Help! I'm Teaching Middle School Science

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Arlington, Virginia

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Help! I'm Teaching Middle School Science

NSTA Stock Number: PB170X
Printed in the USA by Victor Graphics. Printed on recycled paper.

05 04 03 4 3 2 1

Library of Congress Cataloging-in-Publication Data

Swango, C. Jill, 1956-
Help! I'm teaching middle school science / by C. Jill Swango and Sally Boles Steward.
p. cm.
Includes bibliographical references.
ISBN 0-87355-225-3
1. Science—Study and teaching (Middle School)—United States—Handbooks, manuals, etc. I. Steward, Sally Boles, 1973- II. Title.
LB1585.3 .S93 2002
507'.1'2—dc21 2002153474

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CHAPTER 9

Metrics and Measurement

One of the most challenging activities in the middle school science lab is taking measurements. A simple ruler can send students into a questioning mob around a teacher, not unlike a shark-feeding frenzy. Student activities that require using and reading a thermometer can cause teachers to lose their hair from the strain of pulling on it with frustration. Then there is the dread of teaching metrics, or the SI system (International System of Units) as it is now termed in most science texts. However, these training exercises can have the opposite effect when designed for practice and application.

As a start, you may want to review briefly the history of measurement or brainstorm with the class why measurement is important.

Why Have a Standard System?

To duplicate experiments or share information, the science community needs a language of measurement that is uniform and easy to use and understand. Scientists worldwide use the SI. It is based on units of 10, just like the number system students already understand, and is easy to manipulate by dividing or multiplying by 10. Your students will understand the need to have the same system of measurement, but they may argue that SI is not as easy to use or understand as the familiar English system. To show this may not be true, a teacher can quiz students about this "familiar" system by asking questions such as how many bushels are in a peck, drams in an ounce, or furlongs in a mile. (See Appendix A, p. 99, for examples). These questions are difficult for the average student, and many may not have heard of a dram or furlong. The questions may spur interest in metrics, making students willing to learn the easier SI measurements.

The Stair-Step Method

A most useful tool for introducing metric prefixes and easy conversion from one prefix to the next is the stair-step method. This method uses the simple premise of changes that are made by moving up and down a staircase as in Figure 9.1, next page. One of the steps is noted as the unit. The steps above and below the unit step correspond to the different metric prefixes, symbols, and their numeric values, increasing in value as the steps go up and decreasing as the steps go down. (See Appendix A, p. 101, for a copy.)

You can use an actual staircase if there is one at school or copy Figure 9.1 onto chart paper, chalkboard, or wipe board to demonstrate its use while students refer to their own copies. First point out the shaded box and read the statement inside. The three most frequently used measures in SI are meter (m), liter (L), and gram (g). Make sure to use these symbols as well as those of the prefixes when demonstrating the stair-step method. Point out that prefixes are not words when they stand alone; they must have a root word following. So, depending on the measurement being taken, a unit is coupled with the prefix, like centigram or cg. If the measured unit has only one "m," it **always** stands for meter, not milli.

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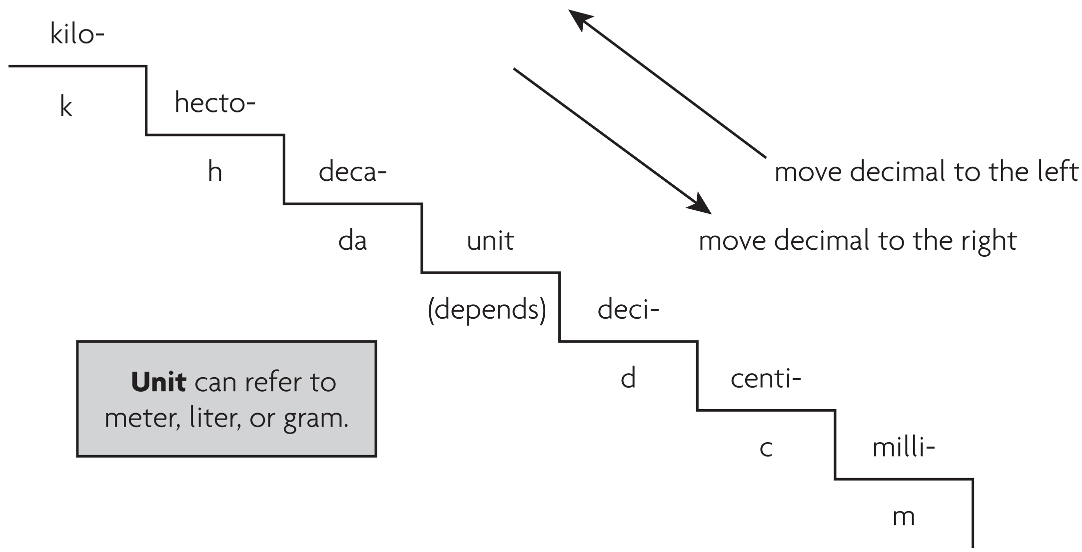
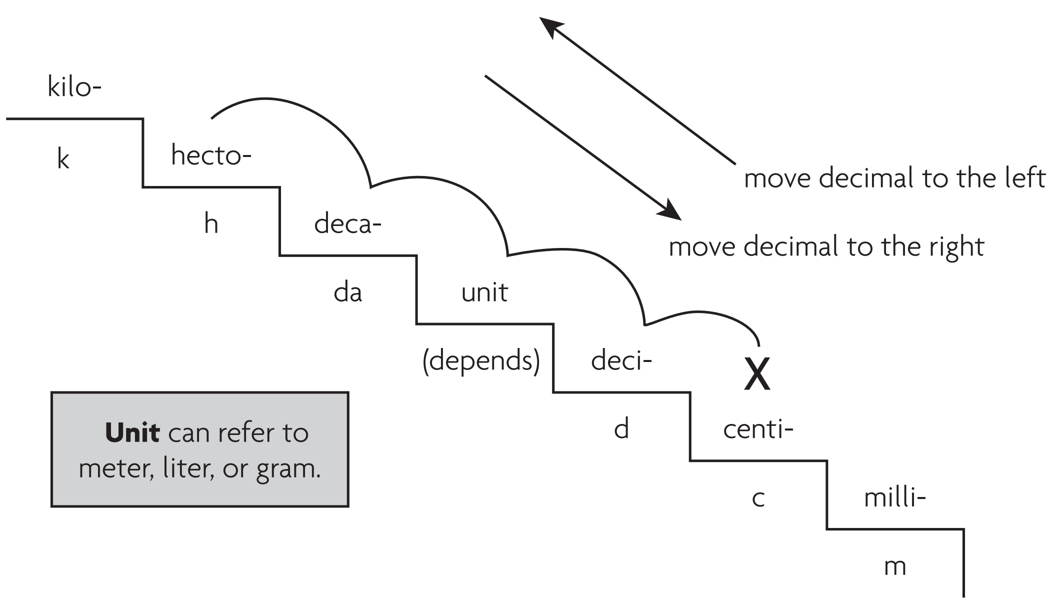
Figure 9.1



Begin by writing a sample conversion problem such as 23.675 cg = _________ hg. Point out that the "g" in cg stands for grams and the "c" is for the prefix "centi." Then explain that the "g" in hg again stands for grams while the "h" is for the prefix "hecto." On the stairstep, start at the step labeled centi- (**X**) in Figure 9.2 and count the number of steps up to the step labeled hecto-. Because it took four steps to get to hecto- and the direction of the move was **up** the stairs, the decimal point in the problem will be moved four steps to the left. Therefore 23.675 cg = .0023675 hg. Students can readily see that moving up the stairs involves dividing by 10 (moving the decimal point to the left), while moving down the stairs entails multiplying by 10 (moving the decimal point to

Figure 9.2



the right). Again, practice is important to learn symbols, prefixes, units, and conversion (See Appendix A, p. 102, for worksheet).

Practice Makes Perfect

Middle school students have had measurement activities in the past, but take the time to refresh memories. Have measurement instruments out for students to view or even touch—they could even be questioned as to how they think the device is used or what it can measure. Some possible instruments to show them are balances; scales; graduated containers like cylinders, flasks, or beakers; stopwatches; standard and metric rulers; yardsticks; meter sticks; and thermometers. You can model using the instruments while thinking aloud and even asking for student help. Point out the "parts" of the instrument, the marks (½, ¼, ¾, etc.) on a standard ruler; the marks (cm and mm) on a metric ruler; how to use and read a stopwatch; the art of reading a measure on a graduated cylinder using the meniscus, or using a balance depending on type—for example, electronic, triple beam, scale with weights.

You may want to show your students the graduation on the containers, balances, and thermometers to determine the number interval being used and how to "read" the marks (see Appendix A, p. 103, for a sample worksheet). Practice makes perfect holds true with measuring devices. Students can practice using each instrument after you have modeled it or manipulate the devices in stations you have set up (see Appendix A, p. 104, for a sample station lab).

Students need to recognize that the SI and English systems can be compared and that changing from one system to another is possible. For example, students are very familiar with the Fahrenheit scale and may also have heard temperatures given in Celsius, but they probably have no experience with the Kelvin scale. Since these are all used for the same quantitative measure, their scales can be changed from one to the other using mathematical formulas. Some science textbooks list these conversions, or equivalencies can be found in some reference books like an almanac, encyclopedia, or in this book (see Appendix A, p. 106).

Everyday Use

Knowing how to use these conversions can have some practical applications, as illustrated in the following project. Tell students to bring in a recipe for some type of homemade cookies and challenge them to change the ingredient amounts to metric measure. Then they can show conversion formulas used and the calculations made during this cookie exchange. Maybe the family and consumer science—what used to be known as home economics—teacher and the math teacher would like to get in on this activity, too. Another way of looking at measurement standards is to make up units using familiar words, phrases, or puns (see Appendix A, p. 107).

Measurements in the science lab are definitely necessary components of sharing data and comparing results. Students should use measurement techniques, instruments, and conversion methods as often as they can in a variety of activities to become comfortable with SI. About 25 years ago, the push was for the United States to go "metric" to make our everyday system of measurement match the one used by virtually the rest of the world. This led to bottling liquids in 1- and 2-liter containers, but little else. If today's students learn SI measurement and become comfortable using and applying this system, then, as consumers of tomorrow, they may not hesitate to adopt the metric approach.

National Science Education Standards Note:

*This chapter specifically addresses Teaching Standard A, bullet point three, and Teaching Standard B, bullet point five.

Teaching Standard A

Teachers of science plan an inquiry-based science program for their students. In doing this, teachers

- ❍ Develop a framework of yearlong and short-term goals for students.
- ❍ Select science content and adapt and design curricula to meet the interests, knowledge, understanding abilities, and experiences of students.
- ● **Select teaching and assessment strategies that support the development of student understanding and nurture a community of science learners.**
- ❍ Work together as colleagues within and across disciplines and grade levels.

Teaching Standard B

Teachers of science guide and facilitate learning. In doing this, teachers

- ❍ Focus and support inquiries while interacting with students.
- ❍ Orchestrate discourse among students about scientific ideas.
- ❍ Challenge students to accept and share responsibility for their own learning.
- ❍ Recognize and respond to student diversity and encourage all students to participate fully in science learning.
- ● **Encourage and model the skills of scientific inquiry, as well as the curiosity, openness to new ideas and data, and skepticism that characterize science.**

*** Bold faced statements are discussed in the chapter.**

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