105 Roll Out the π

Purpose

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

Required Equipment/Supplies

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

Discussion

When making measurements, it's important to keep both the *precision* (the smallest unit that is measurable) 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 (i.e., one) than a vernier caliper measuring the thickness of 1000 pages (i.e., three).

Procedure

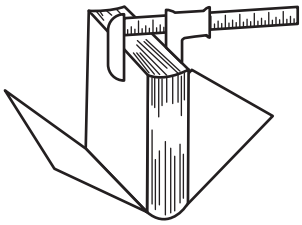
Step 1: Use a meterstick to measure the length, width, and thickness of your lab table. Record the data along with the precision of each measurement. Make each measurement five times each time at a different location on the lab table.

Data Table A: The Dimensions of a Lab Table

Measurement	Length (cm)	Width (cm)	Thickness (cm)	Precision
1				
2				
3				
4				
5				
Average				

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.

V = volume of the top = _____



Step 3: Determine the thickness of a single page in your textbook 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 of the book 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.

number of pieces of paper = _____

Data Table B: Determining the Thickness of a Textbook Page using Two Different Instruments

Trial	Thickness (mm) (Using Meterstick)	Thickness (mm) (Using Vernier Caliper)
1		
2		
3		
Average		

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.

thickness = _____ precision _____

1. Which instrument results in the greater number of significant figures?

_____

_____

_____

2. How do the two values for the thickness per page compare?

_____

_____

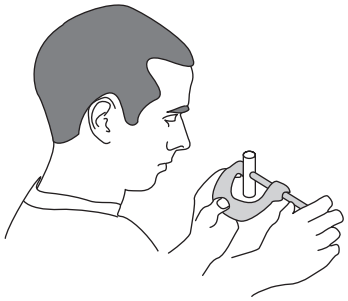
Step 5: Calculate π by rolling a cylinder on a piece of paper beginning and ending at the same point on the circumference. Roll the cylinder as many times as possible without exceeding the maximum distance the vernier caliper can measure. Make your measurement three times and compute the average value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

Data Table C: Circumference of a Cylinder Using a Vernier Caliper

Trial	Distance Rolled (cm)
1	
2	
3	
Average	

Measure the diameter of the cylinder using a micrometer. Make your measurement three times and compute the average value for the diameter.

Data Table D: Diameter of a Cylinder Using a Micrometer



Trial	Diameter (cm)
1	
2	
3	
Average	

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.

$\pi =$ _____

Repeat using cylinders of different diameters.

Analysis

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.

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