Making Measurements Meaningful

RECORD THIS IN YOUR LAB NOTEBOOKS

Show all calculations. All work must be recorded neatly in ink (not pencil).

PART I: Limitations of Measuring Devices

Measuring Device	Recorded volume of water *(with correct precision)*	How many sig figs in recorded value?
100 mL graduated cylinder		
10 mL graduated cylinder		
50 mL buret		
250 mL beaker		
5 mL volumetric pipet		
25 mL volumetric pipet		

Discussion:

1. Compare your volumes to your classmate's values. Were there noticeable differences? Explain why this may have occurred.

2. Did groups report whole numbers, or did they report a value to the tenth or hundredths place? Why? *(Hint: Think in terms of certain vs. estimated digits.)*

3. For which measuring device(s) do you have the most confidence in your values? Explain.

PART II: Assigning Meaning to Values. *Always show calculations neatly, with proper sig figs and units!*

Value Measured	Uncalibrated Painter Stick	Calibrated Painter Stick
Blackboard Length (glumps)		
Blackboard Width (glumps)		

4. Calculate the area and perimeter of the Blackboard using the *uncalibrated* painter stick measurements.

5. Compare your calculated value to other group values. Were there noticeable differences? Explain why this may have occurred.

6. Did groups report whole numbers, or did they report a value to the tenth or hundredths place? What "digit" did everybody agree on? Why?

7. Calculate the area and perimeter of the Blackboard with the *calibrated* painter stick measurements.

8. Compare the uncalibrated and calibrated calculated values. Which value do you have the most confidence in? Explain why.

9. Compare your calculated value to other group values for the ***calibrated*** painter stick. Were there noticeable differences between measurement values? Explain why this may have occurred.

10. Did groups report whole numbers, or did they report a value to the tenth or hundredths place? What "digit" did everybody agree on? Why?

Part III: Practice Questions

Volume Measurements

11. Volume of acetonitrile in 100 mL graduated cylinder _____52.6 mL_____

Volume of dichloromethane in 10 mL graduated cylinder _____3.67 mL_____

Using the densities listed below, determine the mass of each liquid. Remember to show the appropriate level of precision for the values given here. (density = mass/volume)

a) acetonitrile (d = 0.89 g/mL) b) dichloromethane (d = 1.54 g/mL)

12. Which of the volume measurements above was the most precise? Why?

Calibrating glassware

Mass of grad cylinder empty ____75.342 g_____

Mass of grad cylinder with 10.00 mL water ____85.364 g_____

13. Based on the information above, calculate the mass of 10.00 mL water. Report the appropriate level of precision for the values given here.

14. If the density of water = 1.000 g/mL, determine *true* volume of water in a 10 mL grad cylinder filled precisely to the top-most marking. What does this tell you about the accuracy and precision of this measuring device? Should all glassware be calibrated for every measurement? If not, when should you do so?

Density of a bead

15. Mass of glass bead: ____**3.652 g**____
Initial volume of water in grad cylinder: _____**25.5 mL**_____
Final volume of water with bead in cylinder: ____**27.5 mL**_____
Based on the information above, calculate the volume and density of the glass bead. Report the appropriate level of precision.

Statistical Calculations

16. Determine the mean, standard deviation and %RSD for the following results determined for the mass of Barium chloride: 5.2 g, 5.0 g, 5.3 g, 5.3 g, 5.9 g. DO THESE CALCULATIONS BY

HAND - non-statistical calculations such as addition/subtraction/multiplication/division can be done with calculator but show all statistical equations and calculations.

17. Should any of the data points be discarded? Show calculations and explain how you determined this.

18. If the true value for the mass is 5.5 g, what is the percent error for your average mass?

Short Answer

19. Mines students named A, B, and C wants to report the number of **moles** for a sample of $FeCl_3$ to their Teaching Assistant. Student A used a crude, portable balance for determining the sample mass of $FeCl_3$, the balance determined the sample mass to the nearest +/- 0.1 g. Student B had a better balance that reported the mass to the nearest +/- 0.01 g. Lastly, student C used an analytical balance that determined $FeCl_3$ mass to the nearest +/- 0.0001 g. Using the information below, what will each student report as the **number of moles** of $FeCl_3$ based on the precision of the instrumentation that they are using? Explain your reasoning in a few sentences do not forget to show your work.

	Student A	**Student B**	**Student C**
Given Data	Mass of $FeCl_3$ = 19.0 g Fe atomic mass = 55.847 g/mol Cl atomic mass = 35.4527 g/mol	Mass of $FeCl_3$ = 18.99 g Fe atomic mass = 55.847 g/mol Cl atomic mass = 35.4527 g/mol	Mass of $FeCl_3$ = 18.9925 g Fe atomic mass = 55.847 g/mol Cl atomic mass = 35.4527 g/mol

Remember: [illegible] = [illegible] / [illegible]

20. A metal rod has a known length of 1.23 cm. To confirm this observation, you measure its length using three different measuring devices (A, B, and C). You obtain the following data:

Trial Number	Device A (cm)	Device B (cm)	Device C (cm)
1	1.43	1.24	1.19
2	1.43	1.23	1.23
3	1.43	1.25	1.22
4	1.42	1.22	1.26

Your goal is to determine which measuring device is both *accurate* and *precise* using the experimental data listed above. To do this, you must calculate the following:

a) the average (mean) of each device
b) the accuracy of each device (percent error)
c) the precision of each device (sample standard deviation)

You must show all your calculations. Don't forget to report the correct number of significant figures. Circle your final answers for each type of calculation. At the end, you must write a brief paragraph (4-5 sentences) explaining which device gives the best accuracy and precision for measuring the metal rod.

Note: When doing multiple calculations (e.g. standard deviation and percent error), you should minimize rounding errors (errors that come from rounding and then using those rounded numbers in subsequent calculations) by using extra significant figures. Only round to correct significant figures when reporting a final number.