Lab: Math and Measurement

FOR THE TEACHER

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Thanks to:
Dow Chemistry Teacher Summit

Summary
In this lab, students will practice introductory math skills that will be used in chemistry all year. This includes metric conversion, significant figures, scientific notation, dimensional analysis, density, percent error, accuracy and precision, as well as using lab equipment.

Grade Level
High School

Objectives
By the end of this lab, students should be able to

- Use lab equipment to measure volume, mass, and length to the correct number of significant figures.
- Convert units using dimensional analysis.
- Calculate percent error.
- Calculate density and be able to explain why the density of an object does not change.

Chemistry Topics
This lab supports students' understanding of

- Metric conversion
- Significant figures
- Scientific notation
- Dimensional analysis
- Density
- Percent error
- Accuracy and precision

Time
Teacher Preparation: 30 minutes (enough time to gather each stations materials)
Lesson: 45 minutes

Materials
- Five Stations
    - Part A
        - Long object (example: a rod from a ring stand)
        - Meter stick
        - Short object (example: a popsicle stick)
        - Ruler
        - 100 ml graduated cylinder with colored water (to a volume of your choosing)
        - 10 ml graduated cylinder with colored water (to a volume of your choosing)
    - Part B
        - Meter stick
    - Part C
        - Scale
        - 50 ml graduated cylinder
        - Marble

- Part D
  - Scale
  - Ruler
  - Two identical blocks (this can be any regular shaped object that you have two of)
- Part E
  - 50 ml graduated cylinder
  - Scale

Safety

- Always wear safety goggles when handling chemicals in the lab.
- Students should wash their hands thoroughly before leaving the lab.
- When students complete the lab, instruct them how to clean up their materials and dispose of any chemicals.

Teacher Notes

- I do this lab two days before my math and measurement unit exam as a review. We go over everything the next day before students turn it in and then the test is the following day.
- Assign the pre-lab as homework before the lab day.
- Before beginning, review how to properly take a measurement (estimating one past the line).
- This lab works well in small groups that rotate. The length of time spent at each station should be determined by your class period length divided into five (after you have allotted for pre-lab discussion time).
- To have a real-world aspect, you can have students read Crash of Flight of 143 from the October 1996 issue of ChemMatters magazine.

FOR THE STUDENT

Math and Measurement Lab

Instructions

As you work through the measurements in this lab, pay special attention to unit conversions. Measurements should be taken with precision and calculations must have correct significant figures. Show your work using dimensional analysis for all of the conversions in each part of the lab. Circle your final answers to each question.

Prelab Questions

1. What is the formula needed to calculate area of a room?

2. What is the formula needed to calculate volume of a room?

3. What is the formula for calculating density?

4. What is the formula for calculating percent error?

5. Convert 2.00 m^2 to ft^2. (remember to show all work using dimensional analysis)

6. When you are making measurements, how should you estimate the last significant digit?

Conversions to use:			
1 inch = 2.54 cm	1 foot = 12 inches	1 mi = 1.61 km	5,280 ft = 1 mi
*lookup nano and giga			

Objective
Chemistry is a mathematically based science. In this lab you will practice several mathematical processes that will be used during various units throughout the year.

Safety
- Always wear safety goggles when handling chemicals in the lab.
- Wash your hands thoroughly before leaving the lab.
- Follow your teacher's instructions for clean up of materials.

Procedure
<u>Part A: Significant Figures in Measurement</u>
1. Determine the length of the short object in cm using the ruler and record your measurement in the data table.
2. Determine the length of the long object in cm using the meter stick and record your measurement in the data table.
3. Determine the volume of liquid in the 10 ml graduated cylinder and record your measurement in the data table.
4. Determine the volume of liquid in the 100 ml graduated cylinder and record your measurement in the data table.

Question	Measurement	Question	Measurement
#1		#3	
#2		#4	

Post-station Question:
1. Choose one of your measurements and explain how your answer is estimated correctly.

Part B: Measurements and Conversions

1. Using a meter stick, determine the length, width, and depth of your classroom. Record the values below and then convert to other units using dimensional analysis.
2. Calculate the area of a horizontal cross section of the room. Record the value below and then convert to other units using dimensional analysis.
3. Calculate the volume of the room. Record the value below and then convert to other units using dimensional analysis.
   (1 inch = 2.54 cm, 1 foot = 12 inches)

Width (m)	Width (in)	Width (ft)	Width (nm, use sci. notation)

Length (m)	Length (in)	Length (mi)	Length (Gm, use sci. notation)

Depth (m)	Depth (ft)

Area of cross section (m^2)	Area of cross section (cm^2)

Volume (m^3)	Volume (cm^3)	Volume (ml)

Part C: Density of Irregular Shaped Solids

1. Use the balance to find the mass of the object. Include the correct units.
2. Fill a 50.0 ml graduated cylinder about halfway with water. Precisely record the volume as "starting volume".
3. Carefully place the object in the graduated cylinder and record the new volume as "ending volume".
4. Subtract the starting volume from the ending volume. This is the volume of the object.
5. Determine the density of the object.

	Mass	Starting Volume	Ending Volume	Volume	Density
Object					

Post-station Questions

1. What is a meniscus?

2. Name the method used to find the volume of an irregular shaped object.

Part D: Can the density of an object change?

1. Use the balance to find the mass of the block.
2. Use a ruler to find the length, width and height of the block.
3. Calculate the volume.
4. Divide mass by the volume to find the density. Round to the nearest hundredth.

	Mass	Length	Width	Height	Volume	Density
One Block						
Two Blocks						

Post-station Questions:

1. What do you observe about the density of one block compared to two blocks?

2. Write a general statement about what this station is trying to teach you about density.

3. Determine your percent error if the accepted value of the density for the block is 8.96 g/cm^3.

4. What are some things that may have caused your calculated density to not be 8.96 g/cm^3?

Part E: The Density of Water

Mass an empty 50.0 mL graduated cylinder. Measure 35.0 mL of water in the graduated cylinder and reweigh the cylinder and the water together.

Mass of the empty graduated cylinder (g)	
Mass of graduated cylinder with water (g)	
Mass of water (g)	
Volume of water (ml)	

Post-station Questions:

1. Use the data to calculate the experimental density of the water.

2. What is your percent error? (hint: What is the accepted density of water?)

Analysis

1. Which is more dense: water or aluminum? How might you verify this visually?

2. Suppose you poured water, gasoline, and milk in a beaker. In what order would you find the three liquids starting from the top of the beaker? (density of milk = 1.050 g/mL, density of gasoline = 0.737 g/mL)

3. How are significant figures and precision related?

4. The electronic balances and triple beam balances used in class both have smallest labeled increments of 0.1 g. Which of these two balances allows for a more precise answer and why?

5. How do instruments affect the level of precision in measurement? How can you get more precise measurements?

6. Do you think quantities are more accurate when they are measured or when they are calculated? Explain your answer.