Physics
Physics and Measurement

In this laboratory exercise, you will gain experience making measurements as a physicist does. All measurements will be made using units to the precision allowed by your instrument.

Objectives
Measure accurately using typical laboratory equipment.
Measure length and mass in SI units.
Determine the appropriate number of significant figures for various measurements and calculations.
Examine the relationships between measured physical quantities by using graphs and data analysis.

Safety
Perform this lab in a clear area. Falling or dropped masses can cause serious injury.

Materials List
2 rectangular wooden blocks
Metric ruler
Triple Beam Balance
Meter Stick
Rectangular wooden block
Stopwatch

Procedure
1. Read the entire lab procedure, and plan the steps you will take.

Measuring Length, Width, Thickness, and Mass
2. **Each group member** will do the following individually on the same wooden block…
   - Use a metric ruler to measure the length of the wooden block. Record all measured digits plus one estimated digit.
   - Follow the same procedure to measure the width and thickness of the block. Record your data in Data Table 1.
   - Carefully adjust the triple beam balance to obtain an average zero reading when there is no mass on it. Adjust the balance to obtain an average zero reading if needed. Use the balance to find the mass of the block. Record the measurement in Data Table 1.
3. Share your values with others in the group and receive data from the others as well. Record the values in Data Table 1.
4. For trials 4-6, repeat step 2 and with the second wooden block.

Measuring Time and Distance

5. One partner will drop the wooden block from a measured height, and the other person will measure the time it takes the block to fall to the floor. Perform this in a clear area away from other groups.
6. One student should hold the wooden block straight out in front of him/her at shoulder height. Hold the block between your hands. Use the meter stick to measure the height to which the wooden block is raised. Record this distance in Data Table 2.
7. Use the stopwatch to time the fall of the block. Make sure the area is clear, and inform nearby groups that you are about to begin. The student holding the block should release it by pulling both hands straight out to the sides. The student with the stopwatch should begin timing the instant the block is released and stop timing as soon as the block hits the floor. In your data table, record the time required for the block to fall.
8. Repeat for two more trials, recording all data in your data table. Try to drop the block from exactly the same height each time.
9. Switch roles, and repeat steps 5 through 8. Perform three trials. Record all data in your data table.

Data Table 1

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
Length (cm)						
Width (cm)						
Thickness (cm)						
Mass (kg)						

Data Table 2

Trial	Distance (m)	Time (s)
1		
2		
3		
4		
5		
6		

Analysis

1. Organizing Data – Use your data from the first data table, calculate the volume of the wooden block for each trial. The equation for the volume of a rectangular block is volume = length x width x thickness.

2. Analyzing Data – Use the data from the first table and your results from item 1 above to answer the following questions.
   (a) For each block, what is the difference between the smallest length measurement and the largest length measurement?

(b) For each block, what is the difference between the smallest calculated volume and the largest calculated volume?

(c) Based on your answers to (a) and (b), how does multiplying several length measurements together to find the volume affect the precision of the results?

3. Analyzing Data – Did the block always fall from the same height in the same amount of time? Explain how you found the answer to this question?

4. Constructing Graphs – Using the data from all trials in the class, make a scatter plot of the distance versus the time of the block's fall.

Conclusions

5. Drawing Conclusions – For each trial in the first data table, find the ratio between mass and the volume. Based on your data, what is the relationship between mass and volume?

6. Evaluating Methods – For each type of measurement you made, explain how error could have affected your results. Consider method error and instrument error. How could you find out whether error had a significant effect on your results for each part of the lab? Explain the role of human reaction time in your measurements.

Extension

7. Evaluating Data – Have one student drop the wooden block from shoulder height while all other class members time the fall. Perform three trials. Compare results each time. What does this exercise suggest about accuracy and precision in the laboratory?