Science Unit: *Physics Ideas*
Lesson 1: *Measurement in Science*

School year:	2006/2007
Developed for:	Tecumseh Elementary School, Vancouver School District
Developed by:	Paul Nagelkerke (scientist), Marie Chomyn and Fern Louie (teachers)
Grade level:	Presented to grades 6-7; appropriate for Grades 4-7 with appropriate modifications.
Duration of lesson:	1 hour and 20 minutes
Notes:	These activities are likely to take longer than the estimated duration. Originally they were set up in a station approach with an instructor. Students continued to work on science activities during the week following the lesson.

Objectives

1. Learn about the techniques of scientific inquiry.
2. Discover techniques for accurately measuring length, volume, mass.
3. Compare the Metric measurement system to the Imperial system.

Background Information

We use science to understand the natural world around us. As our understanding of the natural world has evolved, our language and systems of measure have evolved also.

The Imperial measurement system (still used in the United States) was cobbled together from many different areas: farming, metallurgy, marine navigation. The units of measure were unrelated, so when they were standardized against each other they had difficult conversion rates:

Distance: 12 inches to the foot, 3 feet to the yard, 1760 yards to the mile (how many feet to a mile?).

Mass: 7000 grains to the pound, 16 ounces to the pound, 12 troy ounces to the pound.

The British Standard was a one pound bar of silver; this was a measure of monetary value (Pound Sterling), along with being a measure of weight and force. This was confusing because mass and force are not the same as weight. For example: how much would a standard pound bar of silver weigh on the moon?

Making things more complicated was the fact that the units of measure differed from country to country, and sometimes city to city. Trading between cities and countries was very difficult.

The Metric System is a scientifically-based system of measure ordered by King Louis XVI of France, and was implemented after his death in the French Revolution (1792). This system clearly identifies mass, force, and length, and gives them unique units of measure. A metre is the same length all over the world, allowing easier global trade. It also associated units of length, area, volume and mass.

Note: all measurement systems are arbitrary; the metric system is just a bit less arbitrary. The metric system is used world-wide because it is scientifically-based and is uses units in multiples of 10.

Vocabulary

Science	The pursuit of explanation of natural phenomenon
Mass	The composition of an object, a measure of matter, a count of atomic particles
Force	Direct (contact) or indirect (gravity, magnetism) interaction between two objects.
Volume	The three dimensional space an object occupies.
Density	The measure of mass vs. volume

Materials per station

- 100 pennies
- Small digital or analog scale: postal scale for example.
- Bathroom Scale
- Block of wood, lump of lead, block of Styrofoam, block of heavy plastic, all around 200-500 grams.
- Large bowl of water (about 2 litres)
- A series of identical containers (for example plastic Easter eggs) filled with different materials (rocks, lead), sealed in small balloons.

In the Classroom

Introductory Discussion

1. Science
    a. What is the scientific model? (Propose a theory, make a prediction, test the prediction, revise the theory if necessary).
    b. What can science do? What can't science do?
    c. How has the history of measurement related to the understandings of science? What are the units based on? Are all measurement systems arbitrary?
    d. How is scientific language different from everyday language?
2. Short description of other items to discuss or review.
    - Concepts of mass, volume, density
3. Summary of instructions for science experiment/activity.
    - Measure items with an accuracy of 1 mm (0.1 cm), and calculate to two decimal places.
4. Briefly describe safety guidelines.
    - Be very careful with the scales, they are accurate, delicate measuring instruments.

Science Activity/Experiment

Four stations are set up in the classroom.

Divide the students into four equal groups. Save some time at the end of the class to discuss the student observations.

1. Penny Measure
    a. Estimate the mass of a single penny in grams without weighing it. Record your estimate.
    b. Measure the mass of one penny in grams using the scale. Record the value if possible.
    c. How can you more accurately estimate the mass of a one penny? Record your method, the relevant measurements, and the calculated values.
    d. What is a penny made of? Research the stated mass of a Canadian penny.

2. Weight of the World
    a. Step on the bathroom scale. Record your mass in kg.
    b. Bounce lightly up and down on the scale. Are you really gaining and losing mass? What is the scale actually measuring? What units of measure is the scale calibrated in?
    c. The Moon has 1/6 the gravity of the Earth. If you weigh 120 pounds on Earth, how much do you weigh on the Moon? Your mass on Earth is 60 kg, what is your mass on the Moon?
    d. What is a more universally appropriate measure: weight or mass?

3. Floating a Weigh
    a. In your science journal create a table with six columns and about 10 rows. Label each column for object description, mass, volume, density, float prediction, and float test results.
    b. Record the description and mass of each object in each row.
    c. Calculate and record the volume of each object in units of cubic centimeters.
    d. Calculate the density of each object in grams per cubic centimeters.
    e. Predict if the object will float in water: water has a density of 1.0 gram/cm^3 Objects with a lower density (< 1.0) will float, objects with a greater density will sink.
    f. Put each object into the bowl of water and record if it floats or sinks.

Science Journal: Students will record their observations and calculations.

Closure Discussion

Examples of questions to ask students:

1. Is being wrong always such a bad thing?
2. Have you been using any scientific term incorrectly?
3. Have you seen any scientific terms used incorrectly on TV?

References

1. http://www.physics.ucla.edu/k-6connection/Mass,w,d.htm

Extension of Lesson Plan

1. Why does the metric system specify the temperature of water in the description of density?
2. Do objects get more or less dense as it gets colder?
3. Does water get more or less dense as it gets colder? Is it normal for ice to float in water?
4. What makes water different from other liquids as it cools and freezes?