

Name _____ Section _____

Partner(s) NONE Date _____

THE ACCURACY AND PRECISION OF VOLUME MEASURING DEVICES

PRE-LAB QUERIES

1. Here are the masses of five paper clips: 5.123g; 5.117g; 5.124g; 5.120g; and 5.126g. Suppose you were asked, "What is the mass of a paper clip?" What is an appropriate statistical response? Include information on variation.

2. In the *Use of the Analytical Balance* activity you determined the volume of a drop of water by two different measurements methods. Three quantities were determined: mass of water; volume of water; and number of drops. Rank the three quantities in order of least to greatest error in their measurement and explain your ranking.

OBJECT

This activity explores the statistical variation in multiple measurements of volume and compares different volume measuring devices. The volume delivered by each device will be massed on the analytical balance.

PROCEDURE

All masses in this activity should be recorded to the nearest 0.1 mg.

1. Obtain and clean a buret, 10-mL pipet, and 25 mL graduated cylinder.
2. Label and pre-mass three plastic jars with lids. Be sure one jar is labeled with an "A", one with a "B", and one with a "C".
3. Measure exactly 10 mL of water into jar A from the buret. Be sure to use the buret correctly. Mass the jar with the lid on to avoid evaporative loss of water. Repeat this procedure four more times adding the water to the same jar and obtain the mass after each additional of water. Record the masses (to the nearest 0.1 mg) in the table below. Record the temperature of the water to the nearest 0.1°C

- Repeat step 3 with jar “B” dispensing the water from a pipet.
- Repeat step 3 using jar “C” and dispensing the water from the graduated cylinder.

DATA

$$T_{\text{water}} = \underline{\hspace{2cm}}$$

Trial	Volume of water (mL)	Mass (g) Jar A (buret)	Mass (g) Jar B (pipet)	Mass (g) Jar C (grad. cyl.)
---	0			
1	10			
2	20			
3	30			
4	40			
5	50			

RESULTS

- For each volume measuring device, calculate the mass of water for each 10 mL increment added in the five trials for each measuring device. Use the graphing calculator or spreadsheet program to compute the mean and standard deviation. Calculate the percent coefficient of variation (% CV). Record your values in the results table.
- Using the density of water at the temperature recorded (available in the CRC Handbook of Chemistry and Physics) or the specific volume of water from the activity “Use of the Analytical Balance”, calculate the mass of 10.00 mL of water. This will be the standard mass. Determine the percent error for each device using the formula below and record the results in the results table:

$$\% \text{error} = \frac{\text{mean mass for device} - \text{standard mass}}{\text{standard mass}} \times 100$$

Attach your calculations for standard mass and % error on separate sheets!

RESULTS TABLE

Trial	Mass of Water (g) Buret	Mass of Water (g) Pipet	Mass of Water (g) Graduated Cylinder
1			
2			
3			
4			
5			
Mean			
s			
% CV			
% Error			

CONCLUSIONS

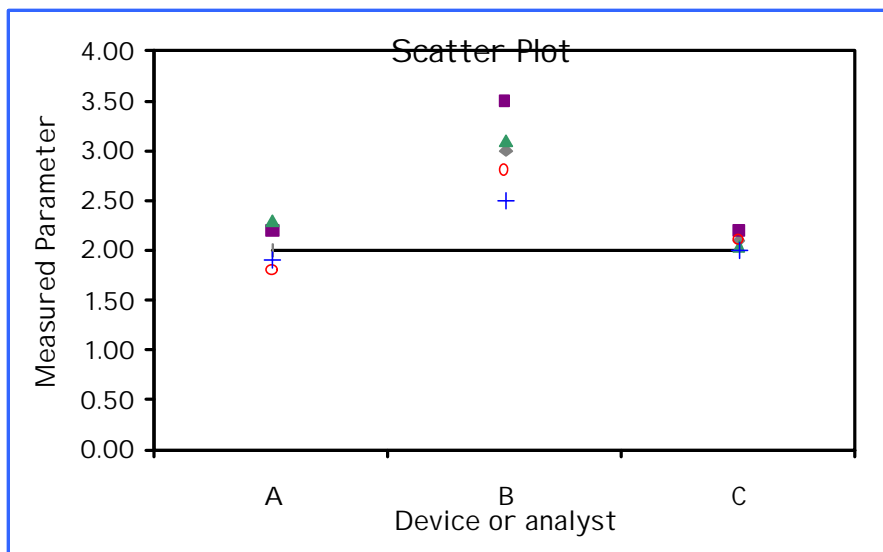
1. Are there significant differences in the means of the three volume measuring devices? Explain using your data.

What might account for these variations?

2. The percent coefficient of variation allows you to compare the amount of variability in the multiple measurements among several devices. This gives you an idea of the **precision** of each device since precision is the reproducibility of a measurement. Based on your data, rank the three volume measuring devices from most to least precise and justify your rank.

POST-LAB QUESTIONS

1. A scatter plot of the masses for each volume measuring device is a method of determining any bias in the devices and their accuracy and precision. **On graph paper,** generate a scatter plot using the standard mass as your reference value. Show the three volume measuring devices as outlined in the sketch below. For each device, plot (in a line parallel to the mass axis) the five trials and the average.



Does the interpretation of this plot agree with your earlier conclusions?

2. The buret and pipet are volumetric glassware designed “to deliver” (TD) a specified volume of liquid. The graduate cylinder is designed “to contain” (TC) a specified volume. Does this difference in design affect the results? Explain why or why not.

What type of volume measuring glassware is a volumetric flask? Explain.