

## Measure the Lakes

K. Kelly Mottl kamottl@gbaps.org  
Washington Middle School, Green Bay, WI

### LESSON OVERVIEW

Measuring the Lakes by K. Kelly Mottl has been designed to help students use mathematics, the language of science, in the classroom. Students need to be prepared to understand metric and U.S. customary measurements, including how to use tools of measurement, how to convert between one system and another, and how to represent data to the general public. This lesson will provide background on the Great Lakes and will incorporate and promote maritime education into the lessons. It is common practice to teach a measurement unit at the beginning of each science year so students are reminded of the importance of units and conversions for use in labs throughout the year. These lessons are designed to be incorporated into the measurement unit. Other lessons in this unit include a measurement lab, and a measurement test. This portion of the measurement unit will take approximately three days, with one day devoted to learning about the Great Lakes, one day completing a chart making conversions from U.S. Customary measures to Metric measures, and another day for changing metric units to other metric units. Students could use extra time on the third day to drawing posters or make models of characteristics of the Great Lakes. The unit can be adapted to the individual teacher's classroom by selecting parts of the lesson as needed.

### SOURCES CONSULTED

**BINDER - Great Lakes Maritime Teacher Institute in Door County, Wisconsin, June 20-24, 2011** sponsored by Michigan Tech University with funding from the Great Lakes Maritime Research Institute and UW-Madison CFIRE program

**The Great Lakes: An Environmental Atlas and Resource Book.** (1995)  
Accessed July 11, 2011 from <http://www.epa.gov/glnpo/atlas/index.html>

**State of Wisconsin Department of Public Instruction Website - Science Standards**  
Accessed July 11, 2011 from <http://www.dpi.state.wi.us/standards/>

**Common Core State Standards for Mathematics** (2010) National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO)  
Accessed July 11, 2011 from <http://www.corestandards.org/the-standards/mathematics/grade-7/>

**Vocabulary** definitions from Dictionary.com Website Accessed July 11, 2011 from <http://dictionary.reference.com> **Conversion** formulas from Online Conversions.com Website

## LEARNING OBJECTIVES

*Students will be able to:*

- convert a metric number from one metric unit to another metric unit.
- convert from U.S. Customary measurements to metric measurements.
- explain how U.S. Customary measurements compare to similar metric units of measure.
- describe the importance of the Great Lakes in my life, including how goods are transported, survival of species, and recreational uses of the Great Lakes.

## STANDARDS/BENCHMARKS ADDRESSED

National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO) Common Core State Standards for Math

### Mathematics Grade 7 Standards:

- **Ratios and Proportional Relationships**
  - Analyze proportional relationships and use them to solve real-world and mathematical problems.
- **The Number System**
  - Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.
- **Expressions and Equations**
  - Solve real-life and mathematical problems using numerical and algebraic expressions and equations.
- **Geometry**
  - Draw, construct and describe geometrical figures and describe the relationships between them.
  - Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.
- **Mathematical Practices**
  1. 5. Use appropriate tools strategically.

Science Standards/Benchmarks – State of Wisconsin

Science, Standard B: Nature of Science Performance Standards - Grade 8

By the end of **grade eight**, students will:

B.8.6 Explain the ways in which scientific knowledge is useful and also limited when applied to social issues

Science, Standard F: Life and Environmental Science Performance Standards – Grade 8

By the end of **grade eight**, students will:

DIVERSITY AND ADAPTATIONS OF ORGANISMS

F.8.10 Project how current trends in human resource use and population growth will influence the natural environment, and show how current policies affect those trends.

Science, Standard G: Science Applications, Performance Standards – Grade 8

By the end of **grade eight**, students will:

G.8.1 Identify and investigate the skills people need for a career in science or technology and identify the academic courses that a person pursuing such a career would need

G.8.2 Explain how current scientific and technological discoveries have an influence on the work people do and how some of these discoveries also lead to new careers

G.8.3 Illustrate the impact that science and technology have had, both good and bad, on careers, systems, society, environment, and quality of life

G.8.7 Show evidence of how science and technology are interdependent, using some examples drawn from personally conducted investigations

Science, Standard H: Science in Personal and Social Perspectives Performance Standards – Grade 8

By the end of **grade eight**, students will:

H.8.3 Understand the consequences of decisions affecting personal health and safety

## MATERIALS NEEDED

Student Materials: Calculators, notebooks, pencils, etc.

Classroom Materials: Calculators, Metric chart, Formulas, Copies of Measuring the Great Lakes Worksheet; Copies of Converting the Great Lakes – Average Depth, Shoreline Length, and Volume of Lake Sheets; Poster paper or large construction paper for lake pictures; markers, colored pencils, erasers, etc.

VOCABULARY – source: Dictionary.com

Accessed July 11, 2011 from <http://dictionary.reference.com>

**volume** - the amount of space, measured in cubic units, that an object or substance occupies. For example, the volume of a lake would mean that all of the water occupying space in the lake would be measured in cubic units.

**length** - the longest extent of anything as measured from end to end. The length of a shoreline, for example, would mean that you start at a point on a lake, go around the whole lake, measuring from end to end, and coming back to the original starting point.

**depth** - a dimension taken through an object or body of material, usually downward from an upper surface, horizontally inward from an outer surface, or from top to bottom of something regarded as one of several layers. For example, the depth of a lake would be measured from the surface of the lake to the lowest point of water in the lake.

**prefix** - an affix placed before a base or another prefix. For example, a unit of measure, the kilometer, would be 1000 times greater than the base unit, meter, because kilo (the prefix) means 10 to the third. The prefix kilo- is always 1000 times greater than the base, so a kilogram is 1000 times larger than a gram.

## Metric Chart

$10^9$	$10^6$	$10^3$	$10^2$	$10^1$	$10^0$	$10^{-1}$	$10^{-2}$	$10^{-3}$	$10^{-6}$
Giga-	Mega-	Kilo-	Hecto-	Deka-	UNIT	Deci-	Centi-	Milli-	Micro-
G	M	K	H	Da	unit	d	c	m	u
Gigameter	Megameter	Kilometer	Hectometer	Dekameter	Meter	decimeter	centimeter	millimeter	micrometer

See additional documents for duplexed, landscape copy of Metric Chart.

### Formulas

**1 foot = 0.3048 meters**

**1 miles = 1.609344 kilometers (rounded to 1.6 for calculations)**

**1 miles squared = 2.58998811 kilometers squared (rounded to 2.6)**

**1 miles cubed = 4.16818183 kilometers cubed (rounded to 4.2)**

## LESSON PLAN

### FOCUS QUESTION

What are some of the things you know about the Great Lakes?

### CLASSROOM ACTIVITIES

1. Think, Pair, Share with a partner about some of the facts you know about the Great Lakes. Students will discuss prior knowledge with table partner, taking turns to listen to each other. Invite students to share facts about the Great Lakes. Teacher will list facts on board (or have student write list using document reader.)
2. Discuss student responses. Teacher should guide discussion to include movement of goods, transportation, recreation, habitats, and other important issues as discussed during Maritime Institute.
3. Tell students about continuing education that teacher experienced during the summer. Stress the importance of learning every day, at every age. Show pictures from class to engage students in personal life.
  - **INSERT CD of MTU class pictures here.**
  - **View pictures and discuss summer class.**
4. Continue lesson by asking students about how big they think the Great Lakes are, in order from smallest to largest. Work in cooperative groups to organize the lakes in order. Have three of the pairs form a group, or form groups by another method. Teacher note: At this time, do not clarify instruction other than **smallest to largest**, in order to demonstrate that a scientist must be precise in language, which reinforces prior lesson about mathematics and the metric system being a universal language.
5. Record student group responses, accepting all answers with explanations on how students derived their responses. Discuss group answers and rationale. Ask students about their feelings to teacher response about all answers being correct. Explain and note why teacher was vague in direction. Note different correct answers DO exist, ie. smallest volume, smallest depth, smallest shoreline length. Make sure students understand that answers would vary as below, depending on attribute selected.

Volume: Erie, Ontario, Huron, Michigan, Superior (smallest to largest)

Depth: Erie, Huron, Ontario, Michigan, Superior

Shoreline: Ontario, Erie, Michigan, Superior, Huron

Length of Lake Name: Erie, Huron, Ontario, (tie) Michigan/Superior

6. Define vocabulary terms as attributes to measuring the Great Lakes. Students should record vocabulary in science notebook vocabulary section. (Volume, Length, Depth, Prefix, and any others as desired). Pass out chart of prefixes to students and have students glue chart into their interactive science notebooks. Go through the example of the unit – meter – adding prefixes. Review measurement information.
7. Display Measuring the Great Lakes Fact Sheet. Allowing time for students to recheck their guesses on smallest to largest Great Lake and compare and discuss answers depending on attribute.
8. Summarize learning for the day. Make sure students understand the importance of the Great Lakes throughout the world and how lucky we are to have this resource so close to our home.

**Suggested possible break** for day's activities. The next day would start with a review of the prior day's lesson.

9. Pass out Measuring the Great Lakes Fact Sheet to all students. Look at units (feet) and remind students that metric is the language of science, referencing common language lesson throughout the world. Tell students that the focus of the lesson, in addition to learning about the Great Lakes, is to become proficient in using measurement in the science classroom. In the United States, our use of Customary Units leads to difficult calculations that must be made in order to do business in a global marketplace. Tell students that the class is going to make a few of these conversion calculations to experience the real world of business.

10. Teach students how to use formulas to change the units from U.S. Customary to metric units. Pass out calculators for student use. Write formulas on board. Work with students to convert the first lake on the chart, Lake Superior. Students will change U.S. Customary units to metric units for the chart.

- The first formula used is **1 foot = 0.3048 meters**. Use this formula to change the average depth of each lake from feet to meters.
- Convert Lake Superior's depth by multiplying 483 feet by 0.3048. Fill in the answer, 147 meters, on blank spot on chart.
- Have students work on converting Lake Michigan's depth by multiplying 279 by 0.3048 to equal 85. Check that students have calculated the correct answer and help those who have not calculated the correct answer.
- Allow time for students to work through all lakes.
- Advanced students can work through Maximum Depth row as time allows, or complete this as homework.
- Differentiation can occur with expectations for students to complete this and other parts of the chart.

11. Remind students that the Great Lakes are very large and that using the unit **feet** to calculate the size of the "shoreline length" of the lake would create very large numbers that would be difficult to use. Each mile contains 5,280 feet. A more appropriate unit for measuring the shoreline length is miles. For example, it would be 2,726 times 5,280 or 14,393,280 feet around the lakeshore, or 14,393,280 times 12 inches in a foot for 172,719,360 inches around Lake Superior. Stress the use of appropriate measures, reminding students of previous lessons.

12. Use the formula **1 miles = 1.609344 kilometers rounded to 1.6 km** to convert the next row, shoreline length.

- Convert Lake Superior's shoreline length of 2,726 miles to kilometers by multiplying by 1.6 for a total of 4,362 kilometers rounded to nearest km. Demonstrate.
- Have students work on converting Lake Michigan's shoreline length by multiplying 1,638 by 1.6 to equal 2,621 kilometers. Check that students have calculated the correct answer and help those who have not calculated the correct answer.
- Allow time for students to work through all lakes.



- Differentiation can occur with expectations for students to complete this and other parts of the chart.
13. Finally, use the formula, **1 miles cubed = 4.16818183 kilometers cubed rounded to 4.2 km<sup>3</sup>** to calculate the volume of each lake. Remind students that volume is length times width times height (depth in this case). The 1.6 is multiplied by itself three times; note this answer is the same as 1.6 to the third power or cubed for length times width times height is approximately 4.2 km<sup>3</sup>.
- Multiply Lake Superior's volume of 2,900 cubic miles times 4.2 for a total of 12,180 cubic kilometers.
  - Have students work independently on Lake Michigan and then check that they have calculated the answer of 4,956 cubic kilometers (1,180 times 4.2).
  - Students should complete the other Great Lakes conversions.
  - Differentiation can occur with expectations for students to complete this and other parts of the chart.
  - Check student's work on these calculations periodically, and assist students as needed. Complete worksheet as homework, if needed for reinforcement.
14. Students can do calculations on Maximum Depth and Water Area as homework. After students finish calculations, a summary of the activity should be completed.

**Suggested possible break** for day's activities, if needed. If not needed, continue on with showing students how much easier it is to work with the metric system.

15. Check students work to begin the next day's class. Stress the difficulty in making conversions from U.S. Customary to Metric units. Not only is it difficult to remember the physical conversion factors, it is also very EASY to make a calculation error, even with the use of a calculator, because numbers can be incorrectly entered by human error. Remind students that "in the old days" all calculations would have been done by pencil and paper, likely resulting in even more errors.
  
16. Now, tell students that we will be working to convert the metric data to different units within the metric system. The purpose of this conversion is to help students understand the metric system and the ease at which conversions can be made within the metric system.
  
17. Students will work on completing the shoreline length sheet, with teacher guiding first column.  
Instructor will work with students that need assistance.
  
18. Students will work on average depth sheet for homework. Advanced students will also work on converting the volume chart, noticing units. Check students homework in class.
  
19. As a follow-up activity, each group will make a poster of the Great Lakes, showing one of the features (volume, depth, shoreline, etc.) of one of the lakes. Differentiation can occur in this part of the activity. Some students will show all features for one lake. Advanced students should work on completing a poster comparing a feature or features of all lakes, individually.

## Great Lakes Information - Physical Facts & Features

Original Data Source: <a href="http://epa.gov/greatlakes/physfacts.html">Great Lakes Atlas http://epa.gov/greatlakes/physfacts.html</a>		Great Lake					Totals
Feature	Units	Superior	Michigan	Huron	Erie	Ontario	
Average Depth <sup>a</sup>	feet	483	279	195	62	283	
	meters	147	85	59	19	86	
Maximum Depth <sup>a</sup>	feet	1,332	925	750	210	802	
	meters	406	282	229	64	244	
Volume <sup>a</sup>	miles <sup>3</sup>	2,900	1,180	850	116	393	5,439
	km <sup>3</sup>	12,100	4,920	3,540	484	1,640	22,684
Water Area	miles <sup>2</sup>	31,700	22,300	23,000	9,910	7,340	94,250
	km <sup>2</sup>	82,100	57,800	59,600	25,700	18,960	244,160
Land Drainage Area <sup>b</sup>	miles <sup>2</sup>	49,300	45,600	51,700	30,140	24,720	201,460
	km <sup>2</sup>	127,700	118,000	134,100	78,000	64,030	521,830
Shoreline Length <sup>c</sup>	miles	2,726	1,638	3,827	871	712	10,210 <sup>d</sup>

	<b>km</b>	4,385	2,633	6,157	1,402	1,146	17,017 <sup>d</sup>
<b>Population:</b>	<b>U.S. 1990</b>	425,548	10,057,026	1,502,687	10,017,530	2,704,284	24,707,075
	<b>Canada 1991</b>	181,573		1,191,467	1,664,639	5,446,611	8,484,290
<b>Totals:</b>		607,121	10,057,026	2,694,154	11,682,169	8,150,895	33,191,365

<b>Retention Time</b>	<b>years</b>	191	99	22	2.6	6
-----------------------	--------------	-----	----	----	-----	---

**Notes:**

<sup>a</sup> Measured at Low Water Datum.

<sup>b</sup> Land Drainage Area for Lake Huron includes St. Marys River. Lake Erie includes the St. Clair-Detroit system. Lake Ontario includes the Niagara River.

<sup>c</sup> Including islands.

<sup>d</sup> These totals are greater than the sum of the shoreline length for the lakes because they include the connecting channels (excluding the St. Lawrence River).

Source: [Great Lakes Atlas](http://epa.gov/greatlakes/physfacts.html) http://epa.gov/greatlakes/physfacts.html

## ASSESSMENT

Student work on homework is to be graded to accuracy of calculations. Summaries will be graded for evidence of learning. Poster would be graded as a group activity based on accuracy and completeness. Rubric for grading this portion of measurement is attached. Since this lesson is part of a

larger, month-long unit on measurement, this unit will be assessed in a final exam. Also see worksheets and answer keys attached.

## APPENDIX

The following documents are used in the lesson. They have been sent as separate documents. Answer keys are provided when appropriate.

- Metric Chart
- Measuring the Great Lakes Fact Sheet (note – some figures have been rounded from original Great Lakes Data)  
Source: Great Lakes Atlas
- Converting the Great Lakes – Shoreline Length Worksheet
- Converting the Great Lakes – Depth Worksheet
- Converting the Great Lakes – Volume Worksheet
- Measurement in Science Vocabulary - Review Worksheet
- Rubric for Great Lakes Measurement