figure 1, the rotation is followed by a vertical translation to make the drawing cleaner. The translation is not shown in Figure 2.

The transformations are a horizontal reflection followed by a 90^{o} counterclockwise rotation.

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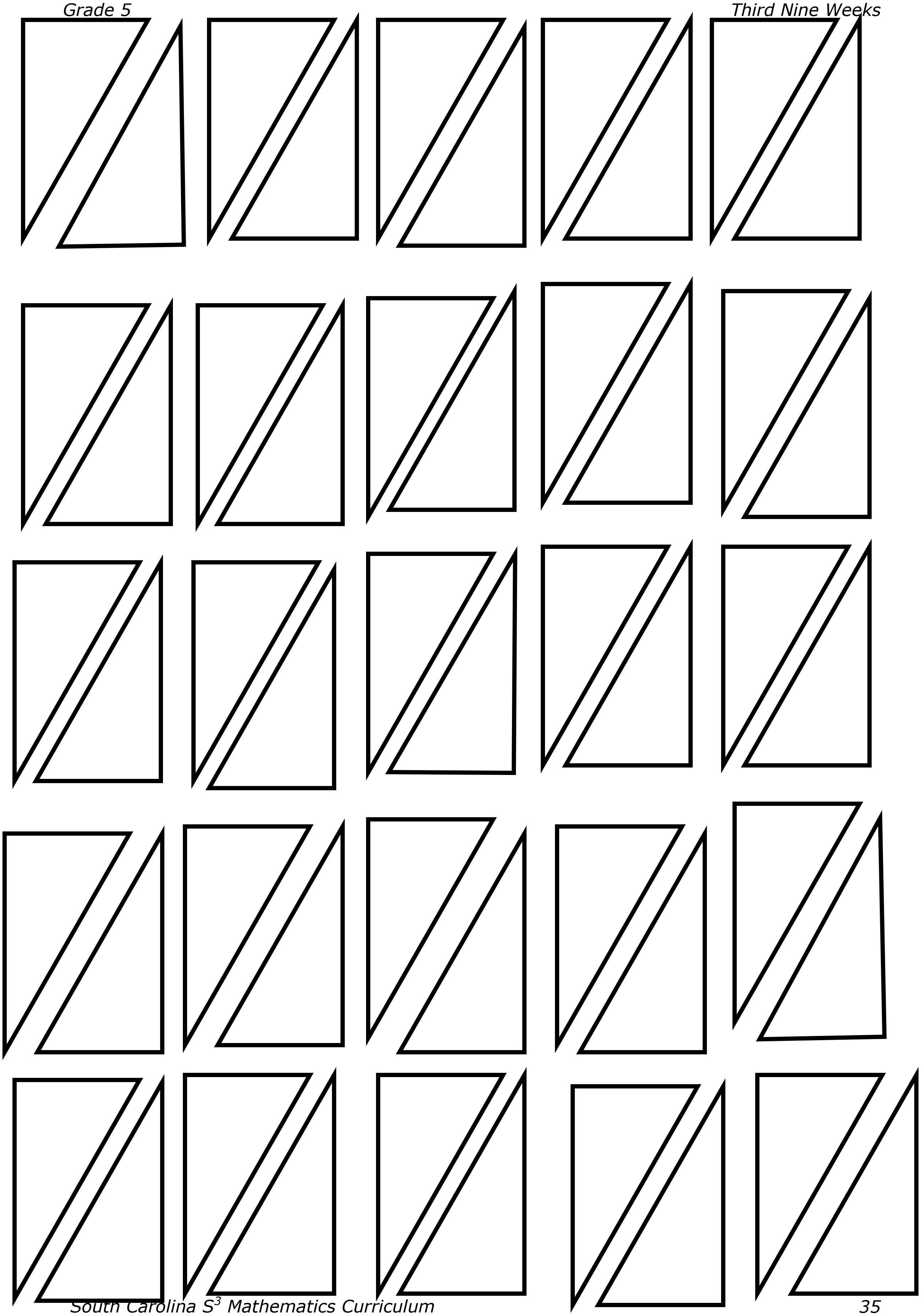

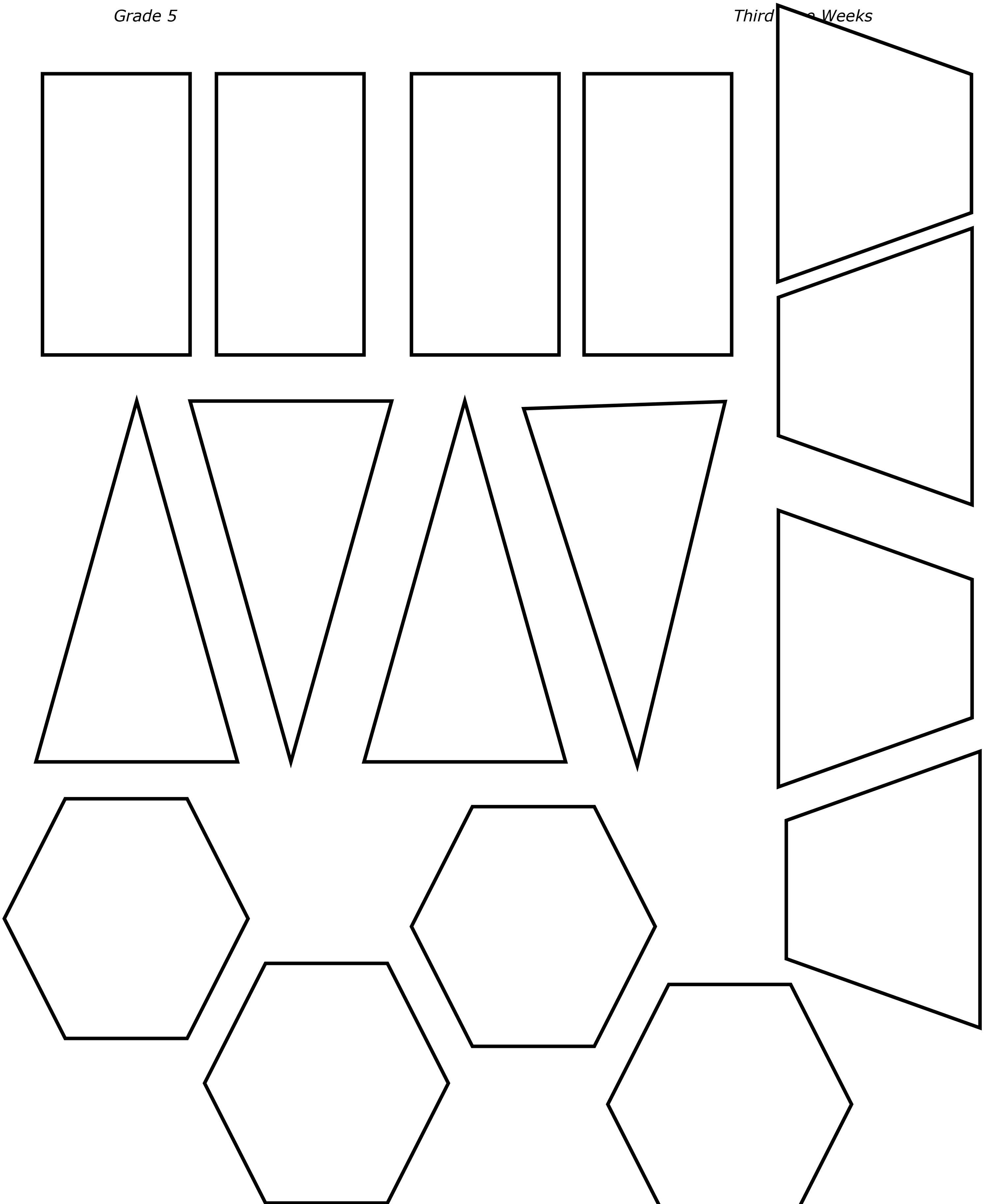

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c. Misconceptions/Common Errors

Students may be confused when the orientation of the shapes changes after the transformations.

d. Additional Instructional Strategies/Differentiation

While additional learning opportunities are needed, no suggestions are included at this time.

e. Technology

Virtual manipulatives should NOT take the place of concrete manipulation of objects/materials. Once conceptual understanding has been reached, you may move to pictorial representations and then virtual manipulatives. Concrete manipulatives should be the focus of learning to build conceptual understanding. Real life situations/representations are critical for conceptual understanding.

There are no specific recommendations for technology for this lesson at this time.

f. Assessing the Lesson

Formative Assessment is embedded within the lesson through questioning and observation, however, other formative assessment strategies should be employed.

Have students respond on index cards. They should trade index cards with another student and see if they agree. Then discuss with each other. Next, have a class discussion.

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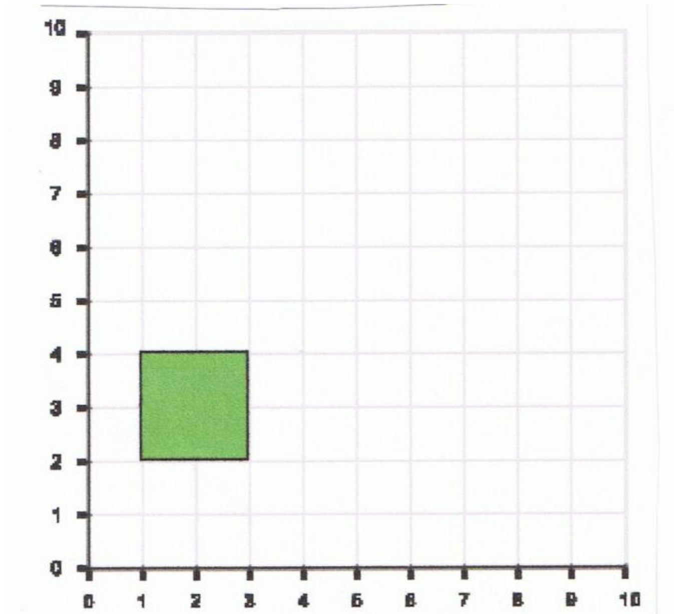
If the square on the grid shown below were to move (by translation) two coordinates up and three coordinates to the right, what would be the resulting four coordinates of its vertices?



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2. ***Teaching Lesson B:*** Determine Line Symmetry and/or Rotational Symmetry

For this indicator, it is **essential** for students to:
- Identify shapes that have line symmetry.
- Identify shapes that have rotational symmetry.
- Identify shapes with no line of symmetry
- Understand that all regular polygons have rotational symmetry.
- A shape that rotates onto itself before turning 360^{o} has rotational symmetry.

For this indicator, it is **not essential** for students to:
None noted

a. ***Indicators with Taxonomy***

5-4.6 Analyze shapes to determine line symmetry and/or rotational symmetry. (B4)

Cognitive Process Dimension: Analyze
Knowledge Dimension: Conceptual Knowledge

b. ***Introductory Lesson***

Materials Needed

Part 1 – Line symmetry
- Page of Shapes I handout
- Folding Shapes handout
- scissors
- clear tape
- colored pencils

Part 2 – Rotational symmetry
- Page of Shapes II – 2 for each student (shapes with angles labeled)
- Turning & Locking handout
- Turning & Locking transparency
- Shapes for you to use on the overhead

Do both of these activities by yourself or with another teacher before you do them with the students.

Part 1 – Line Symmetry

Students should be paired so that they may work together and talk about the math they are doing.

Each students needs a Page of Shapes handout, a Folding Shapes handout and a pair of scissors.

Instruct students to carefully cut out each shape on the Page of Shapes handout. The edges and angles need to be as clear as possible. If you have students who have difficulty cutting things out, you may want to have a couple of sets pre-cut. Then you can make trades if some of their shapes are off enough to make a difference in the exploration.

Once students have their shapes cut out, demonstrate what you want them to do using Shape #1. Fold the shape along a line of symmetry (don't use that vocabulary yet; if a student uses it, that's great!), open the shape and trace the fold with a colored pencil. Fold the shape again, using another line of symmetry. Open the shape and trace the fold with a different colored pencil. Record the number of folds on the Folding Shapes handout in the space for Shape #1.

Students should do this with each of the other shapes, folding, opening, tracing, and recording. (Remind students that each side must match up) They should use a different color pencil for each line they draw on a given shape. This will help them keep up with how many lines of symmetry each shape has.

The questions under the table are to bring that prior vocabulary of line symmetry back to their minds.

Possible descriptions for shapes with multiple lines of symmetry:

- Most of the shapes that have more than one line of symmetry are regular polygons. They have equal sides and equal angles.
- Only Shapes #1 and #7 have more than one line of symmetry without being regular polygons.

When students have completed the Folding Shapes handout, they may tape their cut outs on the back of the paper so that they will have a record of the hands-on work they did.

<u>Part 2 – Rotational Symmetry</u>

Students should be paired so that they may work together and talk about the math they are doing.

Each student needs two copies of the Page of Shapes II handout, a Turning & Locking handout and a pair of scissors.

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Instruct students to carefully cut out each shape on the Page of Shapes II handout. The edges and angles need to be as clear as possible. If you have students who have difficulty cutting things out, you may want to have a couple of sets pre-cut. Then you can make trades if some of their shapes are off enough to make a difference in the exploration.

Once students have their shapes cut out, demonstrate what you want them to do using Shape #3. Put the Page of Shapes II transparency on the overhead and place Shape #3 in the proper position. Place a pencil in the center of the shape and carefully turn it until it "locks" into position. Because the shape is a square, it will "lock" a total of times. Fill in the table for Shape #3.

Students should do this with each of the other shapes, positioning, turning, and recording.

The statements and questions under the table are to introduce the vocabulary rotational symmetry to help the students describe the concept they've been exploring with the turning and locking shapes.

Possible responses for questions:
- It's called rotational symmetry because you rotate the shapes to line up equally again.
- Some of the shapes that have rotational symmetry are regular polygons, like shapes 3, 5, and 9. The others, like shapes 1, 6, and 8 only lock once before turning all the way back around.

c. *Misconceptions/Common Errors*

Students often create figures with rotational symmetry, but often have difficulty describing the regularity they see. They should be using language about turns and angles to describe these figures." *(Principles and Standards for School Mathematics, 167-168)*

d. *Additional Instructional Strategies/Differentiation*

While additional learning opportunities are needed, no suggestions are included at this time.

e. *Technology*

Virtual manipulatives should NOT take the place of concrete manipulation of objects/materials. Once conceptual

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understanding has been reached, you may move to pictorial representations and then virtual manipulatives. Concrete manipulatives should be the focus of learning to build conceptual understanding. Real life situations/representations are critical for conceptual understanding.
There are no specific technology recommendations for this lesson at this time.

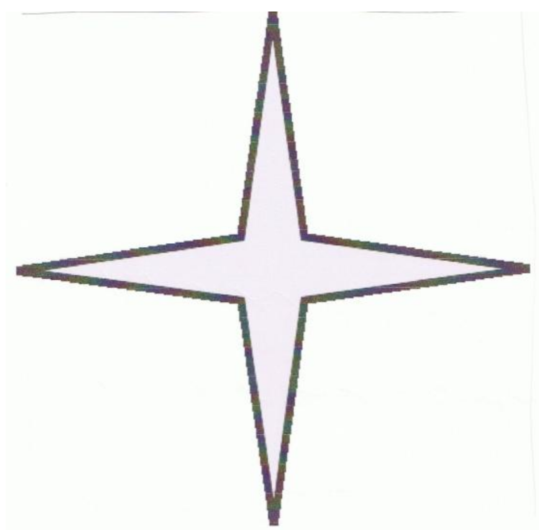
f. *Assessing the Lesson*

Formative Assessment is embedded within the lesson through questioning and observation; however, other formative assessment strategies should be employed.

Math Notebooking: Draw a shape that has symmetry and rotational symmetry. Draw a shape that has symmetry and not rotational symmetry.

Have students respond on index cards. They should trade index cards with another student and see if they agree. Then discuss with each other. Next, have a class discussion.

Draw two lines of symmetry through the figure. Does it also have rotational symmetry? Why or why not?



III. Assessing the Module

At the end of this module summative assessment is necessary to determine student understanding of the connections among and between the indicators addressed in this module.

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5-4.5

The objective of this indicator is predict which is in the "understand conceptual" knowledge cell of the Revised Taxonomy. Conceptual knowledge is not bound by specific examples; therefore, the student's conceptual knowledge of predicting the results of multiple transformations—either reflection, rotation and translation—of a geometric shape should be explored using a variety of examples. The learning progression to **predict** requires students to recall the meaning of reflection, translation and rotation. Student use concrete models to visualize and create transformations of their own. They construct arguments (5-1.2) about what the result will be for a series of transformations. They explain and justify their answers to their classmates and their teacher (4-1.3) using correct, complete, and clearly written and oral mathematical language communicate their ideas (5-1.5). Students analyze this information to solve increasingly more difficult problems (5-1.1) without the use of concrete models.

5-4.6

The objective of this indicator is to analyze, which is in the "understand conceptual" knowledge cell of the Revised Taxonomy. Conceptual knowledge is not bound by specific examples; therefore, the student's conceptual knowledge of rotational and line symmetry should be explored using a variety of examples. The learning progression to **analyze** requires students to recall and understand the meaning of line symmetry. Students experiment with rotating concrete models and generate descriptions and mathematical statements about their observations (5-1.4). They then experiment with teacher generated problem involving rotational symmetry using terms such as clockwise, counterclockwise, 180 degrees, etc…

Students generalize connections between and among line and rotational symmetry. They use this understanding to analyze shapes to determine the type(s) of symmetry. Student explain and justify their answers (5-1.3) using correct, complete and clearly written and oral mathematical language (5 – 1.5).

The following examples of possible assessment strategies may be modified as necessary to meet student/teacher needs. These examples are not derived from nor associated with any standardized testing.

1. Cindy is looking at the triangle on the grid below, trying to figure out where exactly it would end up on the grid if she flipped it up, translated it to

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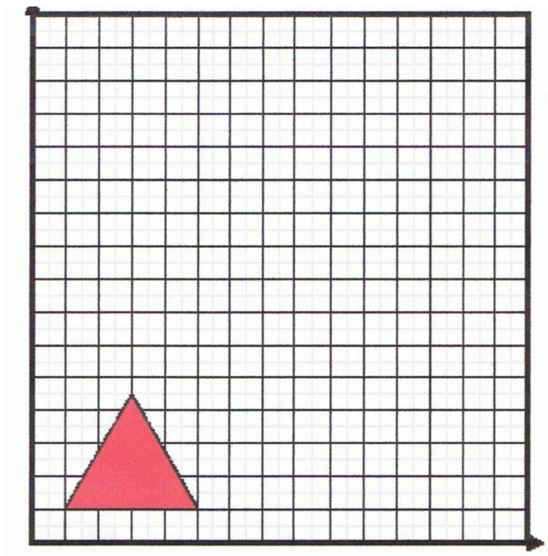
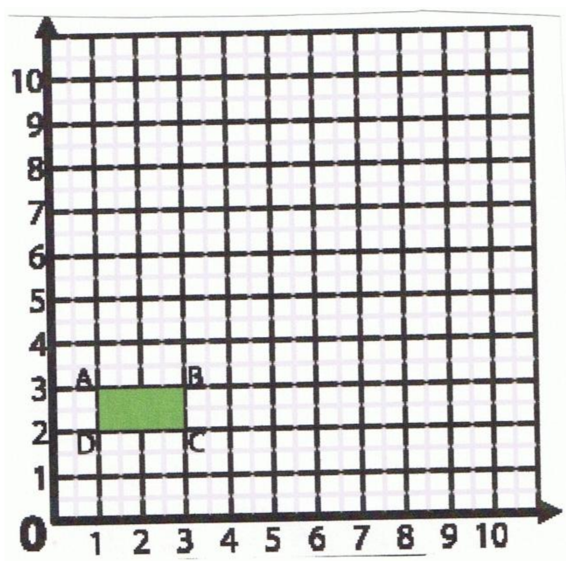
the right 2 units, and flipped it up again. Draw the triangle for Cindy as it would appear after applying those transformations.



2. Complete each set of transformations to draw the shape in its new position on the grid.

- slide the rectangle to the right 2 units
- rotate clockwise 90°, using vertex C as your center
- slide up 2 units



3. Draw two or more lines of symmetry through the design below. Can you tell if the design has rotational symmetry? Explain.

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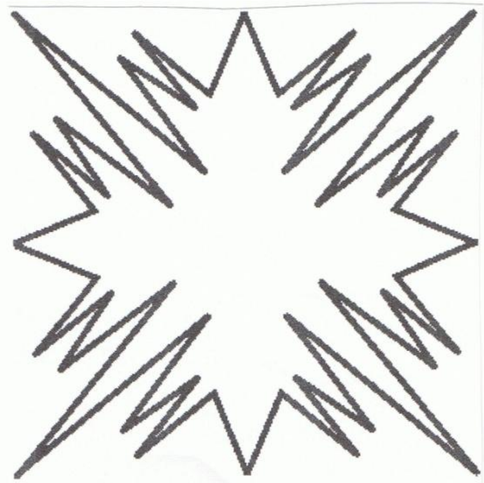
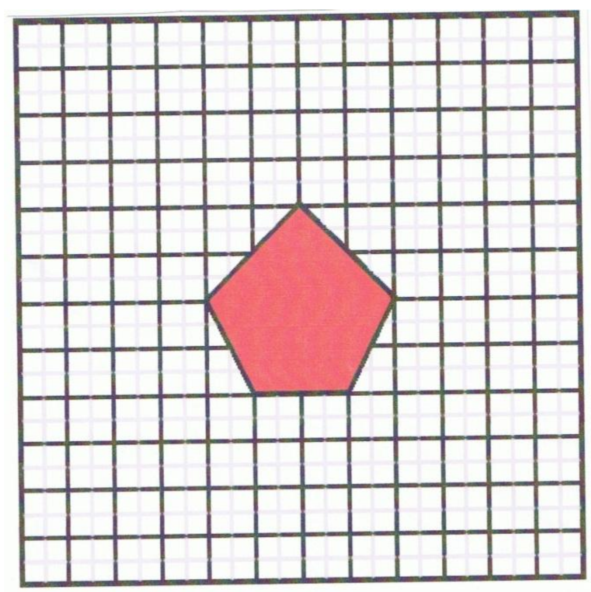


4. Look at the grid below. Does the shape have line symmetry? Does it have rotational symmetry? Explain both responses.



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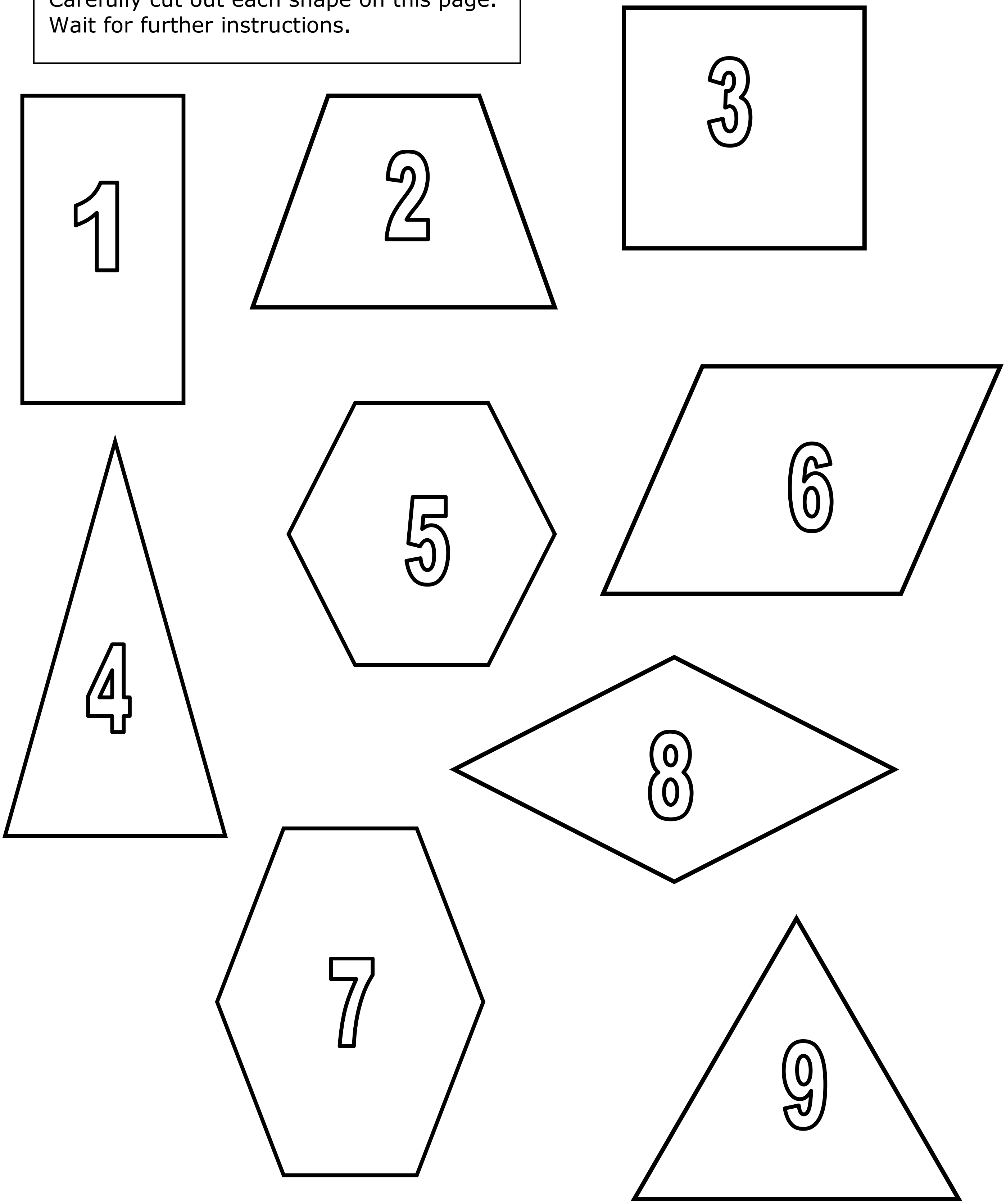
Page of Shapes I

Carefully cut out each shape on this page.
Wait for further instructions.



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Folding Shapes

Fold each shape so that there are two equal halves when you open it.
Use your straight edge to trace the line.

Do this as many times as you can for each shape.

Shape	Number of folds
1	
2	
3	
4	
5	

Shape	Number of folds
6	
7	
8	
9	

Do you remember…

What is the special name for a line that divides an object into two equal parts called?

____

So, if a shape has more than one fold that divides it equally, it has more than one

____

Describe what you notice about the shapes with more than one fold.

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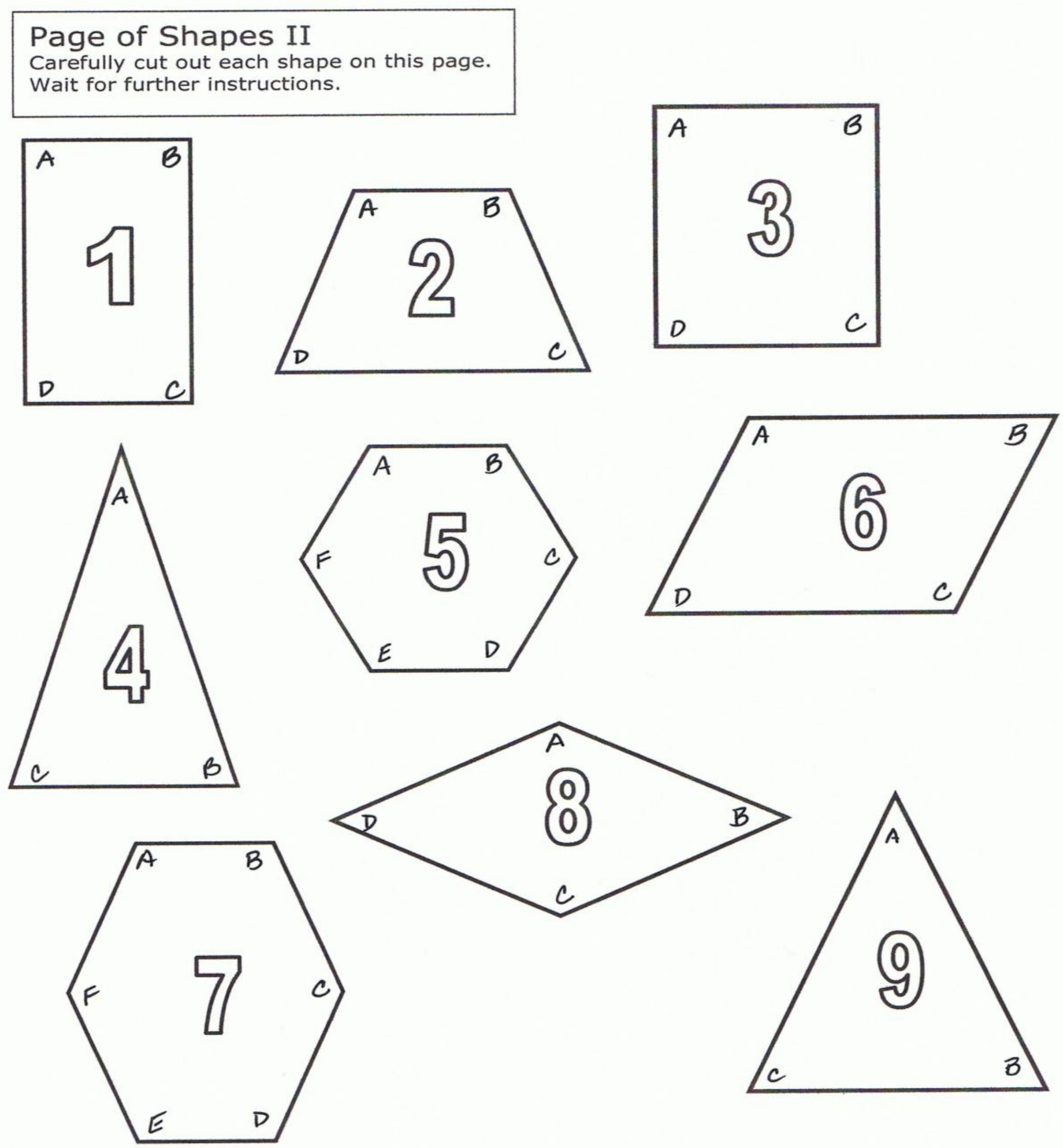
Page of Shapes II
Carefully cut out each shape on this page.
Wait for further instructions.
1
2
3
4
5
6
7
8
9

Turning & Locking

- Take each shape and place it on top of its partner on your extra Page of Shapes II handout.
- Place your pencil in the center of the shape and carefully rotate it until it either "locks" into position <OR> turns completely back to where you started.
- Fill in the table below for each shape.

Shape	Does it "lock" (y/n)	If yes, how many times?
1		
2		
3		
4		
5		

Shape	Does it "lock" (y/n)	If yes, how many times?
6		
7		
8		
9		

When a shape turns and "locks" back into place before turning completely back to where it started, it has a special kind of symmetry.

It's called ***rotational symmetry***. What might be some reasons this turning and locking is called rotational symmetry?

Which shapes above have rotational symmetry?

What, if anything, do these shapes have in common?

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MODULE

3-3

Length

This module addresses the following indicators:

5-5.1 Use appropriate tools and units to measure objects to the precision of one-eighth inch. (C3)

This module contains 1 lesson. This lesson is **INTRODUCTORY ONLY.** Lessons in S^3 begin to build the conceptual foundation students need. **ADDITONAL LESSONS will be required** to fully develop the concepts.

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I. Planning the Module

- **Continuum of Knowledge**

  5.5-1
  In second grade, students use appropriate tools to measure objects to the nearest whole unit: measuring length in centimeters, feet, and yards; measuring liquid volume in cups, quarts, and gallons; measuring weight in ounces and pounds; and measuring temperature on Celsius and Fahrenheit thermometers (2-5.3). They also generate common measurement referents for feet, yards, and centimeters (2-5.4) and use common measurement referent to make estimates in feet, yards and centimeters (2-5.5).In third grade, students use appropriate tools to measure objects to the nearest unit: measuring length in meters and half inches, measuring liquid volume in fluid ounces, pints and liters; and measuring mass in grams (3-5.2). In fourth grade, students use appropriate tools to measure objects to the nearest unit; measuring length in quarter inches, centimeters and millimeters; measuring liquid volume in cups, quarts and liters; and measuring weight and mass in pounds, milligrams and kilograms (4-5.1). They also use equivalencies to convert units to measure within the US Customary System (4-5.3).
  In fifth grade, students use appropriate tools and units to measure objects to the precision of one-eighth inch (5-5.1).

- **Key Concepts/ Key Terms**
  These are vocabulary terms that are reasonable for students to know and be able to use. Terms without the * are additional terms for teacher awareness, knowledge and use and conversation for student.

*Inch
*Half-inch (1/2 inch)
*Quarter-inch (1/4 inch)
*One-fourth –inch (1/4)
*Eighth-inch (1/8 inch)
*Three-quarter-inch(3/4 inch)
*Three-fourths inch (3/4 inch)
*Precision
Yard Stick
Ruler

II. Teaching the Lesson

1. Teaching Lesson A: Measure Objects to the Precision of One-Eighth Inch

In previous years, students have used appropriate tools and units to measure objects to the quarter inch. By fifth grade students have worked with simple rulers and tapes. They should extend their knowledge by making rulers with subunits or fractional units. Fifth grade students have had a variety of experiences with measurement. Therefore, the emphasis should now be on precision and appropriate units. For example, if the length of an object falls

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between say $\frac{2}{8}$ and $\frac{3}{8}$ then the student must understand that if the length is more than half way between $\frac{2}{8}$ and $\frac{3}{8}$ the length would be describe as $\frac{3}{8}$. In essence, students are measuring to the nearest $\frac{1}{16}$ of an inch because that is the half way point between $\frac{2}{8}$ and $\frac{3}{8}$. Simply giving students measuring tools and requiring that they measure in sixteenths is not sufficient to meet the expectation of this Indicator. It is knowing that if one needs to measure to the precision of one-eighth inch, using a measuring tool marked in sixteenths would be a better choice and why that is so.

A lesson that might be used as an introduction to the concept of precision might require that some students use rulers marked in fourths while other students use rulers marked in eighths. After measuring a variety of objects to the nearest eighth of an inch and recording the responses, the class might engage in a discussion as to which group had the more precise measurements and why. (The class should come to the conclusion that the smaller the measurement, the more precise.)

For this indicator, it is **essential** for students to:

- Understand that when measuring to one-eighth of an inch using a tool marked in sixteenths would be a better choice (precision)
- Locate the nearest eighth of an inch
- Understand equivalent fractions
- Use appropriate abbreviation for inches
- Measure using actual tools
- Read a measurement from a pictorial representation

For this indicator, it is **not essential** for students to:

- Measure in units other than inches

a. *Indicators with Taxonomy*

5-5.1 → Use appropriate tools and units to measure objects to the precision of one-eighth inch. (C3)
Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

b. *Introductory Lesson*

Materials Needed

- Super Inch handouts

- Super Inch transparency so that you may demonstrate for the students
- standard measuring tapes (template for paper tapes included ~ **You will need to put these together for them before teaching this lesson.**)
- colored pencils (3 colors for each student)
- Personal Benchmarks handout

Possible Literature Connections

Me and the Measure of Things by Joan Sweeney

What's the difference between a cup and an ounce? What gets measured in bushels and when do you use a scale? Easy-to-understand text and playful corresponding illustrations teach children the differences between wet and dry measurements, weight, size, and length. And all information is conveyed in a unique kid's-eye perspective, using everyday objects and situations.

Millions to Measure by David Schwartz

It explains the development of standard units of measure and shows the simplicity of calculating length, width, height, and volume and the metric system.

Super Inch

Students should be paired so that they may talk about the math they are doing.

Give each student a copy of the Super Inch handout. Tell them that the smaller picture is a copy of part of a standard ruler. Then tell them that you're going to focus in on the parts of an inch. Be sure they understand that the inch starts at the first mark on the ruler, not the end of the ruler. This is a common mistake that students make.

The big picture, Super Inch, is the actual inch enlarged by a factor of four. Students don't necessarily need to know this, they just need to have a clear understanding that we don't use Super Inch to measure. We're just using it to take a closer look at the parts of the real inch. Ask students to use their pencils to draw dashed lines from the beginning mark to the bottom edge of the ruler. Ask them to do the same thing for the 1-inch mark. Demonstrate this on your Super Inch transparency.

Ask students to find the half –inch mark on Super Inch. If they seem unsure, ask them what it means for something to be half of something else. They should be able to tell you that dividing something into two equal parts makes halves. Students should use a colored pencil to mark the half-inch on Super Inch and label it ½. Demonstrate this on your Super Inch transparency.

Ask students to consider the first half of Super Inch. Ask them to find the half-way point between the beginning of Super Inch and the ½ inch mark they've already identified. Move around the room observing and listening as students decide where that half-way point is. Once they decide have them draw a dotted line from the mark to the bottom edge of the ruler with a different colored pencil than the one they used for the ½ inch mark. Demonstrate this on your Super Inch transparency.

Ask students what that mark is called. Some students may quickly recall that "half of a half is a fourth." Others may not see that as quickly. Don't try to convince students who are a little slower in their understanding that is ¼, and don't label the quarter-inch yet.

Ask students to consider the second half of Super Inch. Ask them to find the half-way point between the ½ inch mark and the 1-inch mark. Move around the room observing and listening as students decide where that half-way point is. Once they decide have them draw a dotted line from the mark to the bottom edge of the ruler with the same colored pencil they used to mark the other quarter inch mark. Demonstrate this on your Super Inch transparency.

Ask students how many sections Super Inch has been divided into. Now students who weren't convinced about the ¼ a little while ago can see that Super Inch has been divided into 4 equal parts. That makes each section ¼ of the whole. Have students label the quarter-inch marks. Bring to their attention that ½ is also 2/4. Demonstrate this on your Super Inch transparency.

Ask students to look closely at the unlabeled marks on Super Inch. Have them use the third color (which they shouldn't have used yet) to draw a dot-dash-dot line from each of the marks to the bottom edge of the ruler. Demonstrate this on your Super Inch transparency.

Before asking this next question, stress that no one should shout out the answer so that people may have some "think time." The question is: What do these last marks stand for? If students are stuck, ask them how many parts Super Inch has been divided into. This should lead them to see that there are eight equal parts, so the marks must be eighths. Have students number the eighths. They should notice that ¼ = 2/8; ½ = 4/8; and ¾ = 6/8.
Give students their paper tape measures or real ones. Paper tape measures can be found at: www.scribd.com/doc/7090539/Tape-Measure. Point out that the tape measure can be used for measuring

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inches and cm. They need to know that they should choose the side they want to use. In this case, it's the side that measures inches. They also need a piece of plain paper to write on.

Give students the following tasks (this should be given both visually and verbally):

1. Measure the short edge of your math book cover to the nearest eighth-inch.
2. Measure the long edge of your math book cover to the nearest eighth-inch.
3. Measure the long edge of your desk to the nearest eighth-inch.
4. Measure the short edge of your desk to the nearest eighth-inch.
5. Measure the top of the back of your chair to the nearest eighth-inch.

Students should record these measurements on their papers. You should have measured each of these items ahead of time and have a copy of the measurements for yourself as you talk to students. You should also model the correct notation for students. For example, "The edge of my computer keyboard is about 15 3/8 inches wide."

Form quads from the pairs of students that have been working together. Have them compare their measurements. While they are working, move around the room observing and listening as students work to reconcile their findings with one another. Be especially aware of students who are really off base with their measurements. After a suitable period of time (use your professional judgement), share your findings with the students and lead a class discussion.

Further measurement opportunities
Personal Benchmarks

For this activity, groups of three students will work well. You may want to create a record sheet for them so that they spend more time measuring and less time writing.

Have students work together to measure different parts of their bodies. Suggestions are listed below:

- length of your foot
- length of your stride (you may need to demonstrate)
- hand span (fingers together)
- hand span (fingers opened wide)
- arm span (arms stretched wide, measured finger tip to finger tip)
- arm span (end of finger to tip of nose)
- distance around your wrist
- distance around your head
- height from head to toe

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c. *Misconceptions/Common Errors*

Students may struggle with understand that the measuring tool need to be in increments of sixteenths. Students may still have difficulty understanding equivalent fractions.

When using a ruler or tape measure, students often think the end of the tool is the beginning of the measurement. They need to learn to examine the ruler or tape measure and look for the actual beginning mark. Some rulers and tapes DO start at the very beginning; others have a "dead spot" from the end of the tool to the first mark.

d. *Additional Instructional Strategies/Differentiation*

While additional learning opportunities are needed, no suggestions are included at this time.

e. *Technology*

Virtual manipulatives should NOT take the place of concrete manipulation of objects/materials. Once conceptual understanding has been reached, you may move to pictorial representations and then virtual manipulatives. Concrete manipulatives should be the focus of learning to build conceptual understanding. Real life situations/representations are critical for conceptual understanding.

There is no specific technology recommended for this lesson at this time.

f. *Assessing the Lesson*

Formative Assessment is embedded within the lesson through questioning and observation, however, other formative assessment strategies should be employed.

Have students hold their measurements up on white boards to show their answers. At a glance, the teacher can see how close students are getting.

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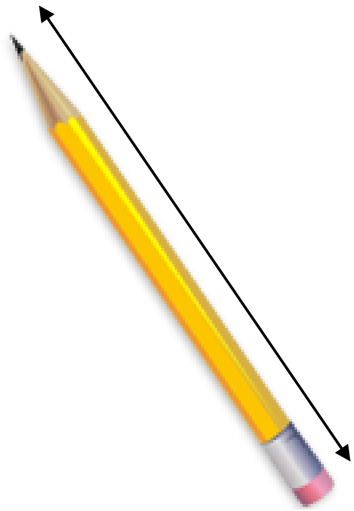
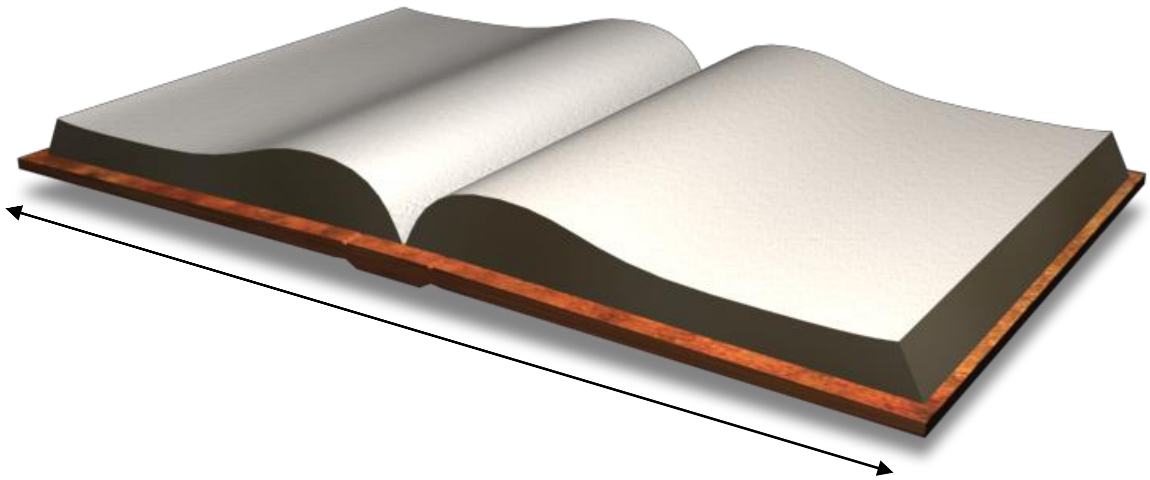


Measure the following objects lengths to the nearest 1/8th of an inch. Look for the arrow.



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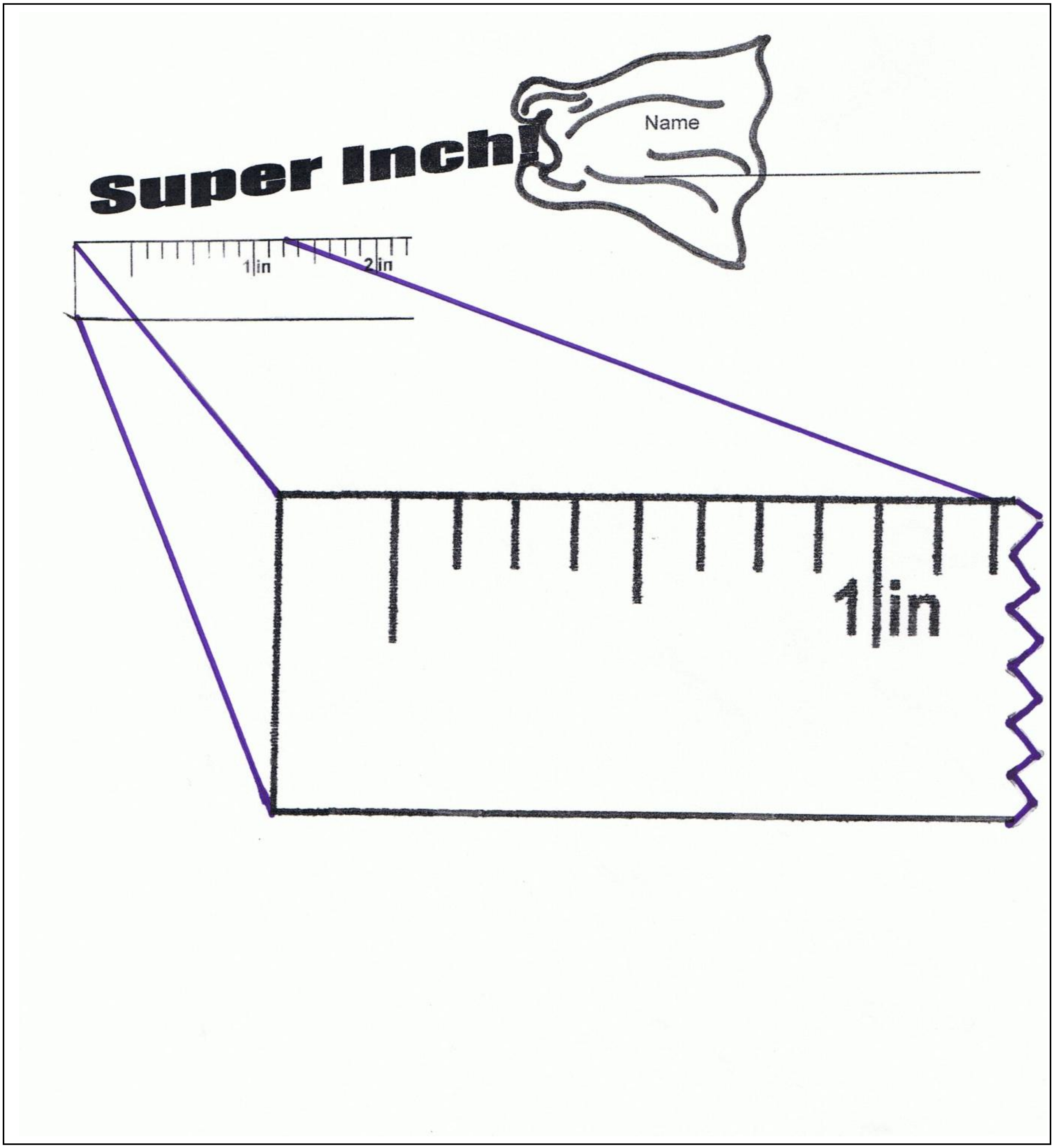
III. Assessing the Module

At the end of this module summative assessment is necessary to determine student understanding of the connections among and between the indicators addressed in this module.

5-5.1
The objective of the indicator is to use which is in the "apply procedural" knowledge cell of the Revised Taxonomy. To apply procedural knowledge is to know how to do something and the criteria for determining when to use those procedures. The learning progression to **use** requires students to understand the concepts of length. Students recall their prior experience with measuring to whole, half and quarter inches and explore a variety of real world situations to generalize connections between eighth of an inch and these related measurements (5-1.6). They also recall their understanding of equivalent fractions related to eighths. Students first estimate the measure using appropriate units. As students measure, they explain and justify their answers (5-1.3) using correct, complete and clearly written and oral mathematical language (5-1.5)

The following examples of possible assessment strategies may be modified as necessary to meet student/teacher needs. These examples are not derived from nor associated with any standardized testing.

Measure the following objects lengths to the nearest $1/8^{th}$ of an inch. Look for the arrow.



Super Inch Student Handout

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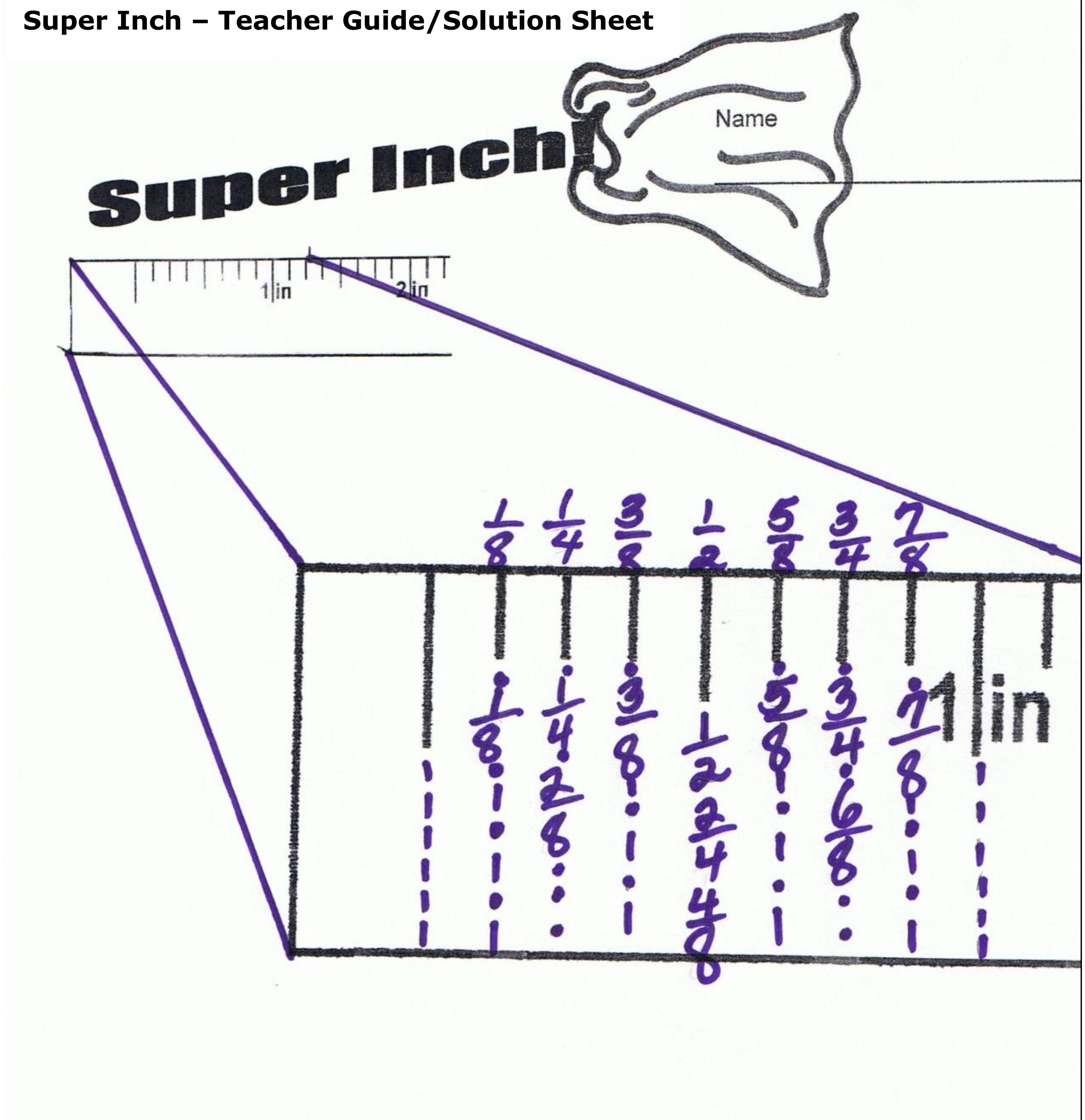
Super Inch – Teacher Guide/Solution Sheet



Personal Benchmarks

Name ____________________________

Group Members____________________

____

Use your measuring tape and your partners' help to find each of these measurements to the nearest one-eighth inch (1/8 inch).

length of your foot (from heel to the end of your middle toe)	
length of your stride When you take a step, your stride is the distance between the toe of the foot in the back to the heel of the foot in the front.	
hand span (fingers together)	
hand span (fingers opened wide)	
arm span (arms stretched wide, measured finger tip to finger tip)	
arm span (end of finger to tip of nose)	
distance around your wrist	
distance around your head	
height from top of head to heel	
height from waist to heel	
height from waist to top of head	

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MODULE
3-4

Equivalencies and Conversions

This module addresses the following indicators:

5-5.8 Recall equivalencies associated with length, liquid volume, and mass: 10 millimeters = 1 centimeter, 100 centimeters = 1 meter, 1,000 meters = 1 kilometer; 10 milliliters = 1 centiliter, 100 centiliters = 1 liter, 1,000 liters = 1 kiloliter; and 10 milligrams = 1 centigram, 100 centigrams = 1 gram, 1,000 grams = 1 kilogram. (A1)

5-5.3 Use equivalencies to convert units of measure within the metric system: converting length in millimeters, centimeters, meters, and kilometers; converting liquid volume in milliliters, centiliters, liters, and kiloliters; and converting mass in milligrams, centigrams, grams, and kilograms. (C3)

This module contains 1 lesson. This lesson is **INTRODUCTORY ONLY.** Lessons in S^3 begin to build the conceptual foundation students need. **ADDITONAL LESSONS will be required** to fully develop the concepts.

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I. Planning the Module

- ***Continuum of Knowledge***

5-5.8

In second grade, students recalled equivalencies associated with length and time (2-5.9). In third grade, students recall equivalencies associated with time and length: 60 seconds = 1 minute and 36 inches = 1 yard (3-5.7).In fourth grade, students recall equivalencies associated with liquid volume, time, weight, and length: 8 liquid ounces = 1 cup, 2 cups = 1 pint, 2 pints = 1 quart, 4 quarts = 1 gallon; 365 days = 1 year, 52 weeks = 1 year; 16 ounces= 1 pound, 2,000 pounds = 1 ton; and 5,280 feet = 1 mile (4-5.8). They also use equivalencies to convert units of measure within the US Customary System: converting length in inches, feet, yards and mile; converting weight I ounces, pounds, and tons; converting liquid volume in cups, pints, quarts and gallons; and converting time in years, months, weeks, days, hours, minutes and seconds (4-5.3).

In fifth grade, students recall equivalencies associated with length, liquid volume, and mass: 10 millimeters = 1 centimeter, 100 centimeters = 1 meter, 1,000 meters = 1 kilometer; 10 milliliters = 1 centiliter, 100 centiliters = 1 liter, 1,000 liters = 1 kiloliter; and 10 milligrams = 1 centigram, 100 centigrams = 1 gram, 1,000 grams = 1 kilogram (5-5.8).

5-5.3

Use equivalencies to convert units of measure within the metric system: converting length in millimeters, centimeters, meters, and kilometers; converting liquid volume in milliliters, centiliters, liters, and kiloliters; and converting mass in milligrams, centigrams, grams, and kilograms.

In second grade, students use appropriate tools to measure objects to the nearest whole unit: measuring length in centimeters, feet, and yards; measuring liquid volume in cups, quarts, and gallons; measuring weight in ounces and pounds; and measuring temperature on Celsius and Fahrenheit thermometers (2-5.3). In fourth grade, students use equivalencies to convert units of measure within the US Customary System: converting length in inches, feet, yards and mile; converting weight I ounces, pounds, and tons; converting liquid volume in cups, pints, quarts and gallons; and converting time in years, months, weeks, days, hours, minutes and seconds (4-5.3).

In fifth grade, students use equivalencies to convert units of measure within the metric system: converting length in millimeters, centimeters, meters an kilometers; converting liquid volume in milliliters, centiliters, liters and kiloliters; and converting mass in milligrams, centigrams, grams and kilograms.

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- **Key Concepts/ Key Terms**
  These are vocabulary terms that are reasonable for students to know and be able to use. Terms without the * are additional terms for teacher awareness, knowledge and use and conversation for students.

*Milli	*Conversion
*Centi	Length
*Kilo	Mass
*Meter	Weight
*Liter	*Equivalency
*Gram	Volume

II. Teaching the Lesson

1. Teaching Lesson A: Metric Measuring

In previous grades, students recalled U.S. Customary equivalencies associated with time, length, liquid volume, and weight. Fifth graders should recall metric equivalencies related to length, liquid volume, and mass. These metric equivalencies will be used when fifth grade students make conversions within the metric system.

In fourth grade students used equivalencies to convert units of measure within the U.S. Customary System. Fifth grade students will make conversions within the metric system. Fifth graders should have the understanding that when you change from one unit of measure to another, you need to know the relationship between the two units of measure.

Changing units in the metric system is like changing units in the customary system. But in the metric system, we use decimals instead of fractions and we don't use mixed measures. Students should have experiences with the metric equivalencies cited in Indicator 5-5.3.

5-5.8

For this indicator, it is **essential** for students to:
- Recall the listed equivalencies

For this indicator, it is **not essential** for students to:
- Perform unit conversions

5-5.3

For this indicator, it is **essential** for students to:
- Understand the meaning of the prefixes: milli, centi and kilo
- Generalize the process of conversion using powers of 10 (by exploring patterns)
- Understand that difference between converting in the Customary System vs the metric system

For this indicator, it is **not essential** for students to:

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None noted.

a. ***Indicators with Taxonomy***

5-5.8 Recall equivalencies associated with length, liquid volume, and mass: 10 millimeters = 1 centimeter, 100 centimeters = 1 meter, 1,000 meters = 1 kilometer; 10 milliliters = 1 centiliter, 100 centiliters = 1 liter, 1,000 liters = 1 kiloliter; and 10 milligrams = 1 centigram, 100 centigrams = 1 gram, 1,000 grams = 1 kilogram. (A1)

Cognitive Process Dimension: Remember
Knowledge Dimension: Factual Knowledge

5-5.3 Use equivalencies to convert units of measure within the metric system: converting length in millimeters, centimeters, meters, and kilometers; converting liquid volume in milliliters, centiliters, liters, and kiloliters; and converting mass in milligrams, centigrams, grams, and kilograms. (C3)

Cognitive Process Dimension: Apply
Knowledge Dimension: Conceptual Knowledge

a. Introductory Lesson

Materials Needed

- A copy of the Teacher Notes pages for yourself
- meter stick for each pair of students (or a paper measuring tape)
- Making Sense of Metrics handout
- Making Sense of Metrics transparency
- gram weight for each pair of students
- liter container for each pair of students

Possible Literature Connection

Millions to Measure by David Schwartz

It explains the development of standard units of measure and shows the simplicity of calculating length, width, height, and volume and the metric system.

Note: Students will use the meter stick to establish the relationships among the metric prefixes. They will then use this pattern to examine the units for liquid volume and weight and mass. It is not practical to have tools to measure milliliters, centiliters, kiloliters, milligrams, or centigrams for each student.

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It is, however, both practical and necessary to have the unit measures, gram and liter, for the students to examine.

Students should be paired so that they may work together and talk about the math they are doing.

Begin by asking students to examine the meter stick. Ask them to tell you what they know about it. They've had prior experience with this tool, so they should be able to recall some of the units and how they relate to each other.

Give each student the first page of the Making Sense of Metrics handout. Ask them to work with their partners to fill in the table. Move around the room, observing students and listening to their conversations as they work.

Pull the class back together. Some students may have worked ahead. That's fine. Call students' attention to the Think… section under the table. Have them put the measurements in order of size from smallest to largest. Ask students how they know they have them in the right order. They should make a note of their thinking in the open space to the left, under the cloud.

Ask students to fill in the remaining blanks on the first page.

Draw the chart on the bottom of the page. Students should work along with you as you do this. Use the Teacher Notes page as your guide.

Ask questions as you add the arrows at the top of the chart.
- How many millis make a centi? 10…so divide 10
- How many centis make a meter? 100…so divide 100
- How many millis make a meter? 1000…so divide 1000
- How many meters make a kilo? 1000…so divide 1000

This is very important. It establishes the pattern for moving from a smaller metric unit to a larger metric unit.

Ask similar questions as you add the arrows at the bottom of the chart.
Going back…
- A kilo has how many meters? 1000…so multiply by 1000
- A meter has how many centis? 100…so multiply by 100
- A centi has how many millis? 10…so multiply by 10
- A meter has how many millis? 1000…so multiply by 1000

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This is very important. It establishes the pattern for moving from a larger metric unit to a smaller metric unit.

Give each pair of students a liter container to examine. Explain that liters are the unit measure for liquid volume in the metric system. Then give each student a copy of the second page of Making Sense of Metrics.

Call their attention to the units used to measure liquid volume. Ask students to compare these units to the ones used for length. They should tell you that the prefixes are the same but that the units are different – meter for length and liter for liquid volume.

Ask students to look closely at the prefixes. Ask them if they think the prefixes have the same meanings for liquid volume as they do for length. They should tell you that they do. After all, the prefixes are exactly the same.

So if the prefixes are the same…
- How many milliliters in a centiliter?
- How many centiliters in a liter?
- How many milliliters in a liter?
- How many liters in a kiloliter?

Ask them to think about taking that liter and either breaking it down into its smaller parts or having a 1000 liters to make a kiloliter.

Students should make notes similar to the ones on the Teacher Notes page on their own sheets. You should also draw the chart at the bottom left of the Teacher Notes page for students to put on their own sheets. Follow the same steps as given for drawing the arrows on the first chart, substituting the liquid volume measures for the length.

Give each pair of students a gram weight to examine. Explain that grams are the unit measure for weight and mass in the metric system. Then give each student a copy of the third page of Making Sense of Metrics.

Follow the same procedure for weight and mass as you did with length and liquid volume. Finish by having students add the last chart to their notes.

Progress to having students use their charts to make conversions within the metric system. Do several examples together. Then have students do some with their partners. There is a handout included that you may take up at the end of

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class to check for understanding. Keep the conversions simple at this point

b. *Misconceptions/Common Errors*

Students may be confused about when to divide and multiply by a power of ten.

c. *Additional Instructional Strategies/Differentiation*

While additional learning opportunities are needed, no suggestions are included at this time.

d. *Technology*

Virtual manipulatives should NOT take the place of concrete manipulation of objects/materials. Once conceptual understanding has been reached, you may move to pictorial representations and then virtual manipulatives. Concrete manipulatives should be the focus of learning to build conceptual understanding. Real life situations/representations are critical for conceptual understanding.

There are no specific technology recommendations for this lesson at this time.

e. *Assessing the <u>Lesson</u>*

Formative Assessment is embedded within the lesson through questioning and observation, however, other formative assessment strategies should be employed.

Have students answer these on index cards or on ½ sheets of paper as an exit ticket.

<u>Use your Making Sense of Metrics handout to make these conversions.</u>

400 cm =	m
5000 mm =	m
20 mm =	cm
100 cℓ =	ℓ

20 ℓ	mℓ
2000 g	mg
12 kg	g
400 cg	kg

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III. Assessing the Module

At the end of this module summative assessment is necessary to determine student understanding of the connections among and between the indicators addressed in this module.

5-5.3

The objective of this indicator is to use which is in the "apply procedural" knowledge cell of the Revised Taxonomy. To apply is to have knowledge of steps and the criteria for when to use those steps. The learning progression to **use** requires students to recall and understand the meaning of degrees. Students also understand the referent angles of 45, 90 and 180 degrees and use that understanding to make estimations of angle measure. They understand the structure of a protractor and how to use it. They explore angle measures in a variety of real world situations. Students explain and justify their answers using correct, clear and complete oral and written language (5-1.5).

5-5.8

The objective of this indicator is to recall which is in the "remember factual" knowledge cell of the Revised Taxonomy. Although the focus of the indicator is to recall factual knowledge, learning experience should integrate both memorization and concept building strategies to support retention. The learning progression to **recall** requires student to explore these measurements in context with concrete and/or pictorial models, where appropriate. They analyze information (5-1.1) from these learning experiences to generate mathematical statements (5-1.4) about the relationship between and among these measures. Students use correct, complete and clearly written and oral language (5-1.5) to communicate their understanding of these relationships and the relationships between larger and smaller units of measure.

The following examples of possible assessment strategies may be modified as necessary to meet student/teacher needs. These examples are not derived from nor associated with any standardized testing.

1) Use the equivalencies you know to convert the following:

a. How many meters are there in 1500 cm?
b. How many mg are in 4 kg?
c. How many meters are there in 16 km?

2) Write the metric unit that makes each statement true.
a) 7.03 __________ = 7,030 mm
b) 550 cg = 5.5 _________
c) 0.234 _________ = 234 mL

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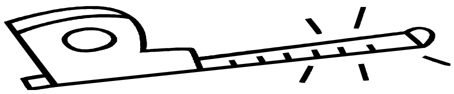
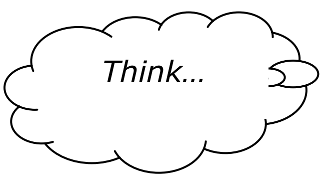
Making Sense of Metrics



length and distance

How many **milli**meters does it take to make one **centi**meter?		**milli → centi**
How many **centi**meters does it take to make a **meter**?		**centi → meter**
How many **milli**meters does it take to make a **meter**?		**milli → meter**
How many **meters** does it take to make a **kilo**meter?		**meter → kilo**



Put the measurements in order of size from smallest to largest.

____

____

____

____

What word do you see in each of the words above? ___________

Circle the prefixes (the word beginnings) in the words above.

Write them here in order of size from smallest to largest: ________________

____

____

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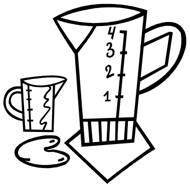

liquid volume

Some of the metric units used to measure liquid volume are:

- milliliter
- centiliter
- liter
- kiloliter

Compare these units to the units used for length. What do you notice about them?

Metric units for length / Metric units for liquid volume

Metric units for length	Metric units for liquid volume
millimeter	milliliter
centimeter	centiliter
meter	liter
kilometer	kiloliter

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weight and mass

Some of the metric units used to measure weight and mass are:

- milligram
- centigram
- gram
- kilogram

Compare these units to the units used for length and for liquid volume. What do you notice about them?

Metric units for length	Metric units for liquid volume	Metric units for weight and mass
millimeter	milliliter	milligram
centimeter	centiliter	centigram
meter	liter	gram
kilometer	kiloliter	kilogram

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Making Sense of Metrics

Teacher notes

length and distance

How many **milli**meters does it take to make one **centi**meter?	10	**milli → centi**
How many **centi**meters does it take to make a **meter**?	100	**centi → meter**
How many **milli**meters does it take to make a **meter**?	1000	**milli → meter**
How many **meters** does it take to make a **kilo**meter?	1000	**meter → kilo**

Think... Put the measurements in order of size from smallest to largest.

millimeters (mm)
centimeters (cm)
meters (m)
kilometers (km)

* I know these are in the right order because mm make cm, cm make meters and meters make km.

What word do you see in each of the words above? meter

Circle the prefixes (the word beginnings) in the words above.

Write them here in order of size from smallest to largest:

milli
centi
kilo

÷1000

÷10 ÷10 ÷1000

milli | centi | meter | kilo

×10 ×10 ×1000

×1000

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liquid volume

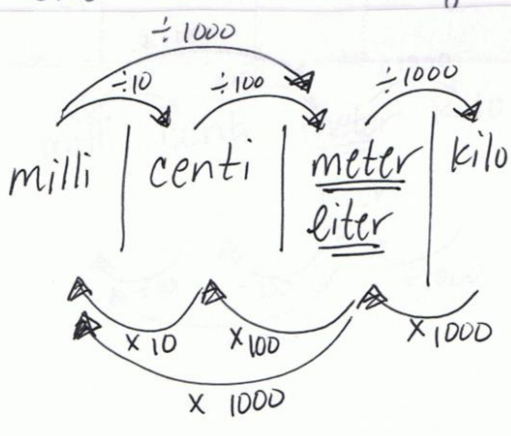
Some of the metric units used to measure liquid volume are:

- milliliter (ml)
- centiliter (cl)
- liter (l)
- kiloliter (kl)

Compare these units to the units used for length. What do you notice about them?

Metric units for length		Metric units for liquid volume	
millimeter	milli	milliliter	milli
centimeter	centi	centiliter	centi
meter		liter	
kilometer	kilo	kiloliter	kilo

- Same prefixes
- One is meters (length)
- One is liters (liquid volume)



weight and mass

Some of the metric units used to measure weight and mass are:

- milligram (mg)
- centigram (cg)
- gram (g)
- kilogram (kg)

Compare these units to the units used for length and for liquid volume. What do you notice about them?

	Metric units for length	Metric units for liquid volume	Metric units for weight and mass
milli →	millimeter	milliliter	milligram
centi →	centimeter	centiliter	centigram
	meter	liter	gram
kilo →	kilometer	kiloliter	kilogram

Same prefixes

length → meter

liquid volume → liter

weight/mass → gram

×1000

×10 ×100 ×1000

milli | centi | meter / liter / gram | kilo

×10 ×100 ×1000

×1000

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MODULE

3-5

Time

This module addresses the following indicators:

5-5.6 Apply procedures to determine the amount of elapsed time in hours, minutes, and seconds within a 24-hour period. (C3)

This module contains 1 lesson. This lesson is **INTRODUCTORY ONLY.** Lessons in S^3 begin to build the conceptual foundation students need. **ADDITONAL LESSONS will be required** to fully develop the concepts.

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I. Planning the Module

- **Continuum of Knowledge:**

5-5.6
In third grade, student used analog and digital clocks to tell time to the nearest minute (3-5.6) and recalled equivalencies associated with time and length: 60 seconds = 1 minute and 36 inches = 1 yard (3-5.7). In fourth grade, students apply strategies and procedures to determine the amount of elapsed time in hours and minutes within a 12-hour period, either a.m. or p.m. (4-5.6). This is the first time students are introduced to the concept of elapsed time.

In fifth grade, students apply strategies and procedures to determine the amount of elapsed time in hours, minutes and seconds within a 24-hour period, either a.m. or p.m. (5-5.6)

- **Key Concepts/ Key Terms**

These are vocabulary terms that are reasonable for students to know and be able to use. Terms without the * are additional terms for teacher awareness, knowledge and use and conversation for students.

*Elapsed time
Hour
Minute
Second

Equivalencies
*a.m.
*p.m.
*24-hour period

II. Teaching the Lesson

1. Teaching Lesson A: Elapsed Time

Fourth grade was the first time students were introduced to the concept of elapsed time. In fourth grade students applied strategies and procedures to determine the amount of elapsed time in hours and minutes within a 12-hour period, either *a.m*. or *p.m*. Fourth grade students did not "cross" between *a.m*. or *p.m*. but rather worked within those 12-hour intervals to determine elapsed time. In fifth grade students should not only move between *a.m.* and *p.m.* (24-hour interval) but also must consider elapsed time down to seconds.

Teacher Notes: Even though students have had experience in previous grades with both the upper and lower case of A.M. and P.M. it is sound practice to continue to expose students to both forms.

Questions about elapsed time should include questions such as "It is now 3:30 p.m. Anna has been driving for 8 hours. What time did she leave home? AND It is 7:32 a.m. and it takes Anna 1 and a half hours to get to work. What time will she arrive at work? In other words students need experiences determining past and future elapsed time.

A teaching strategy that could be used is to convert the circular measurement to a more linear measurement (similar to a ruler) since the students have experience measuring with rulers. To do so, take two strips of paper and mark them from 12:00 to 12:00. Each strip will be a different color, one representing *a.m.* and one representing *p.m.* Between each hour mark, make three smaller marks - each representing 15 minutes. Then demonstrate the use of the analog clock (hands need to be geared together so that the movement of the minute hand also show the movement of the hour hand) to show how much time has passed. Then connect the clock to the number-time line. This lesson can be extended to address smaller units of time.

For this indicator, it is **essential** for students to:

- Understand the meaning of elapsed time
- Understand the difference between a.m. and p.m.
- Understand the meaning of 24-hour period
- Understand past and future time
- Determine elapsed time when the information in given in word or pictorial form
- Find the elapsed time when given the start and end time
- Find the end time when given the start time and elapsed time
- Find the start time when given the end time and elapsed time

For this indicator, it is **not essential** for students to:
None noted

a. Indicators with Taxonomy

5-5.6 Apply procedures to determine the amount of elapsed time in hours, minutes, and seconds within a 24-hour period. (C3)

Cognitive Process Dimension: Apply
Knowledge Dimension: Procedural Knowledge

b. Introductory Lesson

Materials Needed

- yellow strip of paper – one per student (same length as the circumference of the clock face)

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- blue strip of paper – one per student (same length as the circumference of the clock face)
- Make a Clock handouts (one for each student)
- Stiff paper plate (one for each student)
- paper fasteners (brads – one for each student)
- Glue sticks
- Scissors
- Schedule of your school day showing routine events and times (i.e., start of day, recess, lunch, class change, related arts, end of day, etc.)
- What's My Schedule? ***Handout at end of lesson***
- Handout to check for understanding

Possible Literature Connection

Game Time by Stuart Murphy

Keep an eye on the clock as the Huskies and the Falcons gear up for their championship soccer match. Weeks, days, hours, minutes, and seconds--it's all game time!

Pair students so that they may work together and talk about the math they are doing. It may also be helpful to have an extra set of hands to make the time lines.

In this lesson, students will construct a clock and use the strips of paper to make two 12-hour time lines to help them count elapsed time during a 24 hour period.

Have students follow the directions on the Make a Clock handout to construct a personal clock. Gluing the clock on the paper plate helps discourage students from removing the paper fastener that holds the hands on the face of the clock. Trim the edge of the plate to match the size of the clock.

Once clocks are constructed, begin with a quick review of telling time. Go through your school day's schedule and have the students show you on their clocks the times for different events during the day.

To connect the time lines to the hours on the clock face, have the students place one end of the yellow strip of paper at the 12. Move around the face of the clock, making a mark for each hour on the strip. Partners may help each other do this.

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Repeat with the blue strip. Tape the two strips together so the entire 24 hours in a day are represented as one time line, with the morning (AM) hours on the yellow strip, and the evening (PM) hours on the blue strip.

Ask the students, "If there are 24 hours in a day, how many times does the hour hand rotate around the clock in a day?" Students should deduce that the hour hand will rotate around the clock two times in a complete day.

Call the students' attention to the time lines they created. Explain that the yellow time line represents rotation of the clock hands through the 12 AM hours (from midnight to noon), and the blue time line represents the rotation of the clock hands through the 12 PM hours (from noon to midnight).

Tell students that they may use the 24 hour time line or the face of the clock to help figure out how much time passes between two given events. For instance, if school starts at __________, and lunch is at ________, how much time is there between the beginning of the day and lunch time? This question should be posed both verbally and visually. Let students work together to find the answer. Use other times from the schedule to allow students to use the tools to find elapsed time in hours and minutes. You may also have students make their own problems by using their What's My Schedule? handout.

c. *Misconceptions/Common Errors*

No typical student misconceptions noted at this time.

d. *Additional Instructional Strategies/Differentiation*

While additional learning opportunities are needed, no suggestions are included at this time.

e. *Technology*

Virtual manipulatives should NOT take the place of concrete manipulation of objects/materials. Once conceptual understanding has been reached, you may move to pictorial representations and then virtual manipulatives. Concrete manipulatives should be the focus of learning to build conceptual understanding. Real life situations/representations are critical for conceptual understanding.

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This site is included in the formative assessment write up.

If you decide you want to update the marathon results for 2009 (or the current year), you can find the information at http://www.nycmarathon.org/Results.htm

f. Assessing the Lesson

Formative Assessment is embedded within the lesson through questioning and observation; however, other formative assessment strategies should be employed.

New York City Marathon Results

Have students answer some questions on white boards and hold them up when prompted. At a glance, you can see which students are having trouble and which ones are not. You may choose to pair up some of the students as you pose more questions.

These tables are included at the end of the lesson to provide a starting point for practice using real data. Point out how time is noted in hours: minutes: seconds so that students begin to use correct notation.

Some possible questions:

- If the marathon started at 7:00 AM, what time Bolota Asmerom finish the race? What about Sheldon Zinn?
- How much time elapsed between Kara Goucher's finish and June Anderson's finish?

If you decide you want to update the marathon results for 2009 (or the current year), you can find the information at http://www.nycmarathon.org/Results.htm

III. Assessing the Module

At the end of this module summative assessment is necessary to determine student understanding of the connections among and between the indicators addressed in this module.

5-5.6
The objective of this indicator is to apply which is in the "apply procedural" knowledge cell of the Revised Taxonomy. Although the

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focus of the indicator is to apply a procedure, the learning progression should integrate activities that build both conceptual and procedural knowledge. The learning progression to **apply** requires students to recall the meaning of a.m. and p.m. and the meaning of a 12-hour interval. They also understand the meaning of past and future dates and the meaning of elapsed time. Students explore a variety of real world examples given in word, pictorial and concrete form and use their understanding to determine either the elapsed time, start time or end time during a 24-hour period. Students explain and justify their answers (5-1.3) using correct, complete and clearly written and oral language (5-1.5)

The following examples of possible assessment strategies may be modified as necessary to meet student/teacher needs. These examples are not derived from nor associated with any standardized testing.

1. Jeanne was tired of her plain blonde hair. She thought it would be more exciting if her hair was green like in the cartoons, so she bought some green hair color. The instructions say for her to leave the dye in her hair for 2 hours. She put the dye in at 11:00am. While she was waiting, she fell asleep with the dye still in her hair. It is now 11:35pm and her scalp feels like it is on fire. How long has she had the dye in her hair?

2. Daniel and his family want to be in Jacksonville Florida in time for his cousin's high school graduation at 6:00 p.m. They leave their home in Greenville, SC at 8:30 a.m. They arrive in Jacksonville after an 8 hour and 45 minute drive. Do they make it in time for the graduation? Explain your answer.

3. Tuesday, Jodie had a dental appointment and arrived at his summer job late. At 2:00 p.m. he had been at work for 3 ½ hours. What time did he arrive?

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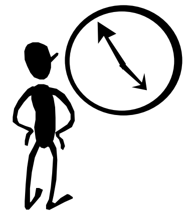
What's My Schedule?



Name ______________________

Fill in the times below. It's okay to estimate.

Before school (in the morning – AM)

I get up at ______________________

I leave for school/
get on the bus at ______________________

After school (in the afternoon – PM)

List at least 3 things you do after school (You may list more if you like. ☺)	Tell what time this activity starts.

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Results from the 2008 New York City Marathon

New York City Marathon Top 5 Men 2008 (USA	
Abdi Abdirahman	2:14:17
Josh Rohatinsky	2:14:23
Jason Lehmkuhle	2:14:30
Bolota Asmerom	2:16:37
Luke Humphrey	2:18:38

New York City Marathon Top 5 Women 2008 (USA)	
Kara Goucher	2:25:53
Katie McGregor	2:31:14
Magdalena Lewy Boulet	2:33:56
Sally Meyerhoff	2:40:57
Ilsa Paulson	2:42:17

New York City Marathon Final Five Men 2008 (USA)	
Bill Arbuckle	6:24:58
Ryszard Glab	6:25:01
Glenn Heiberg	6:25:16
Jason Azar	7:44:33
Sheldon Zinn	7:45:06

New York City Marathon Final Five Women 2008 (USA)	
Haddis Gammage	6:25:12
Maria Vallejo	6:25:15
Jacqueline Carey	7:44:55
Sharon Dong	7:45:07
June Anderson	7:46:28

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MODULE

3-6

Temperature

This module addresses the following indicators:

5-5.7 Understand the relationship between the Celsius and Fahrenheit temperature scales. (B2)

This module contains 1 lesson. This lesson is **INTRODUCTORY ONLY.** Lessons in S^3 begin to build the conceptual foundation students need. **ADDITONAL LESSONS will be required** to fully develop the concepts.

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I. Planning the Module

- **Continuum of Knowledge**

In first grade, students used Celsius and Fahrenheit thermometers to measure temperature (1-5.11).
In fourth grade, students use Celsius and Fahrenheit thermometers to determine temperature changes during time intervals (4-5.7).
In fifth grade, students understand the relationship between the Celsius and Fahrenheit temperature scales (5-5.7).

- **Key Concepts/ Key Terms**

These are vocabulary terms that are reasonable for students to know and be able to use. Terms without the * are additional terms for teacher awareness, knowledge and use and conversation for students.

*Celsius
*Fahrenheit
*Temperature Scale
Temperature
Thermometer
Temperature change
Freezing Point
Boiling Point

II. Teaching the Lesson(s)

1. ***Teaching Lesson A:*** Relationship Between Celsius and Fahrenheit Temperature Scales

In previous grades students have read thermometers using Celsius and Fahrenheit Temperature scales. By the end of fifth grade students should know how to read both Celsius and Fahrenheit liquid and digital thermometers.

Students need to know that the boiling point of water is 212° F and 100°C and the freezing point is 32°F and 0°C. These two facts allow students to estimate and interpolate common temperatures such as hot days (above 95°F or 35°C), cold days (below 32°F or below 0°C), and comfortable days (80°F or 25°C). They should also become aware that the temperature considered hot, cold, or comfortable varies from place to place and depends on other weather conditions such as wind and moisture and on personal preference. The goal for this Indicator is not for students to memorize or convert between scales but to understand how the Celsius and Fahrenheit temperature scales relate to each other.

For this indicator, it is **essential** for students to:

- Understand how to read a thermometer given in concrete and pictorial form

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- Understand that temperature changes over time
- Recognize the notation for Celsius and Fahrenheit
- Recall the benchmark temperatures for each (freezing, boiling, normal body temperature and room temperature)
- Understand what temperatures are considered "cool" on each scale
- Understand what temperatures are considered "hot" on each scale

For this indicator, it is **not essential** for students to:

- Use the Celsius and Fahrenheit formulas

a. Indicators with Taxonomy

5-5.7 → Understand the relationship between the Celsius and Fahrenheit temperature scales. (B2)
Cognitive Process Dimension: Understand
Knowledge Dimension: Conceptual Knowledge

b. Introductory Lesson

Materials Needed

- Thermometers with suction cups to place on the outside of the classroom window
- Indoor thermometers to record the temperature inside
- Overhead Projector, Smart Board, white/chalkboard, chart paper (any one of these will suffice)
- Colored pencils (preferably erasable ones)
- Overhead pens (same colors as pencils)
- Temperature Benchmarks handout
- Temperature Benchmarks transparency
- Weather Logs handout
- Thermometer handouts (*graphics included* – Use them to make handouts that suit your needs.)
- A weeks' worth of high and low temperatures (collected from newspaper or a website like the Weather Channel website – www.weather.com or the WISTV website – www.wistv.com) NOTE: It may be helpful to create a handout with this information on it.

After the material is introduced, set up the thermometers (both indoor and outdoor) at different places in the classroom so that they are accessible to students. Leave them in place even after this material is taught so that students can continue to practice the skill.

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Put students in groups of four so they may work together and talk about the math they are learning. Each group should have at least one real thermometer to examine.

Give each student the Temperature Benchmarks handout. Students really should be able to do this with very little guidance. Remind them to examine the scale on either side of the thermometer. The benchmarks do not need to be memorized; they are offered to give students reference points and an opportunity to mark temperatures on the thermometer. Use the transparency to provide them a check for their work.

After completing the benchmarks handout, students should deduce that even though the Celsius and Fahrenheit scales don't line up exactly, the measurements are in the same general place. This handout will serve as their "notes" for this material and should be kept in their math notebooks for later reference.

Weather Logs (Keeping a Weather Eye Out)

The support document states that students should develop an awareness that the temperature considered hot, cold, or comfortable varies from place to place and depends on other weather conditions such as wind and moisture and on personal preference. To that end, students might keep logs of the weather for a period of days at different times between the introduction of this material and the end of the year. Students might then have discussions with each other about what makes "good" weather and "not so good" weather.

c. Misconceptions/Common Errors

Students may not pay attention to the increments used on the thermometer.

d. Additional Instructional Strategies/Differentiation

While additional learning opportunities are needed, no suggestions are included at this time.

e. Technology

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Virtual manipulatives should NOT take the place of concrete manipulation of objects/materials. Once conceptual understanding has been reached, you may move to pictorial representations and then virtual manipulatives. Concrete manipulatives should be the focus of learning to build conceptual understanding. Real life situations/representations are critical for conceptual understanding.

This link was listed in the materials section of the lesson.

A weeks' worth of high and low temperatures (collected from newspaper or a website like the Weather Channel website – www.weather.com or the WISTV website – www.wistv.com) NOTE: It may be helpful to create a handout with this information on it.

f. Assessing the Lesson

Formative Assessment is embedded within the lesson through questioning and observation; however, other formative assessment strategies should be employed.

Simply take up the handouts completed during the lesson for review. Comment on them or on post-it notes and return. Pair students up to review papers and comments. Hold a class discussion following the pair discussion.

III. Assessing the Module

At the end of this module summative assessment is necessary to determine student understanding of the connections among and between the indicators addressed in this module.

5-5.7

The objective of this indicator is to understand which is in the "understand conceptual" knowledge cell of the Revised Taxonomy. To understand is to construct meaning; therefore, students construct meaning of the relationship between benchmark temperatures one ach scale. The learning progression to **understand** requires students to recall the structure of a thermometer and the notation for Celsius and Fahrenheit. To demonstrate flexibility in mathematical representations (5-1.7), students recall the benchmark temperatures and analyze information (5-1.1) to describe a variety of situations involving temperature. Students explain and justify their answers (5-1.3) using correct, complete and clearly written and oral language (5-1.5).

The following examples of possible assessment strategies may be modified as necessary to meet student/teacher needs. These examples are not derived from nor associated with any standardized testing.

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1. True or False… you must explain your decision.

a. If it is 35°F, it is hot in South Carolina.
b. If it is 80°F, it is comfortable in South Carolina.
c. If it is 32°F, it is freezing.
d. The Farenheit temperature at which water boils is 100°F.
e. The Celsius temperature at which water freezes is 10°C.
f. If it is 5°C, it is hot in South Carolina.

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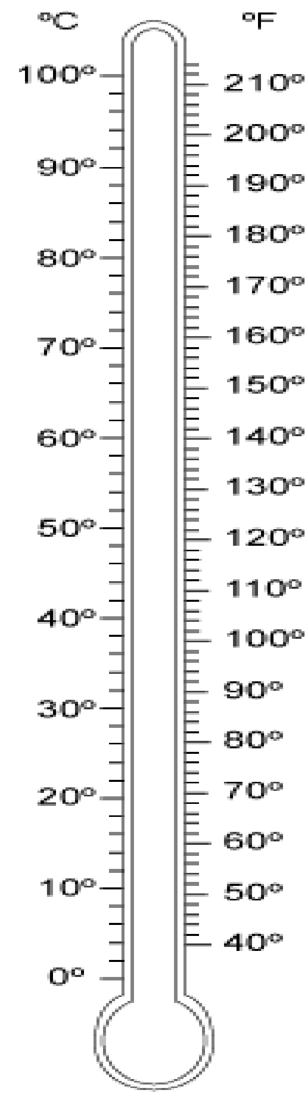
Important Temperature Benchmarks

Name ______________________________

Are you wondering how to go back and forth between Celsius and Fahrenheit? The thermometer can help you.

Find each temperature on the thermometer at the right and mark it with the color indicated.			
water boils	212°F	100°C	red
water freezes	32°F	0°C	orange
normal human body temperature	98.6°F	37°C	yellow
comfortable room temperature	70°F	20°C	green
a hot day in SC	95°F	35°C	black
a chilly day in SC	40°F	4°C	blue
a comfortable day in SC	80°F	27°C	purple



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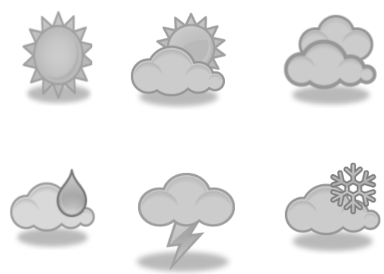
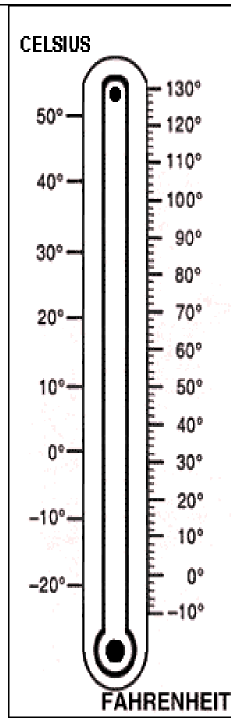
Keeping a Weather Eye Out

Name ______________________________

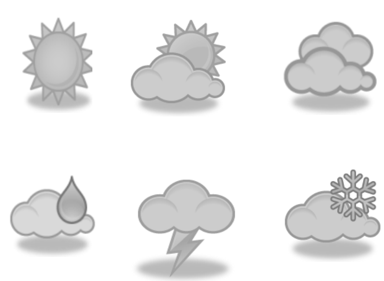
Date:		
High	F	C
Low	F	C
Wind		
Conditions		

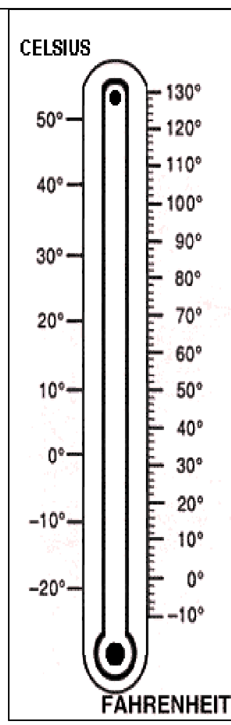




Write a description of today's weather using the data you collected. Include activities that might be appropriate for the weather conditions.

Date:		
High	F	C
Low	F	C
Wind		
Conditions		





Write a description of today's weather using the data you collected. Include activities that might be appropriate for the weather conditions.

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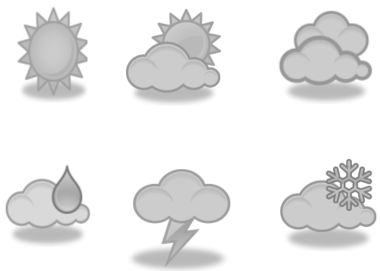
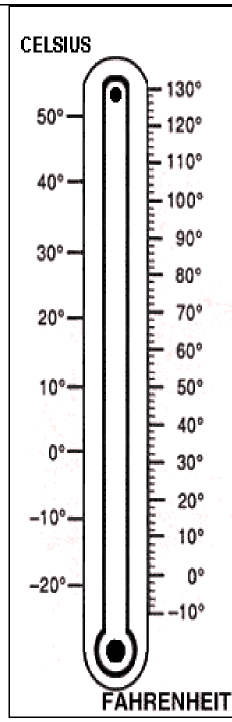
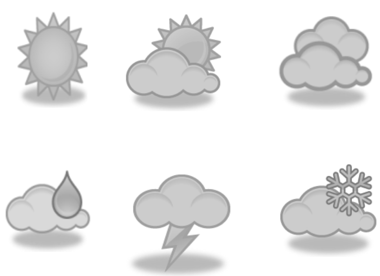
Date:		
High	F	C
Low	F	C
Wind		
Conditions		

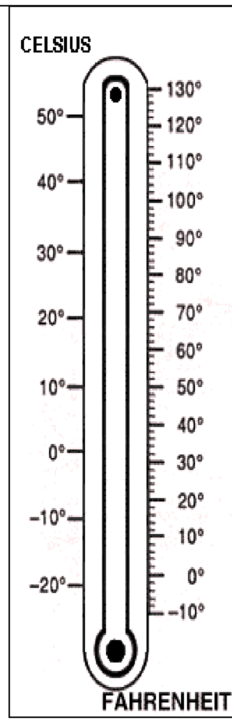




Write a description of today's weather using the data you collected. Include activities that might be appropriate for the weather conditions.

Date:		
High	F	C
Low	F	C
Wind		
Conditions		





Write a description of today's weather using the data you collected. Include activities that might be appropriate for the weather conditions.

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