Data Sheets

Experiment 2 Measurement of Length

Data Sheet and Calculations (Do not duplicate)

Instructor's Initials ______

Date ____________

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Partner's name Edgar

I. Meter Stick

(a). Height of rectangle (cm).

Trial	Meter Stick Reading Top*	Bottom*
1	20.4	0
2	50.4	30
3	65	44.8
4	90.3	70

*Estimate nearest 1/10th mm

(b). Height of rectangle (in).

Trial	Meter Stick Reading Top*	Bottom*
1	8	0
2	17.8	10
3	27.8	20
4	37.8	30

*Inches + 1/8" + estimate 1/10 of 1/8"

(c). Width of rectangle (cm)

Trial	Meter Stick Reading Left*	Right*
1	15.2	0
2	34.8	20
3	54.8	40
4	74.8	60

*Estimate nearest 1/10th mm

II. Vernier Caliper

Identification of cylinder A2

(a). Diameter of cylinder

D1 = 1.6 D2 = 1.61 *D3* = ______

(b). Length of cylinder

L1 = 6.51 *L2* = 6.51 *L3* = 6.51

Zero of the caliper ____________

III. Micrometer

(b). Zero of micrometer

Trial	Zero
1	-0.06
2	-0.065
3	-0.045

(c). Block Identification H2

	Largest	**Intermediate**	**Narrowest**
1	22.13	19.655	12.49
2	22.14	19.61	12.55
3	22.185	19.605	12.545
4	22.175	19.595	12.535

Calculations

1. Height of rectangle (cm).

$\bar{h}$ = ________ σh = ________

1. Width of rectangle (cm).

$\bar{w}$ = ________ σw = ________

2. Convert fractions into decimals.

Trial	Position Top*	Bottom*
1		
2		
3		
4		

Height of rectangle (in).

$\bar{H}$ = ________ σH = ________

3. λ = ____________

4. A = ____________

5. Cylinder I. D. ____________

$\bar{L}$ = ________ σL = ________

$\bar{D}$ = ________ σD = ________

6. V = ____________

7. Block I. D. ______________

	Largest l	Intermediate h	Narrowest w
1			
2			
3			
4			

$\bar{l}$ = ________ σl = ________

$\bar{h}$ = ________ σh = ________

$\bar{w}$ = ________ σw = ________

8. V = ____________

Error analysis

1. $\sigma\lambda$ = ____________

2. Error in λ = ________________
Relative error = ________________

3. σA = ____________

4. σV = ____________

5. Min. uncertainty = ____________

6. Volume uncertainty = __________
Relative uncertainty = __________

Questions:

Please answer the questions on a separate piece of paper and attach.

Procedure

Record the identification of the block to be measured. The micrometer caliper is a delicate instrument and is easily damaged by improper handling. Locate the ratchet at the end of the cylinder. The rod should be closed upon the object carefully with the ratchet until it clicks. **Do not tighten the set lever. Never support an object within the jaws of the micrometer**.

(a) Clean the jaws of the caliper by closing them lightly upon a sheet of clean paper and then withdrawing it. The movable jaw may be brought almost in contact with the sample by turning the cylinder, but the actual contact should be made by turning the ratchet slowly until it clicks several times. Using the ratchet provides more reproducible settings and protects the instrument from undue force.

(b) Record the zero reading of the micrometer. Be sure to determine this reading with great care, for an error in it is just as significant as an error in the reading on the object. Take three readings.

(c) Measure the sides of the rectangular block with the micrometer calipers. Take four readings* of each side. Record the identification of the block.

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* Throughout this manual, whenever multiple measurements are called for, each partner ought to make about one-half of them.

Calculations

1. Calculate values of the height of the rectangle on p. 20 in centimeters by subtracting the readings at the top and the bottom of the rectangle. Compute the mean and standard deviation of the height. Call these quantities $\overline{h}$ and σ_h. Similarly, find the mean value and standard deviation of the width, $\overline{w}$ and σ_w.

2. Convert the readings in inches from the raw data to decimal form. For example, 3-3/8" plus 0.4 x 1/8 " is equal to 3.425". Calculate values of the height of the rectangle on p. 20 in inches by subtracting the readings at the top and bottom of the rectangle. Compute the mean and standard deviation of the height. Call the respective quantities

$\overline{H}$ and σH.

3. Find $\lambda = \overline{h}/\overline{H}$ the experimentally determined length of an inch in centimeters.

4. Calculate the area, A, of the rectangle on p. 20 in cm^2.

5. Copy the cylinder *ID* in the space provided. Compute the mean length $\overline{L}$ and mean diameter $\overline{D}$ of the cylinder and their standard deviations.

6. Compute the volume of the cylinder.

7. Copy the block *ID* in the space provided. Convert the micrometer readings into dimensions of the block by subtracting the average zero from the raw data. Denote the dimensions as follows: Largest dimension, l;

intermediate dimension, h; and narrowest dimension, w. Compute the mean values and standard deviations of the block's dimensions.

8. Compute the volume of the block.

Error analysis

1. Apply your results in the pre-lab exercise to compute the uncertainty in λ due to the uncertainties in $\overline{h}$ and $\overline{H}$.

2. According to convention λ = 2.54 cm/in exactly. Calculate the error in your value of λ and the relative error.

3. Guided by example 1-6, p. 10 compute the uncertainty in the area of the rectangle on p. 26.

4. Guided by example 1-7, p. 11, compute the uncertainty in the volume of the cylinder.

5. There is a minimum uncertainty with which the volume of the cylinder could be deduced from measurements with a Vernier caliper due to the limited precision of the caliper. Calculate this minimum uncertainty in the volume by repeating the previous step (step 4, Error analysis) using the precision of the caliper as σL and σD instead of your standard deviations.

6. Guided by exercise 1-12, p. 11, compute the uncertainty in the volume of the block. What is the relative uncertainty?

Questions

1. The measurements of the diameter and the length of the cylinder are made with the same precision. Which dimension will have the larger relative uncertainty? Why?

2. The value of π to six significant figures is 3.14159. What value of π need you use in your volume of the cylinder calculations? Hint: Decide this by finding the number of significant figures in your measurements.

3. Suppose you measured the diameter of a rod to be exactly one centimeter with a Vernier caliper; i. e., the only mark on the vernier that lined up with a mark on the fixed scale was the final *0*. How would you record that datum? Suppose you measured it only once: What would you record as the uncertainty and why? (See p. 8, *Estimated uncertainty*)

4. Write down the uncertainty in the volume of the cylinder that you calculated in part 4 of the Error analysis. Also write down the minimum uncertainty with which the volume of the cylinder can be determined. Compare these two values and discuss briefly.