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EXPERIMENT No. : 1B

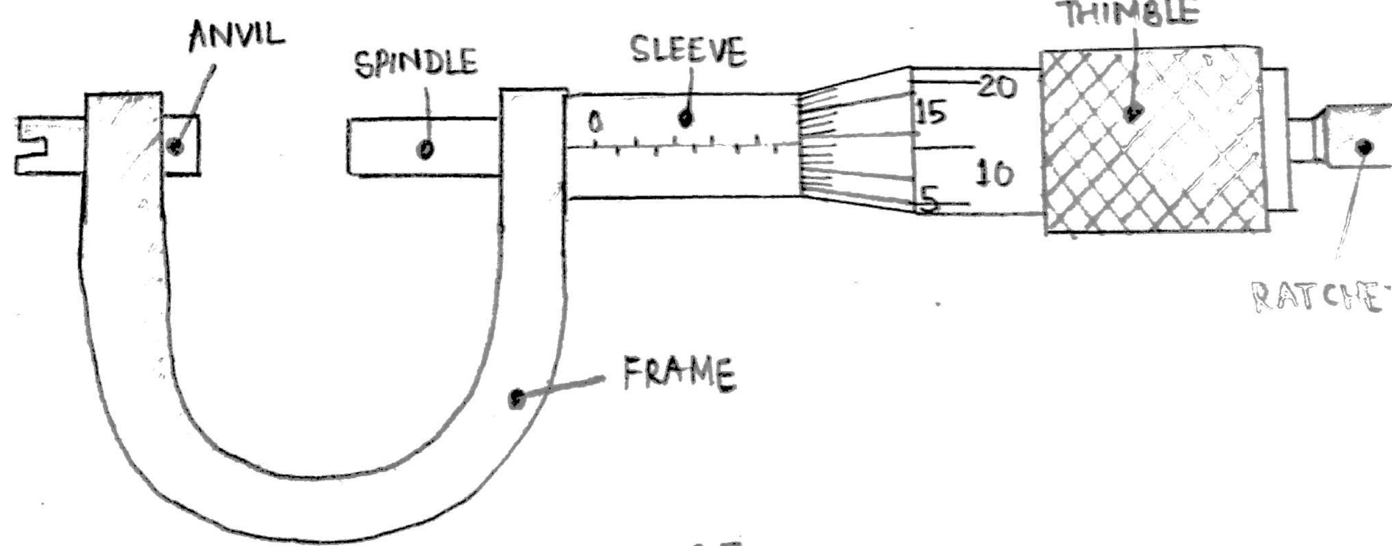
SHEET NO. B 1

MICROMETER CALIBRATION

- **Aim:**
  - To study various types of micrometers.
  - To calibrate the given micrometers, using slip gauge as standard.
  - To study use of combination set.

- **Apparatus:**
  - Set of Micrometers
  - Set of slip gauges
  - combination set.

- **Theory:** A micrometer is a device used widely in mechanical engineering and machining for precision measurement, along with other metrological instruments such as dial calipers and vernier calipers. Micrometer screw-gauge is used for measuring accurately the diameter of a thin wire or the thickness of a sheet of metal. It consists of a U-shaped frame, fitted with a screwed spindle which is attached to a thimble, a shown in the figure below.

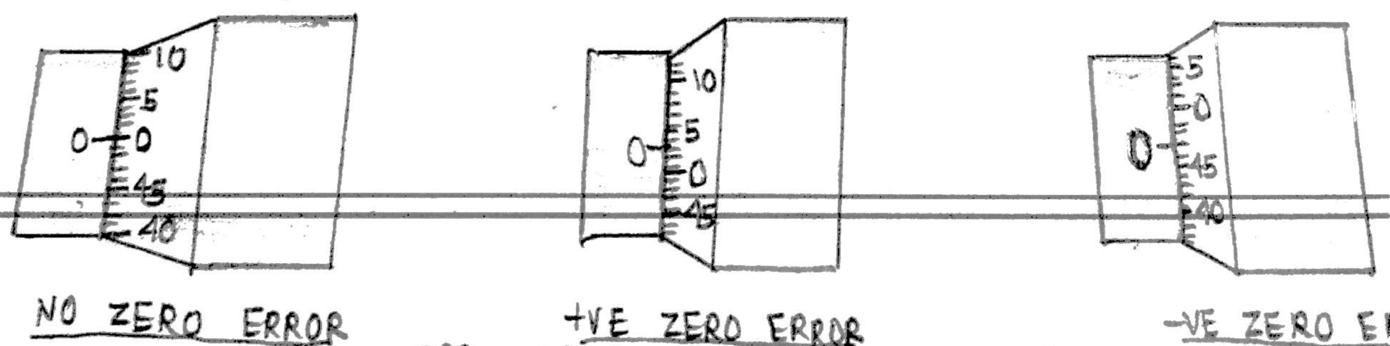


SCREW GAUGE

Micrometers use the principle of a screw to amplify small distances that are too small to measure directly into large rotations of the screw that are big enough to read from a scale. The accuracy of a micrometer derives from the accuracy of the threadform that is at its heart. The basic operating principles of a micrometer are as follows:

· The amount of rotation of an accurately made screw can be directly and precisely correlated to a certain amount of axial movement (and vice versa), through the constant known as the screw's pitch (for single start screw thread). A screw's pitch is the distance it moves forward or backward axially with one complete turn. The screw has a known pitch such as 0.5mm. Hence in this case, for one revolution of the screw the spindle moves axially by 0.5mm. This movement of the spindle is shown on an engraved linear millimeter scale on the sleeve. On the thimble there is a circular scale which is divided into 50 or 100 equal parts.

When the anvil and spindle end are brought in contact, the edge of the circular scale should be at the zero of the sleeve (linear scale) and the zero of the circular scale should be opposite to the datum line of the sleeve. If the zero is not coinciding with the datum line, there will be a positive or negative zero error as shown in the next figure.



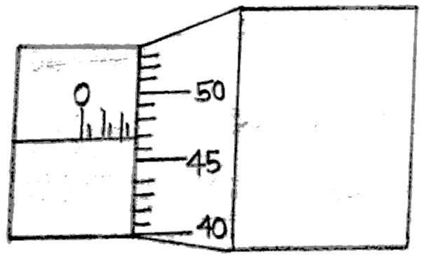
ZERO ERROR IN CASE OF SCREW GAUGE

The least count of the micrometer screw can be calculated using the formula given below:

$$\text{Least Count} = \text{Pitch}/\text{Number of divisions on the circular scale}$$

$$= \frac{0.5\,mm}{50} = 0.01\,mm.$$

- As an example, to determine the diameter of a wire, the wire is to be placed between the anvil and the spindle end, and the thimble is rotated till the wire is firmly held between the anvil and the spindle. The ratchet is provided to avoid excessive pressure on the wire. It prevents the spindle from further movement. The diameter of the wire could be determined from the reading as shown in figure below.

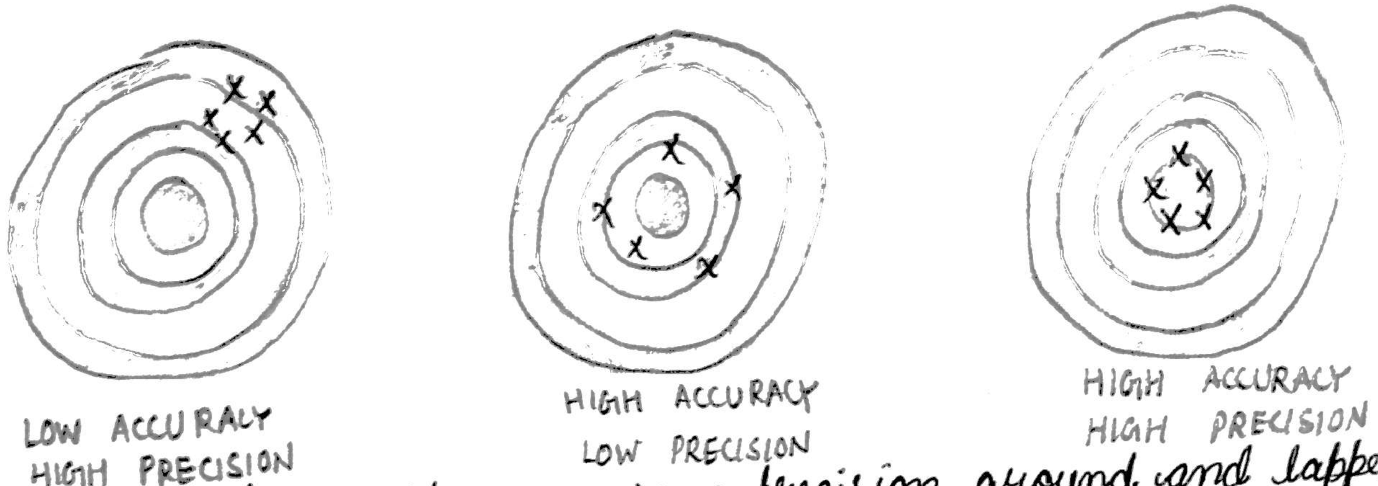


➤ Reading = linear scale reading + (coinciding circular scale × LC)

$$= (2.5 + 46 \times 0.01)\,mm$$

$$= 2.96\,mm.$$

Accuracy of the measured reading is the degree of veracity while precision is the degree of reproducibility. The analogy may be used to explain the difference between accuracy and precision is the target comparison. In this analogy, repeated measurements are compared to arrows that are shot at a target. Accuracy describes the closeness of arrows to the bullseye at the target center. Arrows that strike closer to the bullseye are considered more accurate. The closer a system's measurements to the accepted value, the more accurate the system is considered to be.



Gauge block or slip gauge is a precision ground and lapped length measuring standard. It is used as a reference for the setting of measuring equipment used in machine shops, such as micrometers, sine bars, and dial indicators (when used in calibration or inspection role).

These gauges consists of a set of steel blocks, such as each of which has one pair of opposite faces lapped flat and parallel accurately to a few millionth of an inch. They are used to check the accuracy of workshop and similar gauges, which in use are subjected to wearing action; slip gauges should never be used as ordinary measuring gauges, but as reference or master standards. They are generally employed in connection with comparator instruments when workshop gauges have to be checked.

The slip gauges are supplied in steps, the number in each set varying according to the purpose in view. The most widely employed set consists of 81 gauges of differing thickness.

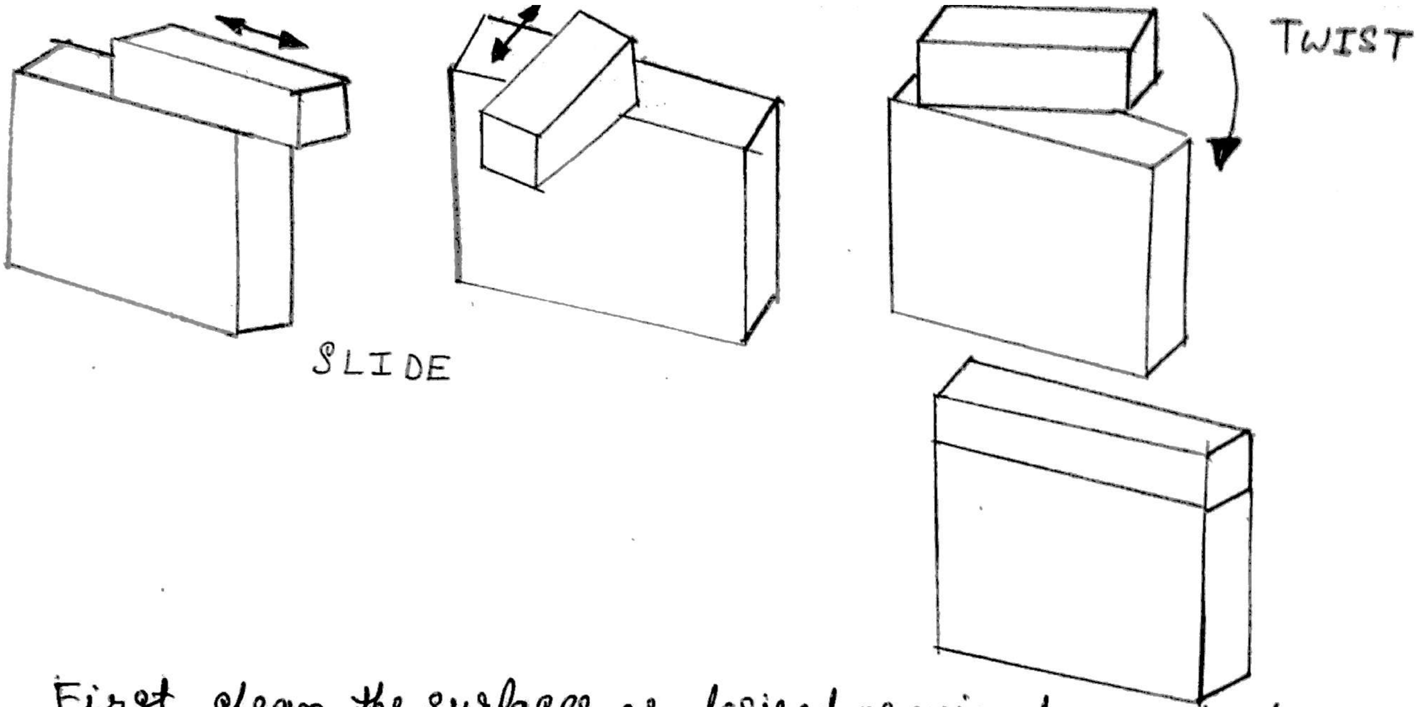
Before using these gauges, they should be wiped with a piece of soft linen cloth. The surface should be wiped over with a soft linen cloth moistened with benzole or petrol in order to remove any grease or in case of protective coating of new gauges. The removal of grease is important as it picks up dirt easily. However in dustless atmosphere, a trace of grease on the surface assists in obtaining a satisfactory wringing action.

Fingering of slip gauges tend to promote tarnishing & thermal expansion effects and should be avoided as much.

It is important to keep room temperature thermostatically controlled at 20°C for fine precision measurements for prolonged periods.

Wringing is the process of sliding two blocks together so that their faces lightly bond. When combined with a very light film of oil, this action excludes any air from the gap between the two blocks. The alignment of the ultra-smooth surfaces in this manner permits molecular attraction to occur between the blocks, and forms a very strong bond between the blocks along with no discernible attention to the stack's overall dimension.

The recommended procedure for a wringing a pair of slip gauges together is as follows & shown in the figure next page.



First clean the surfaces as desired previously, and then place one gauge centrally across the other gauge at right angles to form a symmetrical cross. Finally rotate the upper gauge over the lower one to its final co-incident position. This method results in appreciably less rubbing action than the upper gauge is slid lengthwise over the lower one.

PROCEDURE:

For calibration of micrometers.

1. Check the range of measurement of micrometer.
2. Note down zero error of the micrometer, if any.
3. Select a number of slip gauge combinations.
4. Measure each slip gauge combination with the micrometer and note down micrometer reading (M) & slip gauge combination length (G) in a tabular form.

5. Plot a calibration chart for the micrometer taking M on the X-axis and (M−G) on the Y axis.
6. Repeat the steps 1–5 for other micrometers.

PRECAUTIONS :

1. While making slip gauge combination, do the wringing correctly, so that no foreign particles are entrapped.
2. While taking micrometer reading, care should be taken to clamp the spindle in position, before taking it away from the block, as due to friction the spindle will rotate and give a wrong reading.
3. Turn the spindle always in the clockwise direction to avoid backlash error.

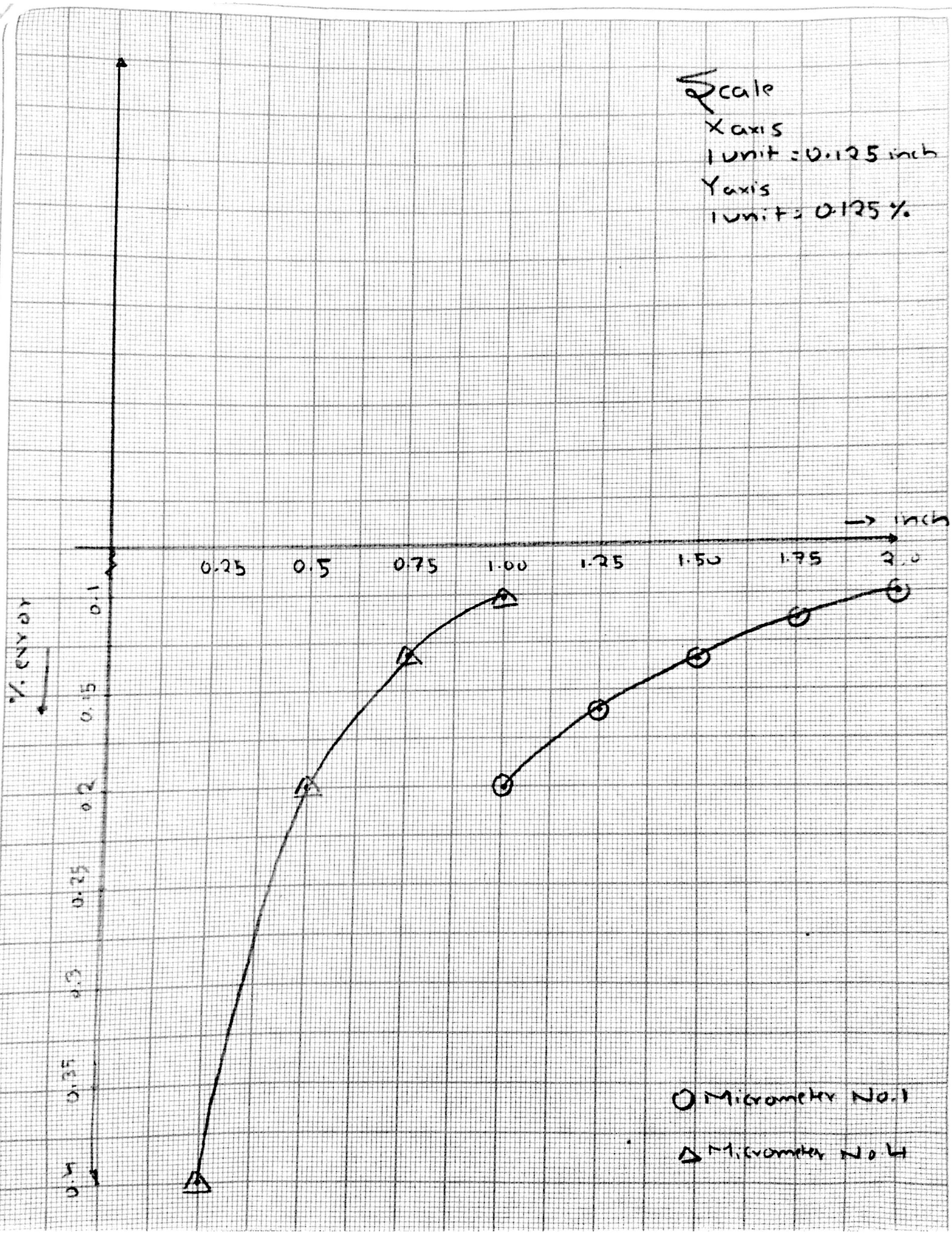
Observation Table:-

Micrometer Details	Sl. No. of reading	Slip Gauge reading (G)	Micrometer Reading (M)	Error M-G	% Error
Range:→ 1-2 inch					
No: - 1	1	25.40	25.3492	-0.0508	-0.20%
Make:- GOODELL PRATT CO.	2	31.75	31.6992	-0.0508	-0.16%
zero error -0.002 inch	3	38.10	38.0492	-0.0508	-0.133%
	4	44.45	44.3992	-0.0508	-0.114%
	5	50.80	50.7492	-0.0508	-0.10%

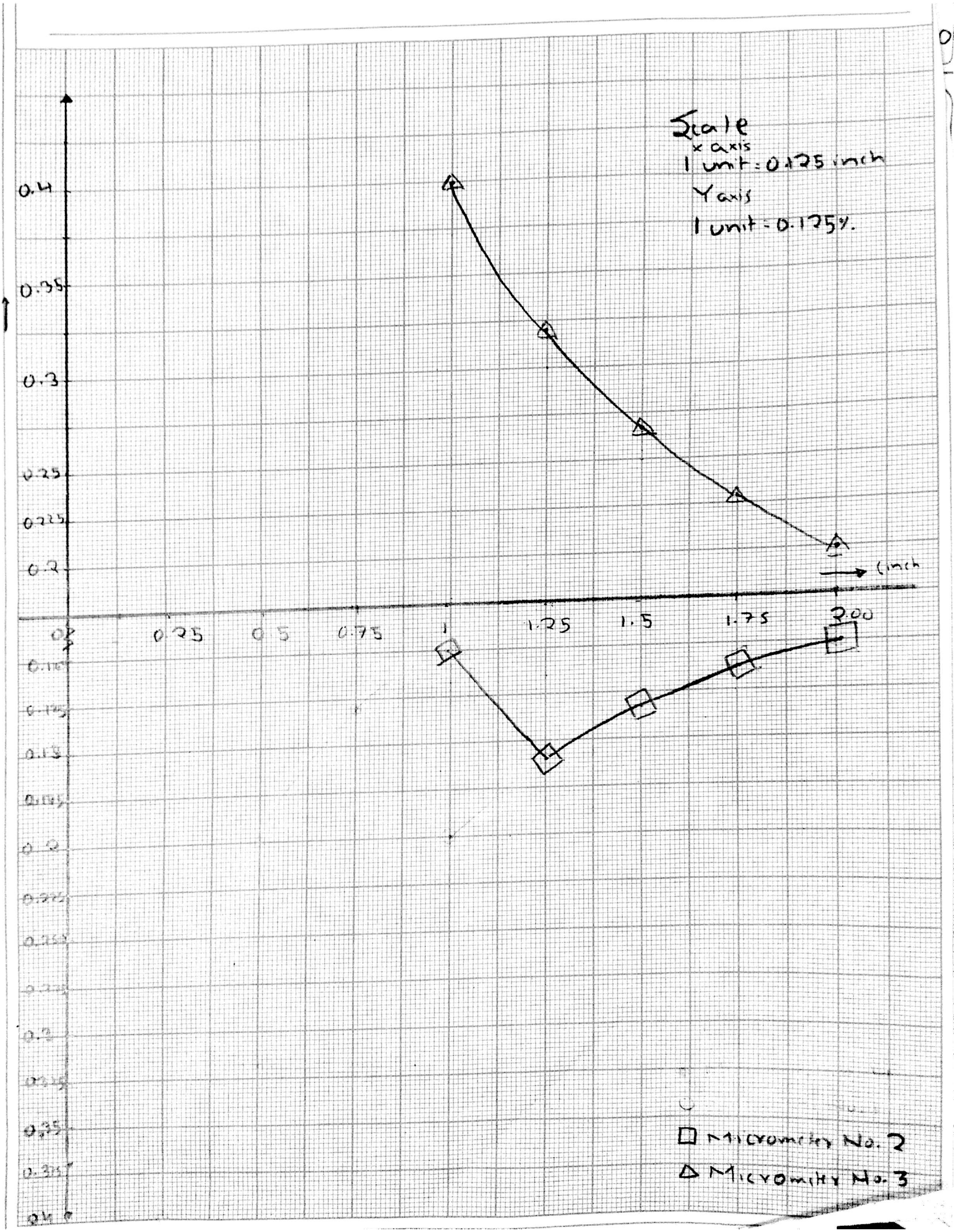
Micrometer Details	Sl. No. of reading	Slip Gauge reading (G)	Micrometer Reading (M)	Error M-G	% Error
Range:→ 1-2 inch	1	25.40	25.3746	-0.0204	-0.10%
No:- 2	2	31.75	31.6992	-0.0508	-0.16%
Make:- GOODELL PRATT. CO.	3	38.10	38.0492	-0.0508	-0.13%
Zero error	4	44.45	44.3992	-0.0508	-0.114%
-0.001 inch	5	50.80	50.7492	-0.0508	-0.10%

Micrometer Details	Sl. No. of reading	Slip Gauge reading (G)	Micrometer Reading (M)	Error M−G	% Error
Range :→ 1-2 inch No:- 3 Make :- GOODELL PRATT CO. Zero Error : 0.004	1	25.40	25.5016	0.1016	0.4 %
	2	31.75	31.8516	0.1016	0.32 %
	3	38.10	38.2016	0.1016	0.266 %
	4	44.45	44.5516	0.1016	0.228 %
	5	50.80	50.9016	0.1016	0.2 %

Micrometer Details	Sl. No. of reading	Slip Gauge reading (G)	Micrometer reading (M)	Error M−G	% Error
Range :- 0-1 inch NO. 4 : Make :- MILLERS FALLS CO. Zero error. −0.001 in	1	0.00	−0.0254	−0.0254	
	2	6.35	6.3246	−0.0254	0.4 %
	3	12.70	12.6746	−0.0254	0.2 %
	4	19.05	19.0246	−0.0254	0.13 %
	5	25.40	25.3746	−0.0254	0.1 %



Scale
X axis
1 unit = 0.125 inch
Y axis
1 unit = 0.125 %
→ inch
0.25
0.5
0.75
1.00
1.25
1.50
1.75
2.0
% error
0.1
0.15
0.2
0.25
0.3
0.35
○ Micrometer No.1
△ Micrometer No.4



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● QUESTIONS:

Q1 Discuss the functions and principles of ratchet drive in case of a micrometer.

Ans The ratchet ensures smooth rotation of the circular-scale and makes a clicking sound when the spindle accurately touches the specimen.

Q2 Why does zero error occur in a micrometer?

Ans Zero error occurs when the zero of the circular scale does not coincide with the zero of the main-scale when the anvil and spindle come in contact.

Q3 Differentiate among terms accuracy, precision, sensitivity and readability.

Ans Accuracy is the closeness of the measured readings with the actual reading

→ while, precision is the closeness among the measured readings

→ Sensitivity of an instrument is the reciprocal of the least count.

→ Readability: is the ease with which readings can be taken (measured) from the scale, proportional to the spacing between least counts of the scale.

Q4. When is an instrument required to be calibrated?

Ans: That is when the instrument converts one quantity to another

Eg: Transducer converting length of displacement into current, or reverse.

5. What is the used of a calibration chart?

Ans:- The use of a calibration chart is to find a relation between two quantities, which don't have any direct dependence.

6. What do you mean by Protector Slip Gauge?

Ans:- There are the particular set of slip gauge with an extra layer of hard material such as wc. to protect wear & tear of the other Slip Gauges.

7. What is wringing? How does it done?

Ans Wringing is the process of sliding two blocks together so that their faces lightly bond, done by excluding any air gap between them, combining with a very thin light film of oil.

8. Sketch the type of anvil required for measuring the thickness of a paper, chip thickness:

Ans :- A flat- face anvil is needed for this purpose