Mechanics

Level-III

Learning Guide-62

Unit of Competence: Perform Advanced Geometric Development

Module Title: Performing Advanced Geometric Development

Module Code: XXXXX

LG Code: XXXXX

TTLM Code: XXXXX

LO1: Measure specifications as required

Instruction Sheet	Learning Guide #62

This learning guide is developed to provide trainees the necessary information regarding the following **content coverage** and topics:

- Introducing to measuring system
- Identifying measuring instruments
- Performing measurements

This guide will also assist trainees to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, trainees will be able to**:

- State measurement
- Identify measuring instruments
- Perform measurements

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described from 3 to 6
3. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3 and Sheet 4".
4. Perform "Operation Sheet 1, Operation Sheet 2, Operation Sheet 3 and Operation Sheet 4 " **in page -10,12,1 and 17.**

Information Sheet 1	Introducing to Measuring system

1.1. Introduction

Measurement is a fundamental part of our lives and used all around us. Everything that is manufactured involves measurement and many measurements are frequently needed to manufacture a single product. Think about it. Look at any object around you and think

about the measurements used to make it. Whenever we refer to distance, weight, dimensions, area, volume, speed, time or temperature, measurement is involved.

1.2. Measuring systems and Instruments

Metric and British system of units are widely used in the world, but currently most part of the world uses metric system.

1.2.1. Units of measurements

There are different units of physical quantities having their own units. The units also called system of international (SI) units.

1.2.2. Important of measurement

The use of measurements is everywhere, both seen and unseen. It is used to describe the dimensions of buildings and furniture, manufacture and sale of products, nutrition information, sport, medical dosage, our weight and height, sale of packaged and loose food products, road signs, energy consumption, mobile phone usage, transport and many other applications of everyday aspects of modern life.

1.2.3. Definition of English/Imperial system

The British imperial system of weight and measures was created by the 1824 Weights and Measures Act. When the act was passed, older measurements were outlawed. As its name suggests, the British imperial system was developed for trade with British colonies within the British Empire. In 1959, the US, which uses its own version of the imperial system called the US Customary System, and the Commonwealth of Nations, which includes the UK, agreed on common definitions for all the imperial measurements still in use. These were all defined in terms of the metric system.

The Imperial system is more complicated than the metric system, as it does not work in multiples of 10 as the metric system does. The Imperial system is used in England and the United States, and you will probably recognize many of the units used.

In the Imperial system the base units are:

- Length, commonly measured in inches (in), feet (ft), yards and miles;
- Time, commonly measured in seconds (s), hours (hr), days (d), weeks and years (yr);
- Weight, commonly measured pounds (lb); and
- Temperature, measured in Fahrenheit (°F).

Note that the Imperial system commonly uses weight, rather than mass. Weight refers to the gravitational pull on an object, whereas mass refers to the amount of matter in the object. An object would have the same mass on the moon as it does on the earth, but it would weight less on the moon as the gravitational pull of the moon is less than the gravitational pull of the earth. Astronauts have the same mass on the moon as they do on the earth, but they can jump higher on the moon because they weigh less there! This difference does not affect us much as all the problems we will be solving assume we are on the earth, but you should be aware of it.

Conversions between the common units of length used in the Imperial system are listed below

12 in = 1 ft , 3 ft = 1 yard 1760 yards = 1 mile

The units of time are generally accepted for use with the metric system, as well as the Imperial system. Conversions between the common units of time are listed below:

• 60 s = 1 min , 24 hrs = 1 day, 7 days = 1 week and 52 weeks = 1 yr

1.2.4. Definition of metric system

The metric system is much easier. All metric units are related by factors of 10.

- Nearly the entire world (95%), now uses the metric system.
- Metric is used exclusively in science.
- Because the metric system uses units related by factors of ten and the types of units (distance, area, volume, mass) are simply-related, performing calculations with the metric system is much easier.

The metric system or SI (International System) is the most common system of measurements in the world, and the easiest to use. The base units for the metric system are the units of:

- Length, measured in meters (m);
- Time, measured in seconds (s);
- Mass, measured in grams (g); and
- Temperature, measured in Celsius (°C).

In the metric system, prefixes are used to describe multiples or **fractions** of the base units. The most common metric system prefixes are:

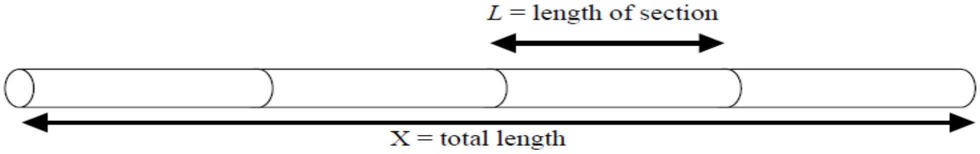
- nano (n)......................./ 100,000,000 = 10^{-9}
- micro (µ)........................./ 1,000,000 = 10^{-6}
- milli (m)................................/ 1,000 = 10^{-3}
- centi, (c).................................../ 100 = 10^{-2}
- deci (d)....................................../ 10 = 10^{-1}
- deca (da)....................................x 10 =10^{1}
- hecto (h)...................................x 100 = 10^{2}
- kilo (k)...................................x 1,000 = 10^{3}
- mega (M).........................x 1,000,000 =10^{6}
- giga (G)....................x 1,000,000,000 =10^{9}

Using the base unit for length:

- 1 nanometer (nm) = 1 m / 100,000,000 = 0.000 000 001 m
- 1 micrometer (µm) = 1 m / 1,000,000 = 0.000 001 m
- 1 millimeter (mm) = 1 m / 1,000 = 0.001 m
- 1 centimeter (cm) = 1 m / 100 = 0.01 m
- 1 decimeter (dm) = 1 m / 10 = 0.1 m
- 1 decameter (dam) = 1 m x 10 = 10 m
- 1 hectometer (hm) = 1 m x 100 = 100 m
- 1 kilometer (km) = 1 m x 1,000 = 1,000 m
- 1 megameter (Mm) = 1 m x 1,000,000 = 1,000,000 m
- 1 gigameter (Gm) = 1 m x 1,000,000,000 = 1,000,000,000 m

LENGTH

N = number of sections



Units of Measurement:

Metric (SI):

- mm = millimeters
- cm = centimeters
- m = meters
- km = kilometers

Imperial:

- in. = inches
- ft = feet
- yards
- miles

Conversion:

Metric (SI):

1 cm = 10 mm

- cm x 10 = mm
- mm x 0.1 = cm

Metric to Imperial (and back):

1 in = 2.54 cm

- cm x 0.393 7 = inches
- inches x .54 = cm

ENGLISH SYSTEM	METRIC SYSTEM

1. Units of Distance

English system:

12 in = 1 ft
3 ft = 1 yd
1760 yds = 1 mi
5280 ft = 1 mi

Metric system:

10 mm = 1 cm
100 cm = 1 m
1000m = 1 km
(basic units are m or km)

(English-Metric conversions: 1 inch = 2.54 cm; 1 mile = 1.61 km)

2. Units of Area

English system:

144 in^2 = 1 ft^2
43,560 ft^2 = 1 acre
640 acres = 1 mi^2

Metric system:

10,000 cm^2 = 1 m^2
10,000 m^2 = 1 hectare
100 hectare = 1 km^2
(basic units are m^2 or km^2)

(English-Metric conversions: 1 in^2 = 6.45 cm^2; 1 mi^2 = 2.59 km^2)

3. Units of Volume

English system:

57.75 in^3 = 1 qt
4 qt = 1 gal
42 gal (petroleum) = 1 barrel
32 qt = 1 bushel

Metric system:

1 cm^3 = 1 ml
1000 ml = 1 liter
1000 liter = 1 m^3

(basic units are liters or m^3)

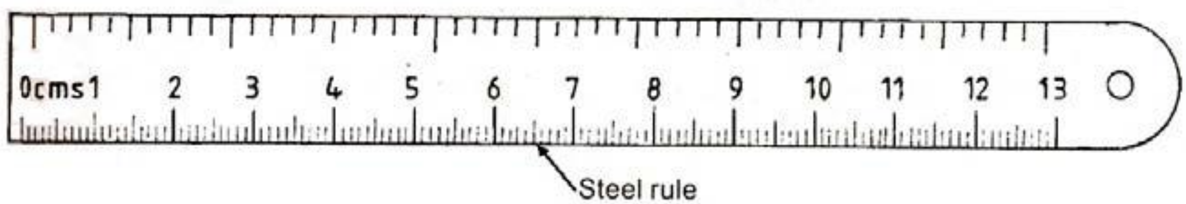
(English-Metric conversions: 16.39 cm^3 = 1 in^3; 3.79 liters = 1 gal)

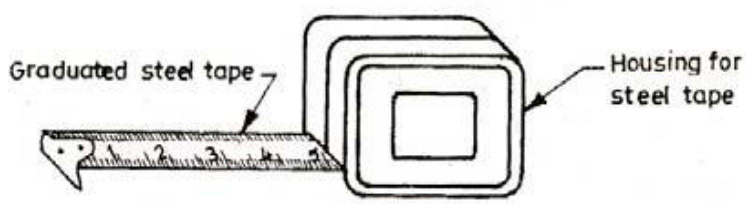
1.3. MEASURING INSTRUMENTS

1.3.1. Steel Rule and Steel tape

Steel rule is a simple measuring instrument consisting of a long, thin metal strip with a marked ***scale of unit divisions***. It is an important tool for linear measurement. **Steel tape is** used **for large measurements**, such as marking on boards and checking the overall dimensions of the work.

It is one of the most useful tools for taking linear measurements of blanks and articles to an accuracy of range from **1.0 to 0.5 mm.** It consists of a strip of hardened steel having line graduations etched or engraved at interval of fraction of a standard unit of length. Depending upon the interval at which the graduations are made the scale can be manufactured in different sizes and styles.

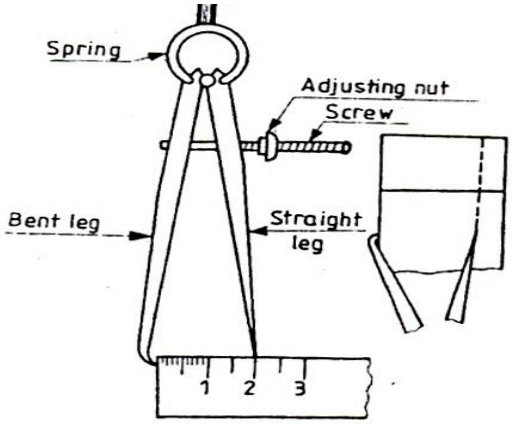


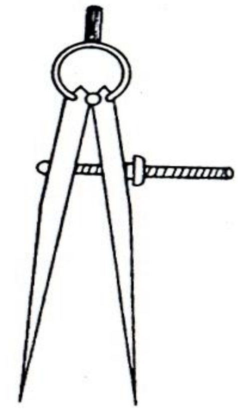


1.3.2. Divider

The tool is used for transferring dimensions. Scribing circles and doing general layout work. In practice one point is placed in the centre top making the exact centre, and the *circle or arc may then be scribed on the joint with the other poin*t. The size is measured by the greatest distance it can be opened between the leap.

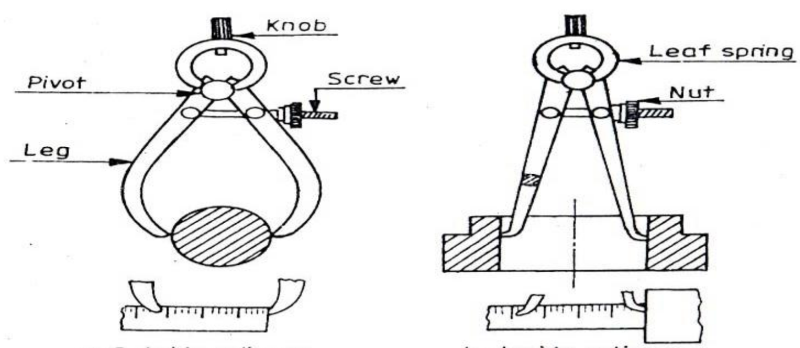
Thus a 100 mm divider open 100 mm between the points. Steel scale must also be used with this instrument.





1.3.3. **Calipers**

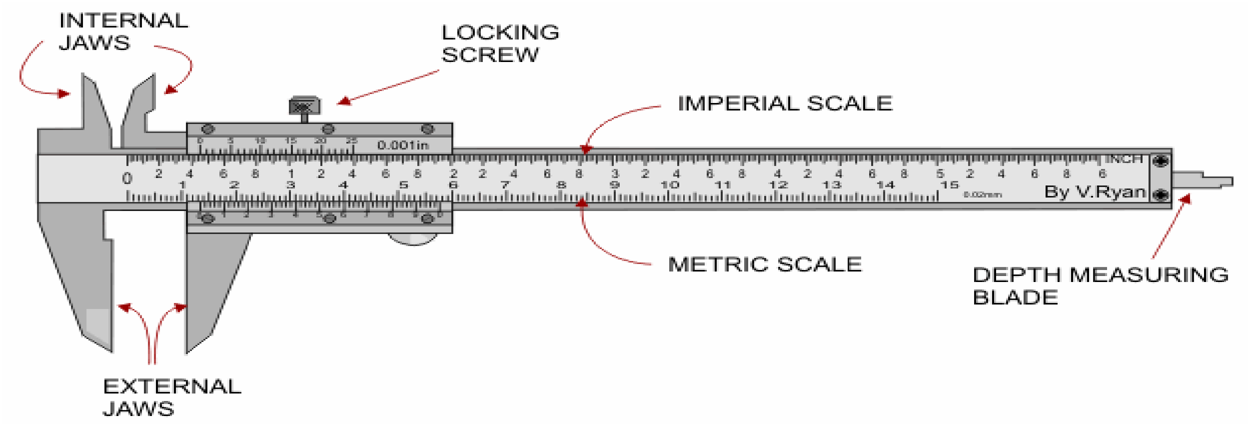
They are indirect measuring tools used to measure or transfer linear dimensions. These *are used with the help of a* steel Rule to check inside and outside measurements. These are made of Case hardened mild steel or hardened and tempered low carbon steel. While using, but the legs of the caliper are set against the surface of the work, whether inside or outside and the distance between the legs is measured with the help of a scale and the same can be transferred to another desired place. These are specified by the length of the leg. In the case of outside caliper, the legs are bent inwards and in the case of inside caliper, the legs bent outwards.



a–Outside calipers   b–Inside calipers

1.3.4. Vernier Calipers

It is primarily used for measuring both **inside and outside** diameters of **shafts, thickness,** of parts, etc. to an **accuracy** of about **0.02 mm** by a **vernier scale** attached to the **caliper**. **A** vernier scale is the name given to any scale making use of the difference between two scales which are nearly, but not quite alike, for obtaining small difference. The instruction comprises of a beam or main scale which carries the fixed graduations. Two measuring jaws, a vernier head having a vernier scale engraved on it and an auxiliary head of a vernier clan which is used for a specific dimension by a micrometer screw. The vernier head and the auxiliary head can be locked to the main scale by the knurled screw.



Using the vernier calliper

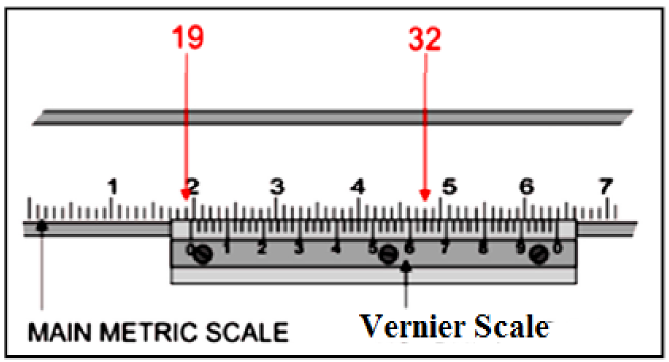
1. Before measuring, close jaws and check that **main scale zero mark** lines up exactly with **vernier scale zero mark.**
2. Adjust jaws.
3. You may need to gently "rock" the jaws to get the right feel – not too tight, not too loose.
4. ***Lock the slide.***
5. Read number of whole millimetres on main scale, before the vernier zero
6. Look for a vernier scale graduation which lines up exactly with any graduation on the main scale
7. Read fraction number on vernier scale where the marks line up
8. Add fraction to whole millimetres to get final measurement.

Ex. 1 How to read a vernier caliper?

➤ First, read the graduation on main scale just before vernier scale starts (i.e. 19th graduation which gives **19 mm**)

➤ Next, read the graduation on vernier scale where two graduation lines on main & vernier scales perfectly match (i.e. 32nd graduation which gives 32 * 1/50 = **0.64 mm**)

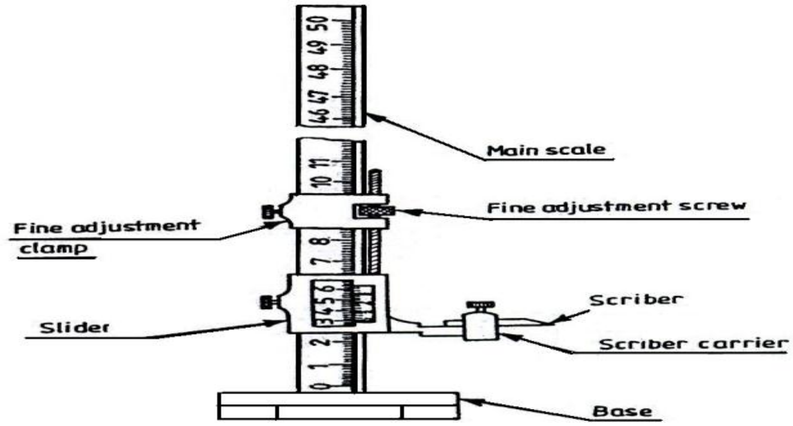
➤ Finally, add fine reading into main reading (i.e. 19 + 0.64 = **19.64 mm**)



1.3.5. Vernier Height Gauge

- The Vernier Height gauge clamped with a **scriber**.
- It is used for **Lay out work** and **offset scriber is used** when it is required to take measurement from the surface, on which the gauge is standing.
- The **accuracy (0.02mm)** and **working principle** of this gauge are the same as those of the **vernier calipers**.
- Its size is specified by the maximum height that can be measured by it.

- It is made of Nickel- Chromium Steel.



1.3.6. Micrometer

- **The** micrometer is primarily used to measure dimensions like **diameters of shafts, screw threads, diameter of holes, thickness of parts** etc. to an **accuracy of 0.01 mm.** The frame is made of steel, cast steel, malleable cast iron or light alloy.
- A **micrometer** generally provides greater precision than a caliper.
  - Use to take very accurate measurements
  - Micrometers look different but all use the same principle. Example,
    1. Outside micrometer
    2. Inside micrometer
    3. Depth micrometer
- A standard micrometer has a screw thread of 0.5 mm pitch with a thimble graduated in fifty (50) equal divisions around its circumference. That is the thimble has fifty divisions; therefore a rotation of one division of the thimble scale produces a change in gap between the measuring faces of a fiftieth of 0.5 mm; *equal to 0.01 mm*.
- Each thimble graduation therefore equals **one hundredth of** a millimetre (**0.01mm= 1/100**).

Size ranges of Micrometer

Micrometers are manufactured in size ranges of 0 mm to 25 mm, 25 mm to 50 mm, 50mm to 75mm ………, 575 mm to 600 mm *etc*.

Operation Sheet 2	Reading Micrometer

As an example,

you would measure a dimension of **19.45** mm with a **0 mm to 25** mm micrometer and a dimension of **580.25** mm with a **575 mm to 600** mm micrometer.

External micrometer

- **External/outside** micrometer is one of the most widely used **precision instruments**. It is primarily used to measure external dimensions like diameters of shafts, thickness of parts etc. to an accuracy of **0.01 mm**.
- If the micrometer has a vernier scale, Metric outside micrometers read in thousandths of a millimeter; (**0.001mm**).
  - It Measures width and length.
- Used for precise measurements eg. reconditioning an engine, measuring pistons, valves, crankshafts etc.

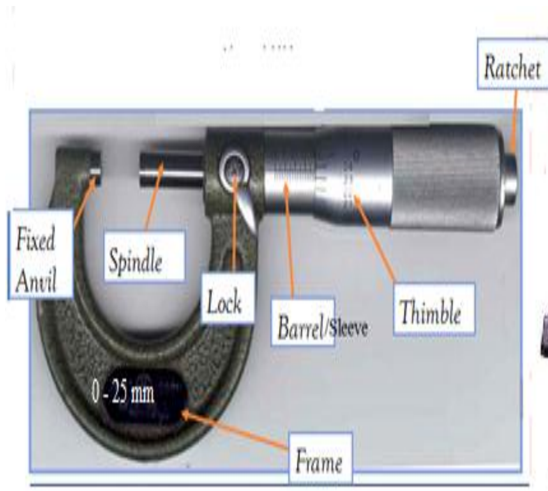


Fig. Spanner

Fig. Parts of outside micrometer

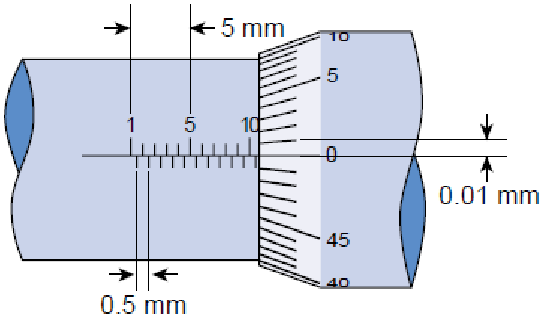


Fig. Metric Micrometer markings and graduations

Micrometer Adjustments

a) Removing Play

- Back off the thimble.
- Insert a **C-spanner** into slot or hole of adjusting nut.
- Turn adjusting nut clockwise until play between threads is eliminated.

b) Adjusting Accuracy

- Clean measuring faces and check for damage.
- Closes faces.
- Turn sleeve until index line on sleeve matches zero (0)

Recheck accuracy by opening and closing faces. Rating should be zero (0). line on thimble.

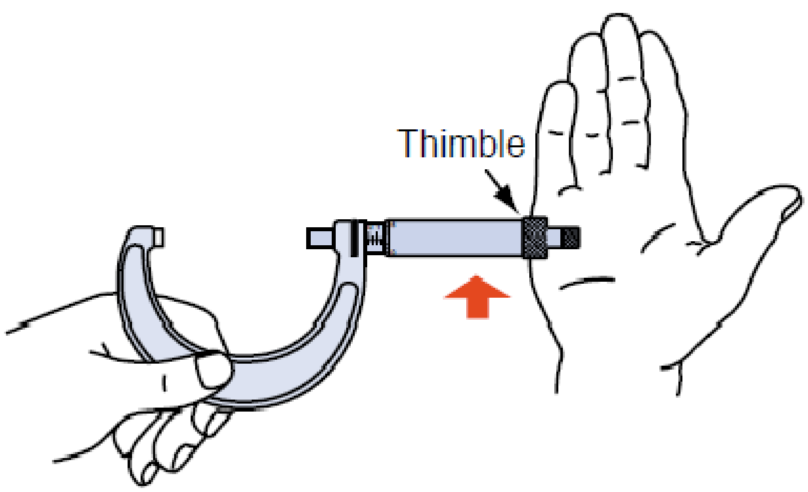


Figure. Roll the thimble on your hand for long spindle movements.

Operation Sheet 3	Procedure for Reading in a Micrometer

Procedure for Reading in a Micrometer

The graduation on the barrel is in two parts divided by a line along the axis of the barrel called the reference line. The graduation above the reference is graduated in 1 mm intervals. The first and every fifth are long and numbered 0, 5, 10, 15, etc. The lower graduations are marked in 1 mm intervals but each graduation shall be placed at the middle of the two successive upper graduations to be read 0.5 mm.

The thimble advances a distance of 0.5 mm in **one complete rotation**. It is called the **pitch** of the **micrometer**. The thimble has a scale of 50 divisions around its circumference. Thus, one smallest division of the circular scale is equivalent to longitudinal movement of 0.5 x 1/50 mm = 0.01mm. It is the least count of the micrometer.

Least Count of micrometer:-

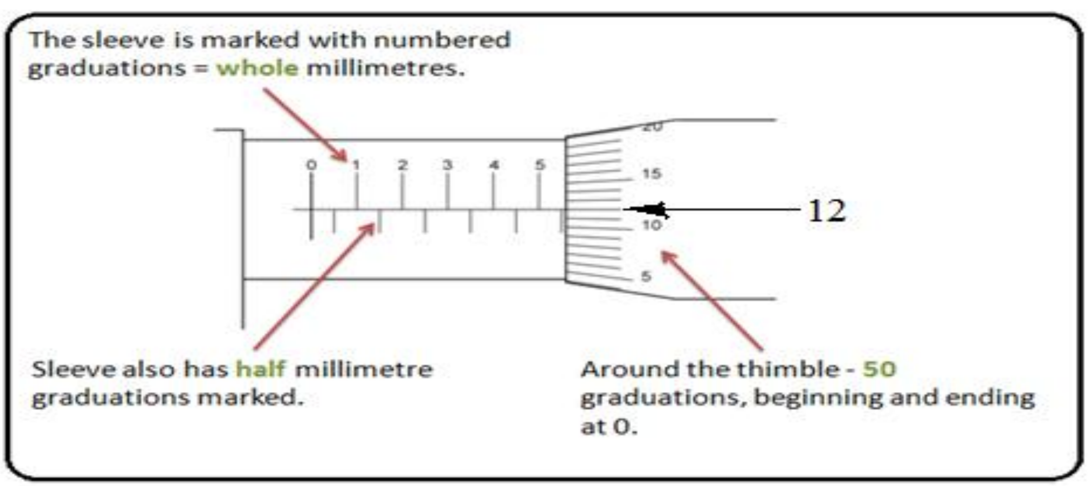
- L.C. = smallest division on main scale

No. of division on vernier scale

- = 0.5 / 50
- = 0.01mm.

Example: 1 To take a reading from the outside micrometer, (range 0 to 25 mm)

(1) The number of main divisions in millimeters above the reference line, (see fig. bellow)

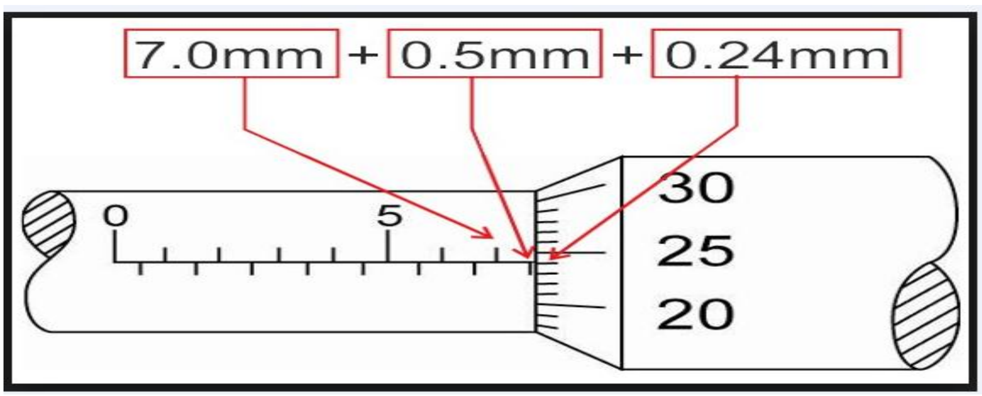


(2) the number of sub-divisions below the reference line exceeding only the upper graduation,

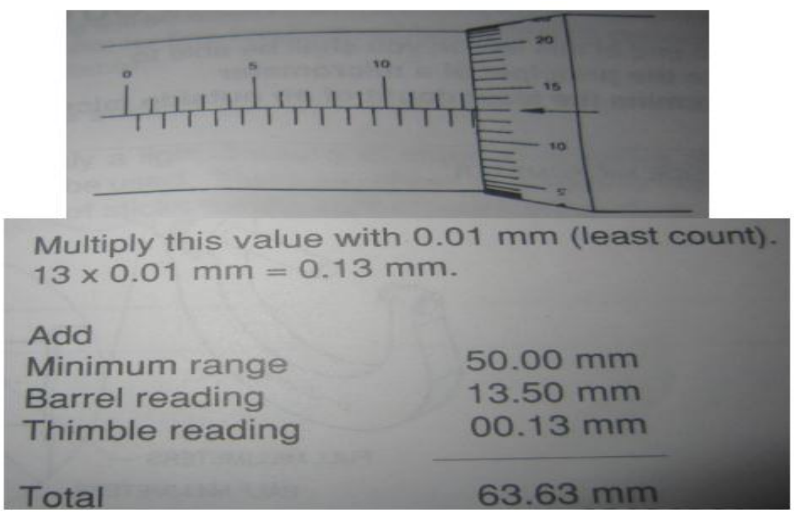
(3) the number of divisions in the thimble have to be noted down. For the above figure of micrometer shows a reading of **5.62** mm when:

5 divisions above the reference line	= 5 .00 mm
1 division below the reference line	= 0.50 mm
12 thimble divisions = 12 x 0.01	= 0.**12** mm
	5.62 mm

Example 2



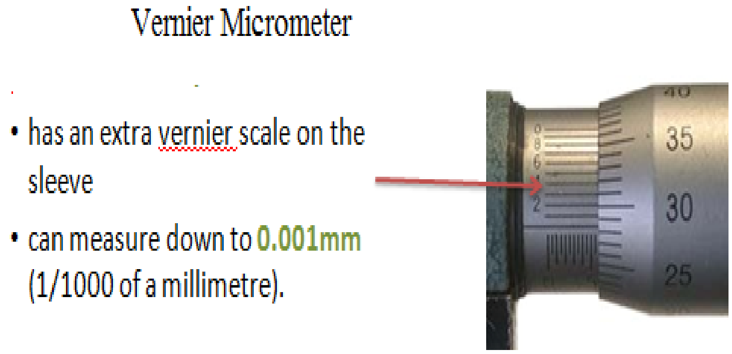
Example. 3 Reading outside micrometer with a **range of 50 to 75** mm. (see figure bellow)



Multiply this value with 0.01 mm (least count).
13 x 0.01 mm = 0.13 mm.

Add	
Minimum range	50.00 mm
Barrel reading	13.50 mm
Thimble reading	00.13 mm
Total	63.63 mm

Question- Sketch the **micrometer** reading which indicates **8.78mm**. (if the range of micrometer is **25-50** mm, what is the total reading?



Operation Sheet 4	Procedure for Reading in VERNIER MICROMETER

1.3.7. VERNIER MICROMETER

i) Calculating Least Count of Vernier Micrometer

10 vernier division = **9** thimble divisions

= **9 x 0,01 = 0.09** mm thimble scale

The value of one vernier division = 0.09/10 = 0.009 mm

Least count = 1 thimble division – 1 vernier division

= 0.01mm – 0.009mm = 0.001 or **1/1000** mm is the **accuracy**.

ii) Reading of vernier mcrometer

1. Rread the number of **whole millimetres** visible on the datum line.
2. Read half milimeter scale.
3. Read thimble graduation and multiply **by 0.01mm**.
4. Read **vernier graduation** that **coincide** with **thimble graduation** and multiply by **0.001mm**.
5. **Add** the steps from **1 up to 4**.

Example. Look at the following figure. (The **range** of micrometer is **0 to 25** mm)

Answer (see the above figure)

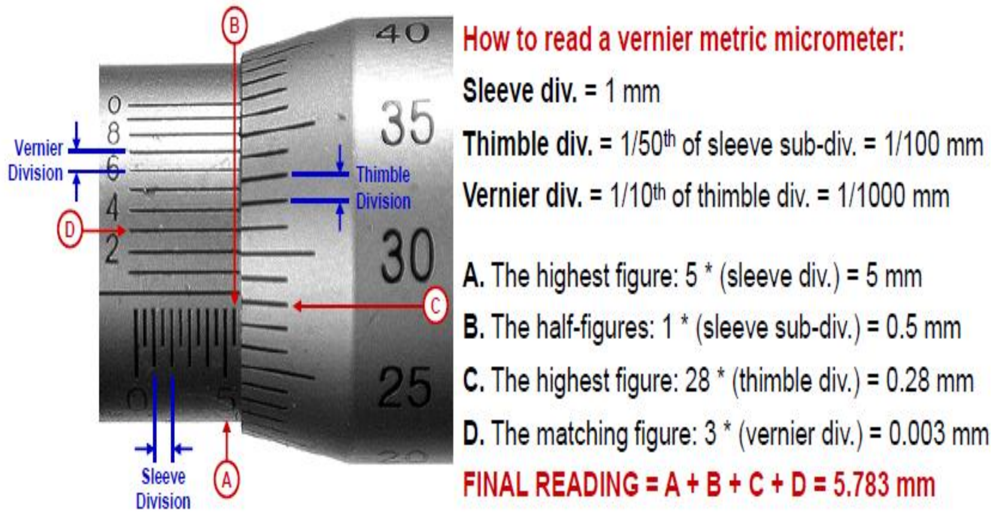
a) Full mm division visible before thimble edge = **15.000 mm**

b) half mm division before visible after full mm division = **0.000**

c) Thimble division **before the index line** = **22 x 0.01mm** = **0.220mm**

d) vernier division coinciding with thimble division, = **3 x 1/1000** = **0.003mm**

e) **Total reading = 15.223mm**



1.3.8. Inside Micrometer

An inside micrometer, also known as an internal micrometer, is a precision instrument for measuring the inside dimension of an object, such as the diameter of a hole or the width of a groove. Though they both take the same kind of measurements, micrometers are adjusted via a screw mechanism while calipers use a pivot point or a slide mechanism. A caliper inside micrometer measures with a pair of movable jaws, while tubular- or rod-style inside micrometers use cylinders or rods with horizontal extensions.

The inside micrometer is intended for internal measurement to an accuracy of 0.01 mm. In principle, it is similar to an external micrometer and is used for measuring holes with a diameter over 50 cm. It consists of:

(a) measuring unit

(b) extension rod with or without spacing collar, and (c) handle.

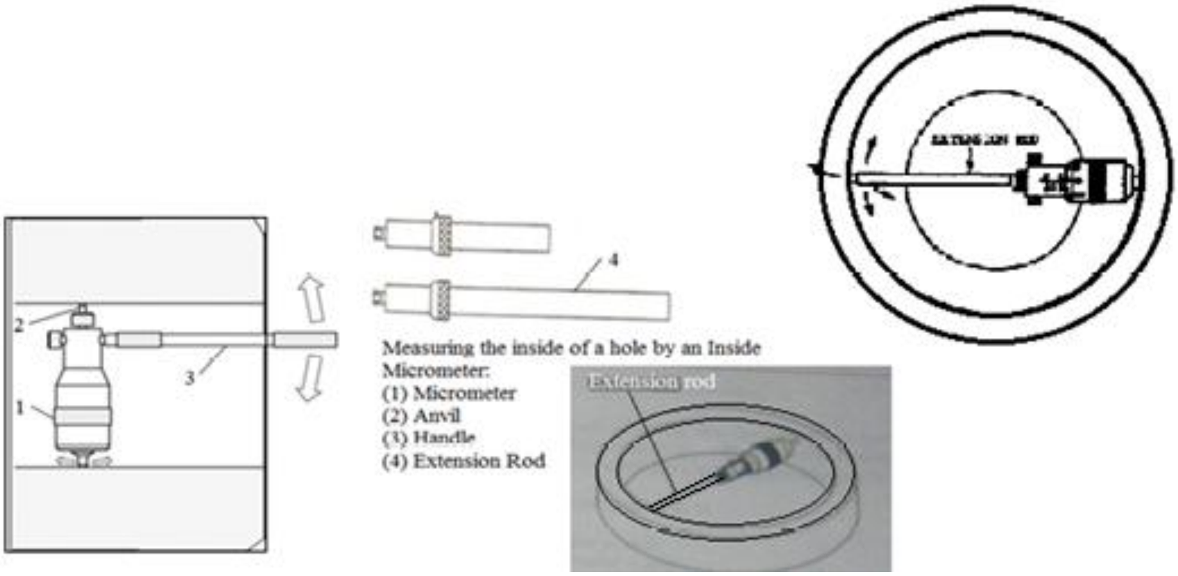


Fig Using Inside micrometer.

An inside micrometer can be used to measure cylinder bores and rod bearing bores. Inside micrometer have extension rods to make them the proper size. They have handles for use in deep cylinder.

Total measurement or reading = barrel or sleeve graduation + thimble graduation + rod length

The measuring screw has a pitch of 0.5 mm. The barrel or sleeve is provided with a scale of 25mm long

and graduated into half-millimeter and millimeter divisions as in the external micrometer. A second scale is engraved on the beveled edge of the thimble. The beveled edge of the thimble is divided into 50 scale divisions round the circumference. Thus, on going through one complete turn, the thimble moves forward or backward by a thread pitch of 0.5 mm, and one division of its scale is, therefore, equivalent to a movement of 0.5 x 1/50 = 0.01 mm. Inside micrometer measures the inside of holes or bores diameter.

- The correct way to measure an inside diameter is to hold the micrometer in place with one hand and "feel" for the maximum possible setting of the micrometer by rocking the extension rod from left to right and in and out of the hole. The micrometer is adjusted to a slightly larger measurement after each series of rocking movements until no rocking from left to right is possible and a very slight drag is felt on the in and out rocking movement.

Extension rods are available in the range of 25 -50 mm,50 – 200 mm, 50 – 300 mm, 200 mm -500 mm, 200 – 1000 mm.

For example. to read Inch system inside micrometer; look at the figure below**.**

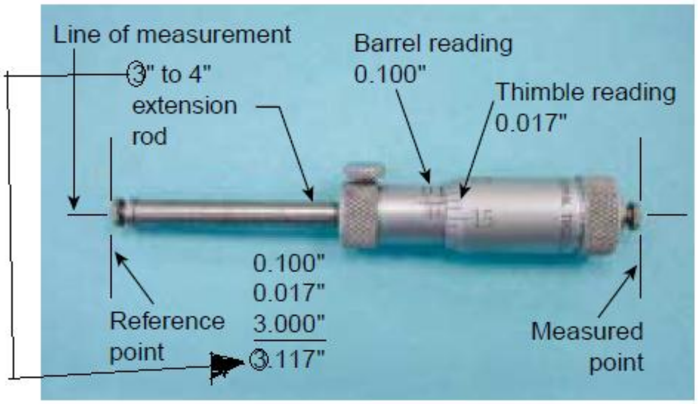
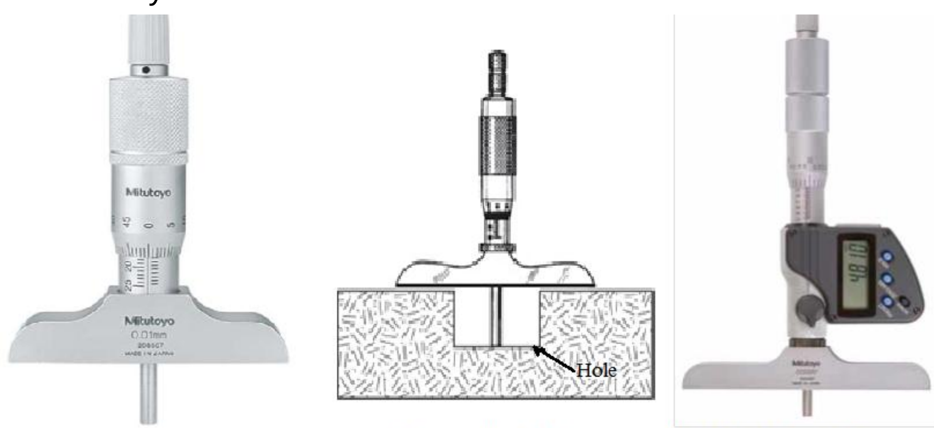


Figure Taking an inside micrimeter measurement

1.3.9. Depth micrometer

A depth micrometer has a flat base attached to the barrel of a micrometer head. Like the inside micrometer, the depth micrometer uses extension rods in a range of sizes.

Depth micrometers can take several kinds of distance measurements. You can use them to measure the depth of a very small diameter hole.



Depth micrometer

Measuring hole depth

Digital depth micrometer

Fig. Digital depth micrometer

- A depth micrometer is used to measure the depth of holes, slots, counter bores, recesses, and the distance from a surface to some recessed part. This type of micrometer is read exactly opposite to the method used to read an outside micrometer. The zero is located toward the closed end of the thimble. The measurement is read in reverse and increases in amount (depth) as the thimble moves toward the base of the instrument. The extension rods come either round or flat (blade like) to permit measuring a narrow, deep recess or groove.

Single rod type depth micrometer

The single rod type depth micrometer (figure above) consists of a micrometer head, spindle and base. The construction of the sleeve and the thimble is the same as that of a standard outside micrometer, but the graduations are given in the reverse direction. The typical measuring range is 25 mm. The end face of the spindle serves as the measuring face. The base is of hardened steel.

Since the bottom face of the base is used as a reference face, it is precision lapped to high degree of flatness.

Interchangeable rod type depth micrometers

An interchangeable rod passes through the spindle and the base. The rod has a precision lapped measuring face on one end. The other end of the rod is fixed to the spindle. The method of clamping the rod to the spindle depends on the manufacturer, for example, using a rod collar and setscrew or pressing the ratchet stop screw against the rod end.

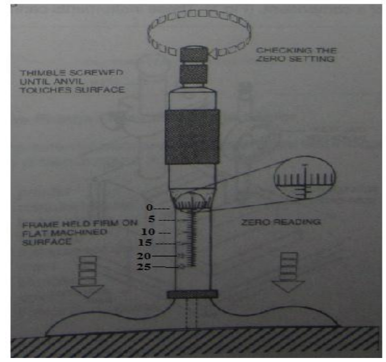
Interchangeable rods of various lengths are available in 25 mm increments and these can be easily fitted to achieve the desired measuring length.

The standard measuring range is 0 mm to 150 mm

although rods are available to measure to a depth of up to 300 mm.

Note: Actual reading is hidden by thimble.

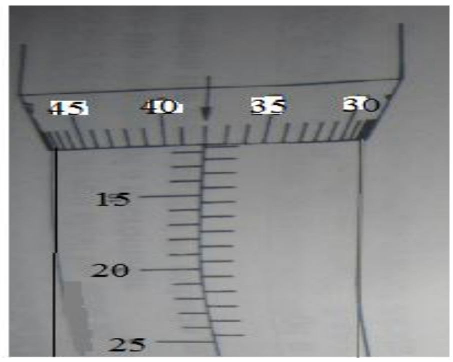
Fig. Interchangeable rod depth micrometer



Reading of Depth Micrometer

1) Inside thimble; mm reading = 11.00 mm.
2) Sud division inside thimble = 0.00
   B/c it is near to 0.5 mm
3) Thimble reading = 38 x 0.01 = 0.38 mm

Total **11.38 mm**



1.3.10. Dial indicators

A variation of the micrometer is the dial indicator, which measures variations in a surface by using an accurately machined probe mechanically linked to a circular hand whose movement indicates thousandths of an inch, or is displayed on a liquid crystal display (LCD) screen.


Starrett

1.3.11. Standard Gauges

Gauge sizes are numbers that indicate the thickness of a piece of sheet metal, with a **higher number** referring to a **thinner sheet**. The equivalent **thicknesses** differ for each gauge size standard, which were developed based on the weight of the sheet for a given material.

Table: Gauge size and chart of Steel

Gauge size standard: Standard steel

	Thickness		Weight Per Area	
Gauge	in	mm	lb/ft²	kg/m²
3	0.2391	6.073	9.754	47.624
4	0.2242	5.695	9.146	44.656
5	0.2092	5.314	8.534	41.668
6	0.1943	4.935	7.927	38.701
7	0.1793	4.554	7.315	35.713
8	0.1644	4.176	6.707	32.745
9	0.1495	3.797	6.099	29.777
10	0.1345	3.416	5.487	26.790
11	0.1196	3.038	4.879	23.822
12	0.1046	2.657	4.267	20.834
13	0.0897	2.278	3.659	17.866
14	0.0747	1.897	3.047	14.879
15	0.0673	1.709	2.746	13.405
16	0.0598	1.519	2.440	11.911
17	0.0538	1.367	2.195	10.716
18	0.0478	1.214	1.950	9.521
19	0.0418	1.062	1.705	8.326
20	0.0359	0.912	1.465	7.151
21	0.0329	0.836	1.342	6.553
22	0.0299	0.759	1.220	5.955

Fig. Measuring using sheet metal gauge

Mechanics

Level-III

Learning Guide-63

Unit of Competence: Perform Advanced Geometric Development

Module Title: Performing Advanced Geometric Development

Module Code: XXXXX

LG Code: XXXXX

TTLM Code: XXXXX

LO2: Mark off/out fabrications

Instruction Sheet	Learning Guide #63

This learning guide is developed to provide trainees the necessary information regarding the following **content coverage** and topics:

- Introducing to marking out fabrications
- Determining Specifications
- Carrying out development
- Datum points
- Determining allowances

This guide will also assist trainees to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, trainees will be able to**:

- State basics of marking out fabrications
- Determine Specifications
- Carry out development
- Datum points
- Determine allowances

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described from 1 to 3
3. Read the information written in the information "Sheet 1

Information Sheet 1	Introducing to Marking Off/Out fabrications

2.1 Introduction

Marking out is defined as a process of transferring a design, layout or dimensions from the drawing to a work-piece, and it is considered as the first step in the manufacturing process. **Marking out and measuring** is a critical part of manufacturing and is usually subject to a number of quality control checks. If components are marked out and measured wrongly, confirm before being cut out, there is no chance of them fitting together when they are assembled.

Always take marking out measurements from a datum. A **datum** edge is a flat face or straight edge from which all measurements are taken. This prevents cumulative errors being made.

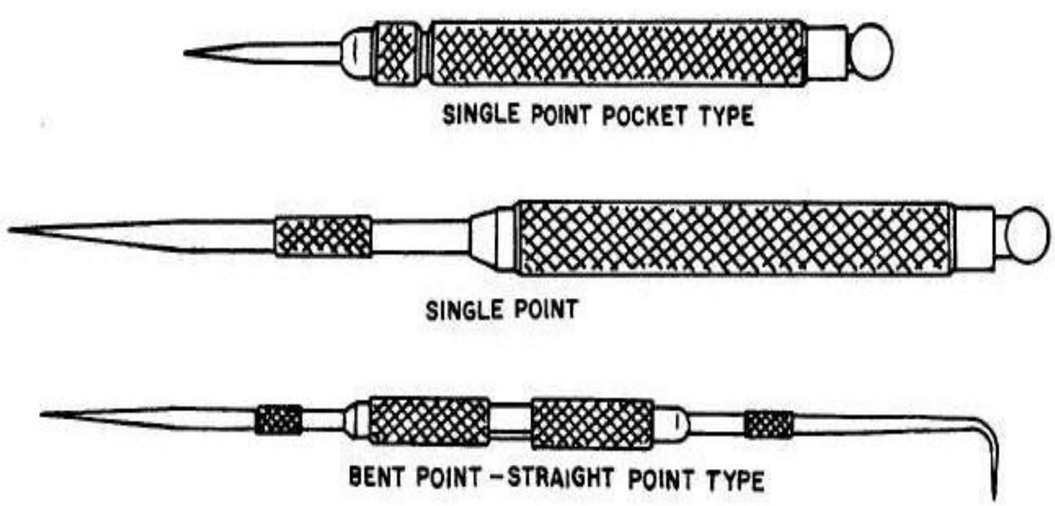
Common marking out tools

1. Scriber
2. Punch
3. Engineer's square
4. Surface plate
5. Surface gauge
6. Angle plate
7. Vice block
8. Dividers
9. Ball peen hammer

Scriber

A scriber is a piece of steel wire having a hardened sharp point todraw lines.

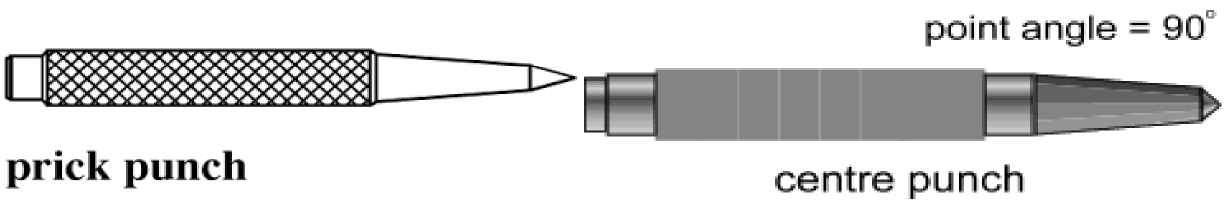
A sharp-pointed tool used for making marks & especially for marking off material to be cut.



Punch

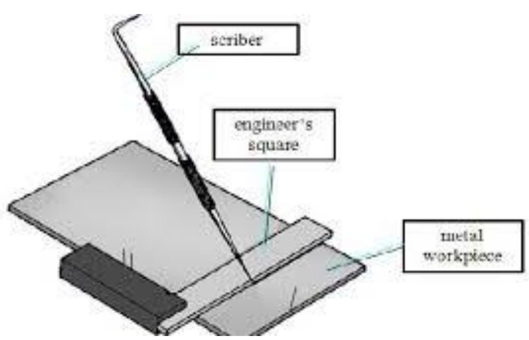
A **punch** is a hardmetal rod with a shaped tip at one end and a blunt butt end at the other, which is usually struck by a hammer. Most woodworkers prefer to use a ball-peen hammer for using punches. **Punches** are used to drive objects, such as nails, or to form an impression of the tip on a workpiece. Decorative punches may also be used to create a pattern or even form an image.

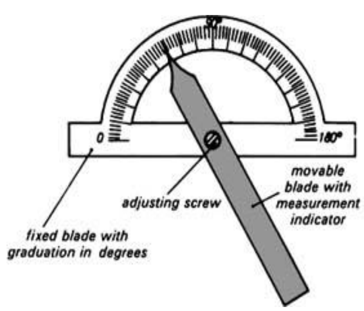
A **center punch** is used to mark the centre of a point. It is usually used to mark the centre of a hole when drilling holes. The tip of a center punch has an angle 90 degrees.
A **prick punch** is similar to a center punch but used for marking out. It has a sharper angled tip to produce a narrower and deeper point. It is also known as a dot punch. The mark can then be enlarged with a center punch for drilling. The tip of a prick punch is 60 degrees.

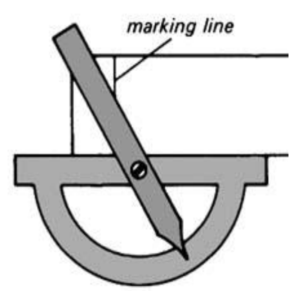


Engineer's square (try square)

Try square is used for making and testing angles of 45 and 90degree. A try square is a metal working tool used for marking and measuring a piece of metal. The square refers to the tool's primary use of measuring the accuracy of a right angle (90 degrees); to try a surface is to check its straightness or correspondence to an adjoining surface. Use: - to check the squareness of machined surface, flatness of surface, make lines at 45 and 90º to the edge of work pieces & to set work piece at right angle on work holding device.   Material: - hardened steel.

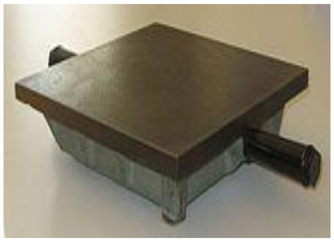
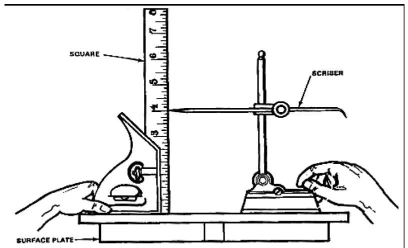






Surface plate

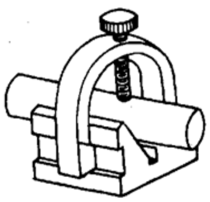
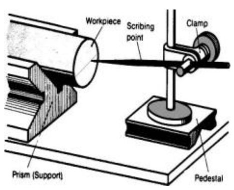
A surface plate is a solid, flat plate used as the main horizontal reference plane for precision inspection, marking out (layout), and tooling setup. The surface plate is often used as the baseline for all measurements to the work piece.

A surface gauge is used on surface plates for scribing lines on work pieces and checking parallel surfaces and heights.

The angle plate is used to assist in holding the work piece perpendicular to the table. It is provided with holes and slots to enable the secure attachment, clamping and adjusting of work pieces.

The Vee blocks are generally used for holding circular work pieces for marking out or machining.

Dividers

Divider: This is used for marking circles, arcs, laying out perpendicular lines, bisecting lines, etc

Surface plate a steel instrument of precision having a dressed flat surface or sometimes two surfaces at right angles and used as a standard of flatness.

Trammel points sometimes called a beam compass, are instrument used for drawing large circles, arcs.

Hammers

It is essentials that sheet metal workers have a variety of hammers. These should include the following: - riveting hammers, setting hammers, nail hammers, raising hammers and ball peen hammers.

Ball peen hammer is hammer having one end of the head hemispherical and used in working metal. Variants include the straight-peen, diagonal-peen, and cross-peen hammer. The straight-peen hammer has the wedge oriented parallel to the hammer's handle, while the cross-peen hammer's wedge is oriented perpendicular. The diagonal-peen hammer's head, as the name implies, is at a 45° angle from the handle. They are commonly used by blacksmiths during the forging process to deliver blows for forging or strike other forging tools.

Caliper: - Calipers are simple measuring tools used to transfer measurement from steel rule to objects and vice versa. They are made from tools steel or high carbon steel.

Types of calipersOutside Caliper, Inside Caliper and Odd leg Caliper

Outside Caliper

1. **Outside Caliper: -** This caliper is used to measure the **Outside** dimensions like the thicknesses of metal part, diameter of shaft, etc. Legs of this caliper are bent in inward direction.
2. **Inside Caliper: -** This caliper is used to measure the inside dimensions like the width of slots, diameter of holes, etc. Legs of this caliper are bent in outward direction.
3. **Odd leg Caliper**:- This caliper is also known as Hermaphrodite caliper or leg and point caliper .They are used for marking lines parallel to inside and outside edges, locating the centre of round bars, drawing parallel lines along outer edges, scribing lines along curved edges.

Mechanics

Level-III

Learning Guide-64

Unit of Competence: Perform Advanced Geometric Development

Module Title: Performing Advanced Geometric Development

Module Code: XXXXX

LG Code: XXXXX

TTLM Code: XXXXX

LO3: Make templates as required

Instruction Sheet	Learning Guide #64

This learning guide is developed to provide trainees the necessary information regarding the following **content coverage** and topics:

- Selecting appropriate template material
- Producing appropriate templates
- Determining and transferring allowances
- Producing Templates following OHS procedures accurately
- Following storage procedures
- Utilizing appropriate tools and equipment

This guide will also assist trainees to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, trainees will be able to**:

- Select appropriate template material.
- Produce appropriate templates.
- Determine and transfer allowances.
- Produce Templates following OHS procedures accurately.
- Follow storage procedures.
- Utilizing appropriate tools and equipment.

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described from 1 to 4
3. Read the information written in the information “Sheet 1,

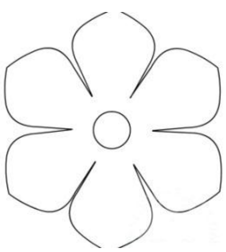
Information Sheet 1	Selecting appropriate template material

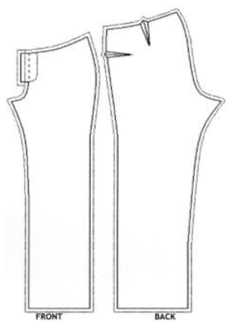
1.4. Selecting appropriate template material

Template is shaped piece of rigid material used as a pattern for processes such as cutting out, shaping, or drilling, something that serves as a model for others to copy.

What is a template used for?

A **template** is a form, mold, or pattern **used** as a guide to making something. Here are some examples: A ruler is a **template** when **used** to draw a straight line. A document in which the standard opening and closing parts are already filled in is a **template** that you can copy and then fill in the variable parts.





1.5. Producing appropriate templates

1.6. Determining and transferring allowances

1.7. Producing Templates following OHS procedures accurately

1.8. Following storage procedures

1.9. Utilizing appropriate tools and equipment

Mechanics

Level-III

Learning Guide-65

Unit of Competence: Perform Advanced Geometric Development

Module Title: Performing Advanced Geometric Development

Module Code: XXXXX

LG Code: XXXXX

TTLM Code: XXXXX

LO4: Develop Patterns as required

Instruction Sheet	Learning Guide #65

This learning guide is developed to provide trainees the necessary information regarding the following **content coverage** and topics:

- Choosing and applying most appropriate development method
- Determining and transferring allowances
- Interpreting and applying standard codes
- Insuring developed patterns with job specification and standards
- Utilizing appropriate tools and equipment

This guide will also assist trainees to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, trainees will be able to**:

- Chose and apply most appropriate development method
- Determine and transfer allowances
- Interpret and apply standard codes
- Insure developed patterns with job specification and standards
- Utilize appropriate tools and equipment

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described from 3 to 6
3. Read the information written in the information "Sheet 1, Sheet 2, Sheet 3 and Sheet 4".
4. Perform "Operation Sheet 1, Operation Sheet 2, Sheet 3 and Operation Sheet 4 " **in page -39,44, 49 and 60.**

4.1. DEVELOPMENT OF SURFACE

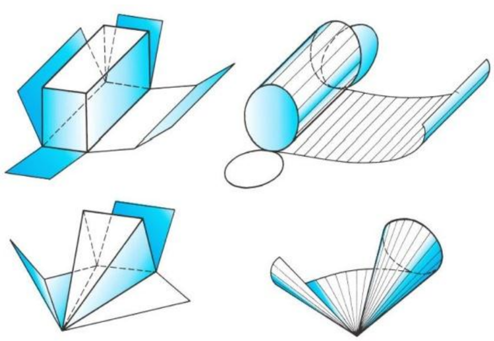
In industrial, world an engineer is frequently confronted with problems where the development of surfaces of an object has to be made, to help him to go ahead with the design and manufacturing processes. For example, in sheet metal work, it plays a vital role, thus enabling a mechanic to cut proper size of the plate from the development and then to fold at proper places to form the desired objects, namely, boilers, boxes, buckets, packing boxes, chimneys, hoppers, air-conditioning ducts etc.

Hoppers: -

- a container for grain, rock, or rubbish, typically one that tapers downward and discharges its contents at the bottom.
- a tapering container, working with a hopping motion, through which grain passes into a mill.

"**The development of surface** of an object means the unrolling and unfolding of all surfaces of the object on a plane."

When the complete surface of a solid is opened out and laid on a plane, the surface of the solid is said to have been "developed" and the figure obtained is called "development" of the surface. Every line on the development must be true length of the corresponding line on the surface.



Many articles such as **cans, pipes, elbows, boxes**, etc. are manufactured from thin sheet materials. Generally a template is produced from an orthographic drawing when small quantities are required, and the **template** will include allowances for bending and seams, bearing in mind the thickness of material used.

Importance of Development: Knowledge of development is very useful in sheet metal work, construction of storage vessels, chemical vessels, boilers, and chimneys. Such vessels are manufactured from plates that are cut according to these developments and then properly bend into desired shaped. The joints are then welded or riveted.

Principle of Development:

Every line on the development should show the true length of the corresponding line on the surface which is developed.

Methods of Development:

a. Parallel-line development
b. Radial-line development
c. Triangulation development
d. Approximate development

1. Parallel line development

Parallel line development is used to develop patterns of square, rectangular and cylindrical shapes (**prisms**). The method divides the surface into a series of parallel lines to determine the shape of a pattern.

Application: Parallel line development is used for the pattern development of pipe work, prisms, and any cylindrical shape**.**

Pattern development can be marked directly onto flat metal plate. The metal is then formed to shape.

Patterns are often turned into templates using paper or thin sheet steel. On formed **stock pipe**, the pattern becomes a wrap around template, and can be used over and over again.

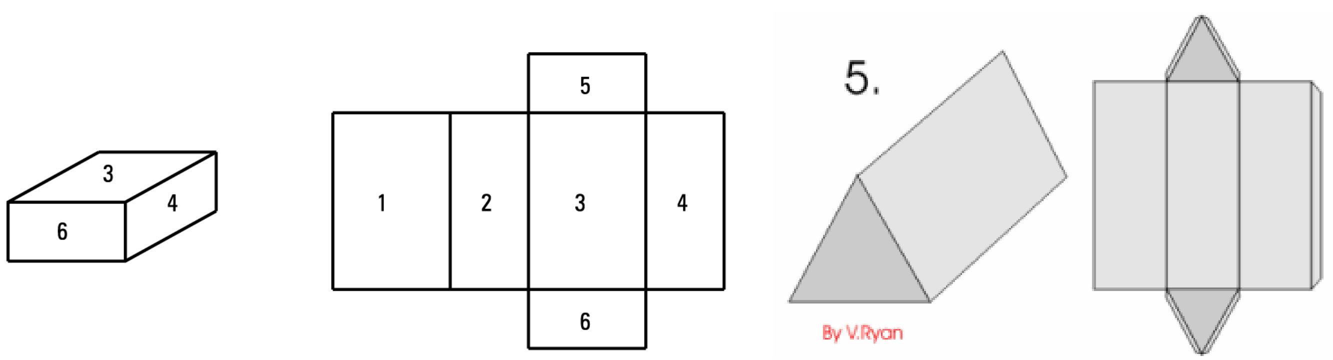
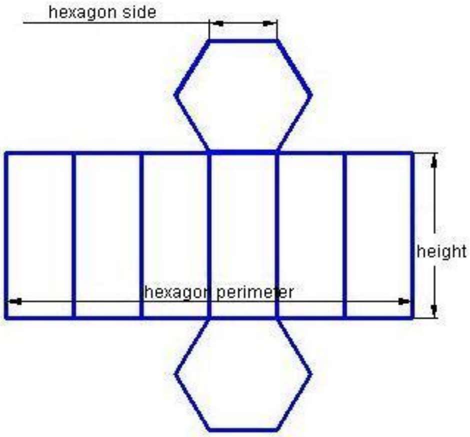
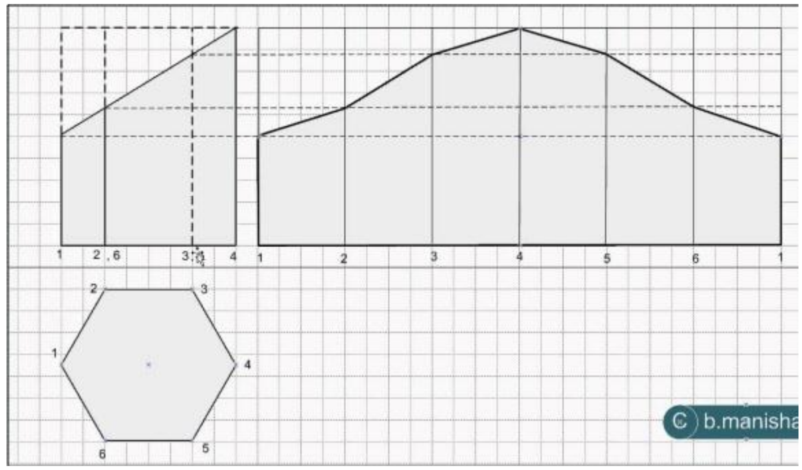


Figure 1: Development of rectangular and triangular prism





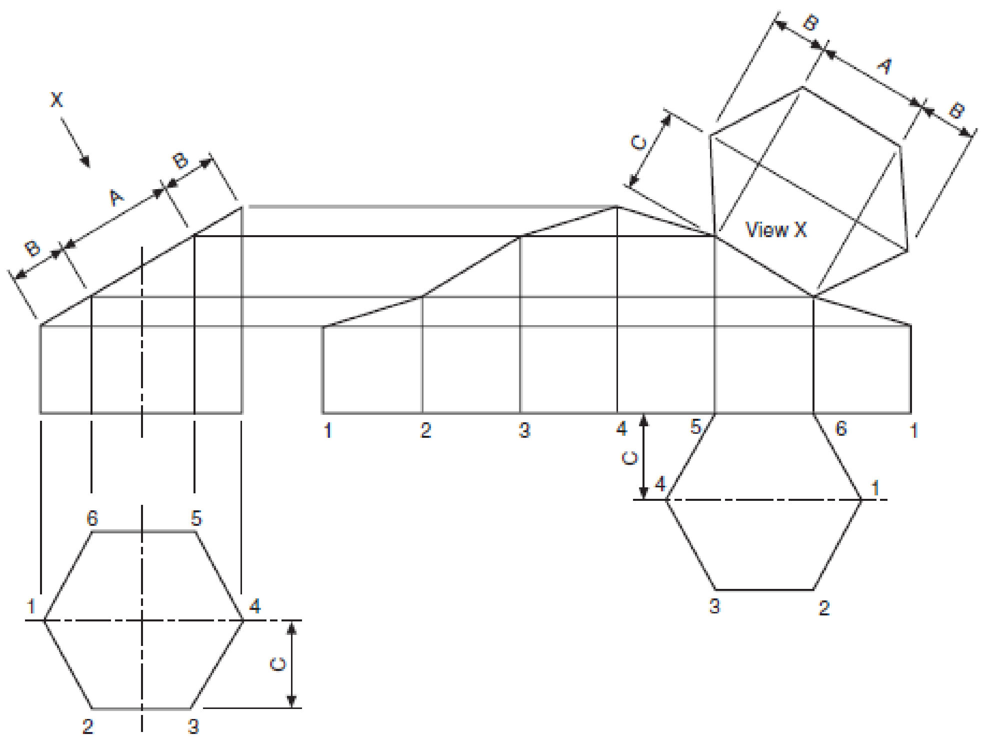
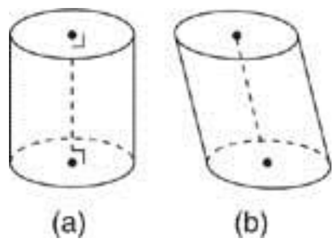


Figure2: Development of hexagonal prism and truncated hexagonal prism

Operation Sheet 1	Practical work

A hexagonal prism, edge of base 20 mm and axis 50 mm long, rests with its base on H.P such that one of its rectangular faces is parallel to V.P. It is cut by a plane perpendicular to V.P, inclined at 45o to H.P and passing through the right corner of the top face of the prism. Draw the sectional top view and develop the lateral surface of the truncated prism.

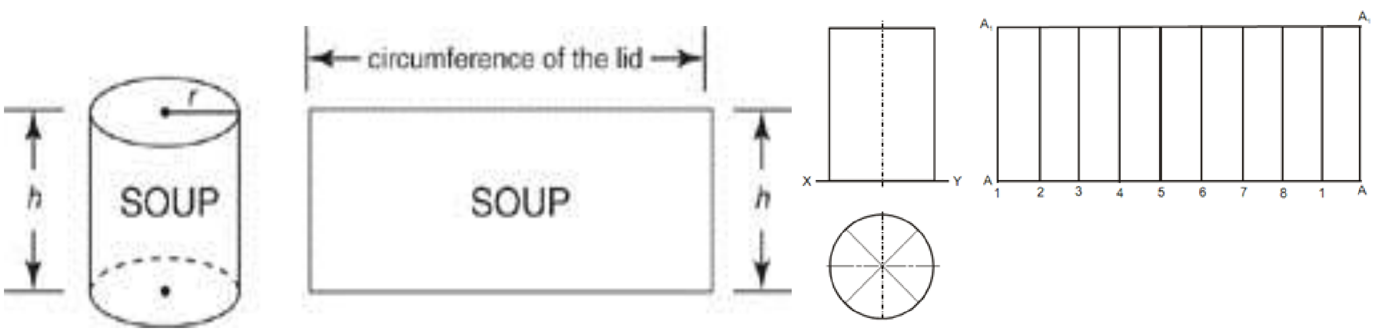
A **prism** shaped solid whose bases are circles is a **cylinder**. If the segment joining the centers of the circles of a cylinder is perpendicular to the planes of the bases, the cylinder is a **right circular cylinder**. In Figure below cylinder (a) is a right circular cylinder and cylinder (b) is an oblique circular cylinder.

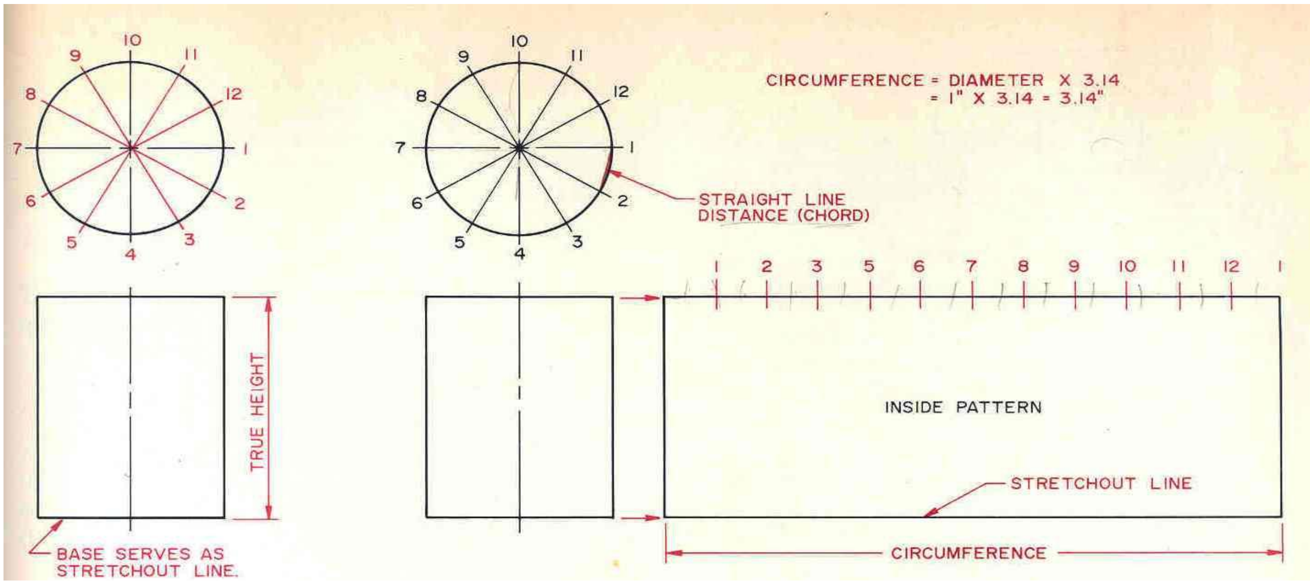


Different type of circular cylinders

If a cylinder is pictured as a soup can, its lateral area is the area of the label. If the label is carefully peeled off, the label becomes a rectangle, as shown in Figure below. The top and front views are divided into eight equal spaces.

The parallel lines give us the chord lengths which are then transferred to the stretch out, which is the circumference. This is also divided into eight equal spaces.





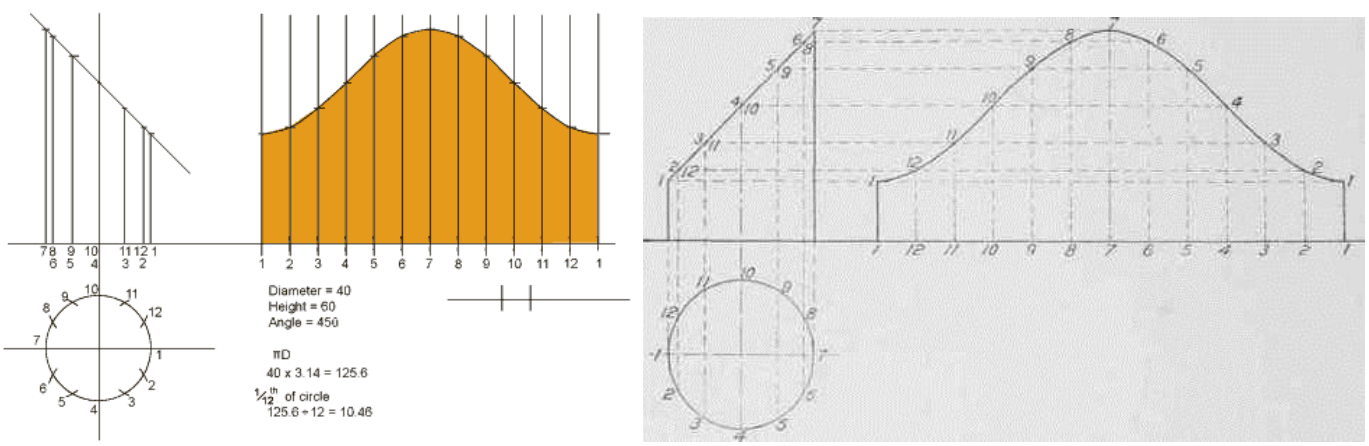
Development of right cylinder

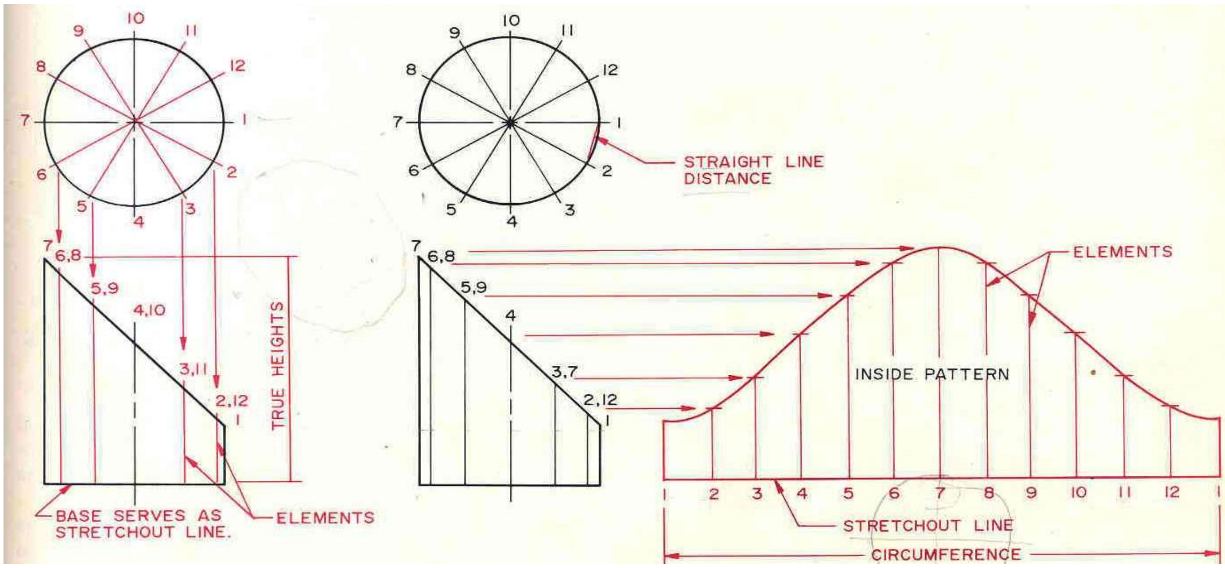
The area of the label is the area of a rectangle with a height the same as the altitude of the can and a base the same as the circumference of the lid of the can. (Circumference of a circle can be approximated by 2πr)

$$A_{right\ circular\ cylinder} = (C)(h)unit^2$$
$$= (2\pi r)(h)unit^2$$

An example of parallel development (Truncated cylinder)

The diagram below shows parallel line development. On the left is the development method for a truncated cylinder. On the right is the stretch out pattern of the shape which is then transferred onto the metal.





The top and front views are divided into twelve equal spaces.

The parallel lines give us the chord lengths which are then transferred to the stretch out, which is the circumference. This is also divided into twelve equal spaces.

The development of surface of an object means the unrolling and unfolding of all surfaces of the object on a plane."

If the surface of a solid is laid out on a plain surface, the shape thus obtained is called the development of that solid." In other words, the development of a solid is the shape of a plain sheet that by proper folding could be converted into the shape of the concerned solid.

2. Radial line method

The radial line method of pattern development is used to develop patterns for objects that have a tapering form with lines converging to a common point, called the **apex point.**

The radial line method uses a series of radial generator lines drawn from a common apex point to develop a specified pattern or shape.

It is employed for **Pyramids** and single curved surfaces like **Cones** in which the apex is taken as centre and the slant edge or generator as radius of its development.

The pattern or development for an object tapering to an apex may be made by the radial line development method. Examples of object whose development can be made by the radial line development method are pyramids and cones.

The radial line development method is based on the location of a series of lines which radiate from the apex down in surface of the object to a base.

The procedure to determine the true length of a line is the most important concept to carry out radial line development. There are different methods to find the true length of line that are not parallel to any principal planes. Here you will be introduced to another method of finding the true length of line known as triangulation method.

The development of pyramid

The development of a pyramid is based on the radial line development method. In the process of developing a right pyramid, a large arc is made with radius equal to the length of the edge of the pyramid. Then, points are marked on this arc using compass by setting arc with radius equal to the true length of the sides of the pyramid. The true lengths of the edges of a pyramid are found by using the triangulation method. The true length of the edges of a pyramid is found by using the triangulation method of finding the true lengths of oblique line by triangulation is discussed below.

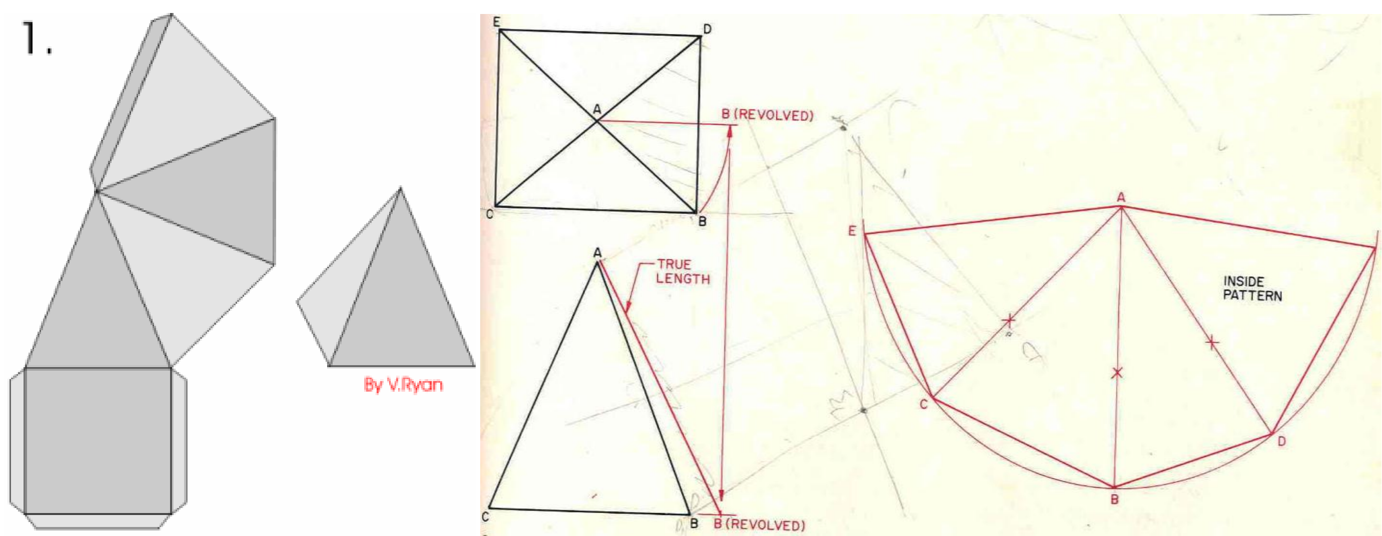
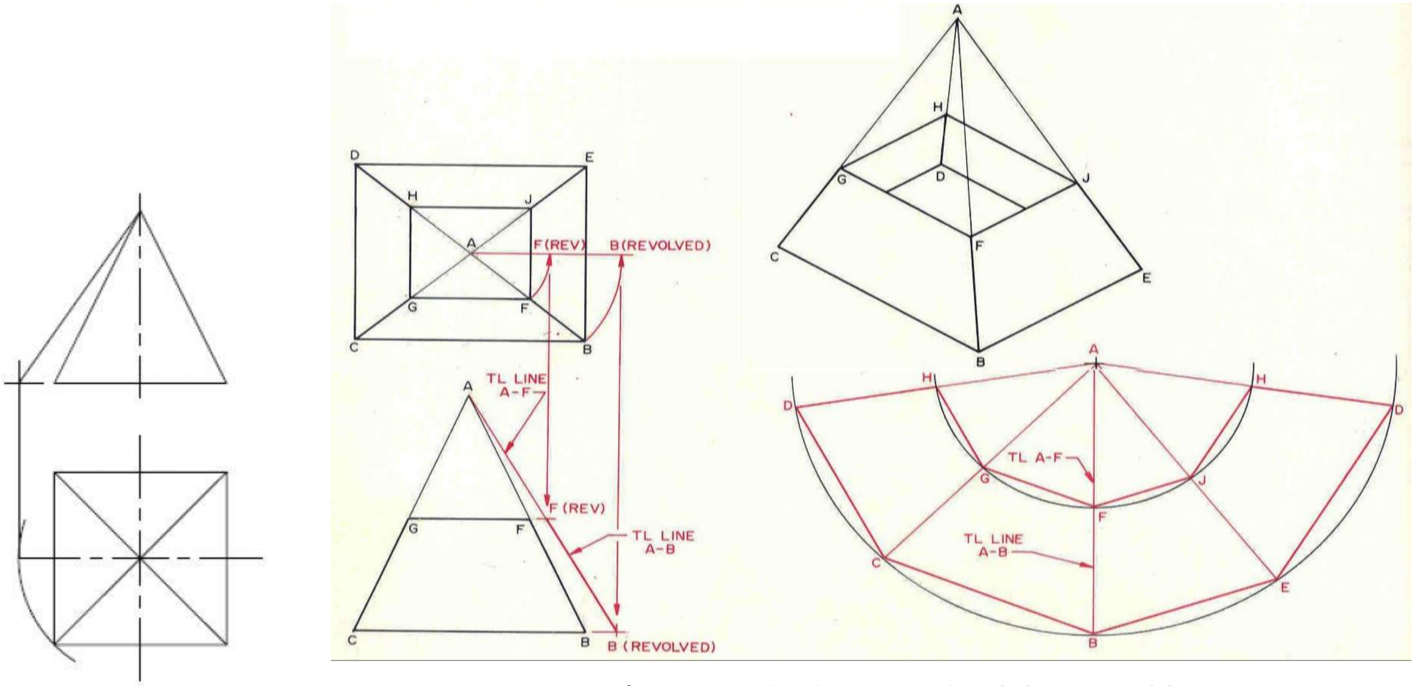
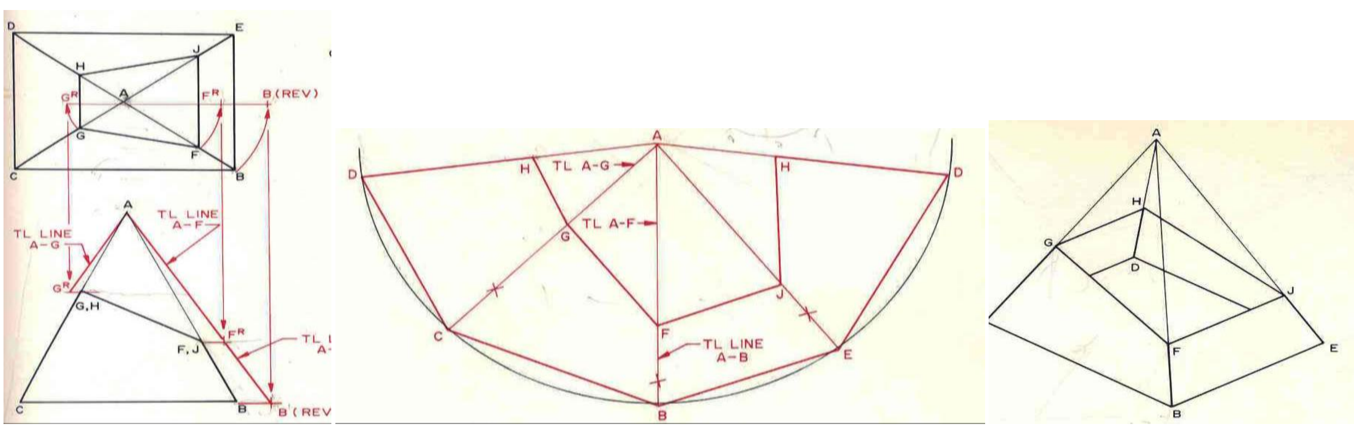


Fig Development of a right rectangular pyramid



Development of a frustum of a right pyramid



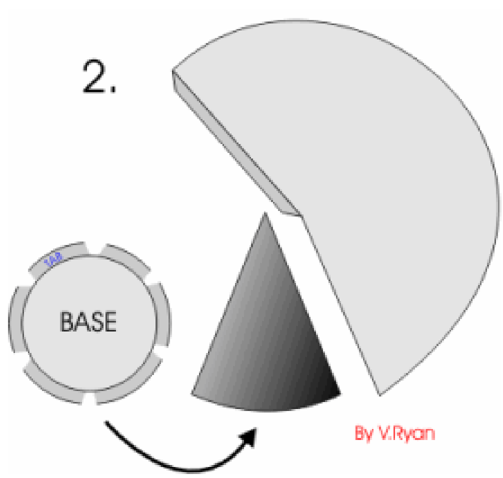
Development of a truncated right pyramid

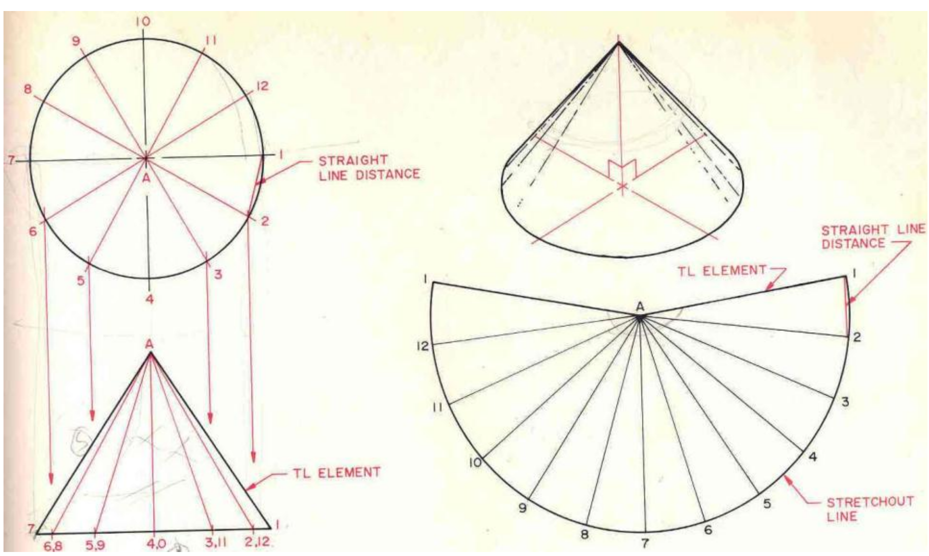
Operation Sheet 2	Practical work

Development of cones

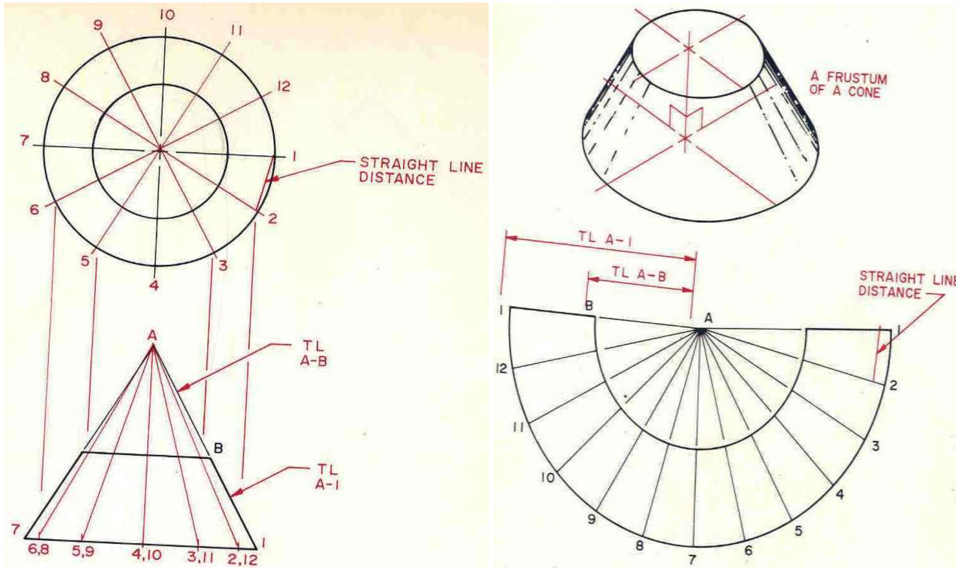
The development of cones is also based on the radial line development method. The cone may be considered as a pyramid that has infinite number of edges. Thus, the development of a cone may be made in similar manner to that or the pyramid. The development of a right full cone is simply a sector whose radius is equal to the hypotenuse of the cone and whose arc length is equal to the circumference of the base of the cone, as shown fig. The subtended angle θ can be formed using the formula: $\theta = \frac{r}{s} \times 360°$

Where r is the radius of the base of the cone and s is the hypotenuse of the cone.

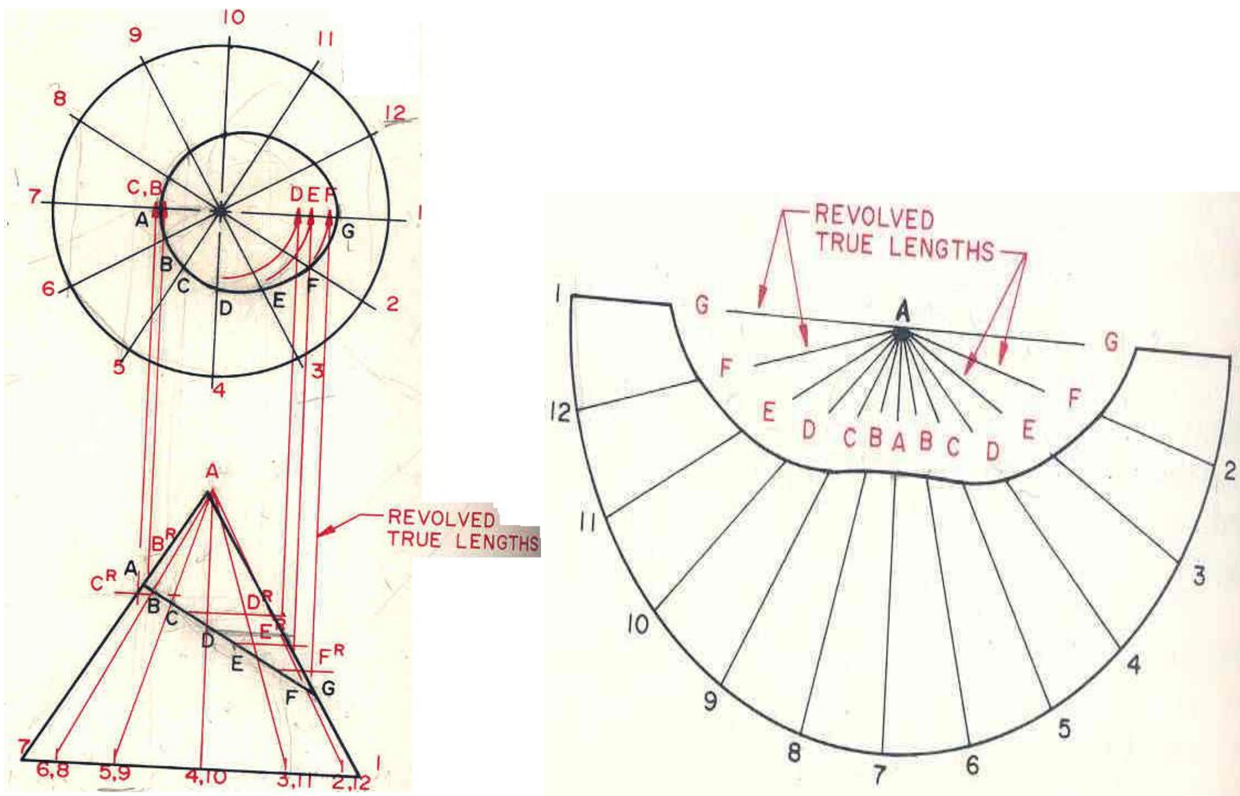




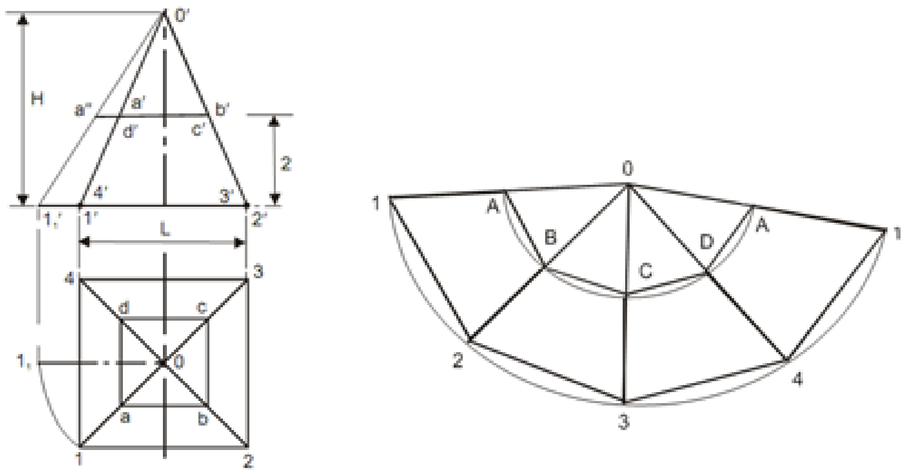
Development of a right cone



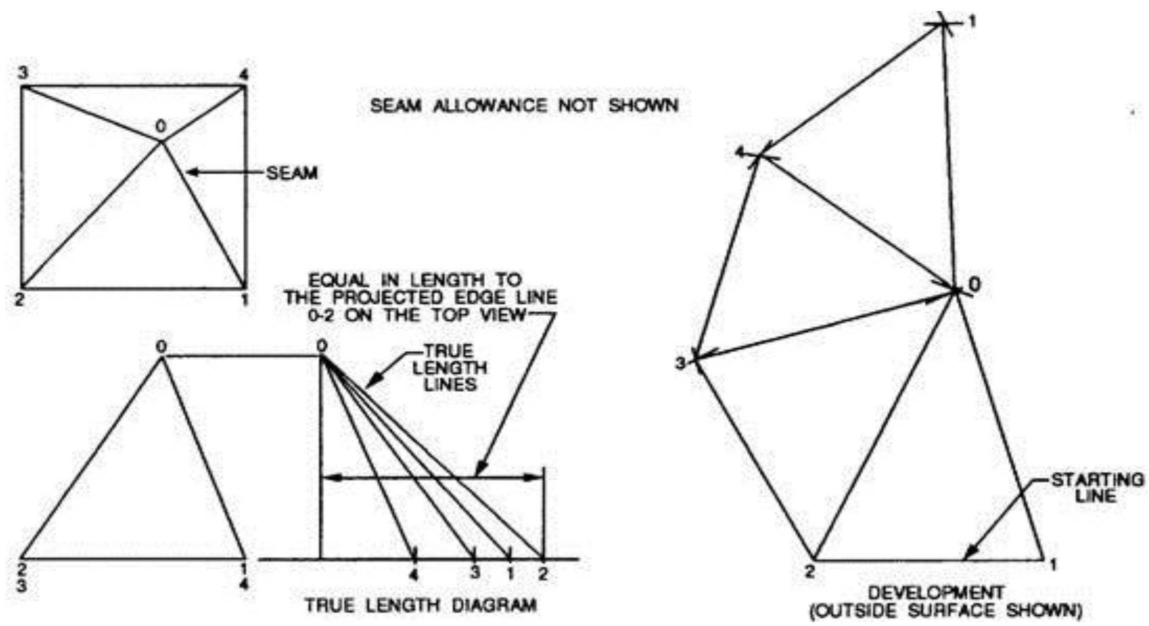
Development of a frustum of a cone

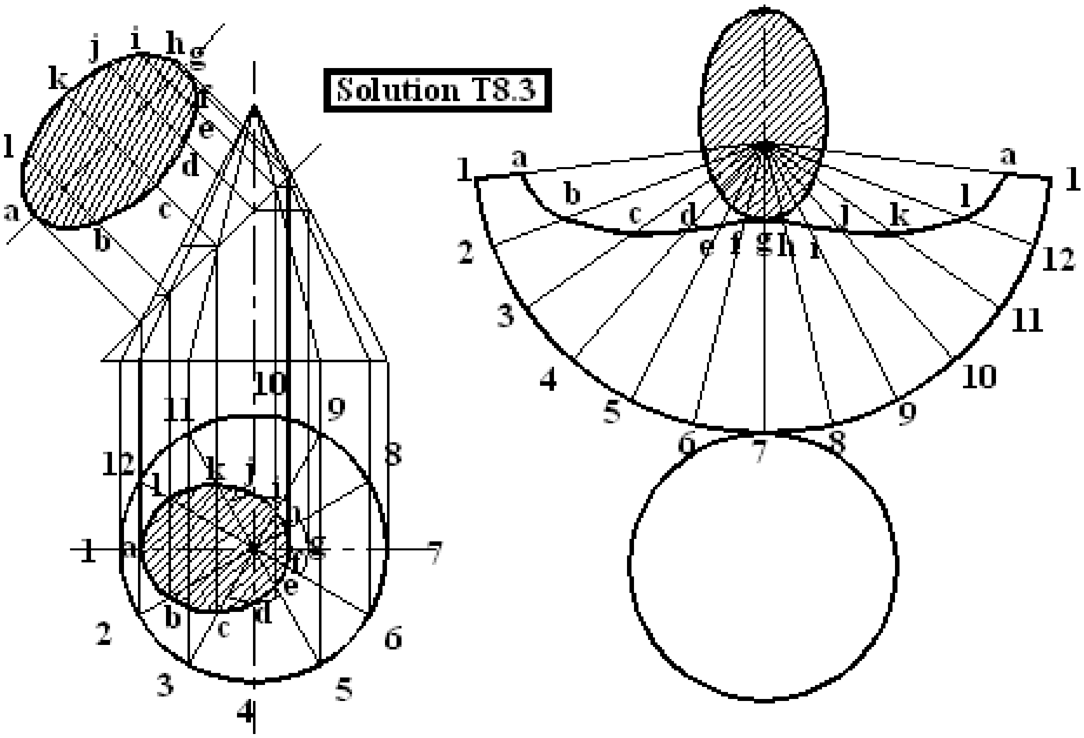


Development of a truncated right cone



Development of a Frustum right pyramid





True length by triangulation

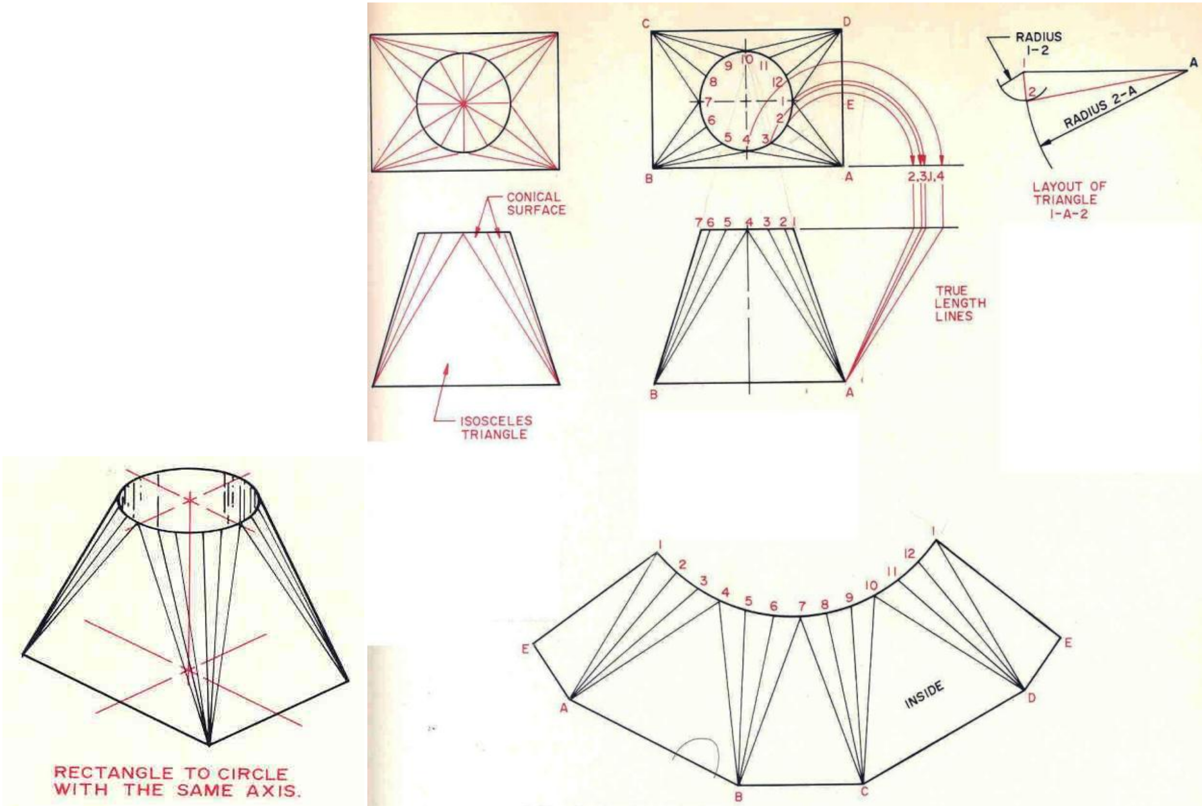
The procedure to determine the true length of a line is the most important concept to carry out radial line development. There are different methods to find the true length of line that are not parallel to any principal planes, as you have learned previously. Here you will be introduced to another method of finding the true length of line, known as triangulation method.

3. TRIANGULATION DEVELOPMENT

It is used for developing transition pieces.

- Transition pieces are usually made to connect two different forms, such as round pipes to square pipes.
- This is done by assuming the surface to be made from a series of triangular surfaces laid side-by-side to form the development.
- This form of development is known as Triangulation

Development of a circular-to-rectangular transition piece with the same axis



Triangulation development

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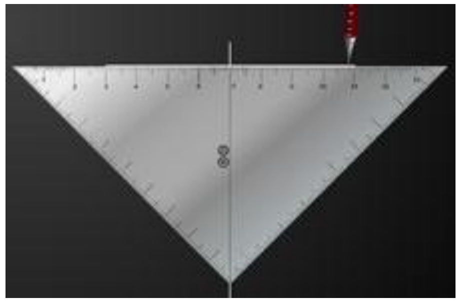
- This is done by assuming the surface to be made from a series of triangular surfaces laid side-by-side to form the development.
- This form of development is known as **Triangulation**

How do we construct a triangulation stretch-out pattern? - text alternative

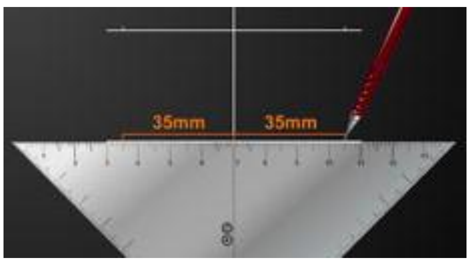
Operation Sheet 3	Practical work on Triangulation development

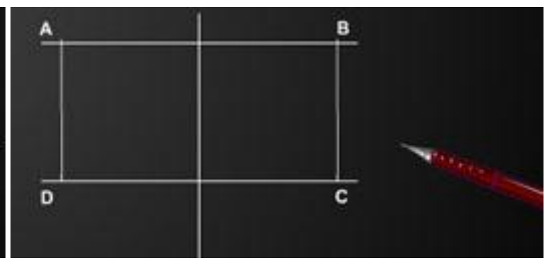
Triangulation development

Step 1 First establish the reference lines.



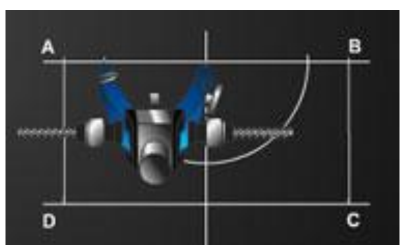
Step 2 Develop the top view. With a set square, mark out the measurements for half the base, and label each corner (from the top left hand corner, moving clockwise) A to D.





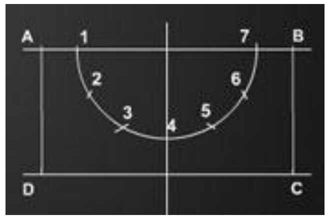
Step 3 From the centre of this half base, draw a semicircle with radius 25mm.

Check that the diameter (D) is 50mm.

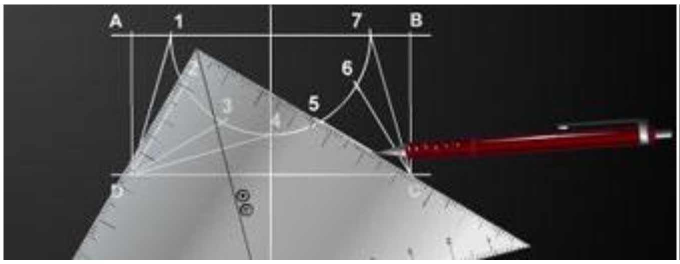


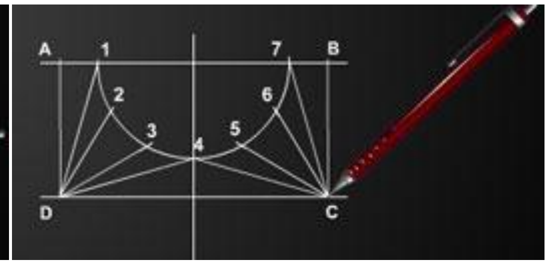
Step 4 Divide the half circle into six equal spacing's by placing the compass point on the three points where the semicircle intersects the reference lines and swinging small arcs (R25mm) to intersect the circle.

Number the points 1 to 7 as shown.

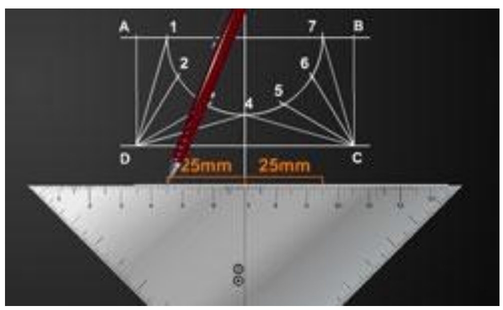


Step 5 Using a set square, draw lines from point D on the base of the shape to points 1 through to 4 on the half circle. Next, draw lines from C on the base of the shape to points 4 through to 7. This completes (half) the top view.

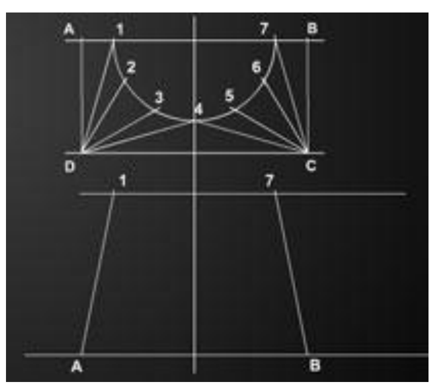




Step 6 Draw the side view. First, draw a reference line. Remember, the vertical height is 50mm, and the diameter of the top is 50mm.



Step 7 The base is 70mm square. Draw lines from the base to the top. Label the base points A and B. Label the top points 1 and 7.



Step 8 Now develop the stretch out pattern for the square to round.

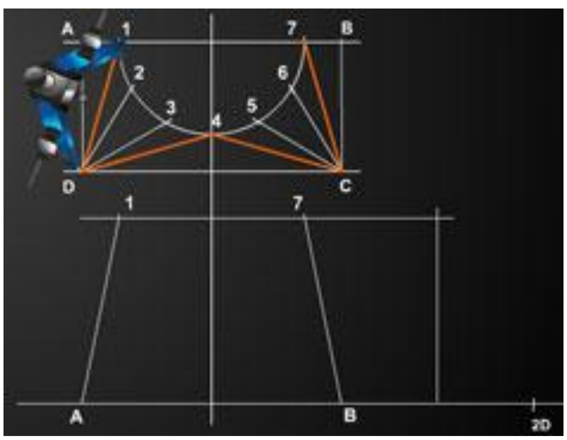
First establish a reference line (extending to the right from point B on the side view) for the base of the stretch out pattern. Draw the vertical height of the square to round somewhere to the right of the side view, perpendicular to the base line.

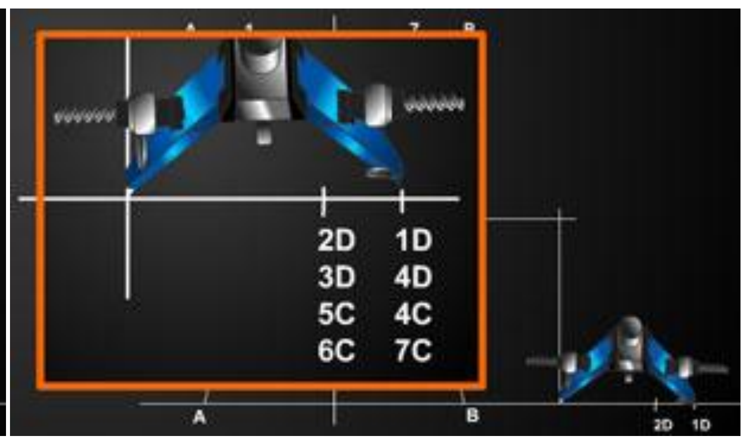
Now place the compass point on D in the top view. Set the radius to point 2 on the half circle. Place the compass point at the intersection of the base line and the vertical height line and swing an arc to mark the base line. Label this point 2D. Note this is the shortest distance from point D to the top of the half circle, the same length as 3D, 5C, and 6C.

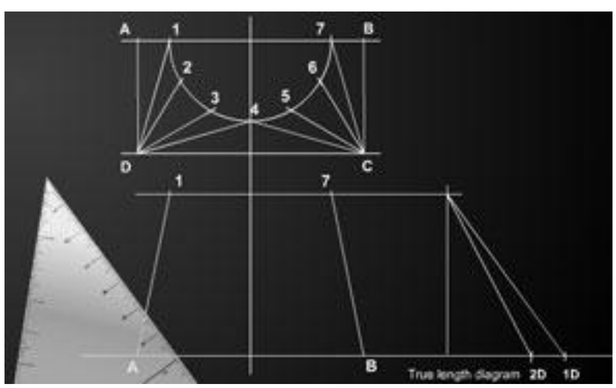
Now place the compass at D and set the radius to point 1 on the half circle. Transfer the compass to the intersection of the base line and the vertical height line and swing an arc to mark the base line. Label it 1D. Note this is the longer distance from point D to the top of the half diameter, the same length as 4D, 4C,& 7C.

Now draw a line from the top of the vertical height line to point 2D, and then from the top to point 1D.

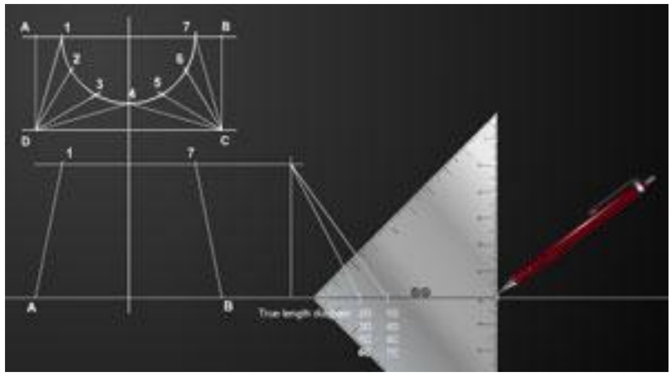
This is called the true length diagram.





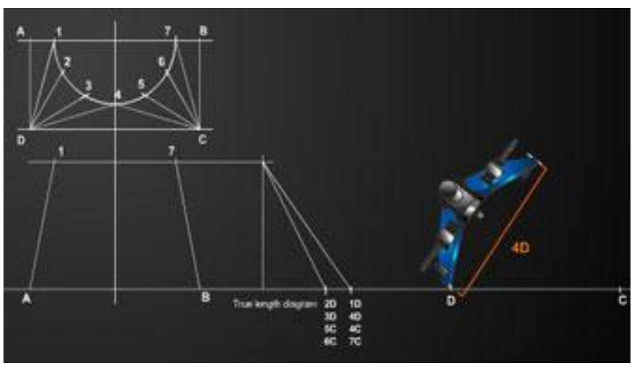


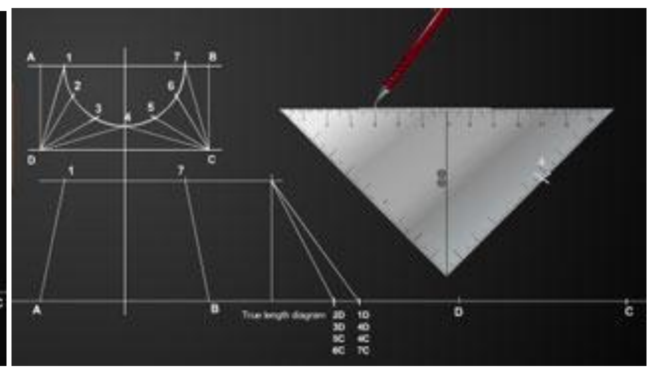
Step 9, Mark a point on the base line to the right of point 1D



Step 10 Set the compass at the distance between D and C on the top view (as this is already true length), then transfer the distance D to C to the base line. Label the points D and C.

Reset the compass to the length of the line 4D. Placing one point on D, draw an arc midway between D and C. Shift the compass to C, draw an arc to bisect the previous one. Label this point 4.





Step 11 Mark out a new short reference line for 1/12th of the circumference of the top of the square to round shape.

Calculate the circumference of the top of the shape, then divide it by 12.

C = πD

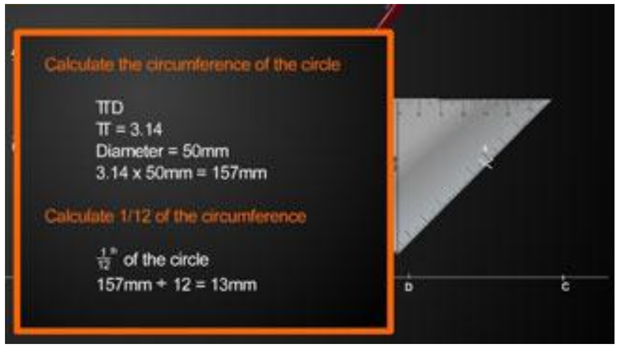
C = 3.14 x 50

= 157mm

1/12th of the circle

= 157 ÷ 12

= 13 mm



Step 12 Measure and mark out 13mm on the reference line. Set the compass at 13mm (1/12th circumference).

Place the compass on point 4, and swing arcs to mark to the right, and to the left.

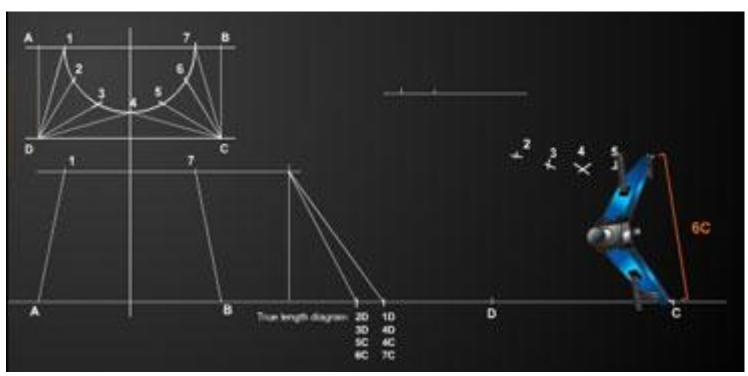
Set the compass at the true length of reference line 2D. Place the compass on point D, and swing an arc to intersect the arc on the left.

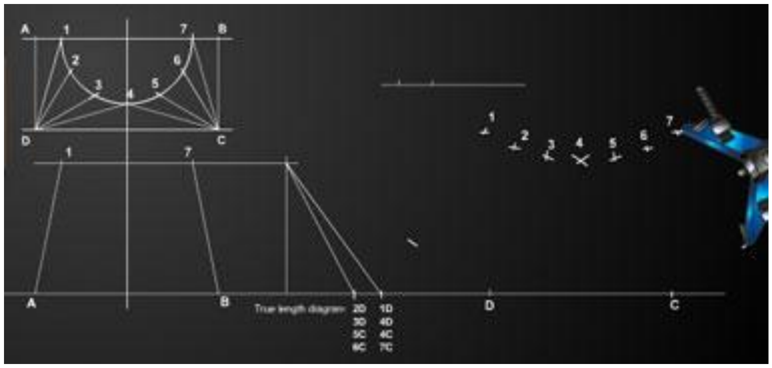
Label this point 3. Place the compass on C, swing an arc to intersect the arc on the right. Label this point 5.

Reset the compass at 13mm, using the measure on the reference line. Place the compass on point 5 and swing an arc to the right hand side. Swing an arc to the left of point 3.

Reset the compass at the length of the reference line 2D. Place the compass on point D, make a mark intersecting the arc and Label this point 2. Place the compass on C and make a mark intersecting the arc and label this point 6.

Repeat the process swinging an arc R13 to the left of 2 and right of 6. This time however, reset the compass to the length of reference line 1D. Place the compass point on D, make a mark intersecting the arc and label this point 1. Place the compass on C and make a mark intersecting the arc. Label this point 7.





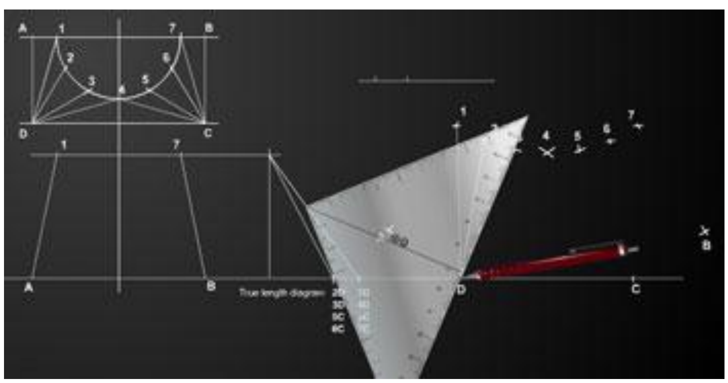
Step 13 Develop the half square base from point D to point A.

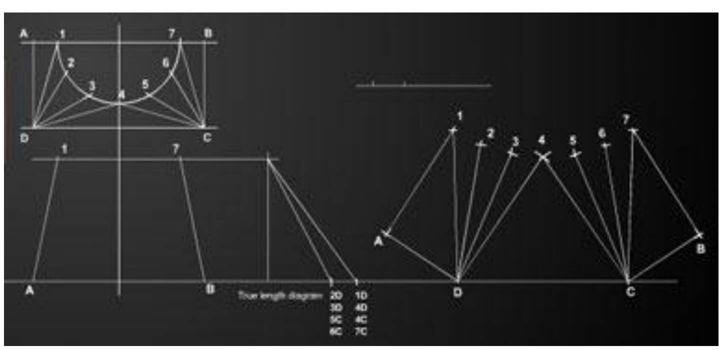
Using the side view diagram, set the compass at the distance between B and 7. Place the compass at point 1 on the stretch out pattern, and draw an arc to the lower left. Repeat the process from point 7 to the lower right.

Reset the compass to the distance between B and C on the top view diagram. Place the compass on D and make a mark intersecting the arc.

Label this point A. Place the compass on C, make a mark intersecting the arc and label this point B.

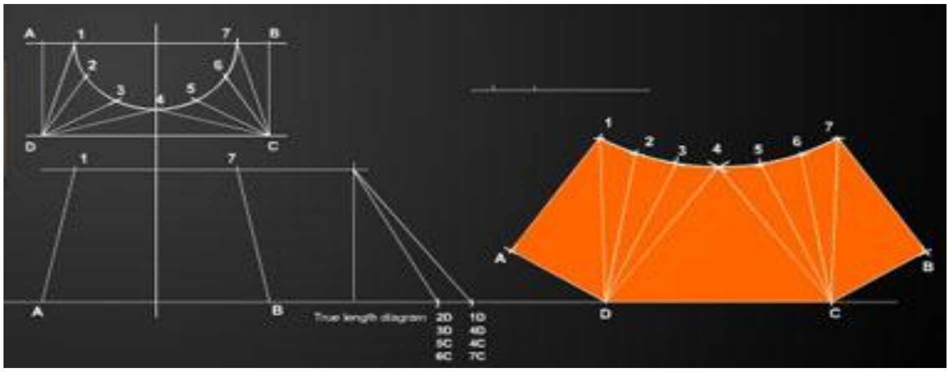
Using a set square or ruler, draw lines joining 1 and A; A and D; 7 and B; and B and C. Draw lines from D to 1, 2, 3, and 4. Draw lines from C to 4, 5, 6, and 7





Step 14 Use a flexible ruler, or freehand to join points 1 to 7.

This completes the stretch out half pattern for a square to round shape, using the triangulation method.



True length tree method

Prepare assembly and detail drawing

Working drawings are specialized engineering drawings that provide information required to make the part or assembly of the final design.

Working drawings depend on orthographic projection and many other graphical techniques to communicate design information for production.

Working drawing is a set of drawing used during the work of making a product.

- The drawings from which a design is built;
- Are legal contacts that document the design details and specifications?

Major components of a complete set of working drawings

- An assembly or subassembly drawing showing all the standard and nonstandard parts in a single drawing.
- Detail drawing of each nonstandard part.
- A bill of material (BOM) -- parts list.
- A title block.

Working drawing separated into **Assembly drawing and Detail drawing**

Assembly Drawing

What is an assembly drawing and why do we need them?

An **assembly drawing** is a drawing of an entire machine or system with all of its components located and identified. We need to know how to put the machine together.

- An assembly drawing shows how each part of a design is put together. (If a design show only part of a total assembly, it is referred to as a subassembly.)
- Assembly drawings show how individual parts fit together to make a machine.
- A standard parts sheet contains purchased items.

Components in an assembly drawing includes: -

(1) All the parts, drawn in their operating position;

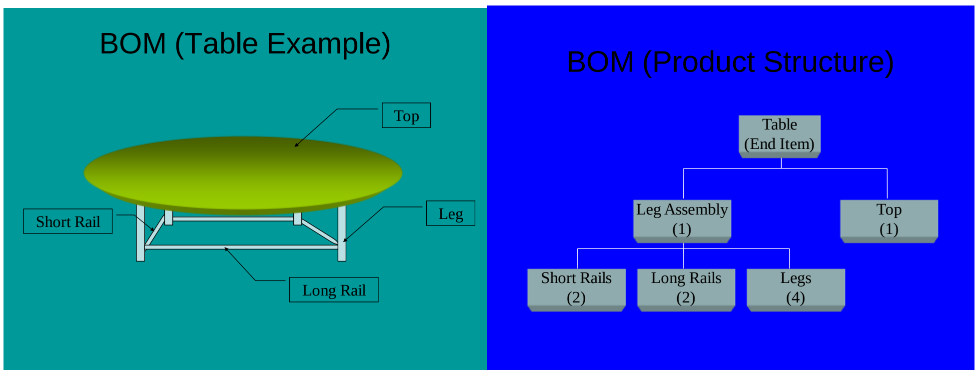
(2) A parts list or bill of materials (BOM);

(3) Leader lines with balloons, assigning each part a detail number, in sequential order;

(4) Machining and assembly operations and critical dimensions related to those functions.

A **bill of materials** (**BOM**) is a list of the raw materials, sub-assemblies, intermediate assemblies, sub-components, parts and the quantities of each needed to manufacture an end product. A BOM may be used for communication between manufacturing partners, or confined to a single manufacturing plant.

A BOM can define products as they are designed (engineering bill of materials), as they are ordered (sales bill of materials), as they are built (manufacturing bill of materials), or as they are maintained (service bill of materials). The different types of BOMs depend on the business need and use for which they are intended.



5			
4	Legs	4	RHS
3	Long rails	2	RHS
2	Short rails	2	RHS
1	Top	1	Sheet metal
No	Part name	Required NO	material

Subassembly Drawing

Subassembly: Two or more parts that form a portion of an assembly.

Examples of subassemblies

- A car differential
- A motorbike engine
- Standard parts sheet (last sheet)

How do we show the size of an individual part?

A detail drawing is a drawing of an individual part, which includes an orthographic projection and dimensions.

Working Drawing Package

Working Drawing Package is a packet of drawings that gives the specifications necessary to manufacture a design.

A typical working drawing package includes;

- an assembly drawing,
- detailed drawings,
- and a standard parts

A standard part sheet contains information about purchased items

Drawing Order

Drawings included in a working drawing package should be presented in the following order.

- _ Assembly drawing (first sheet)
- _ Part Number 1
- _ Part Number 2

Sectional views are used quite often when drawing assemblies. Why?

Assemblies often have parts fitting into or overlapping other parts and we need to look inside the assembly to see clearly.

Section Hatch in Assemblies

Section Hatch: Section hatch in adjacent parts are drawn in opposing directions. In the largest area, section hatch are drawn at 45° Next largest = 135° (- 45^0) Additional areas = 30° and 60° Smaller areas. The distance between the section hatches may also be varied to further distinguish b/w parts.

Things to Include / Not Include

When deciding what to include in an assembly drawing remember; the purpose of an assembly drawing is to *show how the individual parts fit together.*

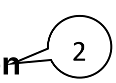
The assembly drawing should not look overly cluttered. Some lines that are necessary in a detailed drawing may be left off the assembly drawing to enhance clearness.

Hidden Lines

Do we include hidden lines? They should be used wherever necessary for clearness. Usually they should be left off when they impair (weaken) clearness. When a section view is used, hidden lines should not be used in that view.

Dimensions

Do we include dimensions? As a rule, dimensions are not given on assembly drawings. Usually not If dimensions are given, they are limited to some function of the object as a whole.

Identification 

Ballooning: A part is located and identified, in an assembly drawing, by using a circle containing the part number and a leader line that points to the corresponding part.

Parts List / Bill of Material

The parts list is an itemized list of the parts that make up the assembled machine.

Parts lists contain the

- part number,
- part name,
- the number required and the material of the part.

Operation Sheet 4	Procedures to create assembly drawing

Steps to create assembly drawing

1. **Analyze** geometry and dimensions of all parts in order to understand the assembly steps and overall shape of device or machine.
2. **Select** an appropriate view.
3. **Choose major parts**, i.e. parts that have several parts assembled on.
4. Draw a view of **major parts** according to a selected viewing direction.
5. Add **detail** view of the remaining parts at their working positions.
6. Apply **section technique** where relative positions between adjacent parts are needed to clarify.
7. Add **balloons**, **notes** and **dimensions** (if any).
8. Create BOM.

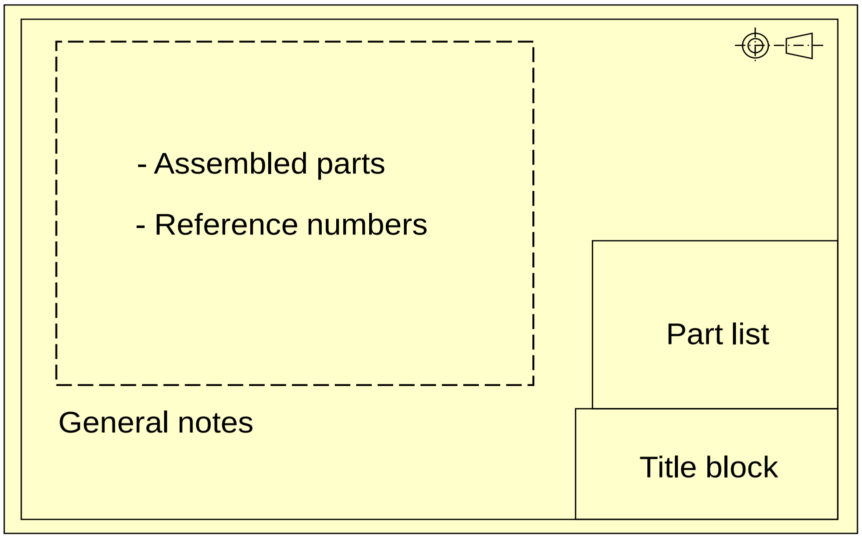
GENERAL PRACTICE

The **number of views** can be one, two, three or more as needed, but it should be **minimum**

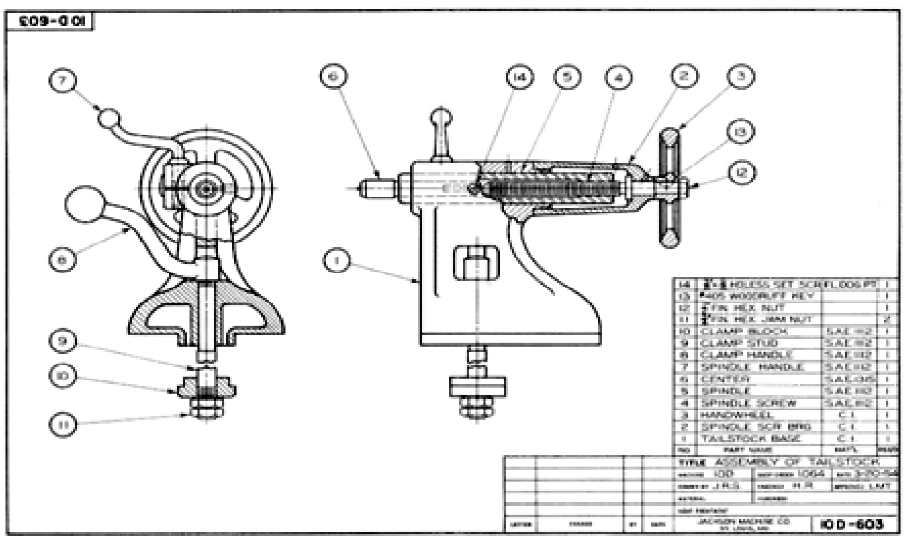
A good **viewing direction** is that represents all (or most) of the parts assembled in their working position.

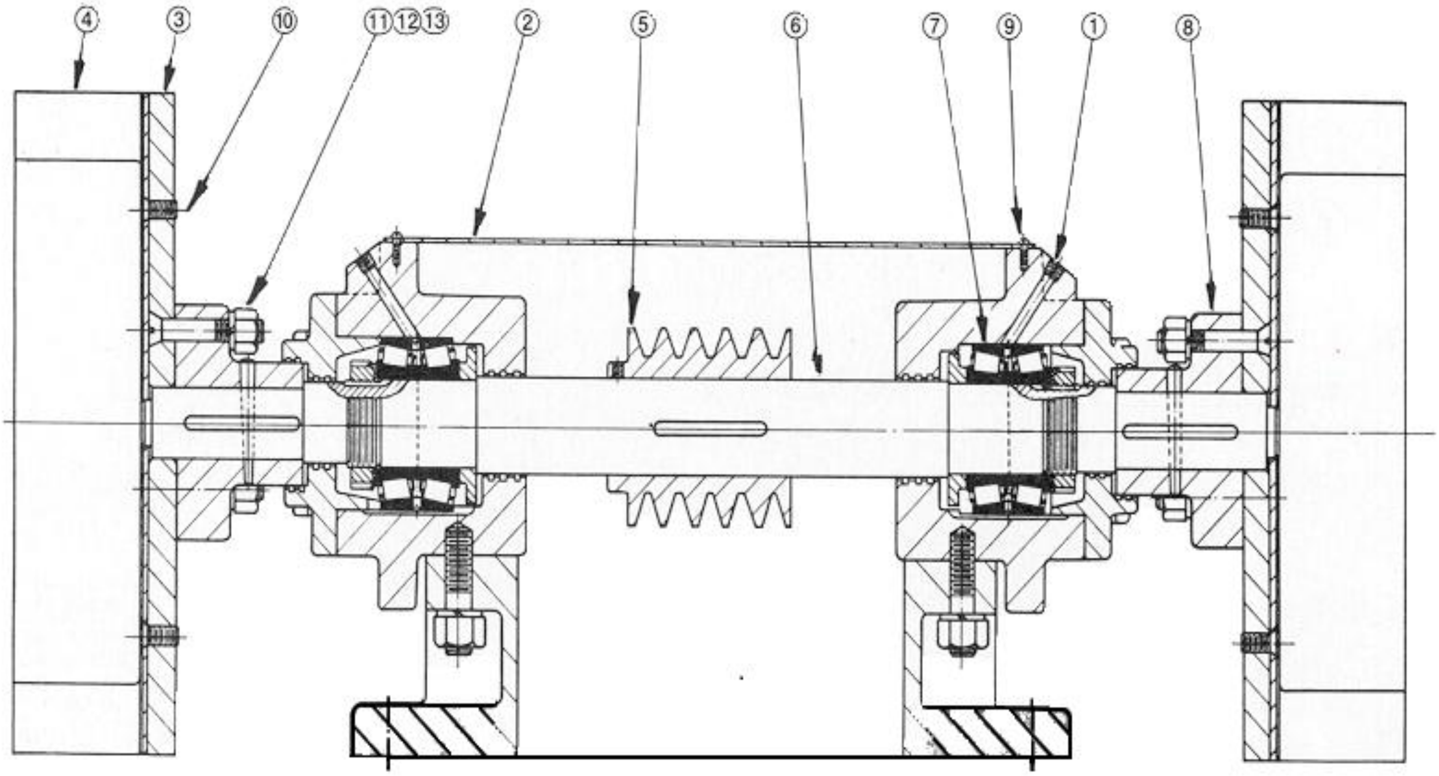
PLACING AN INFORMATION

(This course)



2. GENERAL ASSEMBLY





FLOOR STAND GRINDING MACHINE

Mechanics

Level-III

Learning Guide-66

Unit of Competence: **Perform Advanced Geometric Development**

Module Title: **Performing Advanced Geometric Development**

Module Code: XXXXX

LG Code: XXXXX

TTLM Code: XXXXX

LO5: Estimate quantities of materials from detail Drawings

Instruction Sheet	Learning Guide #66

This learning guide is developed to provide trainees the necessary information regarding the following **content coverage** and topics:

- **I**dentifying correct types of materials.
- **E**stimating quantities from drawing.
- **O**ptimizing materials use and minimizing waste.
- Documentation and submission.

This guide will also assist trainees to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, trainees will be able to**:

- **I**dentify correct materials
- **E**stimate quantities from drawing
- **O**ptimize material use and minimize waste
- Documentation and submission

Learning Instructions:

1. Read the specific objectives of this Learning Guide
2. Follow the instructions described from 1 to 3
3. Read the information written in the information “Sheet 1, Sheet 2, and Sheet 3”.
4. Accomplish the “Self-check 1,” **in page –70**

Information Sheet 1	Identifying correct types of materials

1.10. Identifying correct types of materials

Materials can be **classified** into four main groups: metals, polymers, ceramics, and composites.

Identify materials as

Metals. Most metals are strong, hard and shiny **materials** that can be hammered into different shapes without breaking.

Plastics. Plastics are **materials** made from chemicals and are not found in nature.

Glass. Glass is made by melting sand and other minerals together at very high temperatures.

Wood.

Fabrics.

Information Sheet 2	Estimating quantities from drawing

1.11. Estimating quantities from drawing

The quantity of material in a project can be accurately determined from the drawings. The estimator must review each sheet of the drawings; calculate the quantity of material. Quantity calculations beyond design details are often necessary to.

Elements of a detail drawing BOM (Bill of Materials) are the part nember, the description, the type of material, the specification, and the stock size of the part(s) on the drawing. Elements of an assembly drawing BOM are used to itemize the parts necessary for the assembly of the product.

1.12. Optimizing materials use and minimizing waste

Recycling- is a process to change waste materials into new products to prevent waste of potentially useful materials, reduce the consumption of fresh raw materials, reduce energy usage, and reduce air pollution and water pollution by reducing the need for "conventional" waste disposal. Recycling is a key component of modern waste reduction and is the third component of the "Reduce, Reuse and Recycle" waste hierarchy.

Recyclable materials include many kinds of glass, paper, metal, plastic, textiles, and electronics. The Materials to be recycled are either brought to a collection center or picked up from the curbside, then sorted, cleaned, and reprocessed into new materials clear for manufacturing.

Reuse- is to use an item again after it has been used. This includes conventional reuse where the item is used again for the same function and new-life reuse where it is used for a different function. In contrast, recycling is the breaking down of the used item into raw materials which are used to make new items.

Material use is optimized and wastage is minimized

Waste minimization involves: -

- redesigning products
- changing common patterns, Waste minimization concerning about the consumption and production of material, to prevent the creation of waste. Waste minimization should be seen as a primary focus for most waste management strategies. Proper waste management can require a significant amount of time and resources; therefore, it is important to understand the benefits of waste minimization and how it can be implemented in all sectors of the economy, in an effective, safe and sustainable manner.

Waste management focuses on processing waste after it is created, concentrating on reduce, re-use, recycling, and waste-to-energy conversion.

Regulatory compliance

Waste Reduction - incentives

Reduced costs:

- raw materials, energy
- waste disposal (removal)
- storage and handling
- Improved efficiency
- Improved corporate image

By taking useful products without reprocessing, reuse help save time, money, energy, and resources.

Benefits

Waste minimization can protect the environment and provide good economic and business practices.

Waste minimization can improve:

Efficient production practices. Waste minimization can achieve more output of product per unit of input of raw materials.

Economic returns. More efficient use of products means reduced costs of purchasing new materials improving the financial performance of a company.

Public image The environmental profile of a company is an important part of its overall reputation (name) and waste minimization reflects a practical movement towards environmental protection.

Processes

Resource optimization (most effective use of a resource)

Minimizing the amount of waste produced by organizations or individuals goes hand-in-hand with optimizing their use of raw materials. For example, a sheet metal maker may arrange pattern pieces on a length of sheet metal in a particular way to enable the sheet to be cut out from the smallest area as possible.

Reuse of scrap material

Scraps can be immediately re-incorporated at the beginning of the manufacturing line so that they do not become a waste product. Many industries usually do this; for example, paper mills return any damaged rolls to the beginning of the production line, and in the manufacture of plastic items, off-cuts and scrap are re-incorporated into new products.

Waste exchanges

This is where the waste product of one process becomes the raw material for a second process. Waste exchanges represent another way of reducing waste disposal volumes for waste that cannot be eliminated.

Ship to point of use

This involves making deliveries of incoming raw materials or components direct to the point where they are assembled or used in the manufacturing process to minimize handling.

Zero waste

This is a whole systems approach that aims to eliminate waste at the source and at all points down the supply chain, with the intention of producing no waste.

Self-check 1	Practical work

Direction: Answer all the questions listed below. **(5 pts each)**

1. Make the development of pyramid whose side equal to 40mmand its height is equal to 50mm
2. Make the development of cone whose diameter *equal to 45 mm and its height is equal to 60mm*

Note: **Satisfactory rating – 6 points** **Unsatisfactory - below 6 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ____________

Rating: _____________

Name: _________________________ Date: _______________

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