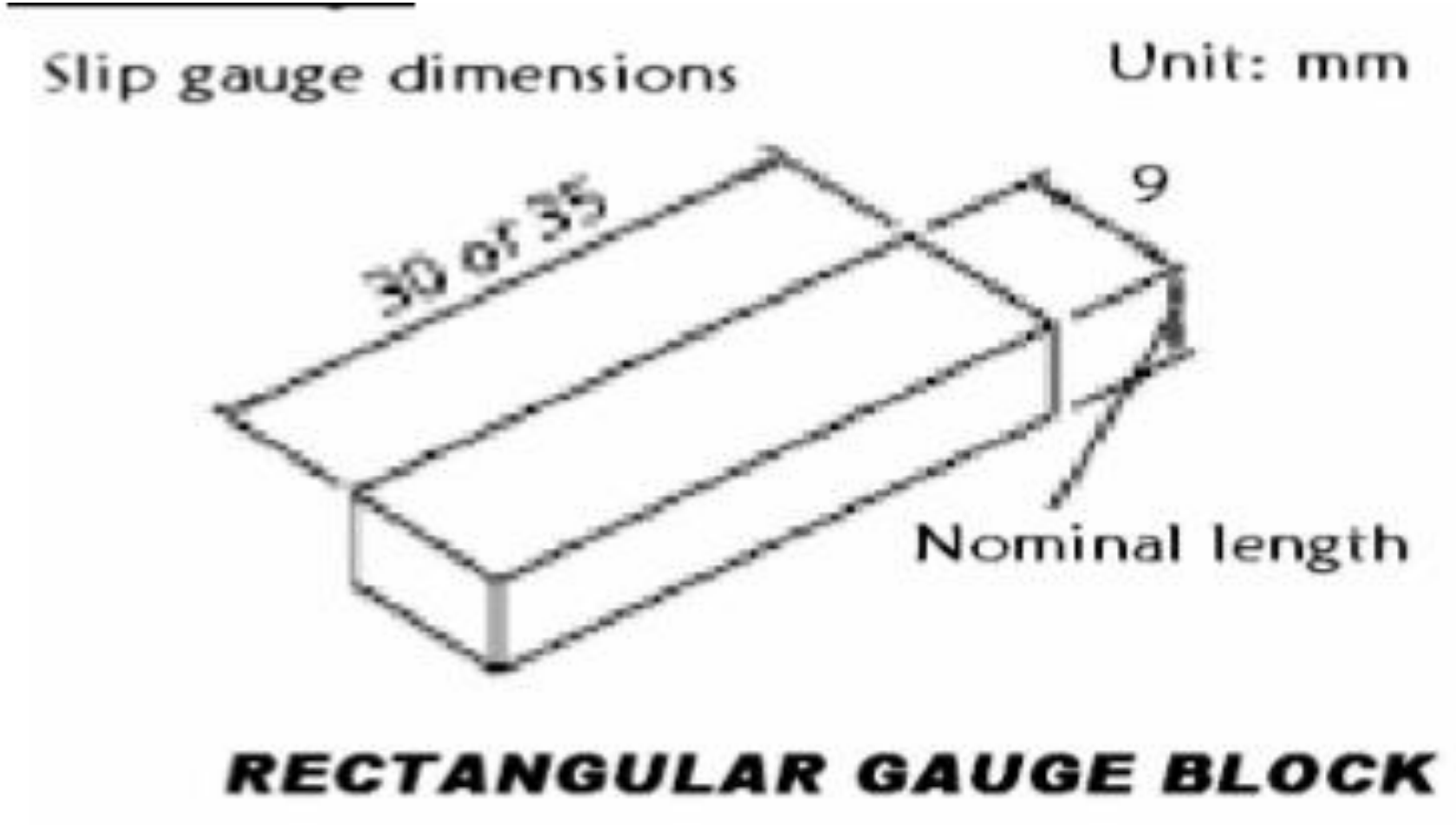
Experiment No: 9

- **Title:** Micrometer calibration by Slip Gauges
- **Objectives:**
- i. to know the use and working of slip gauges,
- ii. to know the classification and working of slip gauges,

Theory:

- Slip gauges are end standards used in linear measurements.
- They are used in workshop for work where a tolerance as low as 0.001mm is needed.
- Slip gauges were invented by Swedish engineer, C.E. Johnson, so they are also called Johnson gauges.
- Slip gauges are rectangular blocks, made of high grade steel, having cross section about 30mm X10mm.

- These blocks are made into required sizes and hardened to resist wear and allowed to stabilize so as to relieve internal stresses.
- This prevents occurrence of size and shape variations. After hardening the blocks, measuring faces are carefully finished to fine degree of surface finish, flatness and accuracy.
- This high grade surface finish is obtained by super finishing process known as lapping.

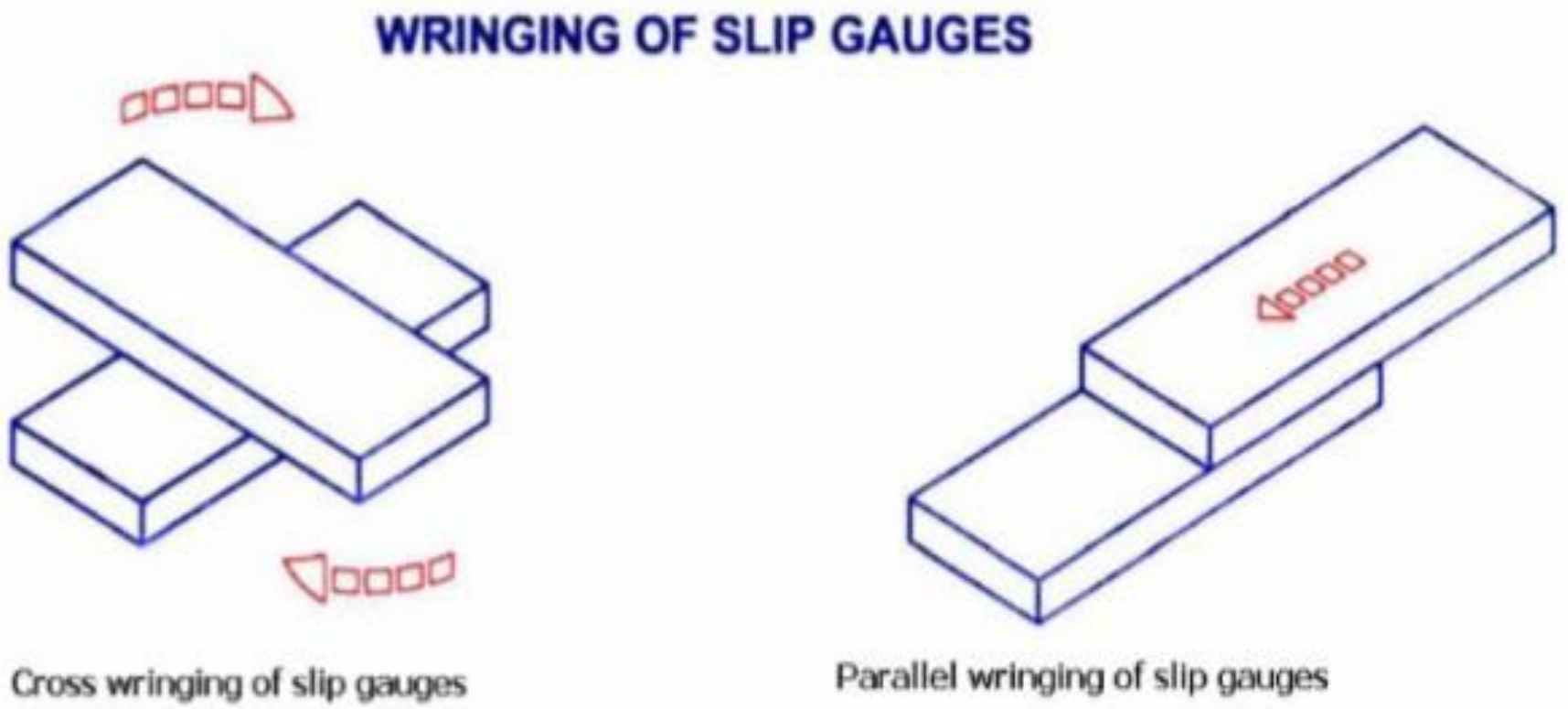

Slip gauge dimensions
Unit: mm
30 or 35
9
Nominal length
RECTANGULAR GAUGE BLOCK

Wringing of slip gauges:

- The measuring face of the gauges is flat and it possesses high surface finish.
- If two slip gauges are forced against each other on measuring faces, because of contact pressure, gauges stick together and considerable force is required to separate these blocks. This is known as wringing of slip gauges.
- Thus, wringing refers to condition of intimate and complete contact and of permanent adhesion between measuring faces.
- Slip gauges are wrung to build desired dimension. Slip gauges are wrung together by hand and no other external means.

- Figure shows 1) Parallel wringing of slip gauges and 2) Cross wringing of slip gauges.
- In cross wringing – the two slip gauges are first cleaned to remove dirt, then they are placed together at right angles in the form of cross and then rotated through 90o, while being pressed together. This method causes less rubbing of surfaces.
- Almost any dimension may be built by suitable combination of gauges. Wringing phenomenon is purely due to surface contact and molecular adhesion of metal of blocks.
- Hence, "wringing is defined as the property of measuring faces of gauge blocks of adhering, by sliding or pressing the gauge against measuring faces of other gauge blocks or reference faces or datum surfaces without the use of external means."

Wringing of slip gauges:



- **Uses of slip gauges.**
- 1. As a reference standard.
- 2. For verification and calibration of measuring apparatus.
- 3. For adjustment of indicating devices.
- 4. For direct measurement.
- 5. For setting of various types of comparators

Particulars of M87 and M45 slip gauge set.

M87 is a special set of slip gauges.

Range (mm)	Steps	Pieces
1.001 to 1.009	0.001	9
1.01 to 1.49	0.01	49
0.5 to 9.5	0.5	19
10 to 90	10	0
1.005	-	1

M45 is a normal set of slip gauges.

Range (mm)	Steps	Pieces
1.001 to 1.009	0.001	9
1.01 to 1.09	0.01	9
1.1 to 1.9	0.1	9
1 to 9	1	9
10 to 90	10	9
		Total 45

M122, M106, M87, M 50, M 33, M27 and E 81, E 49, E 41, E 35, E 28

Table 1.2.

(1) Set M 45 (Normal set)			(2) Set M 87 (special set)		
Range (mm)	Steps (mm)	No. of blocks	Range (mm)	Steps (mm)	No. of blocks
1.001 – 1.009	0.001	9	1.001 – 1.009	0.001	9
1.01 – 1.09	0.01	9	1.01 – 1.49	0.01	49
1.1 – 1.9	0.1	9	0.5 – 9.5	0.5	19
1 – 9	1	9	10 – 90	10	9
10 – 90	10	9	1.005	—	1

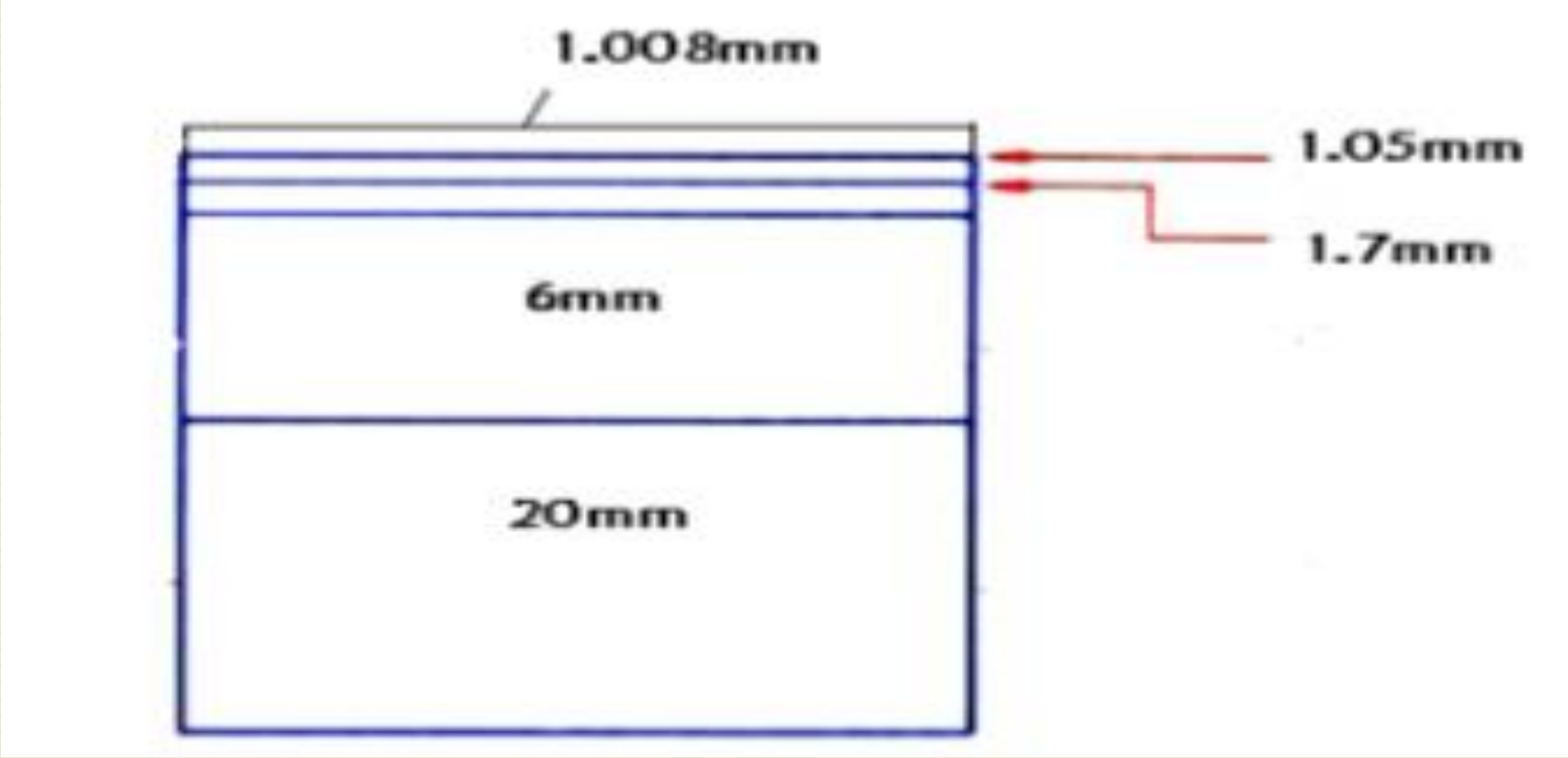
(3) Set M 112		
Range (mm)	Steps (mm)	No. of blocks
1.001 – 1.009	0.001	9
1.01 – 1.49	0.01	49
0.5 – 24.5	0.5	49
25 – 100	25	4
1.0005	—	1

(4) Set E28	
9 Pieces from	0.01– 0.209 in
9 Pieces from	0.21– 0.029 in
9 Pieces from	0.01– 0.09 in
1 Pieces from	0.02005 in

EXAMPLE:

- Determining the dimension of 29.758mm by M45 slip gauge set:
- Rule 1:-Minimum number of slip gauges should be used to build dimension.
- Rule 2:- Always start with the last decimal place.

Procedure	Last decimal	Calculation
a) Write the required dimension		29.758
b) Starting with last decimal place i.e. 0.008 But we can use 1.008 as to follow rule 1.	0.008	- 1.008 28.75
c) After subtraction the value remaining is 28.75. Here the last decimal place is 0.05 but we can use 1.05 slip gauge set so as to follow rule 1	0.05	- 1.05 27.7
d) Value remaining is 27.7 i.e last decimal place is 0.7 But we can use 1.7mm slip gauge so as to follow rule 1.	0.7	- 1.7 26.0
e) Now the value remaining is 26 mm and we have 6mm gauge block available.	6.0	- 6.0 20.0
f) Final value is 20mm and this gauge is available. Remainder should always be zero	20mm	- 20.0 0.0


1.008mm
1.05mm
1.7mm
6mm
20mm

- Hence to build the dimension of 29.758 we need slip gauges of 20mm, 6mm, 1.7mm, 1.05mm and 1.008mm.

Example:

Building a size of 43.716 mm using M45 set.

43.716	
−1.006	1st block
42.710	
−1.01	2nd block
41.700	
−1.7	3rd block
40.00	
40.0	4th block

- **Procedure of performing experiment:**
- (1) Clean the fixed vice and micrometer
- (2) Clamp the micrometer in vice putting cushioning material between micrometer and jaws of vice to protect the micrometer from probable damage due to clamping force.
- (3) Make pile of guage blocks and insert between two anvils of the micrometer and take reading.

- (4) Increase the value of gauge blocks pile and take next few readings.
- (5) Then decrease the value of gauge blocks pile and take same readings in decreasing order.
- (6) Tabulate the readings
- (7) After cleaning the place the gauge blocks should be placed in their respective places.

Observation table:

Range: Least count: Make:

Sr. No	Slip gauges in combination	Micrometer reading in mm				
		Increasing	Decreasing	Average	Error	Correction
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

- Graphs: Following graphs are to be drawn:
- (1) Slip gauges combination – Micrometer average
- (2) Slip gauges combination – Error
- (3) Micrometer average reading – correction