

Measurements

In this lab we will be measuring 9 mL of water in 4 devices; a beaker, a 10 mL graduated cylinder, a 25 mL graduated cylinder, and a 100 mL graduated cylinder. I expect that the 10 mL graduated cylinder is the best tool for measuring 9 mL so it will serve to determine the “correct” value.

Procedure:

In part 1 the markings of the 4 devices will be examined.

In part 2, 9 mL of water will be measured as carefully as possible in a 100 mL graduated cylinder, using an eyedropper if necessary. Pour the water into a 10 mL graduated cylinder and measure the volume. Use the $n+mM+uU$ equation.

In part 3, 9 mL of water will be measured as carefully as possible in a 25 mL graduated cylinder, using an eyedropper if necessary. Pour the water into a 10 mL graduated cylinder and measure the volume. Use the $n+mM+uU$ equation.

In part 4, 9 mL of water will be measured as carefully as possible in a 10 mL graduated cylinder, using an eyedropper if necessary. Pour the water into a different 10 mL graduated cylinder and measure the volume. Use the $n+mM+uU$ equation.

In part 5, 9 mL of water will be measured as carefully as possible in a 50 mL beaker, using an eyedropper if necessary. Pour the water into a 10 mL graduated cylinder and measure the volume. Use the $n+mM+uU$ equation.

Prelab comments:

Prepare your notebook to take data by copying the appropriate portions of the tables for parts 1-5 into your laboratory notebook. Leave at least two inches of room on the right for your work. Remember that some calculations are done at home. Only measurements are recorded here.

Measurement- Instant Lab Report

Purpose: The purpose of this experiment is to introduce several common pieces of glassware and to illustrate why one piece of glassware may be preferred for a particular measurement.

Apparatus:

1 each: 100 mL graduated cylinder, 25 mL graduated cylinder, 50 mL beaker

2 each: 10 mL graduated cylinder

Procedure:

1. Record the following data for each piece of glassware:

glassware	Value of smallest marking (M)	precision (U or marked tolerance)
100 mL graduate		
25 mL graduate		
10 mL graduate		
50 mL beaker		

2. Fill the 100 mL graduated cylinder with water to **exactly** 9 mL as carefully as possible. (Use an eyedropper if necessary) Pour this into a dry 10 mL graduated cylinder and measure the volume.

100 mL grad. cyl.	Measured Volume	Deviation (d)
Trial 1		
Trial 2		
Trial 3		
Average		

3. Fill the 25 mL graduated cylinder with water to **exactly** 9 mL as carefully as possible. Pour this into a dry 10 mL graduated cylinder and record the volume.

25 mL grad. Cyl.	Measured Volume	Deviation (d)
Trial 1		
Trial 2		
Trial 3		
Average		

4. Fill a 10 mL graduated cylinder with water to **exactly** 9 mL as carefully as possible. Pour this into a dry 10 mL graduated cylinder and record the volume.

10 mL grad. Cyl.	Measured Volume	deviation(d)
Trial 1		
Trial 2		
Trial 3		
Average		

5. Fill a 50 mL beaker with water to **exactly** 9 mL as carefully as possible. Pour this into a dry 10 mL graduated cylinder and record the volume.

50 mL beaker	Measured Volume	Deviation (d)
Trial 1		
Trial 2		
Trial 3		
Average		

Calculations:

1. Calculate the average measured volume (\bar{x}) for each piece of equipment.

$$\bar{x} = \frac{\sum x}{n}$$

where x is the value of a trial, and n is the number of trials being averaged.

2. Calculate the deviation (d) for each trial.

$$d = |x - \bar{x}| = (\text{measured value} - \text{average})$$

3. Calculate the average of the deviation values.

$$\bar{d} = \frac{\sum d}{n} = \frac{\text{sum of deviations}}{\text{number of trials}}$$

5. Calculate the Relative Error, a measure of random error than is present in the chosen piece of equipment. It tells us how much error is likely to be found with a particular piece of equipment. If the relative error is high, the equipment is ill-suited for the application. In this experiment, the correct value is 9 mL.

$$\%RE = \left(\frac{U}{\text{correct value}} \right) (100)$$

4. Calculate the % relative average deviation (RAD), a measure of precision. If the measurements deviate from the average greatly, then the numbers were not very reproducible, hence not precise. A high % deviation indicates poor precision.

$$\%RAD = \frac{\bar{d}}{\bar{x}} (100) = \frac{\text{average measured deviation}}{\text{average measured value}} \times 100\%$$

6. Calculate the % error, a measure of accuracy. If your average is close to the correct number, it is accurate. A high % error indicates poor accuracy.

$$\%E = \left| \frac{(\bar{x} - \text{Correct value})}{\text{correct value}} \right| * 100 = \left| \frac{(\text{average measured value} - \text{Correct value})}{\text{correct value}} \right| * 100\%$$

Summary Table of Equipment Performance

Calculation	100 mL graduate	25 mL graduate	10 mL graduate	50 mL beaker
% RE				
%RAD				
% E				

Calculations: On attached page.

Error and Discussion

Two sources of error and their effects on the calculated measurement were:

Modifications: Ways that I would avoid this error in the future are...

Conclusion: The piece of glassware best suited for measuring 9 mL is a _____.

Post Lab Questions:

For each, reference the necessary calculations and explain your answer.

1. Which glassware was most accurate?
2. Which glassware was most precise?
3. Notice that all your measurements had three significant figures because you measured to the hundredths place. How many significant figures in the following numbers?
 - a. 1200
 - b. 5.330×10^{-3}
 - c. 0.0472

Appendix 1: Calculations. Show one of each calculation.

Show your calculation of average for the 100mL graduated cylinder.

Show your calculation of deviation for the 100mL graduated cylinder.

Show your calculation of average deviation for the 100mL graduated cylinder.

Show your calculation for the %RE for the 100mL graduated cylinder.

Show your calculation for the %RAD for the 100mL graduated cylinder.

Show your calculation for the %E for the 100mL graduated cylinder.