Measurement Mania

Strand: Measurement and Geometry

Topic: Estimating, measuring, and identifying equivalent measures within the metric system

Primary SOL: 5.9 The students will
a) given the equivalent measure of one unit, identify equivalent measurements within the metric system; and
b) Solve practical problems involving length, mass, and liquid volume using metric units.

Related SOL: 5.2a, 5.5a, 5.6b, 5.8ab

Materials

- Scale balance, metric weights, scale
- Rulers, meter sticks, metric measuring tapes
- Patterns and Metric Measurements Student Recording Sheet (attached)
- Patterns and Metric Measurements Teacher Answer Key (attached)
- A rope or string 5 meters long
- One small paper clip and one penny for each group
- Metric graduated cylinders, or liter/milliliter measuring cups
- Make a class poster of the Linear Metric Measurements as it appears on the Patterns and Metric Measurements Student Recording Sheet to use for recording during class discussion

Vocabulary

capacity/liquid volume, centimeters, grams, kilograms, kilometers, length, linear measurement, liters, mass, meters, metric, millimeters, U.S. Customary, weight

Student/Teacher Actions: What should students be doing? What should teachers be doing?

1. Ask for volunteers who have seen or heard of the term kilometer to share situations they heard the term used. Listen for situations such as how fast something travels as kilometers per hour in some countries and the distance from one place to another place in some states close to the Canadian border.
    - Hold up a meter stick and ask students how many meters they think are in a kilometer. Allow volunteers to answer, and stop when you get a response that there are 1,000 meters in a kilometer. If no one shares that information, then write kilometer on the board and underline “kilo.” Record on the board that the prefix “kilo” means “times one thousand” or “one thousand of” the units in question. Therefore, kilometer means “1000 x 1 meter” or “one thousand of 1 meters.” There are 1,000 meters in one kilometer.
    - Form two- or three-person groups, and provide a meter stick and a ruler for each group. Ask the groups to look at the metric side of the meter stick and note the beginning measuring point and the ending measuring point. Next, look at the

U.S. Customary measurement side of the meter stick and ask them to note the beginning measuring point and the ending measuring point. Ask for volunteers to share what they notice. Next, ask students to determine how many centimeters it would take to equal the meter stick. Have volunteers share.

- Distribute the attached Patterns and Metric Measurements Student Recording sheet. You will need a poster-sized "What do Those Prefixes Tell Us?" chart (shown on the Student Recording Sheet) to record the information generated during class discussions. Work with the class to complete the first three columns in the chart. Ask students to use their meter sticks and rulers to figure out how many centimeters are in a meter. Call for volunteers, record the correct information on the class charts, and direct students to record the information on their recording sheets. Then, ask students to figure out how many millimeters are in a meter. Call for volunteers and record correct answer.
- Point out to students that the root word for each unit of measure is meter and that the prefixes have meaning, such as kilo (1,000 meters), centi- (0.01 or $\frac{1}{100}$ meter), and milli- (0.001 or $\frac{1}{1000}$ meter). Record the information on the chart. Ask students to look at the term *decimeter* and ask what they think deci- means. Listen for student's ideas that relate to 0.1 or $\frac{1}{10}$ of a meter. Record that information.

2. Bring in as many real objects and pictures as you can find to represent metric liquid volume and mass. Lead a discussion on equivalencies among liquid volume measures and among measures of mass. Are they different or the same as length measurement equivalencies? You may want to create a chart for each, similar to the Linear Metric Measurements, so that students can realize the root word changes (liters or grams) but the prefixes stay the same so the numerical relationships among the units remains the same.
3. Pose these problems to the students:
    - The PE teacher says it will take 45 liters of paint to repaint the playground. Convert the liters to milliliters.
    - The principal said 230 kilograms of sand will be delivered to replace the sand on the playground. Convert the kilograms to grams.
4. Let students know that are going to be measuring real objects in three stations, Length, Liquid Volume, and Mass. They will record their measures in the Data Collection Stations chart on their Metric Measurements Student Recording Sheets. Review the directions on the recording sheet before students begin. Remind students of the need to share space and practice appropriate behavior during the activity. Provide a small paper clip and a penny to each group, in addition to the meter stick and centimeter ruler.
    - Allow the groups to work together to collect and record their answers. Circulate to help direct traffic and to note students' measurement skills.
    - As groups complete the table, have two groups get together to compare answers and discuss and differences and why there may be small differences.
    - Facilitate a class discussion that brings out the ways students found the measure of an object in the other two units once they had measured to find one answer.

If no one used the relationships among the units to calculate the answer, pose a question that asks students to think about why some groups have the length of the desk different based on the units. This discussion should lead to how to convert among meters, centimeters, and millimeters. Facilitate a discussion about which unit would be best in measuring various situations.

- Have students complete the set of questions on the recording sheet in order to synthesize the information about the relationships among the unit measurements and conversions within the metric system. When they have finished, facilitate a class discussion that clarifies appropriate responses for each.

5. Next, students will engage in a task to apply their knowledge and solve a contextual problem. Tell students you have been asked by the PTA to figure out the measurement of the playground in metric units, and you need their help. Ask students to choose the best metric unit of measurement to measure the perimeter of the playground (millimeter, centimeter, meter, and kilometer) and discuss the reasonableness of their choice.
    - In groups of three or four, have students estimate the measurement of the perimeter and record their answers, including the metric unit they chose.
    - Next, move the groups outside to measure the perimeter of the playground. Before going outside, discuss what to take with them and how to behave while they are working on the task outside. It will be challenging to try to use meter sticks for this, so you may want to provide a ball of string that can be used to represent the distance and then use a meter stick to figure out how many units of metric measure the class decided to use. Students may discover ways to work with the string so they do not have to measure the entire length of the string. Make tools available for them to use. Remind students to take notes on what they do and how they arrive at the perimeter of the playground so that they can make a poster for the PTA to explain how they found the perimeter.
    - Use a demonstration tool (e.g., document camera or digital display) or have student groups make a poster to explain what perimeter they found and how they found that perimeter. When each group is finished, pose questions that will allow students to evaluate the accuracy of the measurements, how close their estimates were, why there may be differences in the answers from the various groups, and whether they would do anything differently.
    - Compare the perimeter in meters, centimeters, and millimeters and discuss why meters may be the most appropriate unit to use for the perimeter of the playground. What would it be it be in kilometers?
6. For homework, ask students to complete the fourth column in the "What do Those Prefixes Tell Us" chart, titled, "Related U.S. Standard Measure, or Related Real-world Object." Let students know they can go online with their parents' permission, talk with other adults, look in textbooks, or other books to find the information.

Assessment

- **Questions**
  - What metric units of measurement are used for length? Explain how these units of measure are related.
  - What metric units of measurement are used for weight or mass? Explain how these units of measure are related.
  - What metric units of measurement are used for liquid volume? Explain how these units of measure are related.
  - If you converted a measurement to a smaller unit, would there be more or less of the smaller units?
  - If you converted a measurement to a larger unit, would there be more or less of the larger unit?
  - What strategies did you use to determine your estimates?
  - What benchmarks or referents did you find helpful when making your estimates?
  - How close were your estimates to your actual measurements? What would help you to make estimates that are more accurate?
- **Journal/writing prompts**
  - Describe all the ways you could measure a puppy, including the units of measure you would use.
  - Explain when you would estimate when measuring.
- **Other Assessments**
  - Have students select an object at home to measure in length, mass, and liquid volume. Ask them to bring that object in and be prepared to share with the class that object's length, mass, and/or liquid volume.

Extensions and Connections

- Have students complete the following:
  - Tara needs to give her pet rabbit 56 milliliters of carrot juice a day. Convert to liters.
  - Jacob ran 17 kilometers last week. Monica ran 17,000 meters. Jacob said they ran the same distance. Monica says she ran more. Who is correct? Explain.
  - If the mass of my mathematics book is 4,400 grams, how many kilograms would that be?
  - Estimate the measurement for the following: the length of a crayon, the mass of a marker, the volume of a glue bottle. Find the actual measurement of each item.
  - Students can investigate the history of the metric system, identify which countries do not use the metric system, and investigate the reasons that the U.S. still uses customary units of measure. Where did the customary measurement begin?

Strategies for Differentiation

- Provide a calculator for the computations.
- Students may have difficulty making conversions when fractions are involved. They can round their measurements to the nearest whole unit before making conversions.
- Students who have difficulty deciding whether to multiply or divide by the conversion factor may need to first identify whether the conversion should result in more units because it's a smaller unit of measure or whether the conversion should result in fewer units because it's a larger unit of measure.
- Students may need more strategies for estimating units. Benchmarks or referents may need to be provided, along with suggestions such as trying to mentally subdivide the object being measured or mentally iterate the benchmark unit.
- Instead of making one estimate, students can specify a range.

Note: The following pages are intended for classroom use for students as a visual aid to learning.

Patterns and Metric Measurements Student Recording Sheet

What Do Those Prefixes Tell Us?

The prefix "kilo" means "times one thousand" or "one thousand of" the units in question. So kilometer means "1,000 x 1 meter" or "one thousand of a meters." So, there are 1,000 meters in one kilometer.

Length

Linear Metric Measurements	How many meters?	Abbreviation	Related U.S. Standard Measure, or Related Real-world Object
Kilometer	1000	km.	
Meter	1	m.	
Centimeter			
Millimeter			

Liquid Volume

Liquid Metric Measurements	How many liters?	Abbreviation	Related U.S. Standard Measure, or Related Real-world Object
Liter			
milliliter			

Mass

Mass Metric Measurements	How many grams?	Abbreviation	Related U.S. Standard Measure, or Related Real-world Object
Kilogram			
Gram			

Data Collection Stations

1. Estimate the length, mass, or volume of the objects in each station. Record your estimate in the table.
2. Find the actual measures of the objects and record them in the table. Remember to record the units with your answer.

Length

Use a meter stick or centimeter ruler to measure each object.

Object	Meters (m)		Centimeters (cm)		Millimeters (mm)	
	Estimate	Actual	Estimate	Actual	Estimate	Actual
Length of desk						
A friend's height						
Width of your math book						
Width of a small paper clip						
Width of a penny						
your choice _____						
your choice _____						

Liquid Volume

Use liter or milliliter measuring containers to measure the water that each object holds.

Object	Liter (L)		Milliliters(mL)	
	Estimate	Actual	Estimate	Actual
Plastic cup				
Watering can				
Water bottle				
Milk carton				
Bottle				
your choice _____				

your choice _____				

Mass

Use a balance and gram or kilogram weights to measure the mass of each object.

Object	Kilograms (kg)		Grams (g)	
	Estimate	Actual	Estimate	Actual
stapler				
scissors				
pencil				
library book				
rock				
your choice _____				
your choice _____				

Patterns and Metric Measurements Student Recording Sheet

Complete the following.

1. The root word for each of the linear metric measures is _____, and all of the other measures are described in terms of the _____.

2. The prefix tells us _____.

3. Describe a number pattern you notice in the relationships among the linear metric measurements that can help you convert from one linear metric measure to another.

4. If you know that the rope is 5 meters long, find the length of the rope in the units below. Show your work.

    a. Kilometers (km) _____
    b. Centimeters (cm) _____
    c. Millimeters (mm) _____

5. Describe how to convert from a smaller metric unit to a larger metric unit.

6. Describe how to convert from a larger metric unit to a smaller metric unit.

Patterns and Metric Measurements Teacher Answer Key

The prefix "kilo" means "times one thousand" or "one thousand of" the units in question. So kilometer means "1,000 x 1 meter" or "one thousand of a meters." So, there are 1,000 meters in one kilometer.

Note: In Grade 5, students are responsible for equivalent measures among millimeters, centimeters, meters, and kilometers. The chart includes other metric measures to make the pattern of 10s evident. Also, students do not need to convert between the metric and U.S. Customary system. The benchmarks are developed in the last column to help students make connections to real-world objects as they develop a sense of the size of metric measurements.

Length

Linear Metric Measurements	How many meters?	Abbreviation	Related U.S. Standard Measure, or Related Real-world Object
Kilometer	1000	km	*About 1 mile* *About 3 times around a football field.* *About 6 city blocks*
Meter	1	m	*From the doorknob to the floor* *A little more than 1 customary yard*
Centimeter	0.01 or $\frac{1}{100}$	cm	*The width of your pinky finger* *The width of a large paper clip*
Millimeter	0.001 or $\frac{1}{1000}$	mm	*The thickness of a dime*

Liquid Volume

Liquid Metric Measurements	How many liters?	Abbreviation	Related U.S. Standard Measure, or Related Real-world Object
Liter	1	L	quart
milliliter	1,000	mL	Drop of water

Mass

Mass Metric Measurements	How many grams?	Abbreviation	Related U.S. Standard Measure, or Related Real-world Object
Kilogram	1,000	kg	Mass of 1 liter; 2 pounds
Gram	1	g	Paper clip, piece of paper, pretzel

Complete the following.

1. The root word for each of the linear metric measures is __*meter*___ and all of the other measures are described in terms of the __*meter*___.
2. The prefix tells us _____*how many meters are in the unit of measurement*_____.

3. Describe a number pattern you notice in the relationships among the linear metric measurements that can help you convert from one linear metric measure to another.
   The metric system is a decimal system of measurement based on 10s. Students may be reminded of the base-10 number system. You divide by 10 or multiple by 0.1 or $\frac{1}{10}$ to convert from one unit to the next smaller unit as you move down the second column. You multiply by 10 to convert from one unit to the next smaller unit as you move up the second column.

4. If you know that the rope is 5 meters long, find the length of the rope in the units below. Show your work.
   a. Kilometers __*0.005*_____ km. *5 ÷ 1000 = 0.005 or 5 x $\frac{1}{1000}$ = $\frac{5}{1000}$ = 0.005*
   b. Centimeters ____*500*____ cm. *5 x 100 = 500*
   c. Millimeters ___5000___mm. *5 x 1000 = 5000 or some students may use the answer from b and find 500 x 10 = 5000*

5. Describe how to convert from a smaller metric unit to a larger metric unit.

6. Describe how to convert from a larger metric unit to a smaller metric unit.