Lesson: Quantify It

Subject Area(s)   Measurement, Number & Operations

Associated Unit   Forget the Chedda!

Lesson Title   Quantify It

Grade Level 7 (6-12)

Lesson # 1 of 5

Lesson Dependency

Time Required   20 minutes

Summary

       This is an introductory lesson on measurement which covers the reason we have units and how these standards evolved. Students will put this lesson to use in the related activity by measuring classroom objects and quantities related to their mousetrap car. Students need to know the relation between units in order to convert between measurement systems, a topic covered in the next lesson, "Convert It."

Engineering Connection

Engineers must routinely quantify, analyze, and interpret numbers that are a measure of a certain unit. Checking units that are carried through equations not only clarifies the end solution, but also serves as a check on whether or not the problem was solved correctly (*i.e.* if an acceleration is calculated with the units s^2/m, there must be an error in the solution). When re-creating an experiment at the required length scale is not possible, engineers use their knowledge of units to establish proportionality between a model and the full length scales using dimensional analysis.

The ability to understand and convert between units is necessary to compare measured quantities and rates. The 1999 Mars orbiter is representative of how a misunderstanding of the required system of measurement can lead to losses of time and money. Engineers involved in the mission learned that not following international standards (SI units) may lead to confusion during and result in failure of a collaborative project.

Keywords

measure, classroom object, car, distance, force, meter, inches, foot, yard, English unit, metric unit, SI unit, MKS

Educational Standards

- PA Science:
  - o 3.1.7 – Unifying themes
- PA Math:
  - o 2.1.8.D – Apply ratio and proportion to mathematical problem situations involving distance, rate, time, and similar triangles
  - o 2.3.5.D – Convert linear measurements within the same system
  - o 2.3.8.A – Develop formulas and procedures for determining measurements
  - o 2.4.5.B – Use models, number facts, properties, and relationships to check and verify predictions and explain reasoning

Learning Objectives

After this lesson, students should be able to:
- Understand the divisions in a unit length (inches: sixteenths, eighths, quarters, halves; meters: centimeters, millimeters)

- Understand and use the abbreviation for a length scale

- Use the concept of dividing unit lengths to measure distances

Introduction / Motivation

Have any of you used a tape measure or ruler outside of school? Before you were introduced to a ruler for measuring in school, what did you use? (Hand span, arm lengths). Did everyone using hand spans get the same measurement for the same object? Why? (Hand spans vary, so measurements would vary among the students).

Before international standards were developed, each geographic region had their own measurement standards. The earliest "standard," which measured about 20.6 inches, originated in Egypt and was named the Royal cubit. There are also Roman, Greek, Arabic, Mesopotamian, Babylonian, Jewish, and Persian cubits, all having different lengths.

So how important do you think length scales are? What if you moved to a different part of the country and the length scales were different there? Does it surprise you that there is an international committee for weights and measures, which is in place to oversee implementation of national standards, such as the National Institute of Standards and Technology (NIST) in the United States?

Length scales are important enough for the European Union to require (and since rescind) a ban on imperial measures on products, which would affect international commerce, particularly between the United States, United Kingdom, and the European Union.

The history of imperial units is vague, but metric units, which are increasingly becoming the preferred units in engineering because of their ease of use and international acceptance, are all based on geographical or physical entities. For example, a meter is defined as one ten-millionth $\left(\frac{1}{10,000,000}\right)$ of the distance from the equator to the North Pole through Paris, France; the volume of a liter is defined as one thousandth $\left(\frac{1}{1,000}\right)$ of a cubic meter; the mass of 1 kilogram is equal to the mass of one liter of water. These metric measurements are known as the MKS system, an abbreviation that represents meters, kilograms, and seconds.

Lesson Background & Concepts for Teachers

Units clarify measured quantities that will be used throughout this unit, such as position, velocity, acceleration, and force. This unit will use metric units when measuring distances, accelerations, and forces, so students need to be introduced to imperial equivalents in the metric system. Students may remember the significance of the metric units since they are derived from global constants. Once they realize the significance of metric units, it may help to relate the metric and imperial systems. In the following activity students are encouraged to estimate and measure distances and forces found around the classroom or relevant to their mousetrap car.

Associated Activities
Quantify It

Lesson Closure
Segue into associated activity (end slide provides estimation activity).

Assessment
Check worksheet section associated with "Quantify It" activity.

Additional Multimedia Support
chedda_2_lesson_quantify_it.ppt

References
http://www.cnn.com/TECH/space/9911/10/orbiter.02/

http://en.wikipedia.org/wiki/Cubit

http://en.wikipedia.org/wiki/SI

http://www.express.co.uk/news/view/6521

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Contributors

John C. Fitzpatrick, Mechanical Engineering and Mechanics, Drexel University

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