Food Explorations Lab:

Mastering Measurements

STUDENT LAB INVESTIGATIONS

Name: _____

Lab Overview

During this investigation, you will be asked to measure substances using household measurement tools and scientific measuring tools. You will compare the values you obtain to the expected values and calculate percent error. Relative densities of measured substances will also be compared.

Lab Objectives

In this lab, you will learn how to…

1. Identify measurement tools for mass and volume.

2. Properly use measurement tools to obtain accurate measurements.

3. Identify measurement tools that provide the most precise measurements.

4. Identify factors that can impact the accuracy of a measurement.

5. Use mass and volume measurements to compare relative densities of the measured substances.

You will work in a group to perform a series of measurements. The goal of the investigation is to identify measurement tools, learn precise methods of measurement, and identify factors that can impact accuracy.

Lab Safety: Before beginning ANY investigation you should put on your safety goggles and apron. Always wash your hands following completion of an investigation. When handling food, you should also wash your hands prior to beginning an investigation.

Lab Questions

1. Which of the methods below will produce the most accurate measurement for the dry ingredient flour? (Circle your answer.)

Spooned Method

Dipped Method

Sifted Method

Prediction #1: I predict the _____ method will provide the most accurate measurement of flour because…

2. Which of the below tools will produce the most precise measurement for liquid ingredients? (Circle your answer.)

Liquid Measuring Cup
(Cups and Fluid Ounces)

Dry Measuring Cups
(1 cup, ¾ cup, ½ cup, ¼ cup)

Graduated Cylinder
(mL)

Prediction #2: I predict the _____ will provide the most precise measurement of liquid ingredients because…

Observation of Measurement Types & Accuracy

MATERIALS

Assignment A – Method Accuracy

1 ½ cups flour in a plastic bag
1 set dry measuring cups
1 triple beam balance
1-2 sheets wax paper
1 strainer (wide mesh)
1 medium bowl
1 plastic knife
1 plastic spoon

Assignment B – Tool Precision

1 cup cooking oil in a plastic cup
1 cup water in a plastic cup
1 set dry measuring cups
1 liquid measuring cup
1 graduated cylinder
1 triple beam balance

Obtain your assignment from you teacher. Record your group's assignment below.

My group's assignment is: _____

ASSIGNMENT A: PROCEDURE

MEASUREMENT METHOD ACCURACY - WEIGHING & MEASURING DRY INGREDIENTS

Use three different methods to measure ½-cup of flour: **Dipped Method**, **Sifted Method**, and **Spooned Method**.

1. Before you begin, place the ½-cup dry measuring cup on your balance. Using the balance, find the mass of the measuring cup.

Mass of ½-cup Measuring Cup = _____g

2. Measure flour using the **Dipped Method**:

   a. Dip the ½-cup dry measuring cup directly into the container of flour, filling it to overflowing with flour.

   b. Level with the flat edge of a plastic knife over wax paper and mass the cup plus flour on the balance. Calculate the mass of the flour as follows:

Mass of Flour = Mass of Cup and Flour – Mass of Cup

   c. Record the volume (cups) and mass (grams) of flour in Table A under the "Mass in grams" column.

   d. Place the flour back into the plastic bag.

3. Measure flour using the **Spooned Method**:

   a. Stir the flour in a medium bowl or the bag with a spoon.

   b. Spoon flour gently into a ½-cup dry measuring cup. Level with the flat edge of a plastic knife over wax paper and mass the cup plus flour on the balance. Calculate the mass of the flour as follows:

   Mass of Flour = Mass of Cup and Flour – Mass of Cup

   c. Record the volume (cups) and mass (grams) of flour in Table A under the "Measured Mass (grams)" column.

   d. Place the flour back into the plastic bag.

4. Measure flour using the **Sifted Method**:

   a. Measure ½ cup of flour using the ½-cup dry measuring cup.

   b. Pour the flour into a strainer (½ cup).

   c. Sift onto wax paper by gently tapping the strainer against the palm of your hand.

   d. Spoon flour gently into the ½-cup dry measuring cup. Level with the flat edge of a plastic knife over wax paper and mass the cup plus flour on the balance. Calculate the mass of the flour as follows:

   Mass of Flour = Mass of Cup and Flour – Mass of Cup

   e. Record the volume (cups) and mass (grams) in Table A.

   f. Place the flour back into the plastic bag.

5. Share your data with the other student groups to complete Table B.

Table A: Dry Ingredient Measurements

Method	**Measured Volume** (cups)	**Measured Mass** (grams)
Sifted Flour		
Spooned Flour		
Dipped Flour		

6. Using the *Common Weights and Measures* chart, calculate the actual flour mass (grams) per ½ cup (volume):

ASSIGNMENT B: PROCEDURE

MEASUREMENT TOOL PRECISION - WEIGHING & MEASURING LIQUID INGREDIENTS

Use the following steps to measure ¼ cup of water and cooking oil using three types of measurement tools: **Liquid Measuring Cup**, **Graduated Cylinder**, and **Dry Measuring Cup.**

1. Before you begin, measure the mass of your liquid measuring cup and record its mass below.

   Mass of Liquid Measuring Cup: _____ **grams.** This mass will need to be subtracted from the mass of the liquid.

2. Next, place the dry measuring cup on your balance and record its mass below.

   Mass of Dry Measuring Cup: _____ **grams.** This mass will need to be subtracted from the mass of the liquid.

3. Next, place the graduated cylinder on your balance and record its mass below.

   Mass of Graduated Cylinder: _____ **grams.** This mass will need to be subtracted from the mass of the liquid.

4. Measure water using three types of measuring tools:

   a. Place the liquid measuring cup on a level surface.

   b. Measure out ¼ cup of water in the liquid measuring cup. Be sure to take the ¼ cup measurement at the lowest point of the meniscus (curved upper surface of the liquid).

   c. Mass the water.

   Mass of Water = Mass of Water and Cup – Mass of Cup

   d. Record the volume (ounces) and mass of the water in the column labeled "Water Volume" in Table B.

   e. Repeat steps a through d using a dry measuring cup.

   f. Repeat steps a through d using a graduated cylinder.

5. Measure cooking oil using three types of measuring tools:

   a. Place the liquid measuring cup on a level surface.

b. Measure out ¼ cup of cooking oil in the liquid measuring cup. Be sure to take the ¼ cup measurement at the lowest point of the meniscus (curved upper surface of the liquid).

c. Mass the cooking oil.

Mass of Oil = Mass of Oil and Cup – Mass of Cup

d. Record the volume (ounces) and mass of the cooking oil in the column labeled "Oil Volume" in Table B.

e. Repeat steps a through d using a dry measuring cup.

f. Repeat steps a through d using a graduated cylinder.

6. Share your data with the other student groups to complete Table B.

Table B: Liquid Ingredient Measurements

Measuring Tool	Water Volume (ounces)	Water Mass (grams)	Oil Volume (ounces)	Oil Mass (grams)
Liquid Measuring Cup				
Dry Measuring Cup				
Graduated Cylinder				

Use the *Common Weights and Measures* chart to complete 7-8.

7. Calculate the actual water mass (grams) per ¼ cup (volume):

8. Calculate the actual oil mass (grams) per ¼ cup (volume):

Calculation of Accuracy:

1. Using the *Common Weights and Measures* chart, calculate the % error in Tables B and D.

Example:

First determine the actual mass of your ingredient per ½ cup (volume). Flour masses 115g per cup. Let's say you massed 1 cup of spooned flour and it was 120 grams. To find percent error, subtract 115g (actual flour mass) from 120g (spooned flour mass). Your error is 5g.

$$|120g - 115g| = 5g$$

To find percent error, divide your 5 grams (error) by your spooned flour measure of 120 grams (5g ÷ 115g = 0.04). Then, multiply that value by 100 (0.04g × 100 = 4%). Your percent error is 4%.

$$\frac{5g}{115g} = 0.04$$

$$0.04 \times 100 = 4\%$$

Table C: Dry Ingredient % Error Calculation

Method	Calculations	% Error
Sifted Flour		
Spooned Flour		
Dipped Flour		

Table D: Liquid Ingredient % Error Calculations

Method	Water Calculations	Water % Error	Oil Calculations	Oil % Error
Liquid Measuring Cup				
Dry Measuring Cup				
Graduated Cylinder				

2. Using the % error, determine which measurement method was the most accurate for measuring flour. Why did they differ? Which method masses the most, which masses the least?

3. If 1 cup of sifted flour has a mass of 77 grams, and 1 cup of dipped flour has a mass of 3 ¾ ounces, which has a greater mass? Explain the mass difference.

4. Which measurement tool (dry versus liquid measuring cup) was the most precise for measuring cooking oil and water? Explain why the tools would yield different results.

5. Explain why equal volumes of cooking oil and water would have different masses. Which liquid has the greater density?

6. Infer the affect sifting has on the measured flour's density. Explain why.

7. If you need ½ a gallon of water, but only had a four-cup liquid measure, how many cups would you need to use? How many tablespoons? How many fluid ounces? Use the Common Weights and Measures chart as a guide.

   Cups:

   Tablespoons:

   Fluid Ounces:

8. If you are making zucchini muffins (several times the recipe) for a bake sale at school, how would you measure your dry ingredients (e.g. flour)? Liquid ingredients (e.g. cooking oil)? Why? (*HINT:* What measurement methods were the most accurate? Which measurement tool(s) were the most accurate?)

   Dry Ingredients:

   Liquid Ingredients:

9. Apart from the tools and methods used, what other factor(s) may have impacted your ability to obtain accurate measurements?

10. In your own words, describe why it is important for scientific measurement tools to be precise and be used properly to give accurate measurements.