Name_____ Class_____ Date _____

Observing the Uncertainty of Measurements

Introduction

Scientists use a wide variety of tools to make precise measurements. Some of the tools include a balance that measures mass in grams, a ruler or meterstick that measures length in centimeters, and a graduated cylinder that measures volume in milliliters. The accuracy of a measurement depends on three things: the accuracy of the measuring instrument, the ability of the observer to read the scale properly, and the degree of precision of the measuring instrument. In this investigation you will practice the skill of making accurate measurements using a variety of measuring instruments.

Problem

Are there differences between measurements made by two different observers?

Pre-Lab Discussion

Read the entire investigation. Then, work with a partner to answer the following questions.

1. Why is it necessary to have a particular tool for each task?

2. What might be a better tool for measuring the size of your classroom?

3. What is an advantage of using metric tools over a yardstick or ruler?

4. Is it necessary for the same person in a group to make each measurement?

5. Would you expect every group's measurement of the temperature of the ice water to be the same?

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Materials *(per station)*

Station 1: meterstick
Station 2: meterstick
Station 3: 30-cm ruler
regular object
Station 4: 100-mL graduated cylinder
150-mL beaker of colored liquid
Station 5: triple-beam balance
small pebble
Station 6: 100-mL graduated cylinder
150-mL beaker of water
irregular object
Station 7: Celsius thermometer
250-mL beaker of ice and water
paper towel

Safety

Put on a laboratory apron if one is available. Put on safety goggles. Handle glassware and thermometers carefully. Note all safety alert symbols next to the numbered steps in the Procedure and review the meaning of each symbol by referring to Safety Symbols on page 8.

Procedure

1. Station 1: Use the meterstick to measure the length and width of your science classroom. If the room has an irregular shape, measure the longest width and the longest length. Express your measurements to the nearest tenth of a meter and record them in the Data Table.
2. Station 2: Use the meterstick to measure the length and width of your desk or lab table. If the table has an irregular shape, measure the longest width and the longest length. Express your measurements to the nearest tenth of a centimeter and record them in the Data Table.
3. Station 3: Use the metric ruler to find the volume of the regular object. Volume is found by multiplying the length times the width times the height of the object. Express the volume in cubic centimeters (cm^3) and record it in the Data Table.
4. Station 4: Use the graduated cylinder to find the volume of the colored liquid in the beaker. **CAUTION:** *Be careful to avoid breakage when working with glassware.* Remember to always read a graduated cylinder at the bottom curve of the meniscus. Pour the liquid back into the beaker. Express your measurement in milliliters and record it in the Data Table.

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5. Station 5: Make certain that the riders on the triple-beam balance are moved all the way to the left and that the pointer rests on zero. Place the pebble on the pan on the triple-beam balance. Move the riders until the pointer is at zero. Express your measurement to the nearest tenth of a gram and record it in the Data Table. Remove the pebble and return all riders to the far left of the balance.
6. Station 6: Fill the graduated cylinder half full with water from the beaker. Find the volume of the irregular object. Express the volume of the object in cubic centimeters (cm^3) and record it in the Data Table. Carefully remove the object from the graduated cylinder. Pour the water back into the beaker.
7. Station 7: Use the Celsius thermometer to find the temperature of the ice water. Express the temperature to the nearest 0.5°C and record it in the Data Table. Remove the thermometer and carefully dry it with a paper towel.
8. Compare your measurements from each station with those of classmates by having one member from your group record your data on the class data table your teacher provides. Make a copy of the class data table so that you can answer the questions that follow.

Data Table

Station	Object	Measurement (units)
1		
2		
3		
4		
5		
6		
7		

Analysis and Conclusions

1. **Analyzing Data** Examine the results from all the group measurements. Did the groups get exactly the same measurement results for the task at the same station?

_____

_____

2. **Inferring** Why is the graduated cylinder used instead of a ruler to measure the volume of the irregular object at Station 6?

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3. **Drawing Conclusions** What are two important guidelines to follow in making a good set of measurements?

4. **Comparing and Contrasting** Examine all the data collected and determine which set of measurements showed the greatest variability. What are some possible reasons the measurements are not consistent for a particular set of measurements?

5. **Predicting** Should the volume calculated for the block at station 3 be nearly the same as you would determine using the graduated cylinder technique at station 6?

Going Further

Test your prediction in question 5 by measuring the volume of the block at Station 3 by using the graduated cylinder technique at Station 6. Calculate the difference between the two measurements. How would you determine which is the more accurate?