

Precision and Measurement

Roll Out the π

Purpose

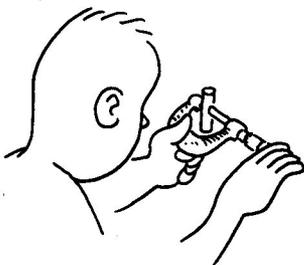
To learn the proper use of a meterstick, vernier caliper, and micrometer.

Required Equipment and Supplies

meterstick
 vernier caliper
 micrometer
 several 4"–6" length dowels or metal cylinders of various diameters
 rectangular laboratory table or equivalent

Discussion

When making measurements, it's important to keep *both* the precision and the significant figures in mind. The number of significant figures in an actual measurement depends on the instrument and its precision. For example, a micrometer is capable of greater precision than a vernier caliper. However, when a micrometer is used to measure the thickness of a single piece of paper it has fewer significant figures (e.g., one) than a vernier caliper measuring the thickness of 1000 pages (i.e., three).



Procedure

Step 1. Use a meterstick to measure the length, width, and thickness of your lab table. Record the data along with the precision of each measurement in Data Table 1.1. Make each measurement five times at each different location on the lab table.

Data Table 1.1

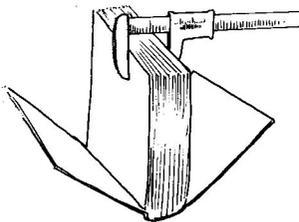
MEASUREMENT	LENGTH	WIDTH	THICKNESS	PRECISION
1				
2				
3				
4				
5				
AVERAGE				

Data Table 1.2

	THICKNESS (USING METERSTICK)	THICKNESS (USING VERNIER CALIPER)
1		
2		
3		

Step 2. Find the average of the length, width, and thickness of the lab table. Use these average values for each dimension of the lab table to compute the volume of the top. Be sure to indicate the proper number of significant figures in your calculation and to attach the appropriate units to your answer. Show your calculations.

volume of the top = _____



Step 3. Determine the thickness of a single page in your text book two ways. Do this by measuring the thickness of the book (excluding the cover) and dividing by the number of pieces of paper. First make your measurements with a meterstick and then repeat using a vernier caliper. Make each measurement three times and obtain an average value. Record all measurements with the proper number of significant figures in Data Table 1.2.

number of pages = _____

thickness of single page using meterstick = _____

thickness of single page using vernier caliper = _____

Step 4. Now measure the thickness of a single page using a micrometer. Make note of its precision.

precision = _____

thickness of single page using micrometer = _____

1. Which instrument results in the greater number of significant figures?
2. How do the three values for the thickness per page compare?

Step 5. Calculate π by rolling a cylinder on a piece of paper beginning and ending at the same point on the circumference. Roll the cylinder as many times as possible without exceeding the maximum distance the vernier caliper can measure. Make your measurement three times and compute the average value of the circumference. Record your data in Data Table 1.3.

Step 6. Measure the diameter of the cylinder using a micrometer. Make your measurement three times and compute the average value for the diameter. Record your data in Data Table 1.4.

Use the average value of the circumference and the average value of the diameter to calculate π . Show your calculations. Be sure to include the proper number of significant figures and appropriate units. Show your calculations.

$$\pi = \underline{\hspace{2cm}}$$

Step 7. Repeat using cylinders of different diameters.

Analysis

3. Mathematical methods estimate π to be 3.14159. How does your experimental value compare? Compute the percentage error by using 3.14159 as the accepted value.

$$\text{percentage error} = \frac{|\text{measured value} - \text{accepted value}|}{\text{accepted value}} \times 100\%$$

Data Table 1.3

DISTANCE ROLLED	
1	
2	
3	
AVERAGE	

Data Table 1.4

DIAMETER	
1	
2	
3	
AVERAGE	