Middle School Does Metrics

Grade level: 7th
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Length of Unit: 6 lessons

I. ABSTRACT

This unit focuses on metric measurement used in the sixth, seventh, and eighth grades. The metric system of measurements is used across the curriculum in math, language arts, science, history, and geography. Students will be actively engaged in manipulating the different aspects of the metric system through poetry, vocabulary, measurement, and science. Student generated projects will show how they can use the metric system in every day life.

II. OVERVIEW

A. Concept Objectives:
   1. Students will understand metric measurement and use tools to solve measurement problems.
   2. Students will appreciate the universality of the metric system.

B. Core Knowledge Content:
   1. The meaning of Latin and Greek words that form common root words.
   2. Solve problems requiring conversion of units within the metric system.
   3. Associate prefixes used in metric system with quantities
   4. The standard measurement for length, mass, and volume in the metric system.
   5. The number that the metric system prefixes stand for.

C. Skill Objectives:
   1. Students will calculate geometric problems.
   2. Students will do experiments and report on their findings.
   3. Students will be able to convert problems within the metric system.

III. BACKGROUND KNOWLEDGE

A. For Teachers:
   1. King Henry Dyed Shirts Drinking Chocolate Milk is an acronym used throughout this unit to familiarize the students with the prefixes for the metric system.

B. For Students:
   1. Measurement - Grade 5, 4, 3, 2, 1
   2. Metric prefixes - Grade 6

IV. RESOURCES

A. Math at Hand. Great Source Education Group. Houghton Mifflin Company. ISBN 0-669-46922-x
B. Education Center. The Mailbox. Intermediate June/July 1999
C. Education Center. The Mailbox. Intermediate April/May 1998
D. Bitter, G., Mikesall, J. and Maurdeff, K. Activities Handbook for Teaching the Metric System. Boston, MA: Allyn and Bacon
E. Dream, Tamara J, and Souvney, Randall J. Measurement Activities. Dale Seymour Publications: 1992 ISBN 0-86651-591-7

V. LESSONS

Lesson One: King Henry Looks Like…

A. Daily Objectives
   1. Lesson Content: Metric quantities and prefixes
   2. Concept Objective: Students will appreciate the universality of the metric system.
   3. Skill Objective:
      a. Students will name the standard measurement for length, mass, and volume in the metric system.
      b. Students will identify the prefixes of the metric system and be able to give a value for them.

B. Materials
   1. One metric ruler per student
   2. enough construction paper cut at the following lengths for each student in the class to have one: 1mm, 1 cm, 1 decimeter, and 1 m
   3. sidewalk chalk
   4. a large/long paved area such as a playground or sidewalk
   5. five or more meter sticks.

C. Key Vocabulary
   1. meter
   2. liter
   3. gram
   4. Kilo-
   5. Hecto-
   6. Deca-
   7. Deci-
   8. Centi-
   9. Milli-
   10. centum
   11. decem

D. Procedures and Activities
   1. Write on board: **K**ing **H**enry **D**yed **S**hirts **D**rinking **C**hocolate **M**ilk using different colors for the beginning letters.
   2. Brainstorm with the students what different types of measurements they are familiar with.
   3. Group the different types of measurements into two groups. Tell the students that they use two types of measurement everyday: the American Standard and the Metric System.
   4. Ask the students why they think we have two measurement systems.
   5. Ask the students what they think King Henry has to do with measurement.
   6. Tell students back in King Henry's time the measurements were always changing because things were measured according to the King, i.e. a foot was the length of the King's foot. Ask the students what could be wrong with this system.
   7. Refer students back to the two measurement systems on the board. Tell the students that the United States is the only country to use the American Standard. Brainstorm what problems this could cause (the same problems the Kings had.)
   8. Tell the students that the scientific world uses the simpler Metric System, as do many countries. Ask why this would be beneficial.
   9. Tell the students that they are going to do a unit on the Metric System and will learn to manipulate measurements within the system.
   10. Tell the students that King Henry is an acronym to help them remember the different measurements within the metric system.

11. Ask students what can be measured. (If they say a table ask them what they use to measure a table - length.) Guide students until you have length, mass, and volume on the board.
12. Tell your students that each of the three measurements on the board is a standard measurement. Each one equals one (one meter, one liter, or one gram.) The standard is what the students will measure fractions of the standard against.
13. Tell the students that the metric system is broken down by powers of 10. Each power has a prefix that King Henry will help them remember.
14. List Kilo, Hecto, Deca, standard, Deci, Centi, and Milli on the board.
15. Ask students "What number does the standard represent?" (1) Ask students "If I am measuring length/mass/volume, what number and unit does the standard represent? (1 meter/ 1 gram/ 1 liter).
16. Ask students what number they think Deca represents and why. Integrate language arts by telling the students that the Greek word Decem means ten. Also remind the students that the metric system is broken down by powers of 10. (When students correctly guess, put a number 10 next to Deca)
17. Ask students what number they think Hecto (100) and Kilo (1000) mean. Write the number next to the prefix.
18. Ask the students "If Deca means ten, how many standard measures of length would I have if I had a Decameter?" (10). Continue to ask students questions like this varying the prefix and the unit until students become familiar with the number associate with the prefix.
19. Ask the students "What does Deci mean?" (1/10) Remind students that on the opposite side of the standard we climbed by powers of ten.
20. Ask students what Centi (1/100) (refer to the language arts vocabulary Centum) and Milli (1/1000) mean.
21. Ask students to predict how many Decimeters are in a meter. Continue to ask questions such as this until students become familiar with the entire King Henry sequence if numbers.
22. Tell the students that during the unit they will learn to visualize each of the measurements starting with length.
23. Pass out the strips of paper.
24. Tell the students to measure the length of the paper. Have them write the length in the corner.
25. Tell the students they should draw King Henry on their paper. Assure the students that some King Henrys will only be 1mm tall.
26. When the students are finished, have them hang their posters on the wall in ascending order to show the difference in height.
27. Ask the students why the largest piece of paper you handed out was one meter. (a Decameter is too tall to hang in most classrooms.)
28. Tell the students that for the rest of the lengths, the class will work together outside. Pass out meter sticks (the more you have the faster the measuring outside will go.) Ask the students what they have just been handed.
29. Outside, ask the students to predict how far away a Decameter is. Ask the students how many meters they need to measure out to reach a Decameter. (10)
30. Measure out the distance and have the students draw King Henry.
31. Ask the students to predict how far away a Hectometer is. Ask "How many meters (100)/Decameters (10) will we need to measure out to make a Hectometer?
32. Measure out a Hectometer and draw King Henry.
33. If you have the room, repeat this activity for a Kilometer. If you have access to a standard size track, a Kilometer is 2 ½ times around the field.

E. Evaluation and Assessment:
   1. This activity has an informal evaluation of question and answer throughout.

Lesson Two: Metric Puzzle

A. Daily Objectives:
   1. Lesson Content: Conversion of metric units.
   2. Concept Objective: Students will understand metric measurement and use tools to solve measurement problems.
   3. Skill Objectives:
      a. Students will solve problems requiring conversion of units within the metric system for length.
      b. Students will convert between the lengths in the metric system.

B. Materials
   1. One metric puzzle set for each group consisting of: 1 meter stick, 5 decimeter pieces, 40 centimeter pieces, 10 millimeter pieces. (These pieces can be obtained by cutting a meter stick into the corresponding pieces.)
   2. pencil and paper

C. Key Vocabulary
   1. See lesson one vocabulary for the prefixes.
   2. Length
   3. Meter
   4. Meter stick

D. Procedures and Activities
   1. Briefly review with the students the King Henry acronym and which number corresponds with which prefix by asking such as "How many meters in a Kilometer?"
   2. Tell the students that today they will get to use manipulatives to see the conversion problems they have been doing.
   3. Ask the students to find the meter stick. Ask what it would be good to use for. Ask if it would be good to measure the length of the classroom and why (Yes because the classroom length is not that long.) Ask if it would be good to use to measure the distance to a different city. (No, the measurement is too large.)
   4. Ask the students to find a decimeter piece. Ask them how they knew it was a decimeter.
   5. Ask the students to record their prediction of how many decimeters will fit in the length of the meter stick.
   6. Have the students test their prediction.
   7. Ask the students "Based on your observations, how many decimeters will fit into 2 meters? (20) How did you arrive at that conclusion?"
   8. Ask, "Based on your observations, how many meters can fit inside 1 decimeter? (1/10) How did you come to that conclusion?
   9. Ask, "Based on your observations, how many decimeters can fit inside 2 ½ meters? How did you reach that conclusion." Continue with questions such as these until the students no longer have to use the manipulative to find the answer.
   10. Have the students locate the centimeter. Predict how many centimeters will fit in a decimeter (10). Have the students test their predictions. Ask, "How many centimeters will fit inside two decimeters?"(20) "How many centimeters will fit inside 10 decimeters? (100) "What is another name for this length? (meter) Continue with questions until the students are experts at converting between centimeters, decimeters, and meters.
   11. Have the students find a millimeter piece. Predict and record how many millimeters is the length of a centimeter.

12. Test your prediction.
13. Continue with questions like the previous ones until the students can convert between millimeters, centimeters, decimeters, and meters. You may want to combine groups so that the students have more manipulative lengths to work with.

E. Evaluation/Assessment
1. Have the students locate a common object around the room or on themselves that they can use as a reference for how long a millimeter, centimeter, decimeter, and a meter are. As their ticket out the door have the student use their common object to help them do a conversion problem such as "How many millimeters in a decimeter? (100)
2. You can also do an informal assessment using the students answers.

Lesson Three: A Layered Solution

A. Daily Objectives:
1. Lesson Content: Mass
2. Students will understand metric measurement and use tools to solve measurement problems.
3. Skill Objectives:
   a. Students will measure different masses within the metric system.
   b. Students will balance masses.

B. Materials: One experiment kit with the following items for each group
1. salt
2. pan balance
3. red, yellow, blue, and green food coloring
4. weights of the following increments: 1gram, 5 gram, 10 gram, 20 gram
5. five small jars
6. stirrer
7. 100 ml graduated cylinder and base
8. pipette or drinking straw
9. oil pencil for writing on glass
10. pencil
11. lab sheet (Appendix A)

C. Key Vocabulary:
1. Gram
2. See Prefix vocabulary from lesson one
3. Density
4. Pan balance

D. Procedures/Activities
1. Refocus: Yesterday, you were able to see how the different lengths within the metric system compared. Would anyone like to refresh our memories on what we learned? (Or the students could pose a conversion problem for classmates to solve.)
2. Say, "Today we are going to measure mass. Who remembers what unit in the metric system measures mass? (grams)
3. You will be using the items at your groups to measure different masses. You will then be able to see how the masses compare by floating them on top of each other.
4. (If your class is familiar with using pan balances, skip this step.) The scale at your group is called a pan balance. Each group should also have four different weights. To make the pan balance work, first be sure the pointer is exactly on middle line of the scale. To do this, squat down and get eye level and directly in front of the needle. This will ensure there are no tricks in perception. If the scale is not balanced, use the adjustment knobs (located at various places depending on your scales) to balance the scale (make sure everyone has a balanced pan). Place a 1 gram weight in one of the

pans. Slowly pour salt into the empty pan. When the needle is exactly on the middle line of the scale again, you know you have one gram of salt. Walk around and make sure all students are using the pan balance correctly.

5. Each jar will need to have 20 ml of water in them. Use a graduated cylinder to get the correct amount. Remember to look straight at the water level, do not look down or hold the cylinder up as this will skew your measurement. Also remember to measure from the bottom of the meniscus.
6. Each person in your group should have a chance to measure water and salt.
7. When all five jars have 20mL of water in them, label them with the following measurements 0 gm, 1 gm, 5 gm, 10 gm, 20 gm.
8. Put 2 drops of different color food coloring in each jar (one jar you may leave colorless or you can combine colors to make a secondary color.)
9. Measure out 1 gram of salt and put it in its respective jar. Stir until all the salt has dissolved.
10. Repeat this for each measurement.
11. Carefully pour 20 ml of the 20 gram solution into the graduated cylinder.
12. Next, float 20 ml of the 10 grams solution on top. To do this use the pipette or drinking straw to **slowly** dribble the solution down the side of the cylinder. Repeat for each layer.
13. Draw a picture of your layered solution.
14. Ask, "Why does one layer of water float on the other?" Introduce the vocabulary word "density"
15. Ask, "What is another name for the 10 grams of salt you put into one solution?" (decagram) "How many decagrams was the 20 grams of salt? (2) "How many grams of salt would I have to put in the water to make the 20 gram solution float? Is there another name (such as hectogram) for that?
16. Ask, "Why do you think we did not measure out a Deci, Centi, or milligram? Do you think this experiment would work with that little salt? Why or why not?

E. Evaluation/Assessment
   1. Collect and evaluate the student's lab sheets.

Lesson Four: Measuring Volume

A. Daily Objectives
   1. Lesson Content: Volume
   2. Concept Objective: Students will understand metric measurement and use tools to solve measurement problems.
   3. Skill Objectives:
      a. Students will use manipulatives to solve volume problems.
      b. Students will be able to measure volume using the metric system.

B. Materials (Materials listed are for small groups)
   1. 10 grams of waterproof clay
   2. small items of various weights (three per group)
   3. 1 graduated cylinder
   4. 20 Ml of water
   5. paper
   6. pencil
   7. pan balance
   8. counter weights for the pan balance

C. Key Vocabulary
   1. See lesson one for prefix vocabulary
   2. Liter
   3. volume

D. Procedures/Activities
    1. Explain to the students that today they will be learning to calculate the volume of an object with the tools they see in front of them.
    2. Ask, "What is volume?" "How do you think we can find the volume of a solid with the tools in front of you?" Continue prompting until someone guesses by putting water in the graduated cylinder dropping in an object and measuring the difference in water height.
    3. Each group needs to have 20mL of water in their graduated cylinder. While one student is getting the water, another student need to mold the ten grams of clay into a shape.
    4. Drop the clay into the water. How much did the water rise? What does this rise in water represent? (The volume of the clay)
    5. Ask each group what their volume is. Ask, "Why do you think the volume remained the same for all the clay even though it was in different shapes?" Record on the board some of the answers.
    6. Predict: weigh the different items on your table. Draw a chart to record the different weights and predict what their volumes will be. Leave a space on the chart to tell what their actual volume is.
    7. Have all the students dump out their clay and water and fill up with 20 fresh Ml.
    8. Test your first prediction. Record your results.
    9. Ask, "Do you have to dump out your water in between each item?" (No you can just begin measuring from the new height.
    10. Test your second and third predictions record your results.
    11. As a class, make a chart of the masses of objects and their volumes?
    12. Do several conversion problems with volume using the examples, i.e.: a 10 gm mass has a volume of 5 ml. How many centiliters is that? (.5) or Your graduated cylinder is 100 ml. What is another name for that amount? (1 deciliter.)
    13. Discuss as a class your findings. Why do some objects of the same mass have a larger or smaller volume? Is the ratio of mass to volume always the same?
E. Evaluation/Assessment
    1. Have the students write a journal on their findings using vocabulary words such as liter, volume, and other metric system units.
    2. Have the students create a graph of the ratio of mass to volume. At the bottom have the students explain why the ratio is (non-) consistent.

Lesson Five: Conversion Train

A. Daily Objectives
    1. Lesson Content: Conversions
    2. Concept Objective: Students will understand metric measurement and use tools to solve measurement problems.
    3. Skill Objectives:
        a. Students will be able to convert amounts within the metric system
        b. Students will be able to convert problems within the metric system.
B. Materials
    1. 5x5 cards with the following denominations on them: 1 decimal point, 1-2, 1-5, and 7-0's. The cards can either be made to hang around the students' necks, or they can be taped to their chests.
C. Key Vocabulary
    1. Conversion
    2. See lesson one for the metric system prefixes
D. Procedures/Activities
    1. This activity may be done inside or outside.

2. Tell the students that for the past week, they have been learning to manipulate the different units of the metric system.
3. Ask, "Who can tell me all of the standard measurements we have learned about?" "Who can tell me in order from least to greatest the breakdown of units for the meter/liter/gram?" (If the students appear stuck remind them of King Henry.)
4. You have been doing simple conversion problems for the past week. Today we will be learning how to do harder conversion problems.
5. Ask for 10 volunteers. Hand each of them a 5x5 card to put on.
6. Ask a student left sitting to give you a standard unit. (for example meter)
7. Ask another student to give you a prefix (For example Kilo)
8. Ask another student to give you another prefix (For example Deca)
9. Tell the students "I have 25 Kilometers." Ask the volunteers to arrange themselves into this number (25.0000000) Ask "Are the volunteers in the correct order?"
10. "I want to know many decameters are in a kilometer, is my final number going to be bigger or smaller?" (bigger) "How can I make this number bigger without changing any of the numbers?" (Move the decimal point to the right.)
11. Ask, "How many places does the decimal point have to move? Why?" (two) If the students can't grasp it, ask "Which spot is the number 25 in? (kilo) Which spot is the first zero in? (Hecto) Which number is in the Deca spot? (the second zero) So how far do I need to move the decimal point? (Two places or to the right side of the Deca spot.)
12. Have the decimal point move one spot at a time. If the students need to hear the move, have the decimal point pause after each space while the class says where he/she is i.e.: Hecto, Deca.
13. Ask, "How many decameters are in a 25 kilometers?" (2500)
14. Repeat steps 6-13 varying your number (sometimes use 2.5, 25, or .25)
15. Enrichment: For students who are mathematically ready, you can teach them unit multipliers. I.e.: 25kilometers=_____meters

    $\frac{1km}{1000m} = \frac{25\ km}{?\ m}$

    To solve this problem cross multiply (1000m)(25km) and divide by 1km which equals 25000 m.

    Larger problems will need to be solved in two steps. I.e.: 25km= _____mm

    1st: $\frac{1km}{1000m} = \frac{25km}{?m}$

    2nd: $\frac{1m}{1000mm} = \frac{25000m}{?mm}$

E. Evaluation. /Assessment
1. Give the students a formal evaluation of several conversions with various units and numbers to solve. For students who need it, have them draw a King Henry diagram (K H D S D C M) and count the spaces.
2. For the enrichment students, have them do unit multipliers to solve the problems.

VI. CULMINATING ACTIVITY
School Measurement

A. Daily Objectives
1. Lesson Content: The metric system.
2. Concept Objective: Students will appreciate the universality of the metric system.
3. Skill Objective: Students will use a meter stick to help them calculate different problems.

B. Materials
   1. One metric ruler (or meter stick) per pair of students
   2. Appendix B (modified to fit your school surroundings.)

C. Key Vocabulary: no new vocabulary

D. Procedures and Activities
   1. Randomly divide students into groups of 2-3
   2. Tell students that a metric measurement of the middle school is needed and they have been chosen to measure the building.
   3. Tell the students that they may measure each classroom and the commons area with the meter stick.
   4. The students will need to give the total measurement of the middle school in meters and centimeters.
   5. Student's will them choose one room to determine the volume of water it would hold.

E. Evaluation and Assessment
   1. Collect and evaluate student worksheets.
   2. Observe student interaction and evaluate informally the process that students use to solve the problems.

VII. HANDOUTS/WORKSHEETS

Appendix A
Appendix B

VIII. BIBLIOGRAPHY

Bitter, G., Mikesall, J. and Maurdeff, K. Activities Handbook for Teaching the Metric System. Boston, MA: Allyn and Bacon

Dream, Tamara J, and Souvney, Randall J. Measurement Activities. Dale Seymour Publications: 1992 ISBN 0-86651-591-7

Education Center. The Mailbox. Intermediate June/July 1999

Education Center. The Mailbox. Intermediate April/May 1998

Glencoe Physical Science Enrichment, McGraw-Hill, New York, ISBN 0-02-827891-7.

Math at Hand. Great Source Education Group. Houghton Mifflin Company. ISBN 0-669-46922-x

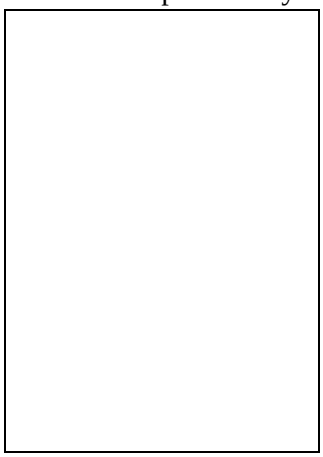
Appendix A: Middle School does Metrics

Floating Water Lab

Materials:
Salt
Pan balance
1 gram weight
5 gram weight
10 gram weight
20 gram weight
5 jars
red, blue, yellow, and green food coloring
graduated cylinder
stirrer
oil pencil
pipette or drinking straw

Procedure:

1. Label the jars 1-5 with the oil pencil
2. Use the graduated cylinder to put 20mL of water in each jar.
3. Put two drops of food coloring in each jar so that each jar is a different color.
4. Do not put any salt in jar #1
5. Measure out 1 gm of salt and dissolve it in jar #2
6. Measure out 5 gm of salt and dissolve it in jar #3
7. Measure out 10 gm of salt and dissolve it in jar #4
8. Measure out 20 gm of salt and dissolve it in jar #5
9. Add 20 ml from jar #5 to the graduated cylinder
10. Using the pipette or drinking straw, slowly dribble 20 ml from jar #4 down the side of the graduated cylinder so that the water from #4 is floating on the water from #5
11. Repeat this procedure taking 20mL from each jar in descending order.
12. Draw a picture of your floating water in the box.



1. Why does one layer of water float on the other?

2. What is another name for the 10 grams of salt you put into one solution?
3. How many decagrams was the 20 grams of salt?

4. Predict how many grams of salt you would have to put in the water to make the 20 gram solution float? Why do you predict this?

5. Why do you think we did not measure out a decigram, centigram, or milligram of salt? Do you think this experiment would work with that little salt? Why or why not?

Adapted from: Glencoe Physical Science Enrichment, p. 10. McGraw-Hill, New York, ISBN 0-02-827891-7.

Appendix B: Middle School does Metrics

School Measurement

Names:_____

You have been asked to measure the school using the metric system. You will need to measure each classroom and the commons area.

Mrs. Spangler's room is _____ long and _____ wide.
_____ long and _____ wide and
_____ tall.

Mr. Rowly's room is _____ long and _____ wide.
_____ long and _____ wide and
_____ tall.

Mrs. Benzel's room is _____ long and _____ wide.
_____ long and _____ wide and
_____ tall.

Mr. Barber's room is _____ long and _____ wide.
_____ long and _____ wide and
_____ tall.

Mrs. Rageth's room is _____ long and _____ wide.
_____ long and _____ wide and
_____ tall.

Mr. Willsea's room is _____ long and _____ wide.
_____ long and _____ wide and
_____ tall.

The commons area is _____ long and _____ wide.
_____ long and _____ wide and
_____ tall.

Congratulations! You have done a lot of measuring. Now that you know how large each room is, you can discover how much water one room can hold if we ever have a pipe burst. Please choose one fairly rectangular shaped room and determine the volume. Please show all your work.

Room:_____

Volume: