

Setting the Standard

Summary

Students will learn about measuring and weighing objects.

Materials

For each student:

Drinking straw (Half of the straws for the class should be shortened by cutting off 3 cm of length.)

Part I

For each group:

Primary balance

Set of objects (steel washer, plastic chip, wooden square)

For the class:

Paper clips: 4 boxes of 100 standard and 4 boxes of 100 jumbo

Part II

For each group:

Primary balance

Set of gram weights (1- g, 5-g, 10-g, and 20-g)

For the class:

Paper clips: 4 boxes of 100 standard and 4 boxes of 100 jumbo

Part III

For each group:

Primary balance

Set of gram weights (1- g, 5-g, 10-g, and 20-g)

For each student:

2"x 3" Ziploc® bag

For the class:

5 lbs. aquarium gravel

Apple or orange

Additional Resources

Books

- *FOSS Measurement*

, by Lawrence Hall of Science, UCB, (available at

<http://www.deltaeducation.com/fossgallery.aspx?subID=&menuID=2>); Item #WX542-2005, ISBN 0-87504-766-1

- *How Big Is a Foot?*

, by Rolf Myller; ISBN 0-440-40495-9

- *Measuring Penny*

, Loreen Leedy; ISBN 0-8050-5360-53

- *Weighing and Measuring*

, Terry Jennings; ISBN 0-8172-3963-4

- *Balances*

, Adele Richardson; ISBN 0-7368-2516-9

Background for Teachers

To facilitate communication, there is a need for a standard unit of measurement. The *foot* has been used for centuries, dating back to the ancient Greek empires. In 1670, the *meter* was established as one 10- millionth of the distance along a meridian from the equator to the North Pole. Today a meter

is defined as 1,650,763.73 wavelengths of light emanating from a specific isotope of krypton. In other words, the meter is an exact unit of measurement agreed upon by scientists throughout the world. In 1795, France was the first country to adopt the metric system. The meter (m) is divided into smaller parts. One-hundredth of a meter is a *centimeter* (cm).

Mass is a measure of the amount of stuff (matter) in an object. *Weight* is how we measure mass on Earth. In outer space, you may be weightless, but you are still made up of the same amount of stuff. An object's mass remains constant no matter where in the universe it is placed. However, its weight may change, depending on the strength of the gravitational pull of its location. Defining mass in terms of weight is the most efficient way for elementary students to begin comprehending these important ideas.

The standard unit of mass in the metric system is the *gram* (g). The gram is defined as the mass of a cubic centimeter of water at 4 C at standard atmospheric pressure. One paper clip is about 1 g. A nickel is about 5 g.

A word about metric symbols: The notations for metric measurement, m for meter, cm for centimeter, g for gram, ml for milliliter, etc. are universally recognized scientific symbols. They are not considered abbreviations, and therefore each is written without a period. This is in contrast to the abbreviations for feet (ft.), inches (in.), ounces (oz.), etc., which are abbreviations followed by periods.

Intended Learning Outcomes

4. Communicate mathematically.
5. Make mathematical connections.
6. Represent mathematical situations.

Instructional Procedures

Invitation to Learn

Hold up a straw and tell students that they are going to measure the tops of their tables using a straw as the tool for measure. Pass out straws to each student giving half of the groups shorter straws and half of the groups longer straws. Have students measure the tops of their desks or tables, length and width. Allow students to use whatever method they can devise to accurately measure to the nearest whole straw. Have each group report their measurements, recording the data on the board. Make sure to write the number and the unit (straws). Ask students to look at the data and to comment on what they see. They may suggest that other students are wrong, that the tables or desks are different sizes, or that the straws are different lengths. Have students compare the suggested variables until they determine that the straws were different. Indicate the need for a standard unit of measurement. Introduce the meter and centimeter (see Background Information). Hand out meter sticks or meter tapes and invite students to measure the length and width of the table or desk in centimeters.

Instructional Procedures

Part I

Show students a set of objects (steel washer, plastic chip, and wooden square). Challenge students to put the objects in order from lightest to heaviest.

Distribute a set of objects to each group. Let students place the objects in order. Have each group report on their decision and write the results on the board. Discuss any discrepancies.

Tell students that there is a tool that can be used to compare the weight of the objects more accurately. Hold up a balance.

Demonstrate how to assemble and use the balance and use the slider to make the empty balance level.

Choose two objects other than the ones they are using to demonstrate that the heavier object of the two will make one side of the balance go down.

Students use the balance to determine more accurately the order of the weight of the three objects that they previously judged by feel.

Ask them if they would like to make any corrections to their previously reported findings.

Use paper clips as a unit for weighing objects.

Model the procedure by placing an object in one cup of the balance and then counting out paper clips until the balance is once again level. Report that the object weighed _____ paper clips.

Students weigh their steel washer using paper clips.

Deliver a cup of paper clips to each group.

Give half of the groups a cup of 100 standard paper clips and give the other half of the groups a cup of 100 jumbo paper clips.

Have the groups weigh their washers and report their results.

Write the results on the board, making sure to write the number and the unit (paper clips).

Discuss why the weights are different, similar to the discussion of the straws from the Invitation to Learn.

Part II

Introduce the metric standard of measuring weight, the *gram* (g).

Hold up a gram weight and explain that the weight of this special cube is exactly one gram.

Hold up and identify the 5-g, 10-g, and 20-g weights.

Have students return the sets of paper clips and distribute a set of gram weights.

Students weigh each of the previous objects using grams.

Have them create a data table in their journal, listing in one column the objects and in the second column the measured weight of each object.

Provide other objects for students to weigh and record.

Students create a bar graph comparing the weights of various objects.

Part III

Hold up an apple or an orange. While this object will fit in the cup of the balance, it is too heavy to weigh using the gram weights.

Create a 100-g weight by measuring out 100 g of aquarium gravel and placing it in a small Ziploc® bag.

Distribute materials and have students create the 100-g weight.

Students use the new weight in conjunction with the gram weights to measure other objects in the room.

Students record their measurements in their journal on the data table.

As a follow up, collect ten of the prepared 100-g weights. Place them together in a larger plastic bag. Introduce the newly created 1000-g weight as 1 *kilogram* (kg).

Extensions

Students measure the weight of a small dry sponge, then soak the sponge to capacity with water and weigh again. Students write a math problem that expresses the weight of the water that the sponge held.

Create a cloth rag that weighs the same as the dry sponge. Soak the rag to capacity and weigh it. Compute the weight of the water it held.

Compare the holding capacity of the sponge to the rag.

Read *How Big Is a Foot?* Students write a similar story about another unit of measurement.

Students research other units of linear measurement, such as hand, rod, league, chain, cubit, fathom, cable, furlong, mil, ell, and report on how long each unit is and what was measured with that unit historically.

Family Connections

Students make a list of containers of packaged food. Next to each, estimate its weight in grams. After estimating, use the advertised metric weight on the label to record the actual weight of the food. There will be some discrepancy because weight listed is the net weight, excluding the weight of the container.

Assessment Plan

Provide a set of objects that you have previously measured and determined their weight. Have students list the objects. Next to each, have them record the estimated weight. Students weigh the objects and record the measured weight, within a reasonable margin of error.

As students work on projects involving weight, move around the classroom observing. Invite individual students to demonstrate the process of assembling the balance and determine the weight of a "found" object from the classroom.

Bibliography

Research Basis

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