

# PRECISION MEASURING INSTRUMENTS

(PMI)

*Facilitator Guide*



# TABLE OF CONTENTS

<a href="#"><u>INTRODUCTION</u></a>	PAGE 1
<b>PROGRAMME PMI-1 TO PMI-6</b>	
<a href="#"><u>SUMMARY PMI-1</u></a>	PAGE 3
<a href="#"><u>SUMMARY PMI-2</u></a>	PAGE 4
<a href="#"><u>SUMMARY PMI-3</u></a>	PAGE 5
<a href="#"><u>SUMMARY PMI-4</u></a>	PAGE 6
<a href="#"><u>SUMMARY PMI-5</u></a>	PAGE 7
<a href="#"><u>SUMMARY PMI-6</u></a>	PAGE 8
<b>MODEL ANSWERS</b>	
<a href="#"><u>LEARNER EXERCISE PMI-1</u></a>	PAGE 9
<a href="#"><u>LEARNER EXERCISE PMI-2</u></a>	PAGE 10
<a href="#"><u>LEARNER EXERCISE PMI-3</u></a>	PAGE 12
<a href="#"><u>LEARNER EXERCISE PMI-4</u></a>	PAGE 14
<a href="#"><u>LEARNER EXERCISE PMI-5</u></a>	PAGE 15
<a href="#"><u>LEARNER EXERCISE PMI-6</u></a>	PAGE 16
<b>CRITERION TEST</b>	
<a href="#"><u>PMI-2</u></a>	PAGE 18
<a href="#"><u>PMI-3</u></a>	PAGE 19
<a href="#"><u>PMI-4</u></a>	PAGE 20
<a href="#"><u>PMI-5</u></a>	PAGE 21
<a href="#"><u>PMI-6</u></a>	PAGE 23
<b>BLANK CRITERION TESTS</b>	
<a href="#"><u>PMI-2</u></a>	PAGE 24
<a href="#"><u>PMI-3</u></a>	PAGE 25
<a href="#"><u>PMI-4</u></a>	PAGE 26
<a href="#"><u>PMI-5</u></a>	PAGE 27
<a href="#"><u>PMI-6</u></a>	PAGE 29
<b>PROGRAMME PMI-7</b>	
<a href="#"><u>SUMMARY</u></a>	PAGE 30
<b>MODEL ANSWERS</b>	
<a href="#"><u>LEARNER EXERCISE 1</u></a>	PAGE 32
<a href="#"><u>LEARNER EXERCISE 2</u></a>	PAGE 33
<a href="#"><u>LEARNER EXERCISE 3</u></a>	PAGE 34
<a href="#"><u>LEARNER EXERCISE 4</u></a>	PAGE 35
<a href="#"><u>LEARNER EXERCISE 5</u></a>	PAGE 36
<a href="#"><u>PRACTICAL EXERCISE</u></a>	PAGE 37
<a href="#"><u>CRITERION TEST CHECK LIST</u></a>	PAGE 39

**PROGRAMME PMI-8**

[SUMMARY](#)

PAGE 40

**MODEL ANSWERS**

[LEARNER EXERCISE 1](#)

PAGE 42

[LEARNER EXERCISE 2](#)

PAGE 43

[LEARNER EXERCISE 3](#)

PAGE 44

[LEARNER EXERCISE 4](#)

PAGE 45

[LEARNER EXERCISE 5](#)

PAGE 47

[LEARNER EXERCISE 6](#)

PAGE 50

[CRITERION TEST PMI-8](#)

PAGE 51

[CRITERION TEST CHECK LIST](#)

PAGE 52

## INTRODUCTION

Precision Measuring is a skill that must be mastered by all aspirant engineering students.

This series is designed upon "Learner-Controlled" principles currently being adopted by most industrialised nations.

### THE PACKAGE COMPRISES

- The Facilitator Guide and Criterion Tests.
- Video Programme.
- The Learner Guide.

It is strongly recommended that learners learn the subject matter in the sequential order of contents. Programmes PMI-1 and PMI-2 being PREREQUISITE for the subsequent programmes.

### CONTENTS OF SUBJECT MATTER

#### 1. VIDEO PROGRAMME

PMI-1	"An overview of micro-measuring".
PMI-2	"Using, reading and maintaining outside micrometers".
PMI-3	"Using, reading outside micrometers over 25 mm".
PMI-4	"Using and reading inside micrometers".
PMI-5	"Using and reading micrometer depth gauges".
PMI-6	"Using and reading vernier callipers".

#### 2. INSTRUCTOR NOTES

These are contained within this manual and are designed to provide an overview to the content of the video programme as quick reference in the case of student / learner questions.

#### 3. LEARNER WORKBOOK (EXERCISES)

Each learner should complete his / her own copy at the end of each lesson (video).

The Instructor should check each learner's completed exercise for evaluation and correction. Corrected exercises are to be returned to the learner to be retained by him / her as Reference Notes.

#### 4. CRITERION TESTS

These should be completed by the learner WITHOUT reference to any notes or video input and marked by a competent person. It is suggested that only two attempts be allowed for completing a CRITERION.

Any learner not able to gain 100% on the second attempt should re-do the programme from the beginning.

### HOW TO USE THIS PACKAGE

The package may be used as a "stand alone" training system or integrated into your existing courses.

Programme No. PMI-1 is an Introductory lesson to incoming ("raw") learners, and should be viewed initially by all learners.

Programme No. PMI-2 is Mandatory and if not viewed in sequence will affect the output of programmes PMI-3, PMI-4 and PMI-5.

Programme No. PMI-6 can be used independently.

### EVALUATION

When the learner(s) have successfully completed this package they will be able to demonstrate the following to any instructor or journeyman:

- The ability to take external measurements with micrometers to an accuracy of 0,01 mm.
- The ability to take internal measurements with inside micrometers to an accuracy of 0,01 mm.
- The ability to take depth readings up to 2,00 mm with an accuracy of 0,01 mm.
- The ability to take external, internal and depth readings with a Vernier Calliper to an accuracy of 0,02 mm.

## PROGRAMME PMI-1 AN OVERVIEW OF MICRO-MEASURING

### TEACHING OBJECTIVE

To provide new engineering learners with the necessary "conceptual" information of the need for "precision-measuring".

### TRAINING AIDS REQUIRED

- 1 x 300 mm Engineer's steel rule.

### ESTIMATED LEARNER TIME REQUIRED

Approximately 30 minutes.

### SUMMARY OF SUBJECT MATTER

- Standard units of linear measure including:
  - Metre.
  - Centimetre.
  - Millimetre.
  - Sub millimetre.
  - Engineer's steel rule.
- Importance of careful measuring.
- Need for careful handling of precision tools.
- Standard method of expressing dimensions.

**PROGRAMME PMI-2**  
**USING, READING AND MAINTAINING METRIC OUTSIDE MICROMETERS**

**TEACHING OBJECTIVE**

To provide the necessary theoretical input and practical demonstration that will enable selected engineering learners to use, read and maintain conventional metric outside micrometers up to 25 mm.

**TRAINING AIDS REQUIRED**

- 1 x 0-25 mm Outside micrometer.
- Assorted machined components both flat and round not exceeding 25 mm.

**ESTIMATED LEARNER TIME REQUIRED**

Approximately 3 hours.

**SUMMARY OF SUBJECT MATTER**

- Parts and functions of typical micrometer (outside).
- Methods of holding and "feeling".
- Principles of reading the main scale.
- Principles of reading the thimble scale.
- Obtaining an overall (combined) reading.
- Principles of maintaining micrometers.

## PROGRAMME PMI-3 READING MICROMETERS OVER 25 mm

### TEACHING OBJECTIVE

To provide the necessary theoretical input and practical demonstration that will enable selected engineering learners to use, read and adjust outside micrometers that read above 25 mm to a maximum 100 mm.

### TRAINING AIDS REQUIRED

- 1 x 25 - 50 Fixed micrometer.
- 1 x 50 - 75 Fixed micrometer.
- 1 x 75 - 100 Fixed micrometer.
- 1 x 0 - 100 Adjustable micrometer.
- Assorted work pieces up to 100 mm.

### ESTIMATED LEARNER TIME REQUIRED

Approximately 3 hours.

### SUMMARY OF SUBJECT MATTER

- Fixed types of micrometers up to 100 mm.
- "Ranges" of readings with fixed types.
- Checking accuracy with setting gauges.
- Contents of adjustable micrometer "kits".
- Changing an anvil.
- Checking reading against setting gauges.
- Adjusting for zero ("standard" settings).
- Using and reading adjustable type.



## PROGRAMME PMI-4 USING AND READING INSIDE MICROMETERS

### TEACHING OBJECTIVE

To provide the necessary theoretical input and practical demonstration that will enable selected engineering learners to use, read and adjust a conventional "inside micrometer" up to 200 mm.

### TRAINING AIDS REQUIRED

- 1 x 50-75 Inside micrometer with extensions.
- Assorted work pieces:
  - Round bores.
  - Square bores.

### ESTIMATED LEARNER TIME REQUIRED

Approximately 3 hours.

### SUMMARY OF SUBJECT MATTER

- Typical applications for inside micrometer.
- Parts / functions of inside micrometer.
- Measuring "ranges".
- Techniques of using the micrometer.
- Checking overall accuracy.
- Reading the instrument.

## PROGRAMME PMI-5 USING AND READING THE DEPTH MICROMETER

### TEACHING OBJECTIVES

To provide the necessary theoretical input and practical demonstration that will enable selected engineering learners to use and read a conventional depth gauge micrometer with a maximum range of 175 - 200 mm.

### TRAINEE AIDS REQUIRED

- 1 x 0-25 Body and extension rod kit - 200 mm.
- Assorted work pieces to measure depths.

### ESTIMATED LEARNER TIME REQUIRED

Approximately 3 hours.

### SUMMARY OF SUBJECT MATTER

- Typical applications for depth reading.
- Parts and functions of depth micrometer.
- Rods (extensions) and changing rods.
- Handling / using techniques.
- Reading the instrument.

## PROGRAMME PMI-6 USING AND READING VERNIER CALIPERS

### TEACHING OBJECTIVE

To provide the necessary theoretical input and practical demonstration that will enable selected engineering learners to use and read a (0,02) metric vernier calliper.

### TRAINING AIDS REQUIRED

- 1 X 0 - 150 mm Conventional vernier calliper.
- Assorted machined work pieces for external, internal and depth measurements.

### ESTIMATED LEARNER TIME REQUIRED

Approximately 2 hours.

### SUMMARY OF SUBJECT MATTER

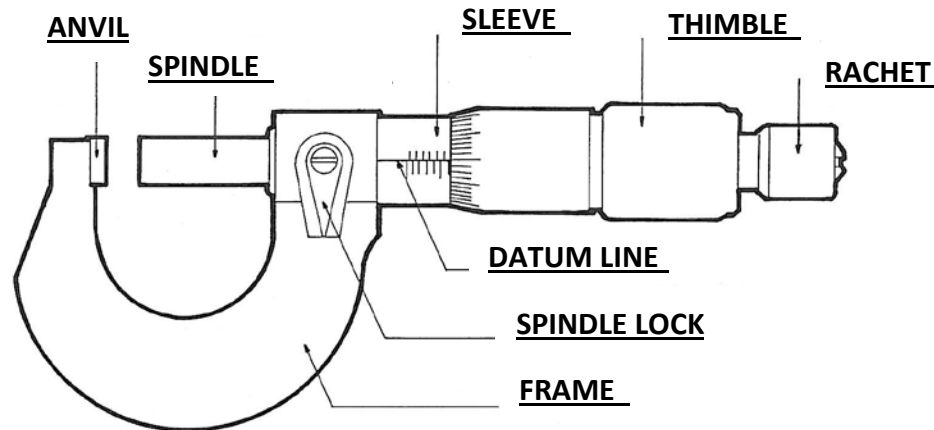
- Overview of typical applications.
- Vernier calliper parts and functions.
- Method of handling the vernier.
- Gauging external, internal and depth readings.
- Reading the instrument.
- Examples of reading.

**MODEL ANSWERS**  
**LEARNER EXERCISE PMI-1**  
**AN OVERVIEW TO MICRO-MEASURING**

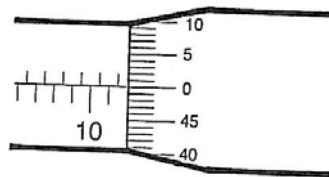
1. The Standard Measuring unit is the **Metre**.
2. A centimetre is exactly **1/100** of a **metre**.
3. A tenth of a centimetre is called a **millimetre**.
4. Engineering conventions express all linear measurements in **metres** and **millimetres** only.
5. The term **centimetre** is used for expressing the dimensions of domestic items.
6. A steel rule is inaccurate for measuring dimensions under **one millimetre**.
7. A **micrometer** is used to measure accuracies up to 1/100 of a millimetre.
8. Dropping or bumping precision measuring instruments may cause them to **read inaccurately**.
9. Micro measurements should include **two** decimal places when writing them down.
10. The letters **mm** should usually be included when writing down your reading.

**MODEL ANSWERS**  
**LEARNER EXERCISE PMI-2**  
**USING, READING AND MAINTAINING METRIC MICROMETERS**

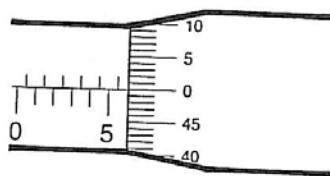
1. Label the parts in the diagram below.



2. The fully closed reading on a 25 mm micrometer is **0,00 mm**.  
 3. The fully open reading is **25,00 mm**.  
 4. Each division below the datum line represents **1,00 mm**.  
 5. The reading shown is **12,00 mm**.

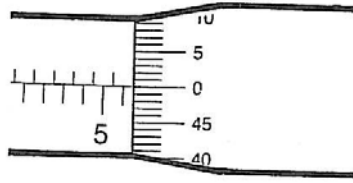


6. This reading is **6,00 mm**.

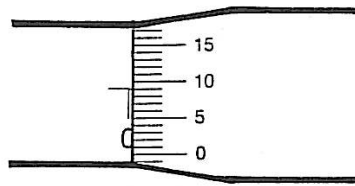


7. Each division above the datum line represents **0,50 mm**.

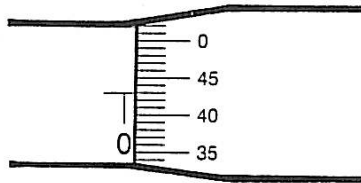
8. This micrometer is set at  $6,00 + 0,50 = 6,50$  mm.



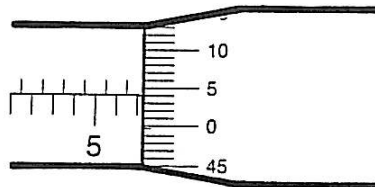
9. Two full turns of the thimble opens the micrometer **one** division which represents **1,00 mm**.
10. The thimble has **50** divisions.
11. Each division on the thimble represents **0,01 mm**.
12. This micrometer is set to **0,09 mm**.



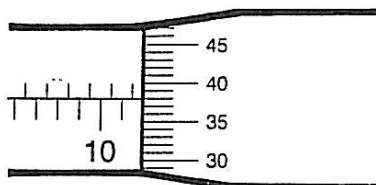
13. This micrometer is set to **0,43 mm**.



14. This reading is  $7 + 0 + 0,04 = 7,04$  mm.

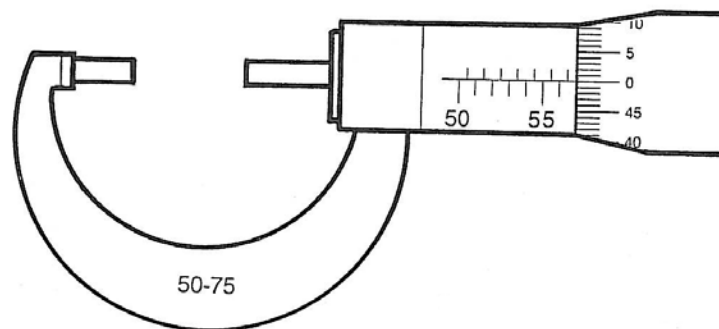


15. This reading is  $11,00 + 0,50 + 0,38 = 11,88$  mm.

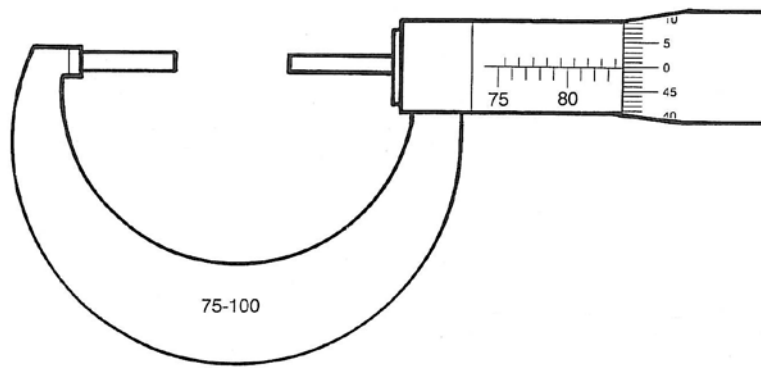


**MODEL ANSWERS**  
**LEARNER EXERCISES PMI-3**  
**USING AND READING OUTSIDE MICROMETERS OVER 25 mm**

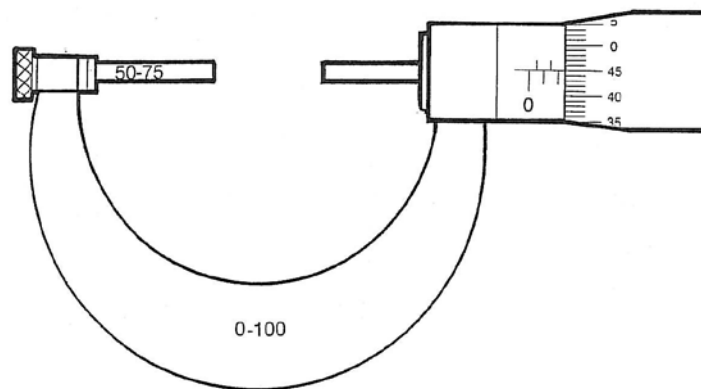
1. A 25 - 50 micrometer has a minimum reading of **25 mm** and a maximum reading of **50 mm**.
2. The measuring "range" of any outside micrometer is **25,00 mm**.
3. When taking a reading off a fixed micrometer you must always remember to include the **minimum opening figure**.
4. Micrometer standards should be checked from time to time using a **setting gauge**.
5. Don't hold a setting gauge in your **hand** as this will cause it to **expand**, giving rise to **inaccurate** readings.
6. An **adjustable** outside micrometer is supplied in kit form and includes **setting gauges, anvils and adjusting wrenches**.
7. When not in use, all loose parts should be stored in the **box**.
8. An adjustable micrometer should always be checked against a setting gauge whenever an **anvil** is changed.
9. When taking a reading on an adjustable micrometer you must always remember to include what in the final reading?  
**The minimum reading of the setting gauge.**
10. What is the full reading on the micrometer shown below?  
**57,00 mm.**



11. What is the total reading on the micrometer shown below?  
**84,00 mm.**



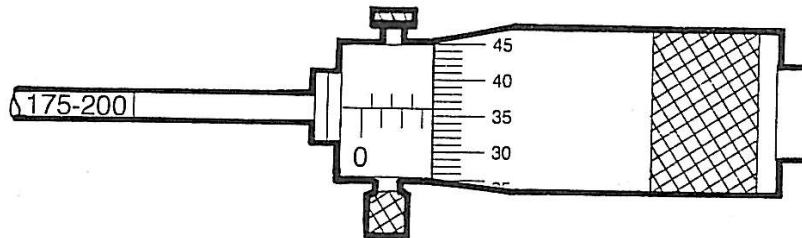
12. What reading total is given on the 'adjustable' micrometer illustrated?  
**50,00 + 2,00 + 0,45 = 52,45 mm.**





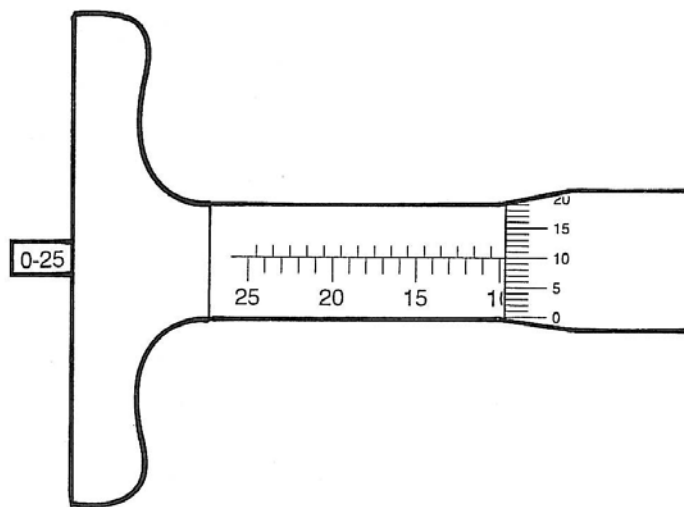
**MODEL ANSWERS**  
**LEARNER EXERCISES PMI-4**  
**USING AND READING INSIDE MICROMETERS**

1. The "reading" range of the internal micrometer shown in the video is **10,00 mm**.
2. The most important thing to remember when determining a reading is to include the **minimum** length of the **extension rod**.
3. A spacing collar, if utilised, adds **12,00 mm** to the total reading.
4. The inside micrometer, before use, should be checked for accuracy using an **outside** micrometer.
5. To adjust an inside micrometer the **anvil** must be turned in or out on the extension rod.
6. What is the total reading shown below?  
**178,36mm.**



**MODEL ANSWERS**  
**LEARNER EXERCISES PMI-5**  
**USING AND READING THE DEPTH MICROMETER**

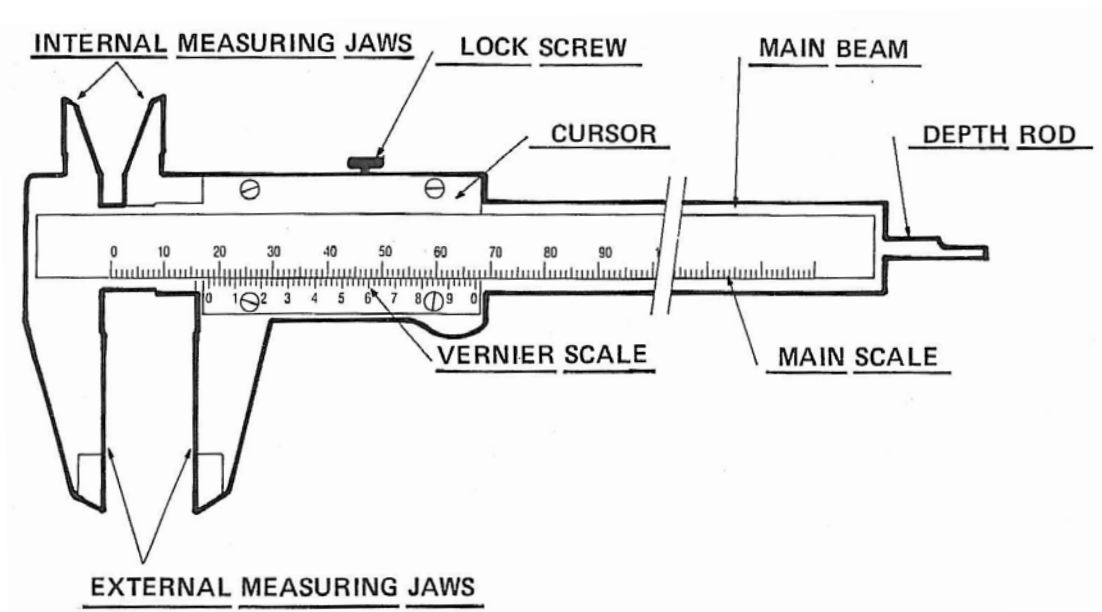
1. A depth micrometer is used to determine such dimensions as **shoulders, ledges** and protrusions.
2. A "standard" rod allows a range of between **0,00 mm** and **25,00 mm**.
3. All un-used items of the depth micrometer should be kept in the **storage box** to avoid loss.
4. It is important that all work piece surfaces are **clean** and free of **burrs**.
5. In order to establish which measuring rod must be used a rough **measurement** can be taken using a steel **rule** or a **vernier calliper**.
6. What is the total reading shown below?  
**9,60 mm.**



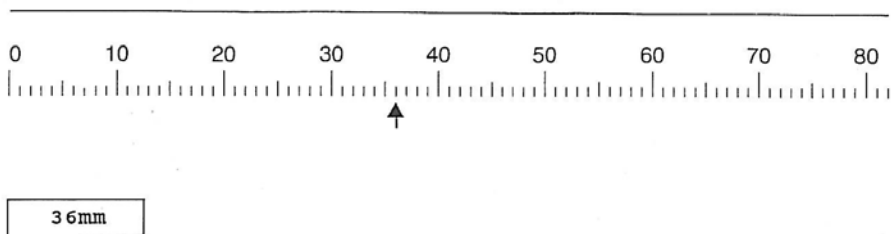
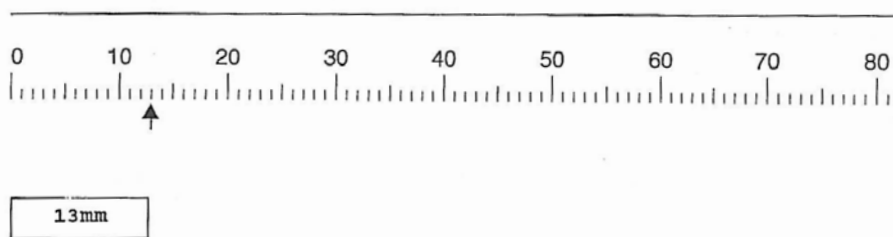
**MODEL ANSWERS**  
**LEARNER EXERCISES PMI-6**  
**USING AND READING VERNIER CALIPERS**

NAME: \_\_\_\_\_ DATE: \_\_\_\_\_

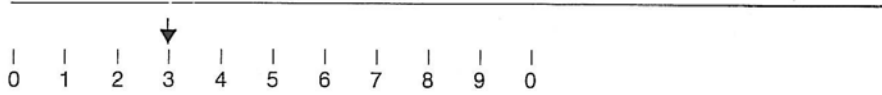
1. There are two commonly used vernier callipers, namely, those with an accuracy of **0,05 mm** and those with an accuracy of **0,02 mm**.
2. Label the part names on this diagram below.



3. Write in the main beam read readings.



4. Write in the vernier scale readings.

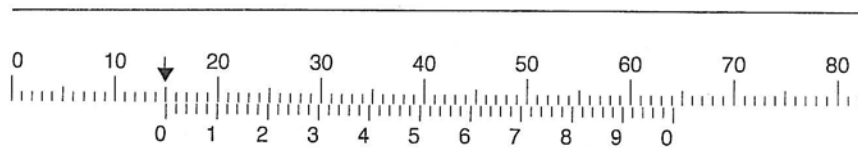


0.30mm

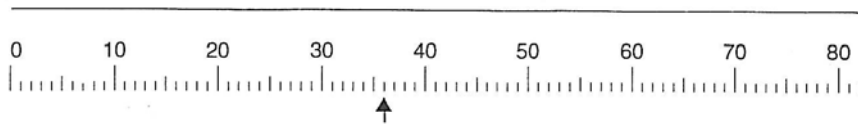


0,68mm

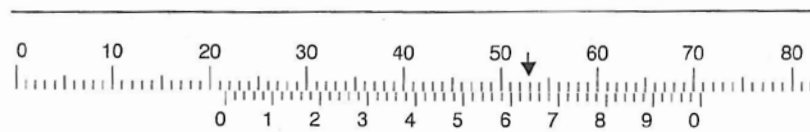
5. Write in the combined readings.



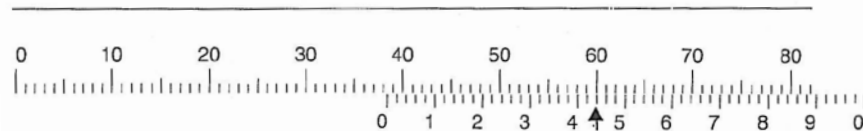
15,00 mm



36mm



21,64 mm



38,44 mm

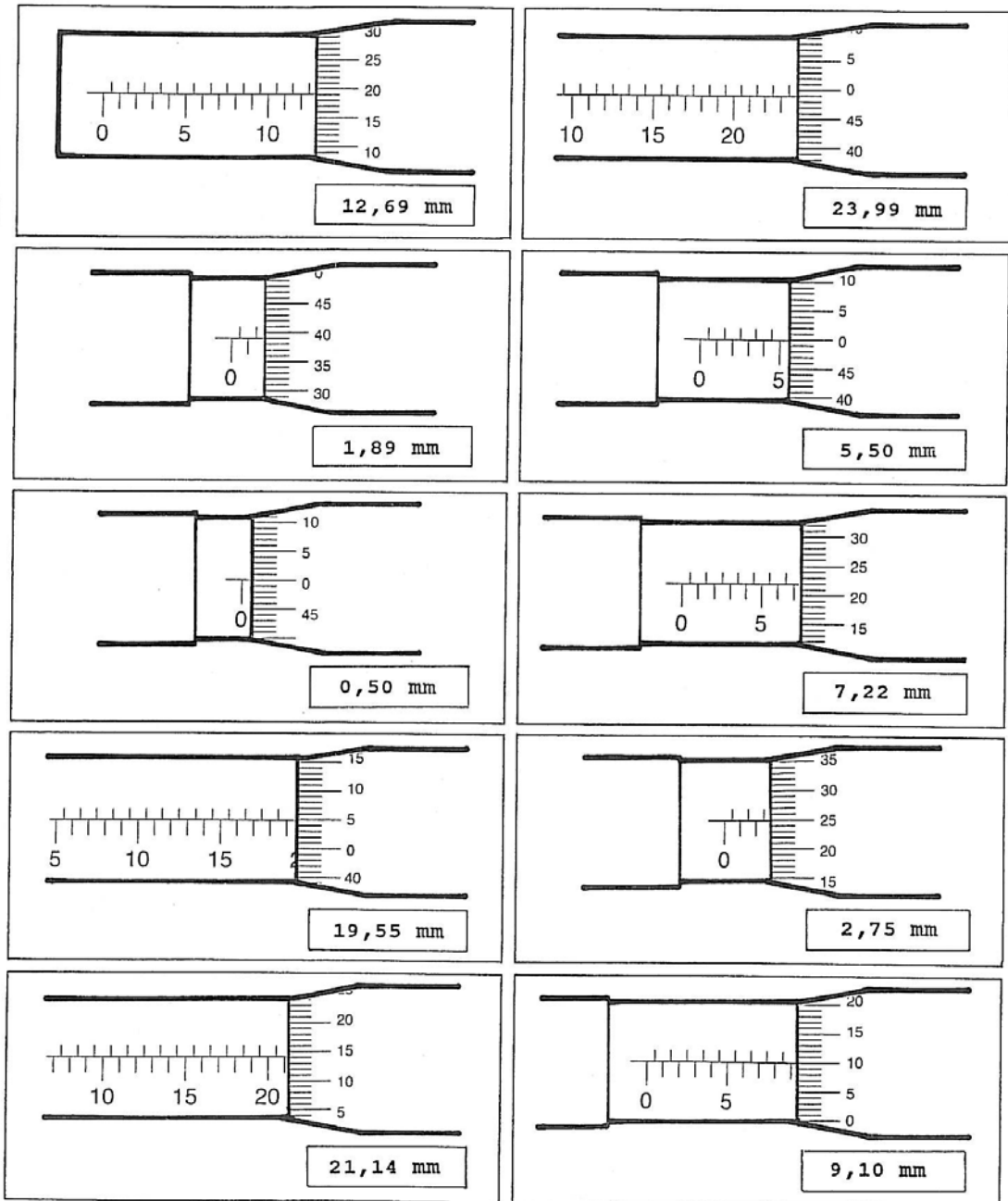
**CRITERION TEST PMI-2**  
**READING AND USING METRIC MICROMETERS**

NAME: \_\_\_\_\_ DATE: \_\_\_\_\_

**INSTRUCTIONS**

Answer all questions then hand in the completed test to your Instructor / Course Controller.

Fill in the readings (taken from a 0 - 25 mm micrometer).



MARKED BY: \_\_\_\_\_ TOTAL OBTAINED: \_\_\_\_\_

**CRITERION TEST PMI-3**  
**READING MICROMETERS OVER 25 MM**

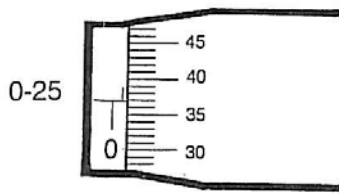
**NAME:** \_\_\_\_\_ **DATE:** \_\_\_\_\_

**INSTRUCTIONS**

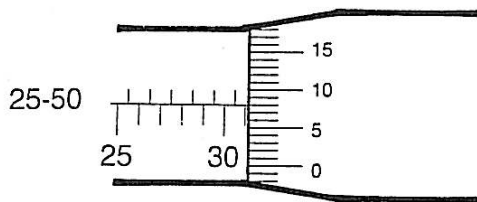
Answer all questions then hand in the completed test to your Instructor / Course Controller.

The readings below are taken from a 0 - 100 mm adjustable micrometer. Fill in the FULL readings only.

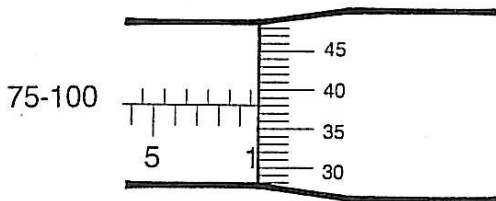
1. Anvil used: - 0 - 25 mm.  
**0,87 mm.**



2. Anvil used: - 25 - 50 mm.  
**31,08 mm.**



3. Anvil used: - 75 - 100 mm.  
**84,88 mm.**



**MARKED BY:** \_\_\_\_\_ **TOTAL OBTAINED:** \_\_\_\_\_

**CRITERION TEST PMI-4**  
**READING INSIDE-MICROMETERS**

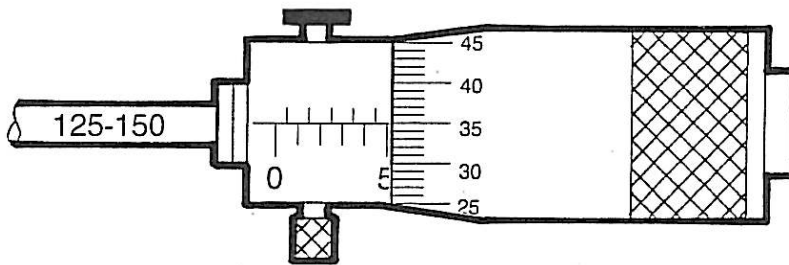
NAME: \_\_\_\_\_ DATE: \_\_\_\_\_

**INSTRUCTIONS**

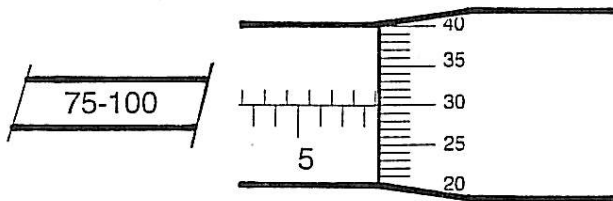
Answer all questions then hand in the completed test to your Instructor / Course Controller.

Note each reading shown.

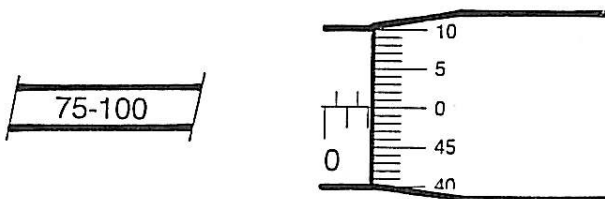
1. **130,35 mm.**



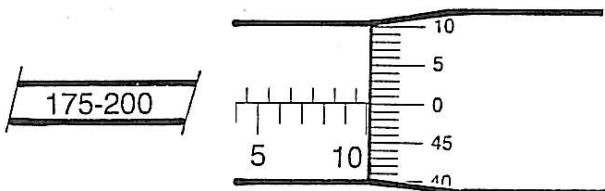
2. **83.80 mm.**



3. **77,00 mm.**



4. **185,00 mm.**



MARKED BY: \_\_\_\_\_ TOTAL OBTAINED: \_\_\_\_\_

**CRITERION TEST PMI-5  
READING DEPTH-MICROMETERS**

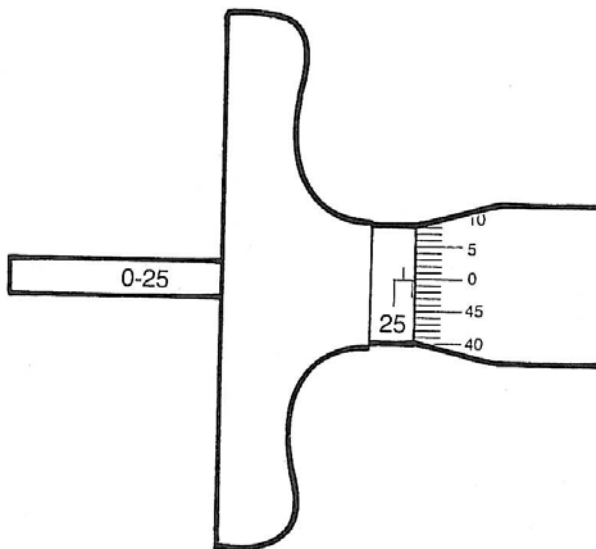
**NAME:** \_\_\_\_\_ **DATE:** \_\_\_\_\_

**INSTRUCTIONS**

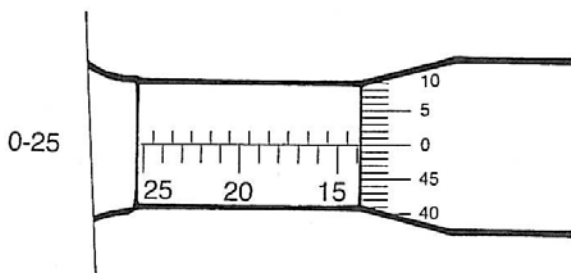
Answer all questions then hand in the completed test to your Instructor / Course Controller.

Note each reading shown.

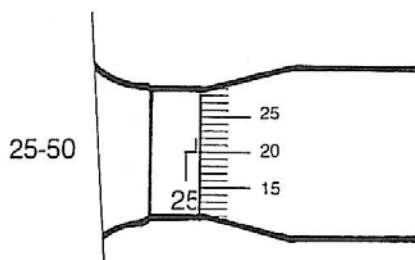
1. **24,00 mm.**



2. **14,00 mm.**

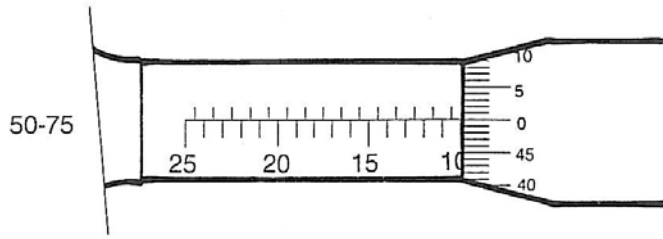


3. **49.20 mm.**

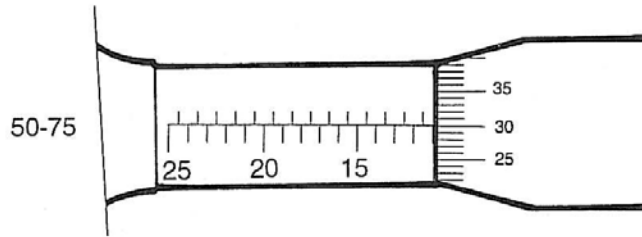




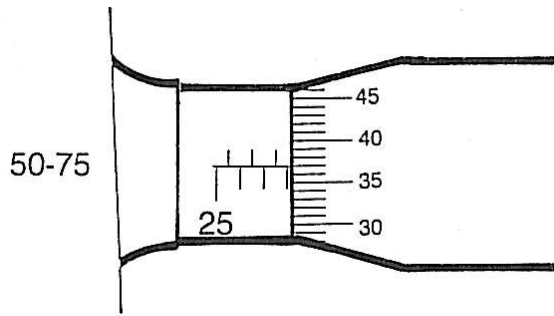
4. 60,00 mm.



5. 61,80 mm.



6. 72,87 mm.



MARKED BY: \_\_\_\_\_ TOTAL OBTAINED: \_\_\_\_\_

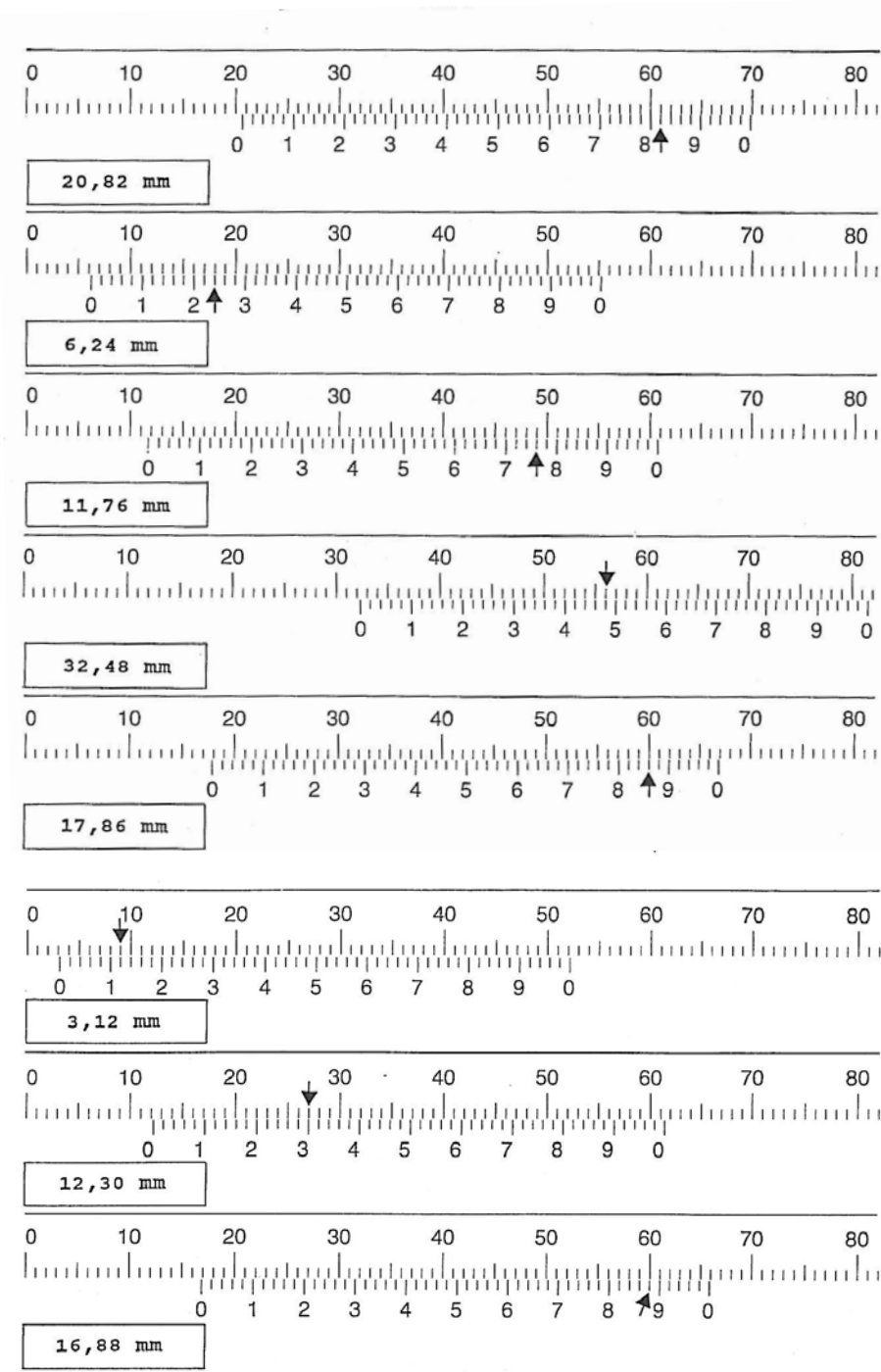
**CRITERION TEST PMI-6**  
**READING VERNIER CALLIPERS**

**NAME:** \_\_\_\_\_ **DATE:** \_\_\_\_\_

**INSTRUCTIONS**

Answer all questions then hand in the completed test to your Instructor / Course Controller.

Complete the readings shown below.



**MARKED BY:** \_\_\_\_\_ **TOTAL OBTAINED:** \_\_\_\_\_

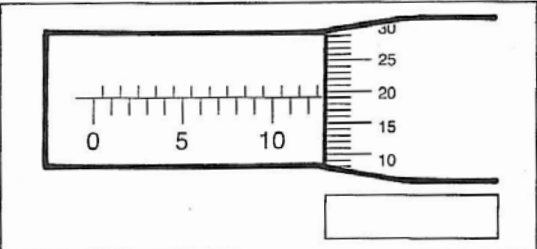
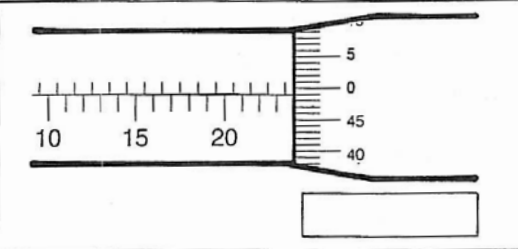
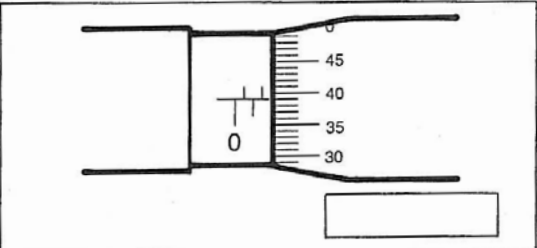
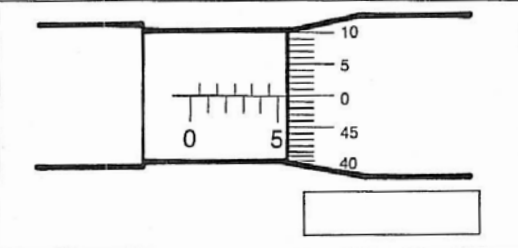
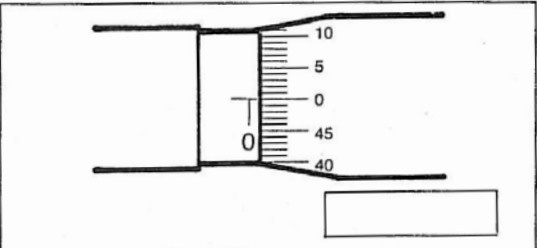
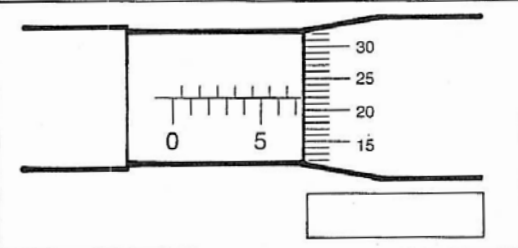
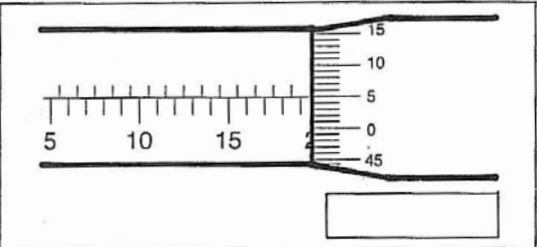
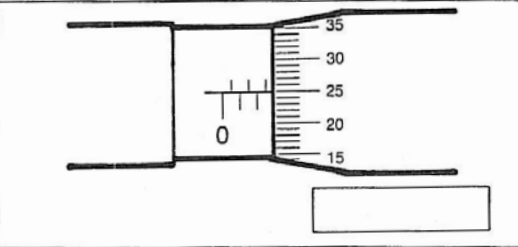
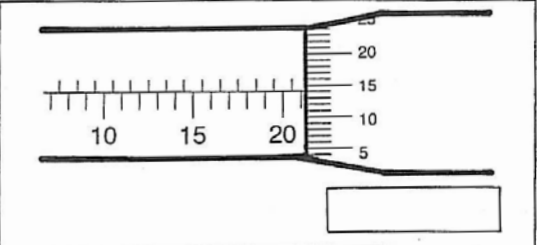
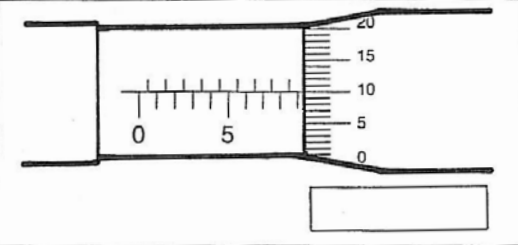
**CRITERION TEST PMI-2**  
**READING AND USING METRIC MICROMETERS**

**NAME:** \_\_\_\_\_ **DATE:** \_\_\_\_\_

**INSTRUCTIONS**

Answer all questions then hand in the completed test to your Instructor / Course Controller.

Fill in the readings (taken from a 0 - 25 mm micrometer).

 <input style="width: 100px; height: 20px;" type="text"/>	 <input style="width: 100px; height: 20px;" type="text"/>
 <input style="width: 100px; height: 20px;" type="text"/>	 <input style="width: 100px; height: 20px;" type="text"/>
 <input style="width: 100px; height: 20px;" type="text"/>	 <input style="width: 100px; height: 20px;" type="text"/>
 <input style="width: 100px; height: 20px;" type="text"/>	 <input style="width: 100px; height: 20px;" type="text"/>
 <input style="width: 100px; height: 20px;" type="text"/>	 <input style="width: 100px; height: 20px;" type="text"/>

**CRITERION TEST PMI-3  
READING MICROMETERS OVER 25 MM**

**NAME:** \_\_\_\_\_ **DATE:** \_\_\_\_\_

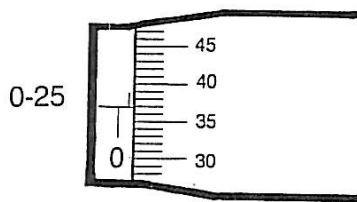
**INSTRUCTIONS**

Answer all questions then hand in the completed test to your Instructor / Course Controller.

The readings below are taken from a 0 - 100 mm adjustable micrometer. Fill in the FULL readings only.

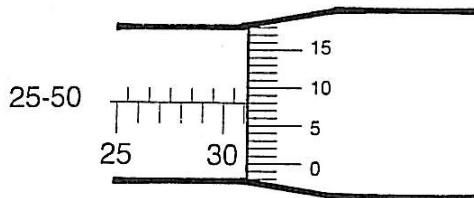
1. Anvil used: - 0 - 25 mm.

Answer: \_\_\_\_\_



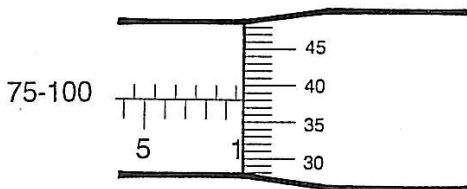
2. Anvil used: - 25 - 50 mm.

Answer: \_\_\_\_\_



3. Anvil used: - 75 - 100 mm.

Answer: \_\_\_\_\_



**MARKED BY:** \_\_\_\_\_ **TOTAL OBTAINED:** \_\_\_\_\_

**CRITERION TEST PMI-4  
READING INSIDE-MICROMETERS**

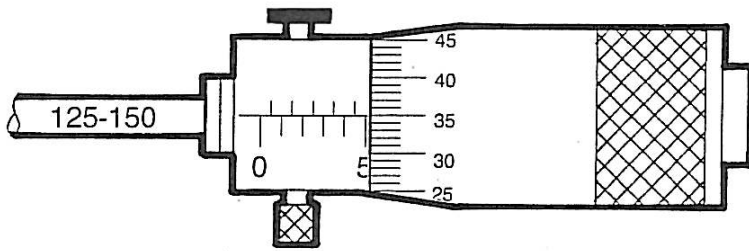
**NAME:** \_\_\_\_\_ **DATE:** \_\_\_\_\_

**INSTRUCTIONS**

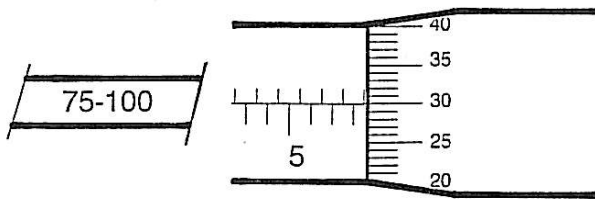
Answer all questions then hand in the completed test to your Instructor / Course Controller.

Note each reading shown.

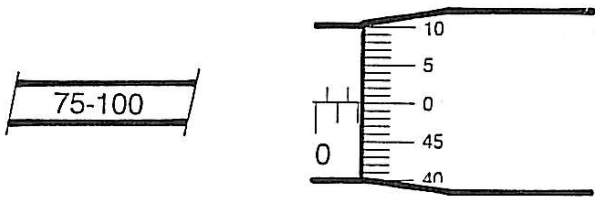
1. **Answer:** \_\_\_\_\_



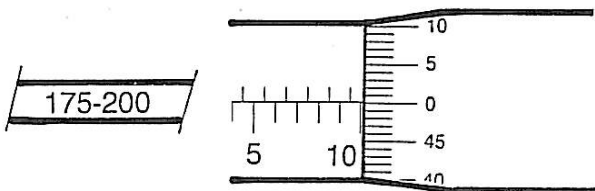
2. **Answer:** \_\_\_\_\_



3. **Answer:** \_\_\_\_\_



4. **Answer:** \_\_\_\_\_



**MARKED BY:** \_\_\_\_\_ **TOTAL OBTAINED:** \_\_\_\_\_

**CRITERION TEST PMI-5**  
**READING DEPTH-MICROMETERS**

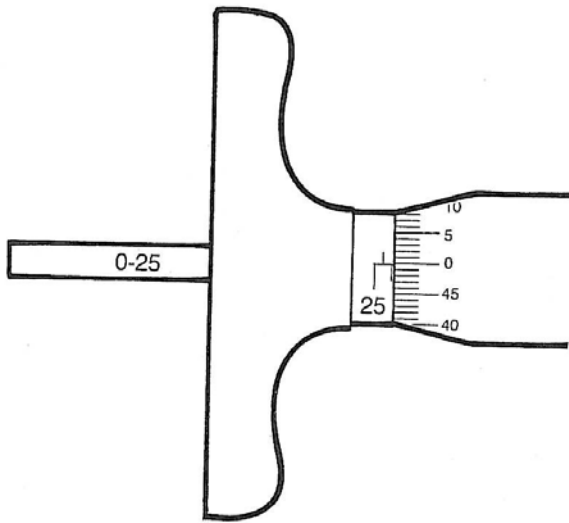
**NAME:** \_\_\_\_\_ **DATE:** \_\_\_\_\_

**INSTRUCTIONS**

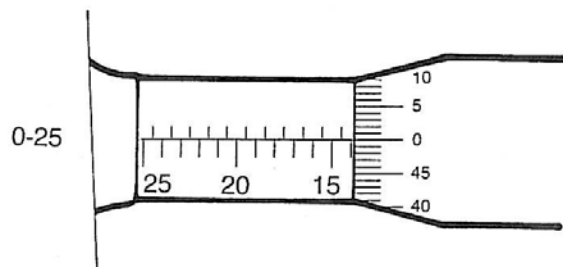
Answer all questions then hand in the completed test to your Instructor / Course Controller.

Note each reading shown.

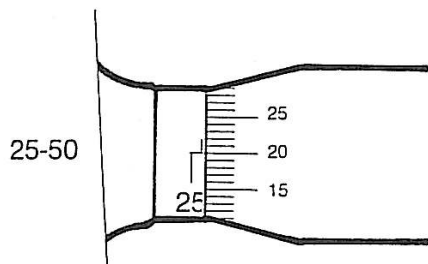
1. **Answer:** \_\_\_\_\_



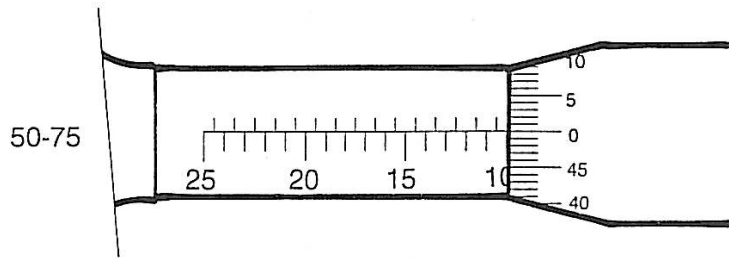
2. **Answer:** \_\_\_\_\_



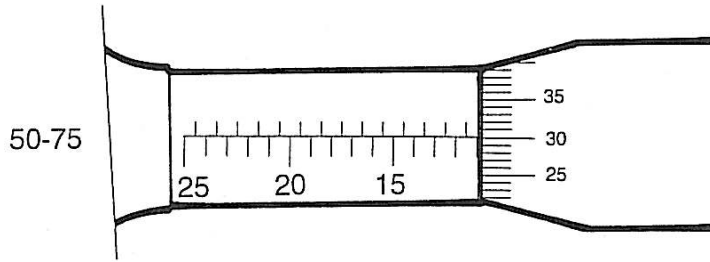
3. **Answer:** \_\_\_\_\_



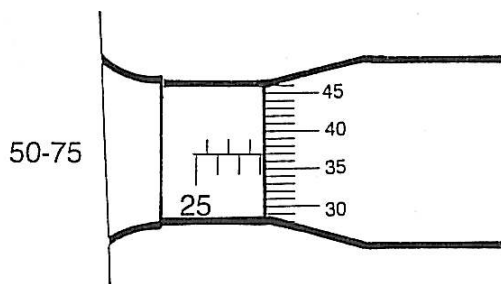
4. Answer: \_\_\_\_\_



5. Answer: \_\_\_\_\_



6. Answer: \_\_\_\_\_



MARKED BY: \_\_\_\_\_ TOTAL OBTAINED: \_\_\_\_\_

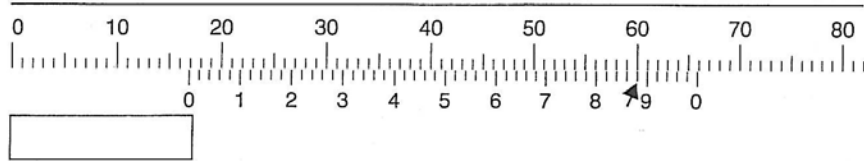
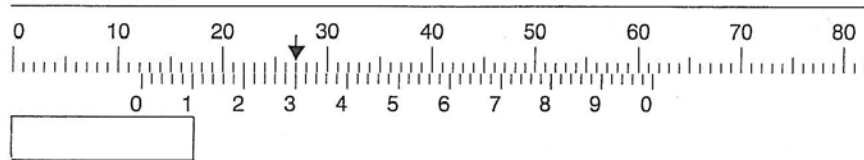
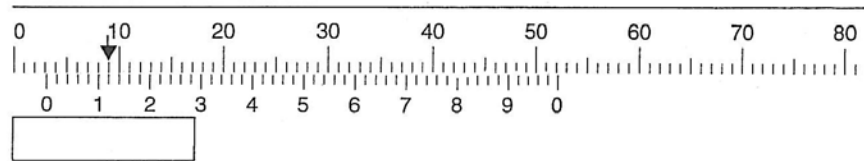
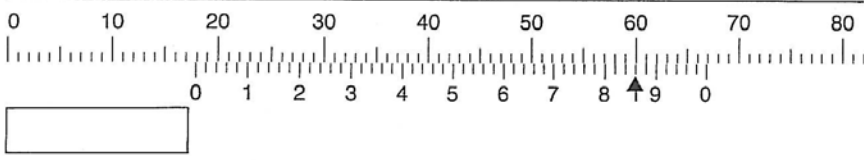
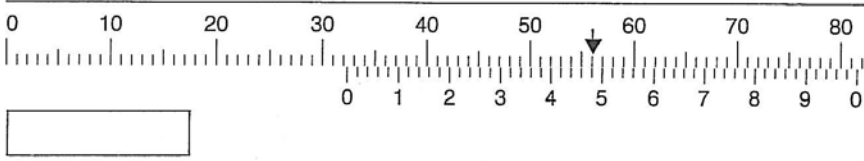
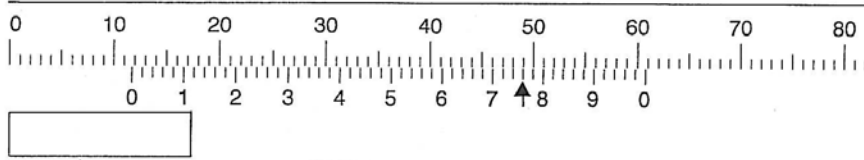
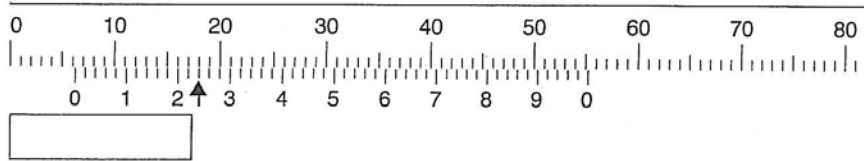
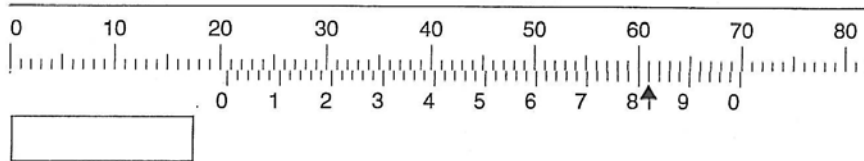
**CRITERION TEST PMI-6**  
**READING VERNIER CALLIPERS**

**NAME:** \_\_\_\_\_ **DATE:** \_\_\_\_\_

**INSTRUCTIONS**

Answer all questions then hand in the completed test to your Instructor / Course Controller.

Complete the readings shown below.



**MARKED BY:** \_\_\_\_\_ **TOTAL OBTAINED:** \_\_\_\_\_



## PROGRAMME PMI-7 METRIC DIAL CALLIPER

### CONTENTS OF PACKAGE

- Video Programme (PMI-7).
- Facilitator Guide.
- Learner Workbook (1 per learner).
- Criterion Test (1 per learner).

### PROGRAMME OBJECTIVE

At the end of this programme each learner will demonstrate his / her ability to use a 0,05 calibrated dial-calliper to measure the following, to a 0,05 mm accuracy.

- Outside dimensions on round and square work.
- Diameter of holes.
- Depth dimensions.

### HOW TO USE THIS PROGRAMME

1. This programme may be used as a "stand-alone" instructional session (e.g. for quality controllers) or integrated into your existing skills training courses.
2. It is important that each learner has a dial-calliper in front of him / her during the video section and whilst performing exercises.
3. A learner is deemed "competent" when he / she gains 100 % in all three criterion test exercises.
4. The procedure of instruction is as follows:
  - 4.1. Learner is given access to the video programme.
  - 4.2. Learner is supplied with 1 X workbook (PMI-7); 1 X 0,05 mm calibrated dial-calliper.
  - 4.3. If necessary a pencil and scrap writing paper.
  - 4.4. Assorted work pieces or objects to measure.
  - 4.5. Learner views video programme.
  - 4.6. Learner performs the necessary practical or theoretical exercise as guided by the workbook.
  - 4.7. The Instructor / Course Controller gives practical "hands-on" assistance as and when necessary.
  - 4.8. The Instructor / Course Controller assesses the results of the learner 's exercises using the model answers provided in this manual.
  - 4.9. The learner, when ready, requests to perform the criterion test.

### THE CRITERION TEST

This test is performed by **each learner** when he / she feels ready.

The test procedure is as follows:

- Ensure learner has a dial-calliper available (must be 0,05 mm graduations).

- Learner s measure the work piece dimensions and record the **total figures only** in the column marked MEASUREMENTS.
- The completed test should be presented for marking to the Instructor / Course Controller.

**NOTE 1:** The **time allowed** per learner on the criterion test is not too important. However, it is suggested that a **maximum** limit of ½ hour be set to complete the test.

**NOTE 2:** Learners who cannot achieve 100 % after 2 attempts should be deemed unsatisfactory or incapable of further precision work.

- The following pages replicate the student exercises and INCLUDE MODEL ANSWERS for your assessment ease.
- Model answers to the criterion tests appear on the last page.

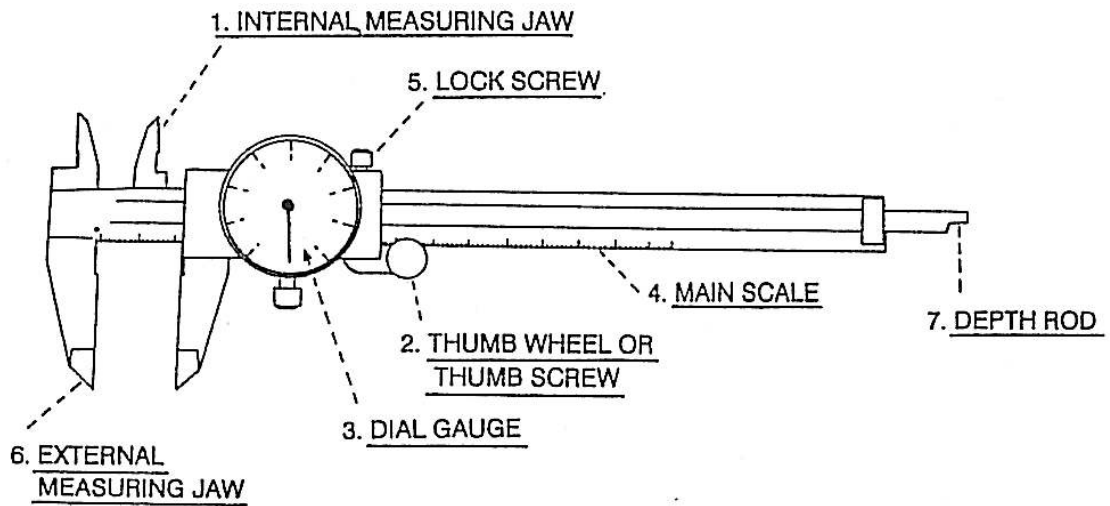
**MODEL ANSWERS**  
**LEARNER EXERCISE 1**  
**THE 0,05 mm DIAL-CALLIPER - PARTS AND PRACTICAL USE**

**INSTRUCTIONS**

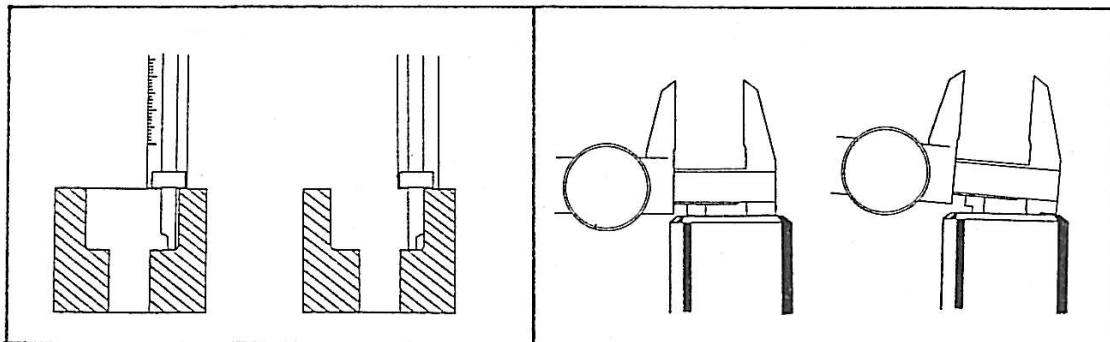
1. Examine a 0.05 mm type dial-calliper.
2. Get to operate the instrument. Open the measuring jaws and watch what happens on the dial-gauge.
3. Practice obtaining the "feel" of the instrument on various work pieces. Try using the outside jaws, the inside jaws and the depth-rod on various objects.

**QUESTIONS**

1. Name the components on the diagram below.



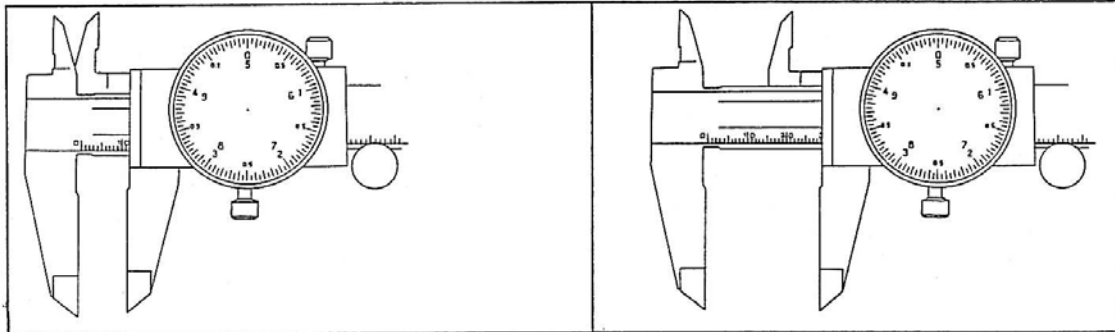
2. Which diagrams below show the correct method of use? (Indicate with a tick below the diagram.)



**MODEL ANSWERS**  
**LEARNER EXERCISE 2**  
**DIAL-CALLIPER - MAIN SCALE / BEAM**

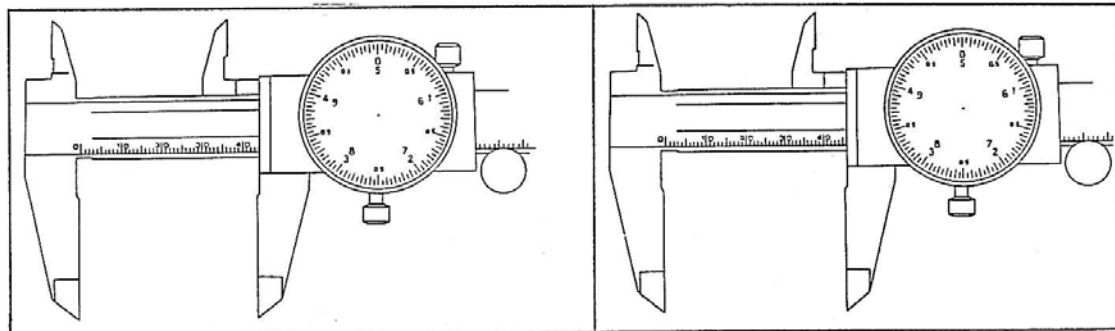
**INSTRUCTIONS**

1. Study the main scale readings for the examples below (To the nearest **full** millimetre).



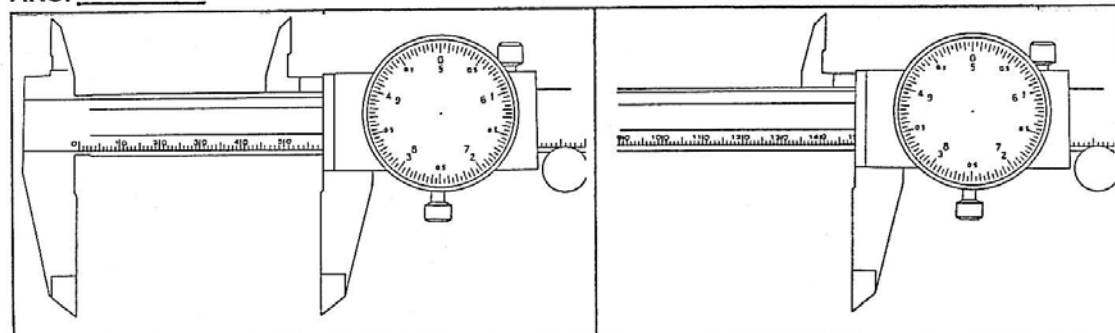
ANS: 12 mm

ANS: 30 mm



ANS: 44 mm

ANS: 46 mm



ANS: 58 mm

ANS: 149 mm

**MODEL ANSWERS**  
**LEARNER EXERCISE 3**  
**READING THE GAUGE**

**INSTRUCTIONS**

1. Slowly open the calliper jaws and observe the movement of the needle around the gauge face.
2. Close the jaws fully -notice where the needle is pointing (it should be at 0).
3. Open the jaws slowly until the needle turns around the face and returns to the top (e.g. zero) again. Now look at the main-scale. What reading do you get?  
.....mm
4. Open the jaws until the needle does another full revolution (back again to zero). Now what reading do you see on the main-scale? .....mm

**QUESTIONS**

1. **One full** revolution of the needle around the dial face represents (how many?)  
**5 Millimetres.**
2. **Two** full revolutions of the needle represent (how many?)  
**10 Millimetres.**
3. How many small divisions are marked between each **full** millimetre?  
**10.**
4. What does each (small) division represent (in millimetres)?  
**0,05.**

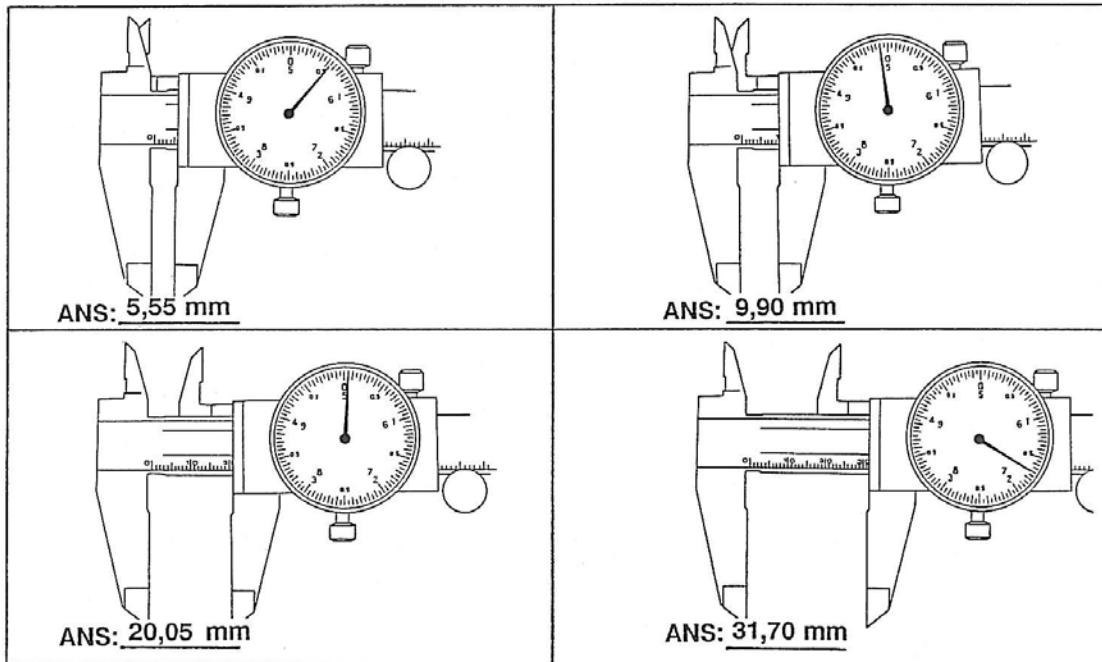
**MODEL ANSWERS**  
**LEARNER EXERCISE 4**  
**TOTAL READING**

**INSTRUCTIONS**

1. Measure objects for which you can obtain the manufacturer's sizes, using your dial-calliper.
2. Compare **your** reading to those given.
3. Ask your Course Controller / Instructor to hand you some objects to measure (for which you do **not** have the specified dimensions). Measure the objects e.g. the width, length, diameter etc, and write your readings on a piece of paper. Have the Instructor then check your results.

**QUESTION**

Write in the full total readings below each diagram.



**MODEL ANSWERS**  
**LEARNER EXERCISE 5**  
**CARE AND ADJUSTMENT**

**INSTRUCTIONS**

1. Check that your dial-calliper reads zero on the dial when the jaws are fully closed.
2. Adjust the needle if necessary as demonstrated on the video programme.

**QUESTIONS**

1. Describe how to "adjust" or "zero" the dial gauge.  
**Ensure jaw faces are clean. Close jaws fully. Needle should be exactly on zero. If not slacken lock-screw and rotate gauge ring until needle aligns to zero. Tighten lock screw.**
2. After use, or before storing the calliper, what must be done?  
**Instrument must be cleaned. Sprayed with an anti-rust and lubricating oil.**
3. Where should the calliper be stored?  
**In its protective case.**

**MODEL ANSWERS**  
**PRACTICAL EXERCISE PMI-7**  
**USING / READING THE 0,05 METRIC DIAL-CALLIPER**

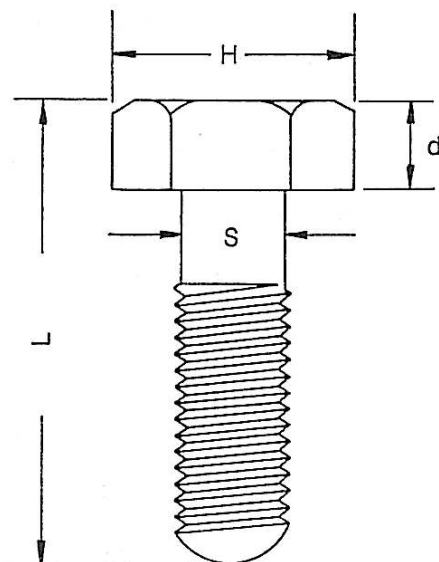
**INSTRUCTIONS**

Using a 0,05 metric dial-calliper measure the indicated dimensions on the various work pieces.

**NOTE:** Your Instructor / Course Controller will hand you the various work pieces on request.

**1. WORK PIECE NO. 1 (BOLT AND NUT)**

Measure and record the indicated dimensions.



**RESULTS**(Typical for 10 mm Bolt)

H = 16,85

d = 7,00

s = 9,85

L = 52,65

D = 8,65

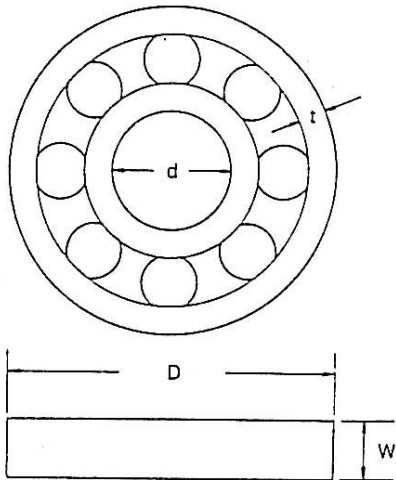
**TOTAL CORRECT**

**HAVE YOUR COURSE CONTROLLER / INSTRUCTOR CHECK YOUR RESULTS.**



## 2. WORK PIECE NO. 2 (BALL BEARING)

Measure and record the indicated dimensions.



**RESULTS**(Write in actual)

D =

d =

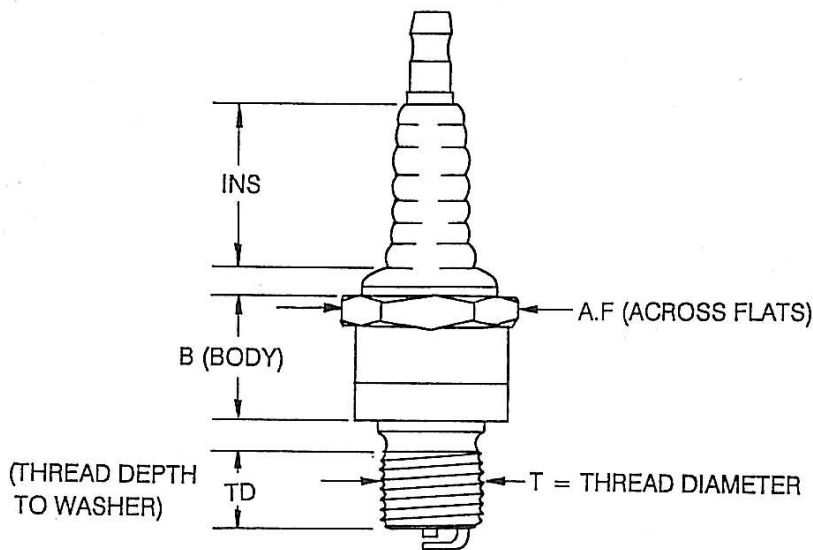
t =

w =

**TOTAL CORRECT**

## 3. WORK PIECE NO. 3 (SPARK PLUG)

Measure and record the indicated dimensions.



**RESULTS**(Typical)

B = 20,30

A.F = 20,60

T = 13,90

TD = 17,25

INS = 25,00

**TOTAL CORRECT**

CHECKED BY: \_\_\_\_\_ OVERALL TOTAL: \_\_\_\_\_

**NOW PERFORM THE CRITERION TEST.**

**CRITERION TEST PMI-7  
CHECK LIST**

**LEARNER:** \_\_\_\_\_ **TEST DATE:** \_\_\_\_\_

**WORK PIECE NO. 1:** (Suggested article - Pre-shaped flat mild steel plate. Approximately 10 X 100 X 50 mm).

ITEM	TOLERANCE	YES	NO
1. Length	Within 0,05 mm		
2. Width	Within 0,05 mm		
3. Thickness	Within 0,05 mm		

**WORK PIECE NO. 2:** (Suggested article - Single piece ball bearing - e.g. 6202 type).

ITEM	TOLERANCE	YES	NO
1. Total diameter	Within 0,05 mm		
2. Internal bore diameter	Within 0,05 mm		
3. Bearing width	Within 0,05 mm		

**WORK PIECE NO. 3:** (Suggested article - Shaft with keyway slot).

ITEM	TOLERANCE	YES	NO
1. Slot width	Within 0,05 mm		
2. Slit depth	Within 0,05 mm		

**COMPETENCY ATTAINED (TICK)**

YES	NO
-----	----

**MARKED / ASSESSED BY:** \_\_\_\_\_

## PROGRAMME PMI-8 THE DIAL TEST INDICATOR

### CONTENTS OF PACKAGE

- Video Programme (PMI-8).
- Facilitator Guide.
- Learner Workbook.

### PROGRAMME OBJECTIVE

At the end of this programme learners will demonstrate their ability to:

- Describe the parts and functions of a typical Dial Test Indicator.
- Read a typical Dial Test Indicator (e.g. 10mm range, calibrated scale 0,01mm).
- Set-up a magnetic base / Dial Test Indicator support.
- Use a Dial Test Indicator to establish lateral run-out to within 0,01 mm on a gear / sprocket facing.

### HOW TO USE THIS PROGRAMME

1. This programme may be used as a "stand-alone" session (e.g. for quality controllers) or integrated into your existing skills training courses.
2. It is important that each learner has a Dial Test Indicator in front of him / her during the video section and whilst performing exercises.
3. A learner is deemed "competent" when he / she gains 100% in criterion test exercises.

### PROCEDURE FOR INSTRUCTION

The procedure for instruction is as follows:

1. Learner is given access to video programme.
2. Learner is supplied with:
  - Learner Workbook (PMI-8).
  - 1 X 0,01mm calibrated Dial Test Indicator (10 or 12mm range).
  - Magnetic base-set.
3. If necessary a pencil and scrap writing paper.
4. Assorted work pieces or objects to measure.
5. Learner views video programme.
6. Learner performs the necessary practical or theoretical exercise as guided by the workbook.
7. The Instructor / Course Controller assesses the results of the learner's exercises using the model answers provided in this manual.
8. The Instructor / Course Controller gives practical "hands-on" assistance as and when necessary.
9. The learner, when ready, requests to perform the criterion test.

### THE CRITERION TEST

1. This test is performed by each learner when he / she feels ready.
2. Ensure the learner has a dial test indicator available (must be 0,01 mm graduations).
3. The completed test should be presented for marking to the Instructor / Course Controller.

**NOTE:** The time allowed per learner on the criterion test is not too important. However, it is suggested that a maximum limit of ½ hour be set to complete the test.

4. Learners who cannot achieve a 100% after 2 attempts may be deemed unsatisfactory or incapable of further precision work.

The following pages replicate the student exercises and INCLUDE MODEL ANSWERS for your assessment.

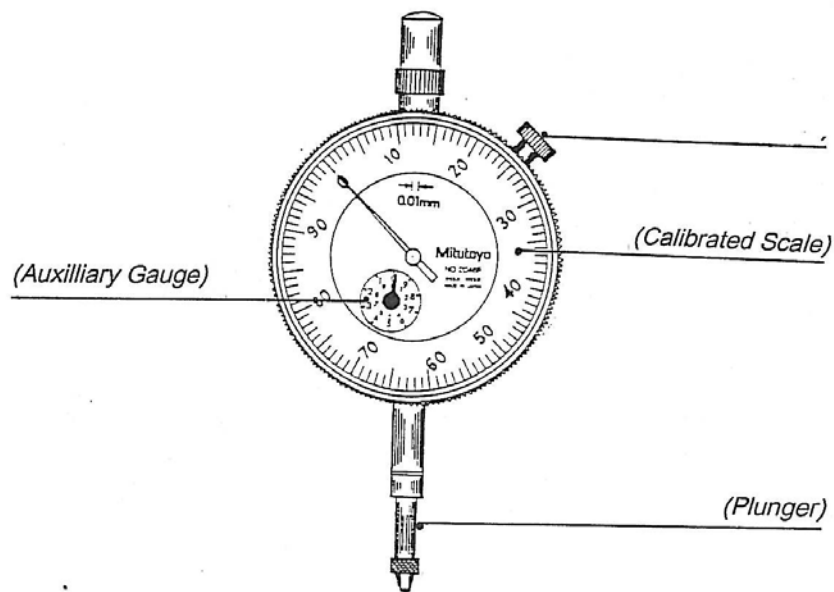
## LEARNER EXERCISE 1 PARTS AND FUNCTIONS

### INSTRUCTIONS

1. View video PMI-8 up to the first "Review Break".
2. Ask your Instructor / Course Controller for a Dial Test Indicator for purposes of visual examination.
3. Using great care examine the instrument then answer the questions below.

### QUESTIONS

1. Write in the part names as indicated on the diagram below.



**NOTE:** Different design features often exist between other manufacturers so look carefully at your instrument and note the differences (and similarities) from the model shown in the video, if applicable.

## LEARNER EXERCISE 2

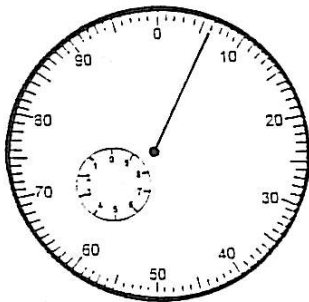
### READINGS UP TO ONE MILLIMETRE

#### INSTRUCTIONS

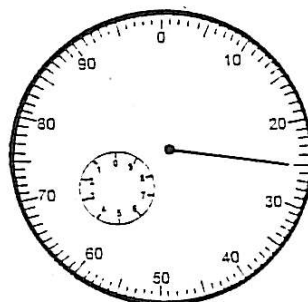
Answer the questions below once you have viewed the video section on "Reading the DTI".

#### QUESTIONS

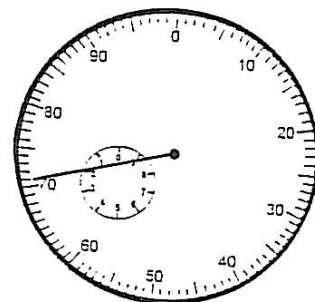
1. On the DTI demonstrated in the video, what effect will a one millimetre movement of the plunger have on the main pointer?  
**It will make it rotate by one revolution around the clock circumference.**
2. What do the (large) numbers, on the calibrated scale, represent?  
**1/0 or 0,10 mm Divisions.**
3. What does one "small division" represent?  
**1/100 or 0,01 mm Divisions.**
4. On the figures below write in the readings observed (NB: Use the main pointer figure only).



0,06 mm.



0,25 mm.



0,71 mm.

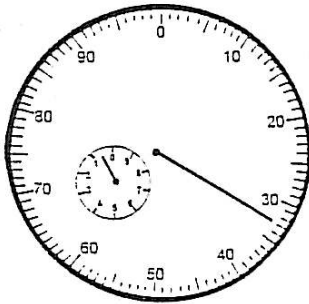
### LEARNER EXERCISE 3 READINGS ABOVE ONE MILLIMETRE

#### INSTRUCTIONS

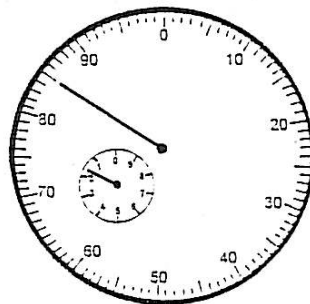
Answer the questions below once you have viewed the video section on "Readings above one millimetre".

#### QUESTIONS

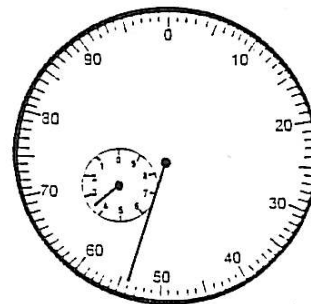
1. What does the "auxiliary gauge" read when (on video demonstration):
  - i) Plunger is fully extended?  
**Just below 0 mm.**
  - ii) Plunger is fully depressed?  
**Just past 0 mm.**
2. What therefore is the "effective" range of our DTI?  
**10mm.**
3. Write the total readings as illustrated in diagrams below.



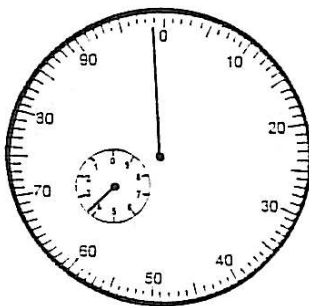
**0,33 mm.**



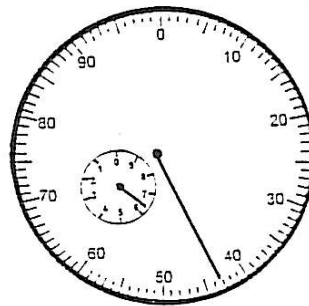
**1,85 mm.**



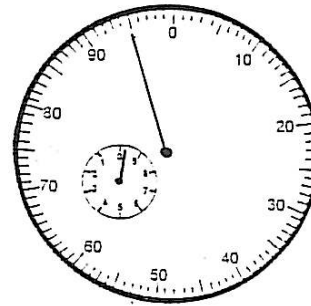
**3,54 mm.**



**3,99 mm.**



**6,43 mm.**



**9,95 mm.**

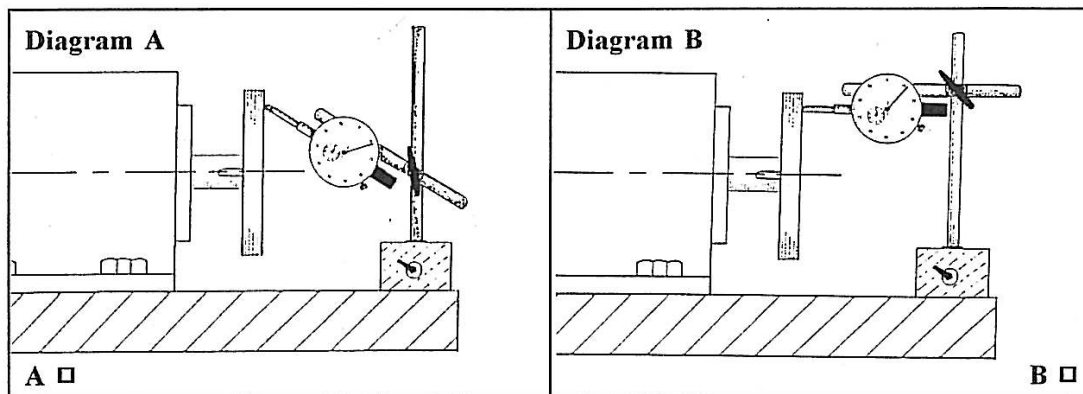
## LEARNER EXERCISE 4 USING THE DIAL TEST INDICATOR

### INSTRUCTIONS

1. Answer the questions listed in the "Question" section then, ...
2. Perform practical exercises in your workplace under the supervision of your Instructor or Course Controller.

### QUESTIONS

1. What important "preparatory" work needs doing before you set-up a DTI?  
**Clean work, component, remove burrs, high-spots etc.**
2. If you are using a magnetic-base / support what must you also do, in preparation for setting up?  
**Ensure surfaces are clean, dry, flat and are suitable for a magnet.**
3. Study the illustrations below. Which of the illustrations (A or B) shows the correct set-up of a DTI? Give reasons for your answer.



- "B" - Because plunger is coincident with expected line of movement.**
4. After "setting-up" your DTI how can you be sure that the plunger is actually contacting the work surface? (Two methods).
    - 1) **Note auxiliary gauge - it will show a reading.**
    - 2) **Lightly tap on DTI's top - pointer should deflect.**



## SUGGESTED PRACTICAL EXERCISES

- Ask your Instructor or Course Controller to provide you with a suitable work example on which you can practice the set-up of a typical DTI, preferably using a magnetic-base (support arrangement).
- When you have completed the set-up then, using the "check list" below, assess the job according to the criteria provided. (Tick Yes or No column).

ITEM	PERFORMANCE	YES	NO
Work piece:	Surfaces clean, free of high-spots, burrs etc.		
Magnetic-base:	Mounted on a clean, dry, flat surface. Firmly attached (i.e. cannot move or rock).		
DTI:	Can easily <b>read</b> the gauge (i.e. good position). Plunger at correct "plane" (i.e. coincident). Plunger contacting work piece.		
Supports:	All clamps, locks, securing screws tightened.		
Verification:	Has your Instructor / Course Controller checked your work.		

## LEARNER EXERCISE 5 TAKING A RUN-OUT READING

### INSTRUCTIONS

1. Answer the questions listed in "question" section. then ...
2. Perform practical exercises in your workplace under the supervision of your Instructor or Course Controller.

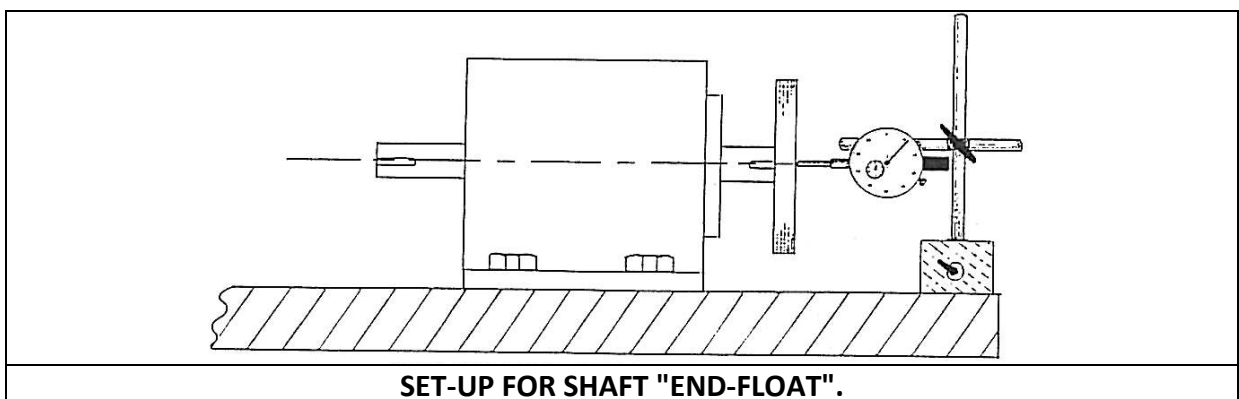
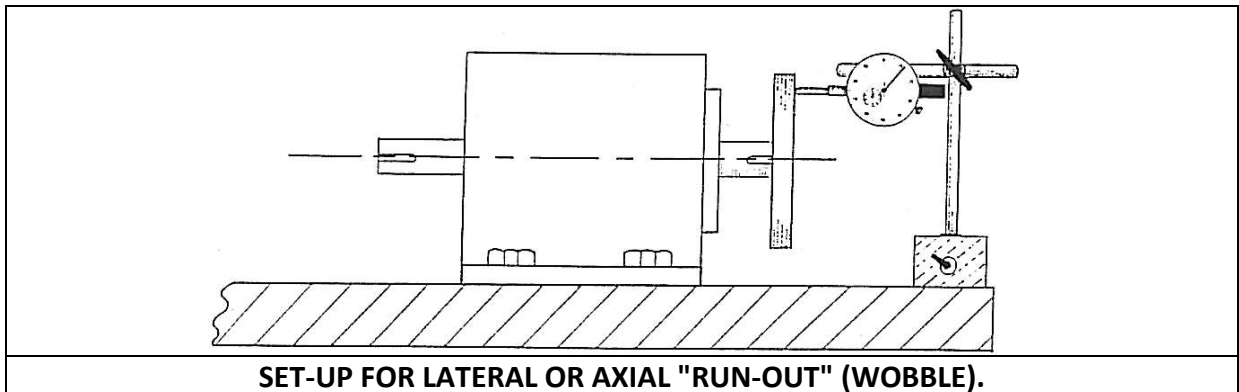
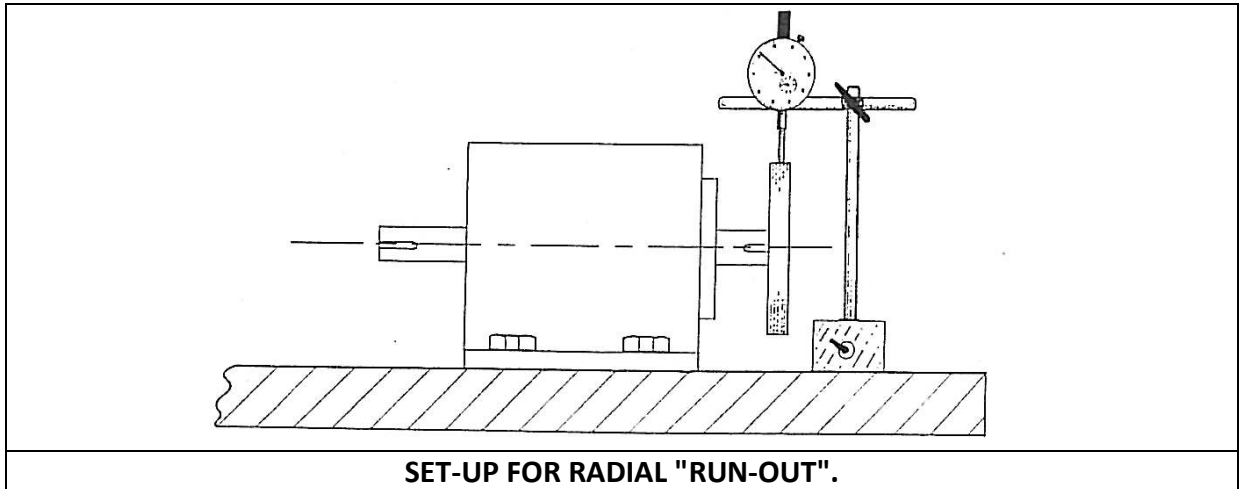
### QUESTIONS

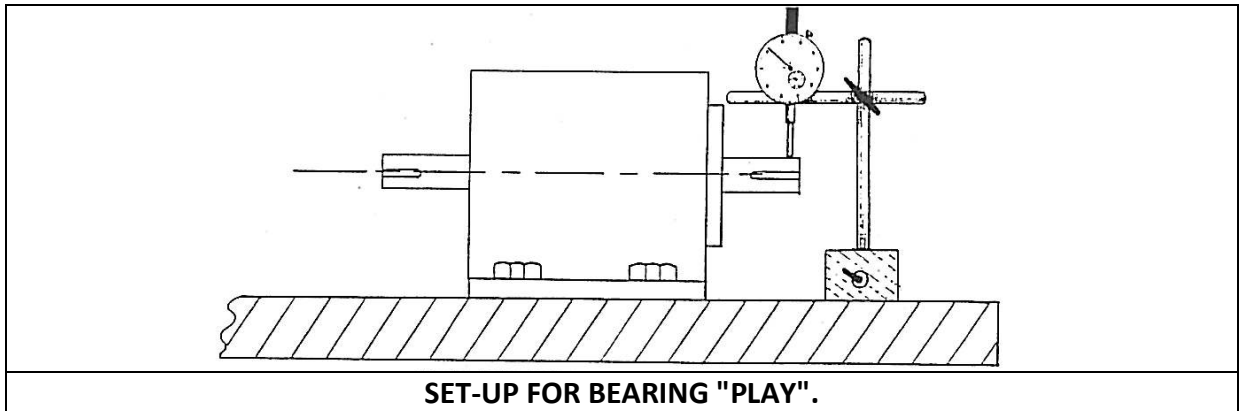
1. What is meant by a "positive" pointer movement (i.e. main pointer)?  
**The pointer turns clockwise.**
2. What do the terms "high reading" or "low reading" mean?  
**The maximum positive and maximum negative pointer movement.**
3. When we have established **where** a "high point" is (on a component facing for example) how do we usually indicate this?  
**By marking (+), with a plus sign.**
4. At which position (on the perimeter of the facing) do we normally "zero" the DTI?  
**On either the (+) or (-) mark.**

### SUGGESTED PRACTICAL EXERCISE

On your previous practical exercise -continue the task by assessing (measuring) run out (i.e. lateral or radial) on your work-face (as applicable).

**NB:** For your reference the diagrams will help explain certain terms which you should be familiar with.





Evaluate your exercise using the check-list below (assuming a lateral or radial run-out exercise).

ITEM	PERFORMANCE	YES	NO
High & Low points:	Points marked on surface of work.		
Zero DTI:	DTI zeroed on high or low point.		
Reading:	Run-out reading assessed to within 0,01 mm.		
Verification:	Your Instructor has checked your reading. Your instructor agrees with your reading.		

## LEARNER EXERCISE 6 CARE AND MAINTENANCE

### INSTRUCTIONS

Answer the following questions.

### QUESTIONS

1. How should a DTI be stored when not in direct use?  
**In its protective container.**
2. What method of cleaning is recommended for the DTI?  
**Wipe with dry, clean cloth.**
3. How can you tell when a DTI has been dropped or "knocked" on its plunger?  
**The plunger will have a "sticky" movement.**
4. What "tools" are necessary for tightening or loosening clamps, lock-screws etc. on a base-set?  
**No tools - hands / fingers only.**

## CRITERION TEST PMI-8

### INSTRUCTIONS

- Ask your Instructor or Course Controller for the relevant exercise involving the measurement of one of the following:
  - Lateral (axial) run-out.
  - Radial (eccentric) run-out.
  - Lateral or vertical end-float.
- Using the appropriate procedures perform the following:
  - Prepare job for measuring.
  - **NB:** This step may involve SAFTEY in respect to ISOLATION; if this is necessary then do not proceed until your Instructor, Supervisor or any responsible person has issued the necessary authority.
- Set-up the DTI with is associated support devise.
- Assess the existence and magnitude of the relevant variance movement.

**CRITERION TEST  
EVALUATION CHECK LIST**

**LEARNER NAME:** \_\_\_\_\_ **TEST DATE:** \_\_\_\_\_

ITEM	PERFORMANCE	YES	NO
Preparation of job.	Work / unit safely isolated (if applicable). Contact surface cleaned / well prepared.		
Set-up (Applicable only to magnetic base-set).	Magnetic-base correctly assembled. Base positioned onto clean, flat steel surface. Unit firmly attached, all clamps secured. Plunger coincident with movement / action. Plunger making "positive" contact (to work).		
Reading / Assessing.	Both high and low points marked. Accurate reading recorded (i.e. to within 0.01 mm).		
Storage / Handling.	Instrument / equipment handled carefully. Equipment packed away after use.		

**INSTRUCTOR / COURSE CONTROLLER** \_\_\_\_\_

is satisfied that this learner has achieved the desired competency in using, reading and caring for the Dial Test Indicator.

**SIGNED:** \_\_\_\_\_