

METRIC MEASUREMENTS

OVERVIEW

Students will make measurements of length and mass and use them to calculate conversion constants between the metric and English systems of units.

CONCEPTS

- There are direct conversions between metric units and English (U.S.) units.
- Most scientists and most countries use metric units, but most Americans are accustomed to English units.
- Note that mass and weight are not the same. Mass is a numerical measure of the amount of material in an object. The gravitational force of Earth on that mass is its weight on Earth. The conversion of 2.2035 lb/kg is only valid on Earth. On Earth a 70-kg Astronaut would weigh 154 pounds. On the Moon the Astronaut would weigh about $154/6 = 26$ pounds. At both locations a mass balance would read 70 kg. Earth has a mass of 6×10^{24} kg but its weight has no meaning since it cannot gravitationally attract itself.



MATERIALS

- Meter sticks
- Mass Balances
- Sheets of 8 1/2 x 11 inch paper
- Several empty cereal boxes and 2-liter bottles
- Several small objects for weighing
- Paper and pencil to record observations

PREPARATION

The type of mass balances available will determine which objects can be “weighed.” Coins, books, and watches are objects whose mass in grams can easily be measured.

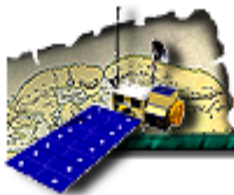
PROCEDURE

Engagement

Ask students what objects they have seen that are usually measured in the metric system. Most packaged products list sizes in both systems. Mention that film sizes are usually referred to in metric units: 8, 16, 35, and 70 mm. For electricity measurements, English system units are not used, only metric (e.g. watts). Several 100 seconds-to-the-minute clocks were made, but the change was never accepted. We have retained using the number 60 for seconds and minutes from the ancient Babylonians.

Activity

1. Use a *meter* stick to measure the length and width of a standard sheet of 8-1/2 x 11 inch paper to the nearest *millimeter* [mm] (0.1 *centimeters* [cm]).



Visit to an Ocean Planet



2. Choose a suitable item for the mass balance available and record the reading in *grams* to the smallest readable division.
3. Record the “net weight” from a cereal box (or other) in ounces and grams.
4. Record the volume on the label of a 2-liter bottle in fluid ounces. Note that the word “ounces” is used to refer to both a weight unit and a volume unit (fluid ounces).
5. Calculate from step No. 1 the cm/inch ratio for the 8 1/2 inch x 11 inch paper.
6. Convert the larger of your lengths from step No. 1 to millimeters (mm) and meters (m). Example: 20 cm x (10 mm/1 cm) = 200 mm.
7. Calculate from step No. 3 the grams/ounce ratio.
8. Convert the mass in grams from the cereal box to *kilograms*. Example: 530 g x (1 kg/1000 g) = 0.530 kg.
9. Calculate from step No. 4 the liter/quart ratio.
10. (Extra) A U.S. gallon (4 quarts) was originally a cylindrical container 7 inches in diameter and 6 inches high. Calculate that volume to see if it is the present legal definition of 231 cubic inches.

Explanation

A major advantage of the metric system is that converting to a larger or smaller unit is done by simply moving the decimal point. Familiarity with the metric system is becoming increasingly important in commercial usage. So consumers should have a rough idea of how to convert to metric units, although memorization of exact numbers is not necessary.

Accepted conversions corresponding to the exercises above are: 2.54 cm per inch, 28.4 grams per ounce, and 1.057 liters per quart.

EXTENSION

The United States is the only large country still using the English system of units, but general usage of the metric system in the U.S. is increasing. Drinkable liquids and automobile engine sizes are now rated first in liters.

Not long ago, a shipment of American-made irons to another country were rejected because the cords were six feet long instead of the usual 2-meter cords used in that country. Can your students come up with other examples where unfamiliarity with the metric system might pose a problem?

Ask students who have travelled outside the U.S. whether they had difficulties with weights or measurements (such as volumes, temperature) during their stay. If no students have travelled abroad, have them ask this question to friends or family members who have done so.

VOCABULARY

centimeter

gram

kilogram

meter

millimeter

SOURCE

San Juan Institute.