Accuracy of Glassware

A Carolina Essentials™ Activity

Student Worksheet

SAFETY REQUIREMENTS

MATERIALS

Beaker

Erlenmeyer flask

Graduated cylinder

Volumetric flask

Electronic balance

Thermometer

Container of room temperature tap water

Your volumetric flask will determine the volume of water you pour into each piece of glassware.

Overview

Measurement is the cornerstone of all good scientific investigations. It's common to measure mass and volume in chemistry labs, length or force in physics labs, and concentration and time in biology labs. How do you know that measurements are correct? In this activity, you'll look at 2 factors that influence the quality of measurements you make:

- The tool you select to make the measurement and the tool's percent error
- Your skill with the tools

Remember: as with any skill, improvement comes with practice.

Scientific tools are designed with a specific purpose in mind. If the amount measured just has to be close (about 100 mL), then the tool can be less accurate. If the amount has to be exact (100.05 mL), then the tool must have a higher degree of accuracy. Accuracy is defined as how close a measurement is to a standard or the "truth." In scientific measurement, accuracy is often reported as percent error. Notice that some glassware includes percent error printed on it.

Phenomenon

Accurate measurement is important not only in science—it matters in the kitchen, too. Kitchen measurement tools must be accurate for a recipe to yield consistent results. No one wants wet, doughy bread one time and then dry, crumbly bread the next. Moist, soft bread is what a recipe should produce.

If you do any cooking or watch any cooking shows, you may have wondered why there are 2 types of measuring cups: 1 for liquids and 1 for dry ingredients. What's the benefit to having different types of measuring cups? Is a liquid cup the same volume as a dry cup? Are both cups accurate? Is one more accurate than the other? These same questions will be investigated for several pieces af laboratory glassware.

Essential Question

How does the accuracy of a piece of glassware help determine its use?

Activity Objectives

1. Determine the percent error in volume for several pieces of laboratory glassware.
2. Make a claim about the acceptable laboratory use of each piece of glassware based on accuracy.

Safety and Disposal

Watch where you place glassware. Make certain it is on a level surface and away from table edges. Do not pick up broken glass with your hands. Use a broom and dust pan, and place the glass in the appropriate disposal container.

Activity Procedures

A. Visual Inspection

1. Weigh each piece of glassware and record the mass in table B.
2. As a group, begin with the volumetric flask. Record the volume printed on the flask, then fill the flask with tap water so the meniscus sits on the etched line.
3. Pour the water into another piece of glassware and record the volume on that piece of glassware. Estimate the volume if needed.
4. Repeat step 2 for the remaining pieces of glassware.

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B. Glassware Accuracy Using Density Calculations

1. Each group member must collect data on every piece of glassware.
2. Record the value on the volumetric flask. You will add water to that mark on each piece of glassware. _____mL
3. Add water until the volume recorded in step 2 is present in the piece of glassware being tested. Use the graduations on the glassware. Do not pour water from 1 piece of glassware to another.
4. Record the temperature of the water.
5. Weigh the glassware with the water and record the value.
6. Repeat steps 3 to 6 for the other 3 pieces of glassware.
7. Calculate the mass of water in each piece of glassware.
8. Calculate the group average for the mass of water in each piece of glassware and temperature.

Data and Observations

A. Visual Inspection

Glassware	Volume (mL)
Volumetric flask	
Graduated cylinder	
Beaker	
Erlenmeyer flask	

B. Glassware Accuracy Using Density Calculations

Glassware	Empty Mass (g)	Volume of Water (mL)	Mass of Glassware with Water (g)	Mass of Water Only (g)	Water Temperature (C)
Volumetric flask					
Graduated cylinder					
Beaker					
Erlenmeyer flask					

Group Averages

Glassware	Theoretical Volume of Water (mL)	Average Mass of Water (g)	Average Water Temperature (C)
Volumetric flask			
Graduated cylinder			
Beaker			
Erlenmeyer flask			

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Analysis and Discussion

1. Based on the visual inspection only, rank the glassware from most accurate to least accurate. Use your data to explain your ranking.

2. Using individual data and the Density of Water table, calculate the actual volume of water in each piece of glassware. Density = mass/volume

Density of Water by Temperature	
Temperature (C)	**Density (g/mL)**
4	*1.0000*
15	*0.9990*
16	*0.9989*
17	*0.9988*
18	*0.9986*
19	*0.9984*
20	*0.9982*
21	*0.9979*
22	*0.9978*
23	*0.9975*
24	*0.9973*
25	*0.9970*
26	*0.9968*
27	*0.9965*
28	*0.9962*
29	*0.9959*
30	*0.9956*

(Handbook of Chemistry and Physics, 53rd Edition)

3. Average the individual actual volumes for each piece of glassware and place the values in the table.

Glassware	Average Actual Volume of Water (mL)	Theoretical Volume of Water (mL)	Percent Error
Volumetric flask			
Graduated cylinder			
Beaker			
Erlenmeyer flask			

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Analysis and Discussion continued

4. Calculate the percent error for each piece of glassware and record the values.

$$\text{Percent error} = \frac{(\text{theoretical volume} - \text{actual volume})}{\text{theoretical volume}} \times 100$$

5. Based on percent error only, rank the glassware from most accurate to least accurate. Use your data to explain your ranking.

6. How do the 2 methods of determining accuracy compare? Were the results the same or different?

7. Based on accuracy, assign each piece of glassware appropriate uses and state evidence for your choice. For example, which pieces should be used for measurement, and which should not be used for measurement?

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