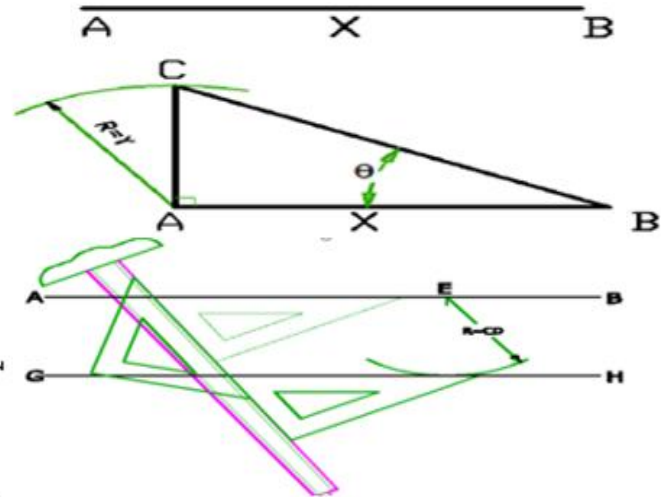
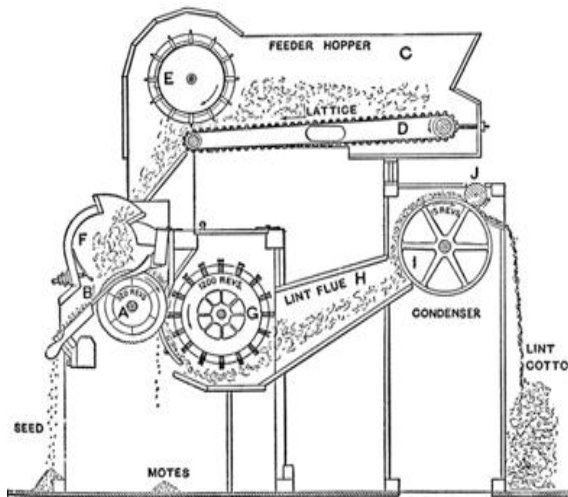


Ginning and Spinning Operation

LEVEL – I

Based on March 2022, Curriculum Version 1



Module Title:- Basic Technical Drawings

Module code: IND GSO1 M05 0322

Nominal duration: 60 Hour

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Acknowledgment

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Acronym

CAD: Computer Aided Design

LAP test: Learning Activity performance Test

PPE: Personal Protective Equipment

SOPs: Standard Operating Procedures

WHS: Workplace Health and safety

Introduction to the Module

Humans have used cloth for the last seven thousand years. From the beginning, the cotton fiber is manually processed by hand until the 18th century. After the invention of the automatic ginning machine, the process becomes so easy. In which ginning or separating of cotton lint from its seeds were done by hands until the evolution of different ginning machine. To improve and understand easily different models or designs of the ginning machine, technical drawing has a vital role for engineers, technologists, industry workers and students.

People learned to draw pictures of the objects around them long before they learned to write. The ability to make simple drawings helped people develop their first written language. There were no words or characters in ancient writing. Ideas of things were conveyed by pictures of the battles, and hunting was recorded in these “picture” languages.

There are two divisions of drawings; ***artistic and technical***. Artistic drawings are outside the scope of this text. An artistic drawing has many techniques and expressions that are not used in technical drawings. First of all, a technical drawing must communicate the same message to every user or reader of the drawing, whereas an artistic drawing is usually interpreted differently by everyone who sees it. To limit the interpretation to only one possible conclusion, the technical drawing is controlled by accepted standards, drawing "conventions" and projection techniques. Technical drawing is the art and science of describing structures and structural details completely and accurately by graphical means.

This module covers the units:

- Basic technical drawing equipment
- Alphabet of line
- Lettering
- Geometric construction

Learning Objective of the Module

- Identify basic technical drawing equipment
- Identify and create alphabet of line
- Describe drawing lettering
- Identify, construct and apply geometric construction

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

Unit one: Basic technical drawing

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Drawing materials and instruments
- Utilization of drawing materials and instruments
- Working area arrangement and self-preparation
- WHS requirements for drawing tasks
- Quality requirements for technical drawing

This unit will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Identify the difference between drawing materials and instruments
- Use drawing materials drawing materials and instruments properly
- Arrange appropriate working area before starting drawing and prepare oneself for making technical drawing
- Apply WHS requirements for drawing tasks
- Apply quality requirements for technical drawing

1.1 Drawing materials and instruments

Technical drawings must be prepared in such a way that they are clear, concise, and accurate. In order to produce such drawings equipment (i.e. materials and instruments) are used. Because time is an important factor in any of work, a clear understanding of all drawing equipment and their uses is important to speed up the process of drawing preparation. It includes but not limited to the following.

A. List of drawing instruments: -

- Drawing board
- Tee-square or Mini Drafter
- Set-square
- Scale
- Protractor
- French curves
- Templates
- Drawing instruments box

B. List of equipment's: -

- Drafting machine
- Computer for AutoCAD (Monitor, UPS, CPU, Keyboard, Mouse, etc.)
- Plotter / Printer

C. List of materials: -

- Drawing papers
- Drawing pencils
- Rubber / Eraser
- Drawing paper fasteners (Drawing pins, Cello tape)
- Tracing paper

1.2 Utilization of drawing materials and instruments

Various drawing instruments are used for making all drawings. The quality of a drawing depends on the quality of drawing instruments and drawing materials used. The drawing instruments need proper care and right adjustment. The following drawing instruments are required for preparing a neat and correct drawing.

- Basic Instruments

1. Drawing board
2. Drawing sheet
3. Drawing pencil
4. Drawing clips or pins
5. Eraser
6. Eraser shield

- Instruments for Drawing Straight Lines

1. T- square
2. Set- squares

- Instruments For Drawing Curved Lines

1. Large size compass
2. Small bow compass
3. French curve

- Instruments For Measuring Distance

1. Large size divider
2. Small bow divider
3. Scales

- Instruments For Measuring Angles

1. Protractors
2. Set-squares

- Special Tool

1. Mini drafter

- **Drawing Board:** - A drawing board with its working surface upward. The top surface of the board is perfectly smooth and level. The bottom of the drawing board. A drawing board is rectangular in shape and is made of well seasoned soft wood such as

oak or pine. A straight ebony edge is fitted on the left side on the board against which the head of the T- square moves.

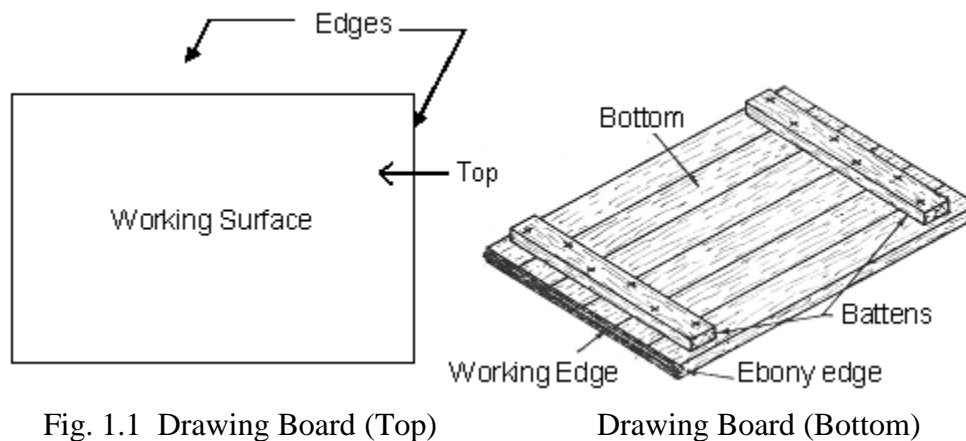


Fig. 1.1 Drawing Board (Top)

Drawing Board (Bottom)

- **Drawing Sheet**:-The drawing is frequently made in pencil on the drawing sheet. The best drawing sheet has the following qualities:

1. Light cream buff in color to have good appearance
2. Fine grains to pick up the graphite and produce clean, dense black lines
3. Strong fibers
4. Superior erasing qualities
5. Folding strength
6. Toughness
7. Smooth surface
8. Hard surface

Drawing papers are the materials on which the drawings are made. Depending on its

application different types of drawing papers are available. These are: white plain paper, profile paper, plan/profile paper, cross-section paper and tracing paper.

A. White plain papers: are general-purpose for office uses and drawings.

They are manufactured according to ISO (International Organization for Standardization) standard paper sizes. Standard drawing sheet sizes are in three series,

designated An, Bn, and Cn. Paper frames and drawing frames are standardized for each size of papers.

B. Profile, Plane/ Profile and Cross-section papers: are referred to as gridded papers. The first two are used for road design and the later one is used for drawing road cross sections, rough design, sketching, preparing schedules, plotting graphs, etc.

C. Tracing paper: is a high-grade white transparent paper, upon which copies or “tracings” are made for the purpose of reproducing by blueprinting or by other similar processes. Tracing may be made in ink, usually it takes ink well, and from which pencil lines can easily be erased. Reproductions (printing) can be made directly from pencil drawings on tracing paper; however, for better results in production, a pencil drawing on tracing paper is usually inked over. This paper must not be folded.

Drawing paper is the paper on which the drawing is produced. The common paper sizes are:

A0: 841 * 1189

A1: 594 * 841

A2: 420 * 594

A3: 297 * 420

A4: 210 * 297

- Drawing Pencil:- Neatness, quality and accuracy of the drawing greatly depends upon the type and conditions of the pencil used for drawing. Pencil leads are made of graphite with clay added in varying amounts to make 18 grades from 9H to 7B. These grades can be divided in three groups:

1. Hard : 9H to 4H
2. Medium : 3H to B (3H, 2H, H, F, HB and B)
3. Soft : 2B to 7B

Pencil of 9H is the hardest and that of 7B is the softest. Harder pencils have leads of small diameters and softer pencils of larger diameters to give adequate strength. The choice of grade of pencil depends upon the type of work, texture of paper, atmosphere, humidity, etc. Following pencils should be used for drawing work in class:

1. 2H Pencil - For drawing outlines, Centre lines, Break lines, etc.
 2. H Pencil - For dimensioning, arrowheads, hatching lines, lettering, sketching, circles, arcs, etc.
 3. Micro tip pencil - 0.5 mm for drawing outlines and 0.8 mm for shading and sketching
- **Drawing Clips Or Pins** :- Drawing clips or pins are used to fix the drawing sheet on the drawing board at the required place. Frequent use of pins cause formation of impressions of pin pricks on the board, thus spoiling the surface of the board. The present trend is to go in for steel clips, if the size of the drawing paper is the same as that of the drawing board. Clips are used at all the four corners of the drawing board to clamp the paper. Adhesive tapes are also used for fixing the drawing sheet.
 - **Eraser** :- Eraser is used to remove the extra lines, lines/marks drawn by mistake and to clear soiled spots on the drawing. Only pencil eraser is used. Soft India-rubber is the most suitable kind of eraser for pencil drawings. The eraser used should be such that the surface of the drawing paper is not spoiled in anyway. It is desirable to use erasing shield to protect the near by lines from being erased. The rubber crumbs formed after erasing should be swept away with a clean duster and should never be brushed off with hands. Use of eraser should be minimized by proper planning.

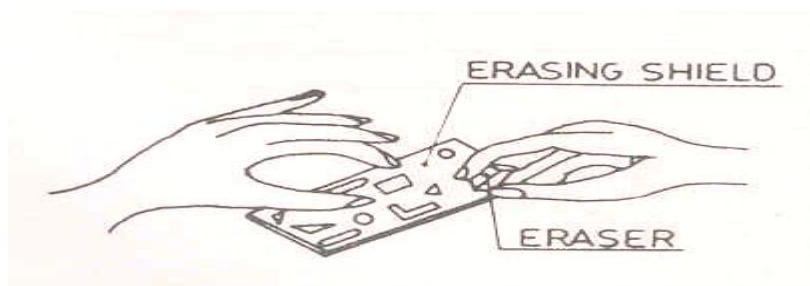


Fig. 1.2 Eraser

- **Erasing Shield** :- It is a thin metal or plastic plate cut with slots, circles and curves of different dimensions. It helps to erase unwanted pencil lines without erasing the surrounding lines.
- **T- Square** :- It is composed of a long strip called blade, which is screwed rigidly at right angle to a shorter piece called head or stock. It is made of mahogany or pear wood, which is harder than the board wood. The head also has an ebony edge which slides against the working edge of the board. T- Square is used for making horizontal, vertical, inclined or parallel lines on the drawing sheet.

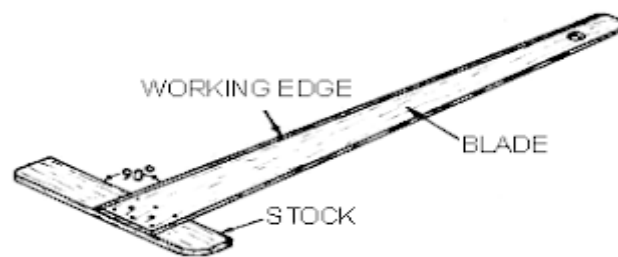


Fig. 1.3 T-square

- **Set-Squares** :- Set-squares are made of transparent plastic and are available in the shape of triangles, having a French curve or simply a gap cut in the body. These are used for drawing short straight lines, measuring and drawing certain angles. A good combination of set-squares is $30^\circ \times 60^\circ$ set square with a long edge of 250 mm and a 45° set squares with each edge of 200 mm.

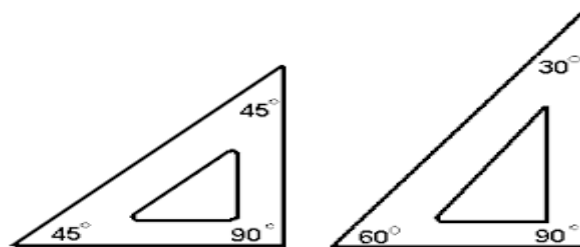


Fig. 1.4 set-square

- **Large Size Compass** :- The compass is used for drawing circles and arcs. It consists of two legs hinged together at its upper end. A pointed needle is fitted at the lower end of one leg, while a pencil lead is inserted at the end of the other leg. The lower

part of the pencil leg is detachable and it can be interchanged with a similar piece containing an inking pen. Both the legs are provided with knee joints. Circles up to about 120 mm diameter can be drawn with the legs of the compass kept straight. For drawing smaller circles, both the legs should be bent at the knee joints so that these are perpendicular to the surface of the paper.

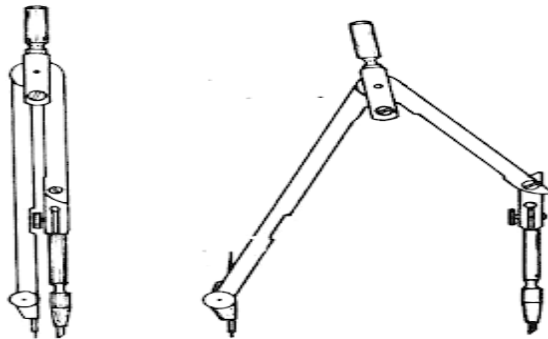


Fig. 1.5 large size compass

- **Small Bow Compass** :- Small bow compass is conveniently used for drawing circles and arcs of small diameters. It is very handy when a number of small circles of the same diameter are to be drawn. The adjusting nut of the small compass may be on the side or at the centre. This adjusting nut is provided to make fine adjustment for accurate small circles.

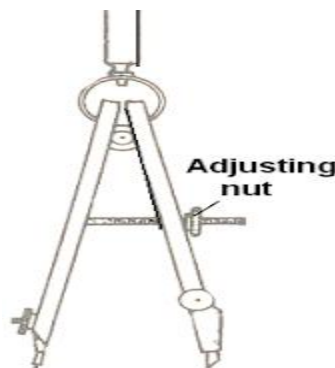


Fig. 1.6 small bow compass

- **French Curves** :- French curves are used to draw irregular curved lines, which can not be drawn with a compass. A light pencil curve is first drawn free hand through the known points. Neat continuous curve is finally drawn with the longest possible curve

coinciding exactly with the free hand curve. Proper care must be taken to ensure that no corners are formed anywhere on the curve. Proper use of French curves requires skill. French curves are made of transparent celluloid or plastic. These are available in various shapes. One of the french curves.

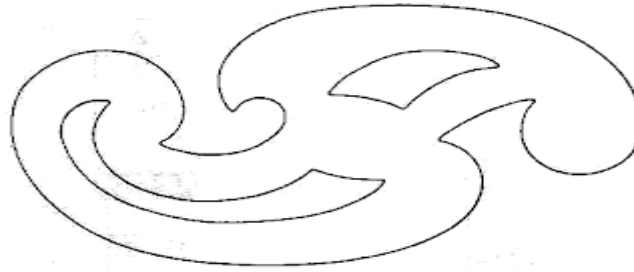


Fig. 1.7 French curve

- **Large Size Divider** :- The dividers has two legs hinged at the upper end and is provided with steel pins at both the lower ends, but it does not have the knee joints.



Fig. 1.8 Large size divider

- **The dividers are used to**
 - Divide straight or curved lines into desired number of equal parts.
 - Set off distances from the scale to the drawings.
 - Transfer measurements from one part of the drawing to another.
- **Small Bow Divider** :- The small bow divider is adjusted by a nut and is very convenient for marking minute divisions and large number of short equal distances.

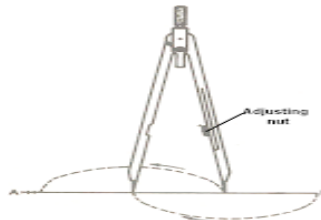


Fig. 1.9 Small bow divider

- **Scales** :- Scales are made of wood, steel, celluloid or plastic. Stainless steel scales are more durable. Scale may be flat or of triangular cross- section. 15 cm long and 2 cm wide or 30 cm long or 3 cm wide flat scales are commonly used. These are usually about 1 mm thick. The longer edges of the scale are marked with inch and its sub-divisions on one side and centimeter and its sub-divisions on the other side.

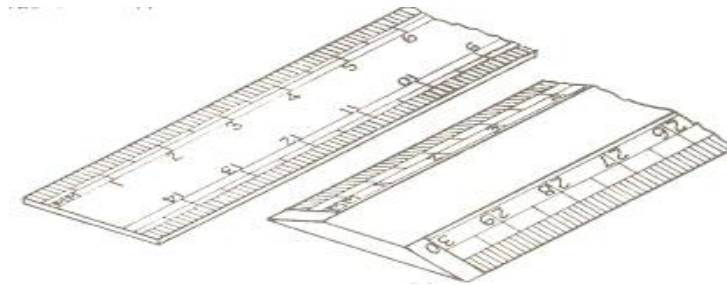


Fig. 1.10 Scales

- **Protractors** :- Protractors or Pro-circles are used for drawing any desired angle. These are made of hard transparent plastic. The edges are either squared or beveled. Semi-circular type protractor.

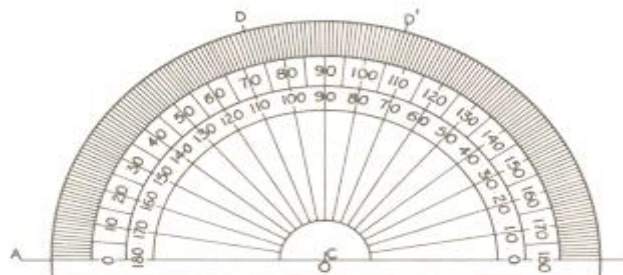


Fig. 1.11 Protractors

- **Mini Drafter** :- A T-square, protractor and set squares can be replaced by a drawing drafter. With this, lines can be drawn at any desired angle. A mini drafter is made with several links. The scale is attached at the working end of the links. The scale unit can be rotated and set at any desired angle. The clamp end is fixed to the upper or lower edge of the drawing board. There is no need to have a working edge on a drawing board when a mini drafter is used. Mini drafter saves considerable time.

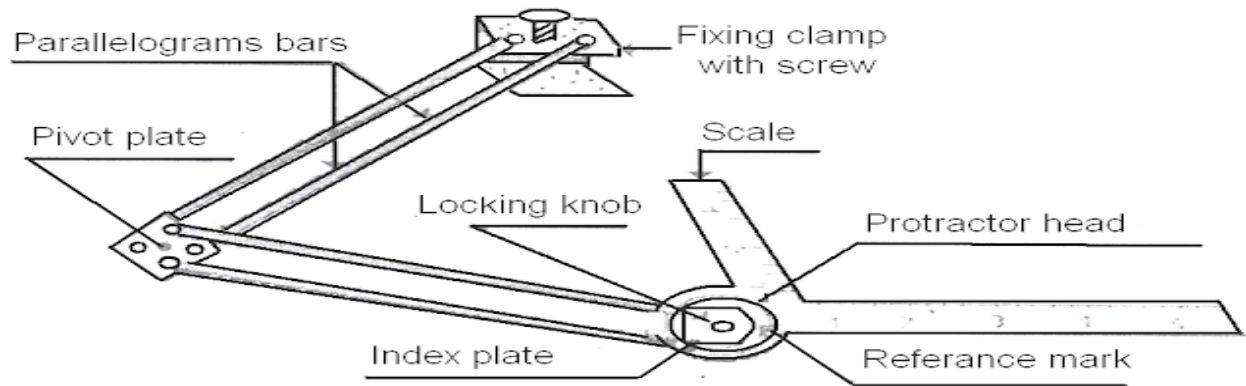


Fig. 1.12 Mini drafter

- **Guidelines For Use** :- The mini drafter is clamped on the board for use as follows :
 1. Set the protractor head such that zero on protractor coincides with the reference mark on index plate. Lock the head by locking knob.
 2. Insert the clamp at the left-top corner of the drawing board along horizontal or vertical edge.
 3. Align the bottom of horizontal scale along the bottom edge of the board. In this position tighten the clamp screw.
 4. Place the drawing sheet, with already drawn border lines, underneath the scales of mini drafter and align the bottom borderline of sheet with the edge of horizontal scale of mini drafter.
 5. Fix the drawing sheet in the same position by drawing clips or adhesive tape.
 6. The protractor head along with scales can be moved to any place on the drawing sheet.
 7. To draw horizontal and vertical line the reference mark should coincide with the zero on protractor head. To draw inclined line the protractor can be set to any desired angle coinciding with the reference mark on the index plate.
 8. All the positioning is done by one hand while the other is used for drawing the lines.

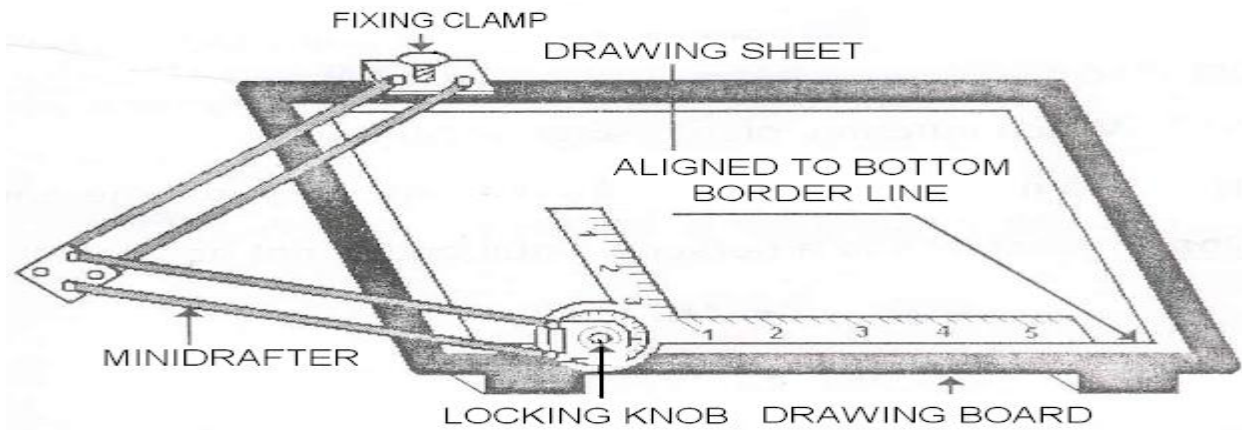


Fig. 1.13 Guide lines for use of mini drafter

- **Templates:-** contain pre-dimensioned holes in the right scale to accurately draw a symbol or sign. For drawing circles and circle-arcs, circle templates which contain a set of suitably-sized holes are used. Templates are also available for other geometric shapes such as squares and for drawing ellipses, as well as many specialized varieties for other purposes.

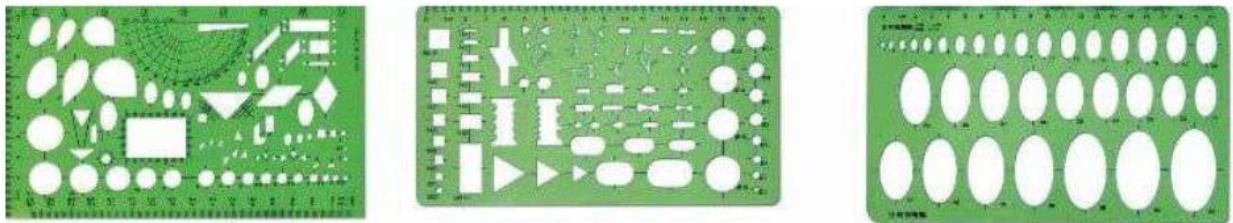


Fig. 1.14 Templates

- **Rapidograph:-** is a type of drawing pen by which lines are drawn on tracing papers. It produces light resistant, waterproof, precise and consistent ink lines for any application. Since most rapidograph pens require different pen sizes (line widths) for various projects, they are manufactured in different sizes.

1.3 Working area arrangement and self-preparation

- All the drawing instruments should be kept clean by wiping with a cloth/towel.
- Prepare the required instruments, materials and tools
- The hands should be kept clean at all times during work

- Special emphasis is to be given to sliding instruments on the drawing sheet, such as T-square and set squares. These instruments must be cleaned properly every time.
- Dirt and graphite particles from the pencil will make the drawing dirty. Hence, every care should be taken to remove them from the drawing sheet.
- Direct contact of hand with the drawing sheet should be avoided.
- Rubbing or erasing should be done properly with soft eraser.

1.4 WHS requirements for drawing tasks

Workplace procedures (WHS) May include but not limited:

- requirements prescribed by legislation, awards, agreements and conditions of employment
- SOPs
- work instructions
- PPE
- oral, written and visual communication
- quality practices, including responsibility for maintenance of own work quality and contribution to quality improvement of team or section output
- housekeeping
- tasks related to environmental protection, waste disposal, pollution control and recycling.

1.5 Quality requirements for technical drawing

- **Precautions for Neatness in Drawing Work** :- Cleanliness and neatness in drawing work are very important requirements. Following precautions are required to be taken to keep a drawing neat and clean:
 1. The hands should be kept clean at all times during work.
 2. All the drawing instruments should be kept clean by wiping with a cloth/towel.

3. Special emphasis is to be given to sliding instruments on the drawing sheet, such as T- square and set squares. These instruments must be cleaned properly every time.
4. Pencil should always be kept sharp and used properly. It should be sharpened away from the drawing sheet and other instruments.
5. Dirt and graphite particles from the pencil will make the drawing dirty. Hence, every care should be taken to remove them from the drawing sheet.
6. Direct contact of hand with the drawing sheet should be avoided.
7. Rubbing or erasing should be done properly with soft eraser.

Self check-1

Part-I Matching

Instruction: select the correct answer for the give choice. You have given 1 Minute for each question. Each question carries 2 Point.

| A | B |
|---------------------|---------------------------------|
| -----1. T-square | A. Measuring distance |
| -----2. Scale | B. For drawing circles and arcs |
| -----3. Protractor | C. The capacity of an object |
| -----4. Hard pencil | D. For drawing straight lines |
| -----5. Compass | E. For angles |
| | F. 9H |
| | G. 2H |

Part II: Short answer writing

Direction: Give short answer/explain to the following questions. Time allotted for each item is 3 minute and each question carry 5 point.

1. Drawing board
2. Compass
3. Set square
4. Drawing instrument vs materials

Part III: Fill the blank space

Direction: fill the blank space to the following questions. Time allotted for each item is 1 minute and each question carry 3 point.

1. _____are used to draw irregular curved lines, which can not be drawn with a compass.
2. _____is used for drawing circles and arcs.
3. _____is a type of drawing pen by which lines are drawn on tracing papers.

Note: Satisfactory rating – above 60% Unsatisfactory - below 60%

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

Unit Two: Alphabet of line

This unit to provide you the necessary information regarding the following content coverage and topics:

- Types and purpose of lines in drawing
- alphabet of lines for proper working drawing

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Know types and purpose of lines in drawing
- Apply alphabet of lines for making proper working drawings

2.1 Types and purpose of lines in drawing

Lines of various forms and thickness are used as alphabets of the graphic language. If these lines are properly and systematically composed, they have the capacity to describe the shape of an object adequately. It is beneficial to develop the capacity of discriminating each line in shape and thickness. The alphabet of lines may be categorized into three groups based on their weights or thickness. The object line, the cutting plane line, and the short break lines should be drawn thick. The center lines, dimension lines, extension lines, long-break lines, and phantom lines should be thin and the hidden should have an intermediate thickness between the thin and the thick lines. In fact, thick lines are (0.5 to 0.8 mm) wide, thin lines between (0.03 to 0.5 mm) wide. The actual width each line is governed by the size, the style of the drawing and the smallest size to which it is to be reduced.

All the main line types are listed below:

- Visible
- Hidden
- Center
- Dimension
- Extension
- Leader
- Cutting plane

- Section
- Break
- Phantom

| Types of Lines | Weight |
|-----------------------|--------|
| Object | Thick |
| Hidden | Medium |
| Center | Thin |
| Phantom | Thin |
| Extension & Dimension | Thin |
| Leader | Thin |
| Section | Thin |
| Cutting plane | Thick |
| Short break | Thick |
| Long break | Thin |

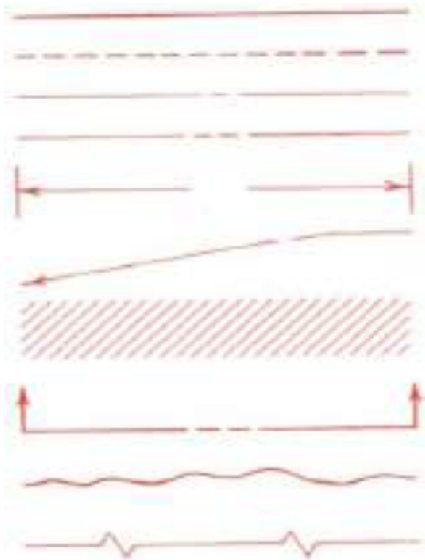


Fig.2.1 types of lines

2.2 Apply Alphabet of lines

Object lines: are dark, heavy solid to show the out line and shape of an object and define features you can see in a particular view. These lines are the most prominent lines on drawings. The object line is also identified as visible line.



Fig. 2.2 object lines

Hidden lines: are medium weight short dashed lines. They are used to show the out line of a feature that can not be seen in a particular view and help clarify a feature, but can be omitted if they clutter a drawing. The dashes of hidden lines should be drawn approximately 3 mm long with a space of 1.0mm left between each dash. However, the length may vary slightly to suit the size of the drawing.



Fig. 2.3 Hidden lines

Center lines: are thin lines composed of one long dash and one short dash spaced alternately. It is used to indicate axis of circles and symmetrical surfaces of an object. Depending up on the size of the drawing, the length of the long dash approximately ranges from 20-40mm. The short dash is about 3mm and the spacing between the long and short dashes is about 1.5mm.

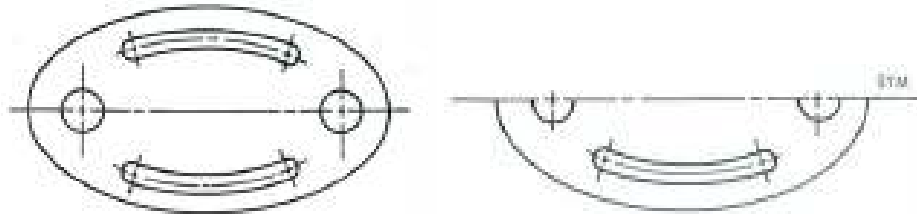


Fig. 2.4 Center lines

Dimension lines: are thin lines with arrowheads at its ends. It is used to Show the length, width, and height of the eatures of an object.

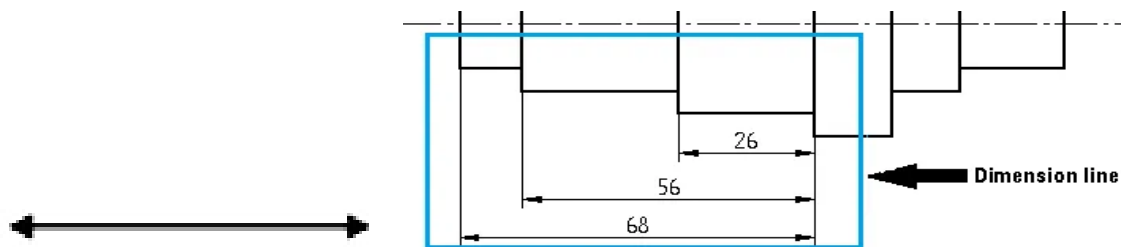


Fig. 2.5 Dimension lines

Extension lines: are thin solid lines used to show the starting and stopping points of a dimension. Extension line is drawn approximately 1.5mm away from object line and is extended 3mm long beyond the outermost arrowhead.

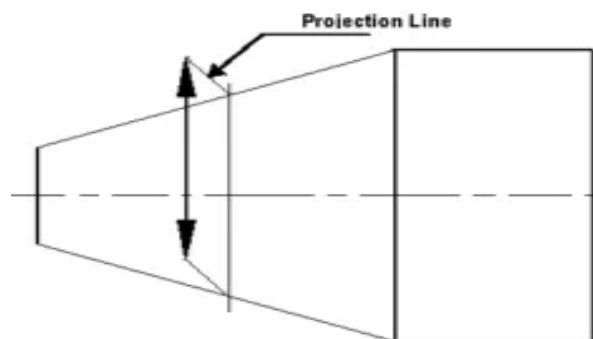


Fig.2.6 projection/extension lines

Cutting plane lines: are used to indicate the location of the cutting of cutting plane in the process of sectioning. Two forms of lines may be used. The first one is a dark line composed

of one long and two short dashes spaced alternately. The long dashes are drawn approximately 20 to 40mm long or little more depending upon the size of the drawing. The short dashes are drawn approximately 3mm long, with a space of 1.5mm between each dash. The second form of cutting plane line is composed of equal dashes approximately 6mm long with spaces of 1.5mm between each dash. The ends of the cutting plane lines are bent 90° angle and are terminated by arrowhead to indicate the direction of sight.

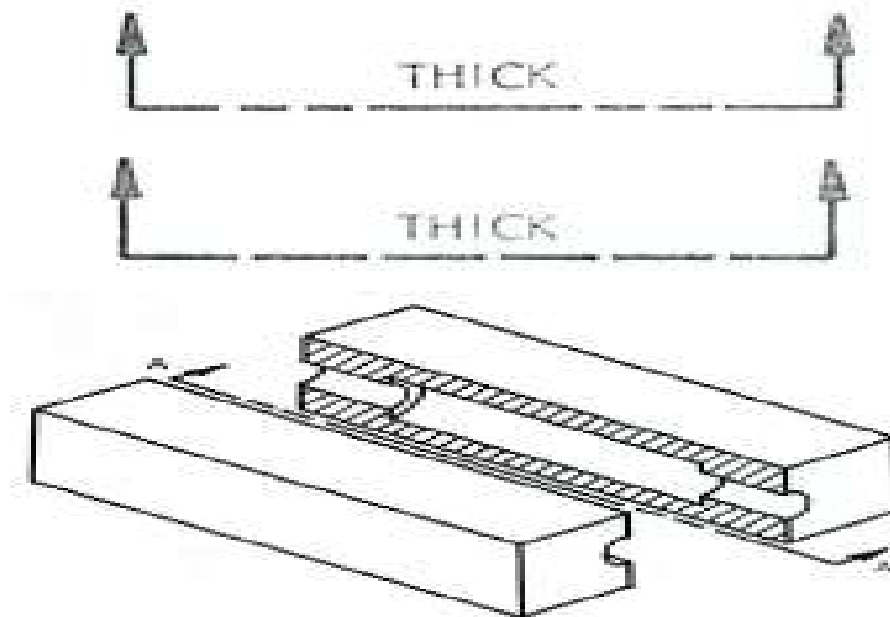


Fig. 2.7 cutting plane lines

Section Lines: are used to indicate the cut surface of an object in sectional view. The section lines are usually drawn thin at 45 degree angle to produce a contrast with visible line. It should be equally spaced and proportional to the mass of the sectional surface.

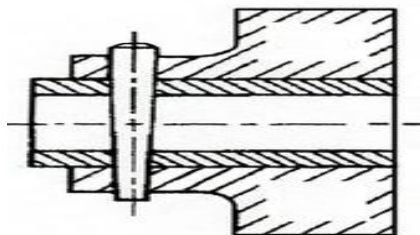


Fig.2.8 section line

Break Lines: generally are used to break out sections for clarity or for shortening apart.

Three types of lines with different line weights are used in break line. These are:

- ☐ Long breaks
- ☐ Short breaks
- ☐ Cylindrical breaks

Long Break Lines: are long and thin lines. It is used to show that the middle section of an object has been removed so it can be drawn on a smaller piece of paper.

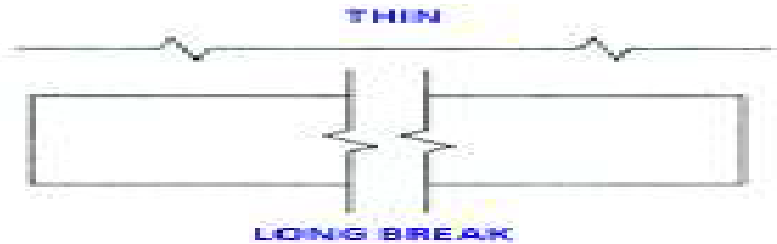


Fig. 2.9 long break lines

Cylindrical Break Lines: are thin lines. It is used to show round parts that are broken in half to better clarify the print or to reduce the length of the object.

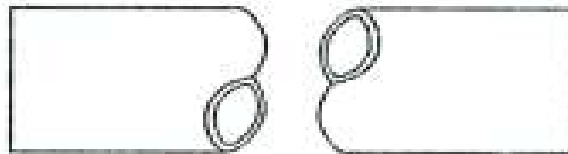


Fig. 2.10 cylindrical break lines

Phantom Lines: are thin lines composed of long dashes alternating with pairs of short dashes. The long dashes are drawn approximately 20-40mm long or a little more. The short dashes are drawn 3mm long with space of 1.5mm between each dash. Phantom lines are used for three purposes in drawings:

- ☐ To show the alternate position of machine part and lines of motion.
- ☐ To show the relationship of parts that fit together.
- ☐ To show repeated detail.

Self-check-2

Part-I Matching

Instruction: select the correct answer for the give choice. You have given 1 Minute for each question. Each question carries 2 Point.

| A | B |
|------------------------|--|
| -----1. Hidden line | H. Indicate axis of circles |
| -----2. Center line | I. To show length and width |
| -----3. Dimension line | J. The capacity of an object |
| -----4. Object lines | K. Show the out line of a feature that can not be seen |
| -----5. Break lines | L. For shortening apart |
| | M. are dark, heavy solid |

Part II: Short answer writing

Direction: Give short answer/explain and put their symbols/ to the following questions. Time allotted for each item is 6 minute and each question carry 5 point.

1. Hidden
2. Center
3. Dimension
4. Cutting plane
5. Section

Part III: True or false

Direction: say true or false to the following questions. Time allotted for each item is 1 minute and each question carry 3 point.

1. Object lines are medium weight short dashed lines.
2. Section Lines are used to indicate the cut surface of an object in sectional view.

Note: Satisfactory rating – above 60% Unsatisfactory - below 60%

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

Unit Three: Lettering

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

- Purpose of lettering in drawing
- Types of lettering styles
- Lettering pencils, lettering device and letter guide lines

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Describe the Purpose of lettering in drawing
- Identify the various Types of lettering styles
- Identify proper types of lettering pencils, lettering device and letter guide lines

3.1 Purpose of lettering in drawing

The information that a drawing must present cannot be revealed by graphic shapes and lines alone. To make a drawing informative and complete, you must include lettering in the form of dimensions, notes, legends, and titles. Lettering can either enhance your drawing by making it simple to interpret and pleasant to look at, or it can ruin your drawing by making it difficult to read and unsightly in appearance. Therefore, it is essential that you master the techniques and skills required for neat, legible lettering.

3.2 Types of lettering styles

There are various forms of a letter used in the art of lettering and each approximate for some particular purpose.

3.2.1 Roman Letters

The term Roman refers to any letter that has wide downward strokes and thin connecting strokes, as would result from the use of a wide pen, and the ends of the strokes are terminated with spurs called serifs. Roman letters include the Old Roman and Modern Roman and may be vertical or inclined.

3.2.2 Italic Letters

Inclined letters are also referred to as italic, regardless of the letter style.

3.2.3 Text Letters

The Text letters are often loosely referred to as “Old English”, are little used where legibility is important, but only where a decorative effect is sought. These letters may be easily and rapidly made with a broad-nib pen.

3.2.4 Gothic Letters

German Text is the only form of medieval Gothic in commercial use today. Commercial Gothic is a relatively modern development that originated from the earlier Gothic forms. Also called sans-serif Gothic, this letter is the only one of interest to engineer. It is the plainest and most legible style and is the one from which our single-stroke engineering letters are derived. While admittedly not as beautiful as many other styles, sanserif letters are very legible and comparatively easy to make. They may also be drawn in outline and filled in.



Fig. 3.1 Classification of letter styles

3.3 Lettering pencils, lettering device and letter guide lines

Lettering is freehand drawing and not writing. Therefore, the six fundamental strokes and their direction for freehand drawing are basic to lettering, Fig.. The horizontal strokes are drawn to the right, and all vertical, inclined, and curved strokes are drawn downward.



Fig. 3.2 basic lettering strokes

3.3.1 Pencil for Lettering

First, sharpen the pencil to a needle point; then dull the point very slightly by marking on paper while holding the pencil vertically and rotating the pencil to round off the point. Pencil lettering should be executed with a medium pencil, such as an F or H for ordinary paper; the strokes should be dark and sharp, not gray and blurred. In order to wear the lead down uniformly and thereby keep the lettering sharp, turn the pencil frequently to a new position. In general, draw vertical strokes downward or toward you with a finger movement, and draw horizontal strokes from left to right with a wrist movement without turning the paper. Since practically all pencil lettering will be reproduced, the letters should be dense black. Avoid hard pencils that, even with considerable pressure, produce gray lines.

3.3.2 Guide lines

The use of light pencil lines called guidelines. Guidelines ensure consistency in the size of the letter characters. If your lettering consists of capitals, draw only the cap line and base line. If lowercase letters are included as well, draw the waist line and drop line. The waist line indicates the upper limit of the lowercase letters. The ascender is the part of the lowercase letter that extends above the body of the letter;

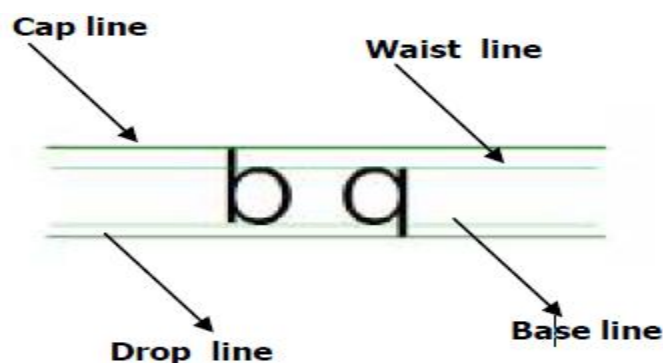
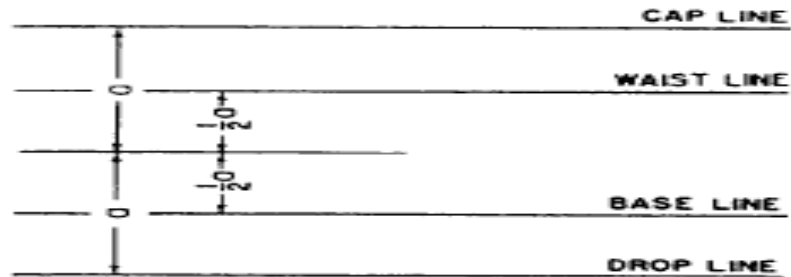


Fig. the four guide lines

Navy Training

CAP LINE
WAIST LINE
BASE LINE
DROP LINE

A



B

Fig. 3.3 Laying off guidelines

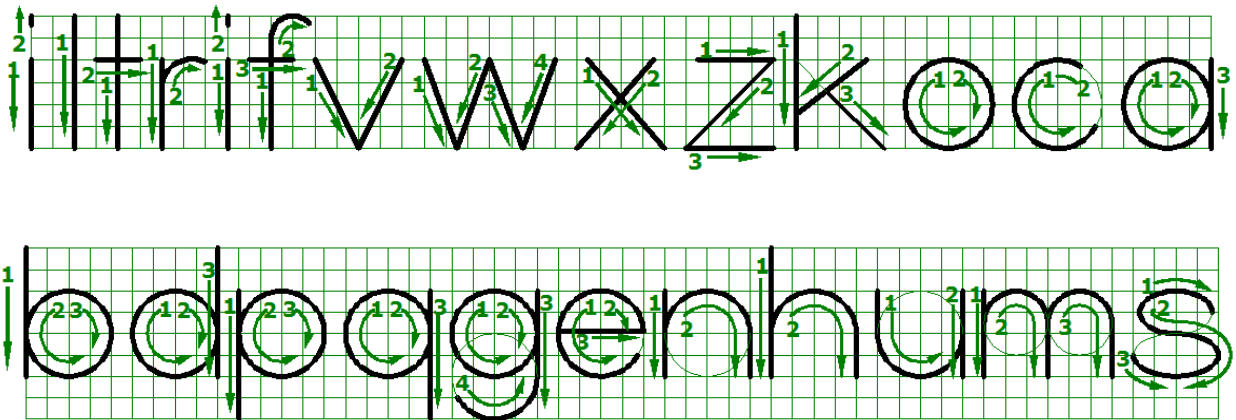
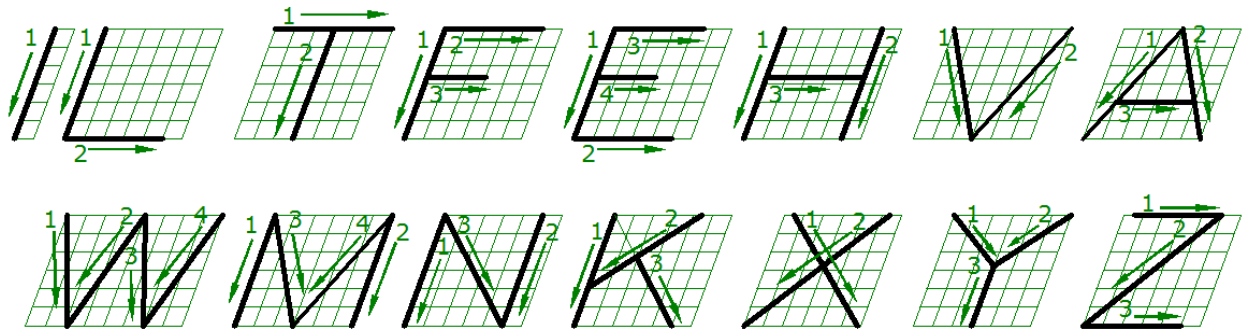


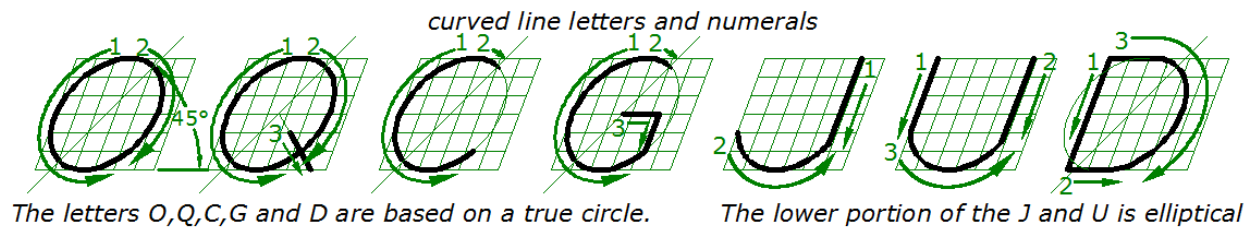
Fig. 3.4 vertical lower case letters

Inclined Capital, Lower-Case Letters and Numerals:

The order and direction of the strokes and the proportions of the inclined capital letters and numerals are the same as those for the vertical letters except that they are commonly tilted at an angle of $67 \frac{1}{2}^\circ$ from a horizontal guide line. Inclined letters are also classified as straight-line or curved line letters, most of the curves being elliptical.



"w" is the only letter over 6 unit wide. Letters in "TOMQ, VAXY" are 6 units wide-all the others are 5, except "I" and "w"



The letters O, Q, C, G and D are based on a true circle.

The lower portion of the J and U is elliptical



8 is composed of two ellipses and 3, s and 2 are based on 8.



0, 6 and 9 are elliptical

Fig. 3.5 Inclined capital letters and numerals



Fig. 3.6 Inclined lowercase letters

Spacing between Guidelines: The spacing between two lines of capitals may vary from one half of the height to the full height of a capital. Two thirds of the height is customarily used.

The space indicated by the letter S equals the vertical distance between the waist line and the cap line.

3.3.3 Guide Lines Devices

Special devices are widely used for spacing. Lettering triangles are made in a variety of forms and sizes. These triangles are provided with sets of holes in which the pencil point may be inserted; the guide lines are produced by moving the triangles with the point of the pencil along the T-square. The lettering triangles are also provided with a slot which has an inclined edge suitable for drawing inclined guide lines.

The Braddock-Rowe lettering triangle has a series of holes arranged to provide guidelines for lettering and dimensioning figures, and for spacing section lines. The numbers at the bottom of the triangle indicate spacing of guide lines.

The Ames Lettering Instrument is an ingenious transparent plastic device composed of a frame holding a disk with three columns of holes. The vertical distances between the holes may be adjusted quickly to the desired spacing for guide lines or section lines by simply turning the disk to one of the settings indicated at the bottom of the disk. These numbers indicate heights of

letters. Thus, for different height of letters, different corresponding No setting would be used. The center column of holes is used primarily to draw guide lines for numerals and fractions, the height of the whole number being two units and the height of the fraction four units.

Self check-3

Part I: Answer the following questions

Direction: Give an answer/explain/ to the following lettering styles questions. Time allotted for each item is 6 minute and each question carry 5 point.

1. Roman lettering styles
2. Italic lettering styles
3. Gothic lettering styles
4. Text lettering styles
5. List out the four guide lines
6. Explain about pencil for lettering

Part II: True or false

Direction: say true or false to the following questions. Time allotted for each item is 1 minute and each question carry 3 point.

1. Pencil lettering should be executed with a medium pencil, such as an F or H for ordinary paper.
2. Inclined letters are also referred to roman letters, regardless of the letter style.

Part III: Fill the blank space

Direction: fill the blank space to the following questions. Time allotted for each item is 1 minute and each question carry 3 point.

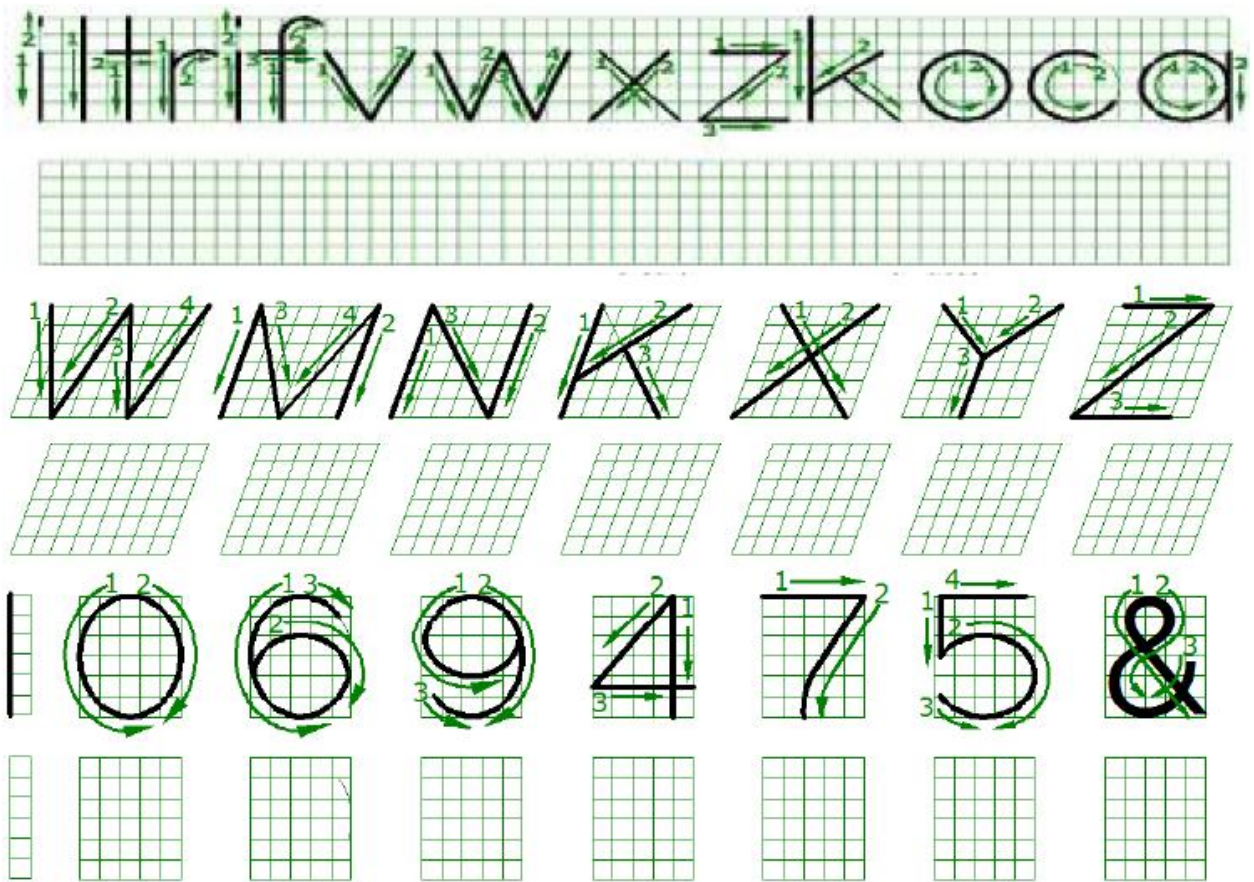
1. _____ ensure consistency in the size of the letter characters.
2. _____ is freehand drawing and not writing.

Note: Satisfactory rating – above 60% Unsatisfactory - below 60%

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

Operation sheet- 3.1: lettering in drawing

- **Operation title:** Procedures of lettering in drawing
- **Purpose:** To practice and demonstrate the knowledge and skill required in writing letters with the four guide lines and to practice the stroke or direction of capital and small letters
- **Instruction:** Use the given figure below (Figure), the tools and equipment write the letters given in the fig.. For this operation you have given 2Hour.
- **Tools and requirement:**
 1. This operation sheet
 2. Ruler,
 3. Scale
 4. Pencil
 5. Lettering triangles and Drawing paper
- **Precautions:** prepare and use properly the guide lines and the stroke direction before writing the letters
- **Procedures in doing the task**
 - Step-1:** Use the given figure
 - Step-2:** prepare lettering pencils, lettering device and the guide lines
 - Step-3:** identify the type of letter and their stroke direction
 - Step-4:** write the letter on the prepared guidelines



Scale 1:1

Figure: 3.7 Figure given for operation sheet 3.1

- **Quality Criteria:** the lettering should be done in neatly and correctly.

Lap Test 3

- Task-1: prepare the guide lines
- Task-2: Perform strokes of letters/the numerals
- Task-3: write the letters and numerals
- Task 4: check the uniformity, composition and stability of letters

Unit Four: Geometric construction

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

- Plane geometries and their basic elements
- Constructing geometrical figures

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Identify different types of plane geometries and their basic elements
- Construct different types of geometrical figures

4.1 Plane geometries and their basic elements

The geometric construction forms the basis for all technical drawings. The purpose of the geometric construction is to accurately develop plane geometric shapes ranging from squares, triangles, and three dimensional cylinders to complex irregular curves and ellipses. These constructions are normally produced without the aid of a scale, but rather with simple drafting tools. Engineers, designers, and drafters regularly perform the task of producing geometric construction in their work, applying the principles of plane geometry. The process involved in the production of geometric constructions requires a basic understanding of plane geometry. Geometric construction skills can be acquired and demand precision and the correct use of drafting instruments. In developing geometric constructions it is important that drafting tools be in good condition. 4H to 6H leads are normally used for constructions that produce very lightweight lines. These lines need not necessarily be erased when the construction is completed. A small error or inaccuracy in the solving of a geometric problem could result in a serious error in the final construction.

4.2 Methods and rules of constructing geometrical shapes

Construction of Point, Line and Angle:

There are a number of basic geometric constructions with which the student should be familiar. At the beginning the student should follow the basic sequence in each illustration that follows the learner how to develop the various geometric forms.

4.2.1 Points

The construction of geometric figures begins from representation of points on drawings. A *point* represents an exact location in space which has neither width, height nor depth. Points are commonly represented by intersection of two lines, a short cross bar on a line or by small cross (Fig.).



Fig. 4.1 Representation of points

4.2.2 Line

can be defined as:

- ☐ A path between two points
- ☐ A moving point
- ☐ Geometric figure that has only one dimension: length.

Line may be straight, curved, or a combination but the shortest distance between two points is called straight line and it is commonly referred simply as a “line”.

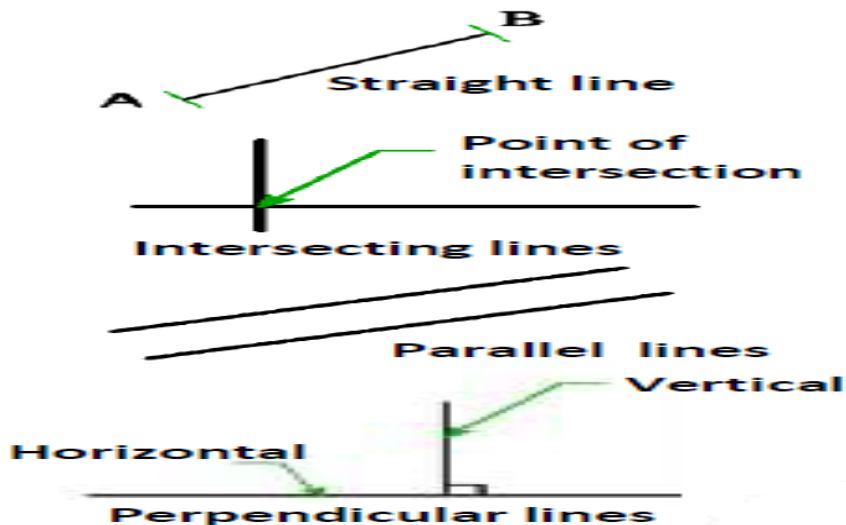


Fig. 4.2 Types of lines

Drawing Parallel Lines

To draw a line parallel to a given line through a given distance

Method 1

1. Draw a line AB at any angle.
2. Locate point E near A and point F near B on line AB.
3. E and F as centers and radius CD, draw two arcs.
4. Draw a line (GH) tangent to the arcs using any straight edge.

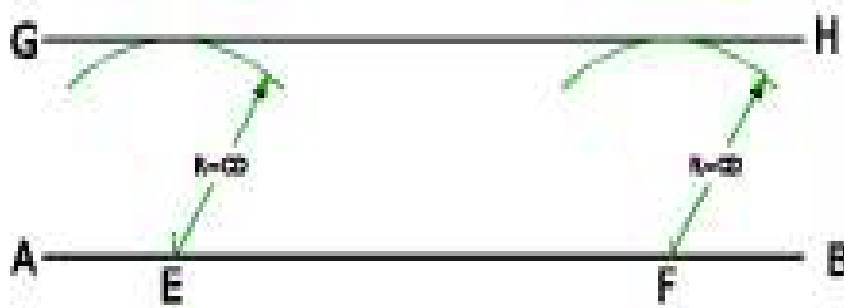


Fig. 4.3 Drawing parallel lines

Method 2 (preferred method)

1. Draw line AB at any angle.
2. Open your compass to radius = CD.
3. With any point E on AB as a center, and radius = CD, strike an arc.
4. Align your set square with line AB with the T-square or another set square as a support.
5. Slide the set square until it is tangent to the arc.
6. Draw line GH using the edge of your set square.

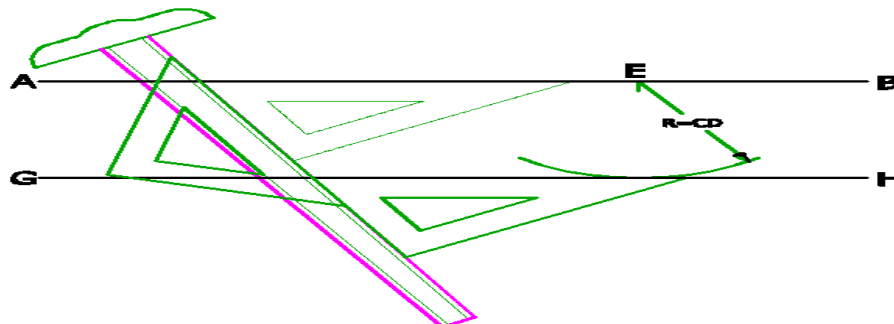


Fig. 4.4 Drawing parallel lines

Drawing Perpendicular Lines

Constructing perpendicular to a line through a point on the line (Fig)

1. Draw line AB and locate point P on it.
2. With arbitrary radius r and p as a center, strike arcs to intersect AB at C and D.

3. With radius greater than $\frac{1}{2} CD$, and centers at C and D, draw arcs to intersect at E. Use straight edge to draw line EP. $EP \perp AB$.

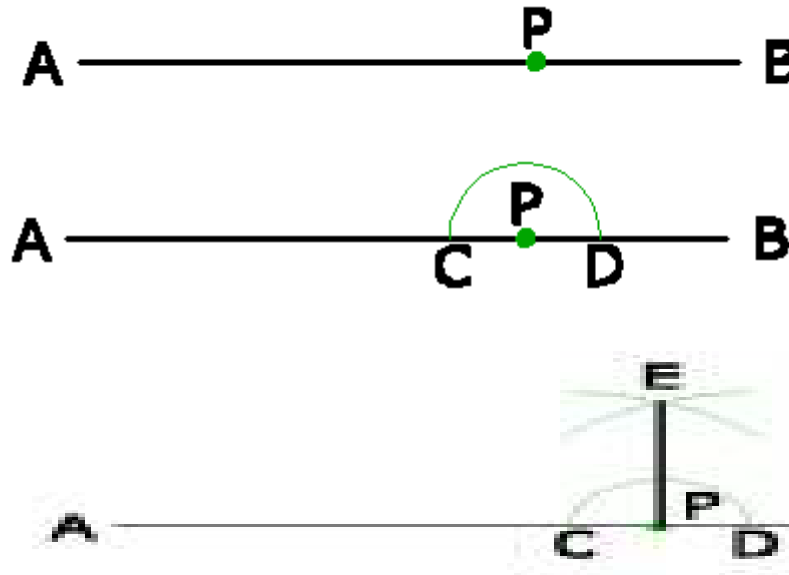


Fig. 4.5 Drawing perpendicular line through a point on the line

4.2.3 Angles

Angles are formed by the intersection of two lines. The point of intersection is called the *vertex*. Angles are measured in degrees ($^{\circ}$), minutes ($'$), and seconds ($''$). There are 360° in a full circle, 60 minutes in a degree, and 60 seconds in a minute. $2^{\circ}43'36''$ is read as 26 degrees, 43 minutes, 36 seconds. The concept of dividing angle by minutes and seconds is based on the fact that, the earth completes its rotation (360°) in 24 hours. A straight angle is an angle of 180° and appears as a straight line. Obtuse angles are angles less than 180° but more than 90° . An angle of 90° is referred to as a right angle because of the relationship between the two intersecting lines. Acute angles are angles less than 90° . When two angles are combined to total 90° , they are referred to as complimentary angles. Supplementary angles form when two angles combine to total 180° . You may draw angles at any degree of angularity using triangles or a protractor.

Drawing Angles:

- Tangent Method

Both the tangent and sine methods are based on mathematical solutions and require a basic knowledge of trigonometry. To construct an angle assume a convenient value for x . (preferably multiple of 10).

1. Draw line AB whose length is x at any convenient angle.
2. Draw a line perpendicular to AB at A.
3. Find the tangent of angle θ in a table of natural tangents.
4. Calculate $y = x \tan \theta = R$.
5. With A as a center and radius $R = y$, draw an arc to intersect the perpendicular at C.
6. Connect B to C. Angle ABC is the required angle.

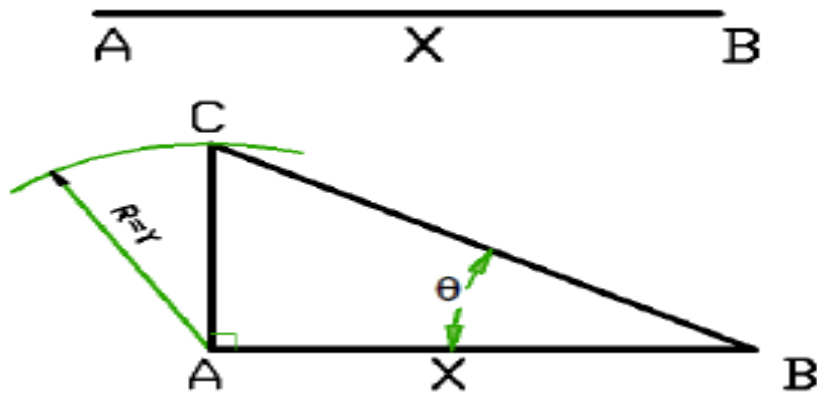


Fig. 4.6 Tangent method

4.2.4 Polygons

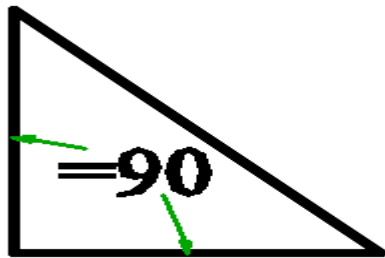
A polygon is a plane, having boundary defined by three or more sides that are all straight. Polygons can be mainly classified as regular and irregular. Irregular polygons are planes which either their sides or angles are of different sizes. Regular polygons are planes which their sides are kept in a regular manner, such as equal length, equal angles and so on (including equilateral triangles and squares) and can be constructed by inscribing in or circumscribing around a circle, a technique covered later in this chapter. The following list shows how the names of the regular polygon change with the number of sides:

Table 4.1: names of the regular polygon change with the number of sides

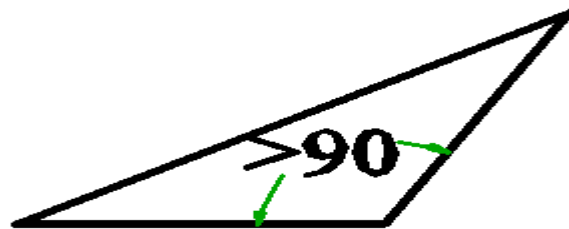
| Sides | Name |
|-------|-----------|
| 3 | Triangle |
| 4 | Square |
| 5 | Pentagon |
| 6 | Hexagon |
| 7 | Heptagon |
| 8 | Octagon |
| 9 | Nonagon |
| 10 | Decagon |
| 12 | Dodecagon |

A. Triangles

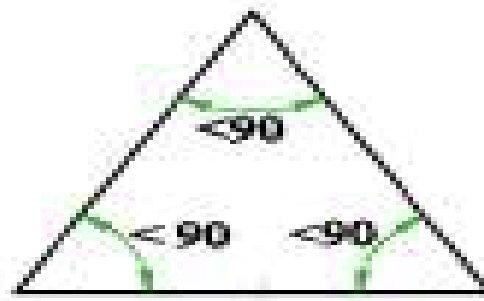
A Polygon having three sides is called a triangle. The sides of a triangle make three interior angles and the sum of these angles is always 180° .



Right angle triangle



Obtuse angle triangle



Acute angle triangle

Fig. 4.7 Classified based on angles

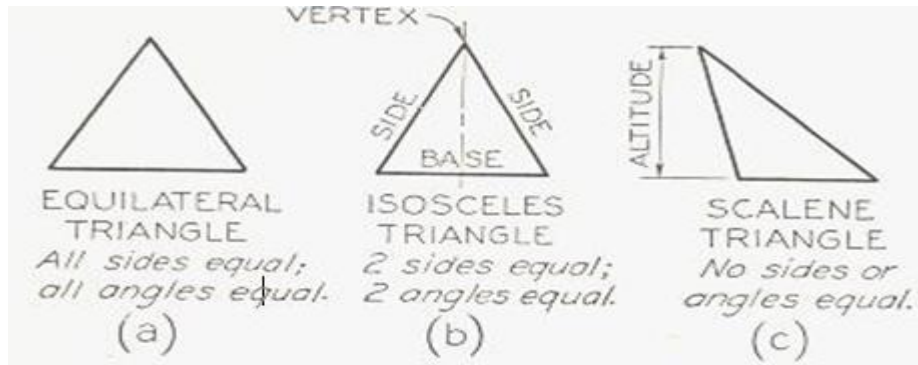


Fig. 4.8 Classified based on sides

Construction Methods: The construction of a triangle can be done in several methods. Some of the methods are described as follows.

Constructing any triangles given three sides AB , AC , and BC .

1. Draw line AB .
2. With center at A and radius AC , draw an arc.
3. With center at B and radius BC , draw another arc that cut the previous arc at C .
4. Connect point C to A and B .

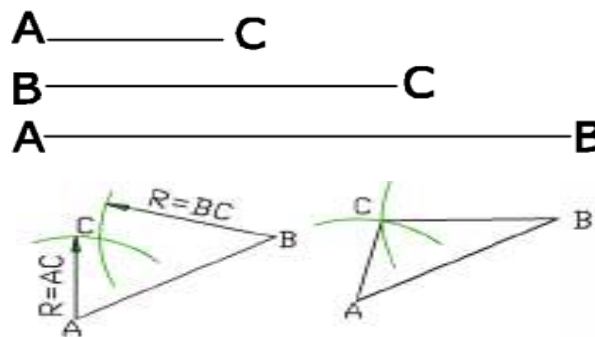


Fig. 4.9 Constructing triangle given three sides

Constructing a triangle given two sides and an included angle

Let the given angle CAB be θ , sides given be AB and AC .

1. Draw the base line AB .
2. Draw line AD at an angle of θ from AB , using any proper instrument.
3. A as a center and AC as a radius, strike an arc on AD to get point C .
4. Connect C to B . ABC is the required triangle.

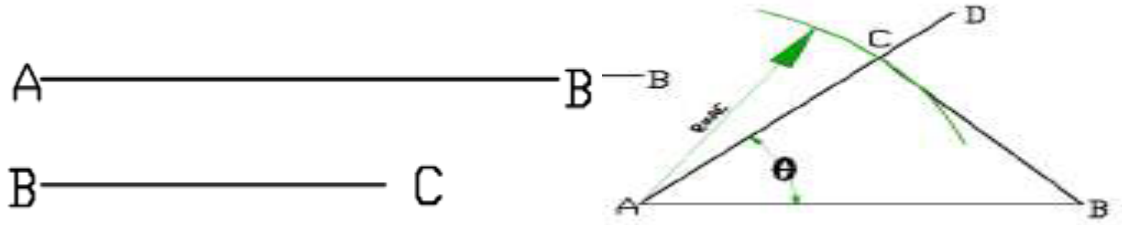


Fig. 4.10 Constructing triangle given two sides and included angle

Constructing a triangle given one side and two included angles

Let the given side be AB and the angles be θ and α .

1. Draw the base line AB.
2. Draw angle θ using set squares, or protractor from point A.
3. Draw angle α using set squares or protractor from point B.
4. Extend lines drawn at Steps 2 and 3 to intersect each other at point C.

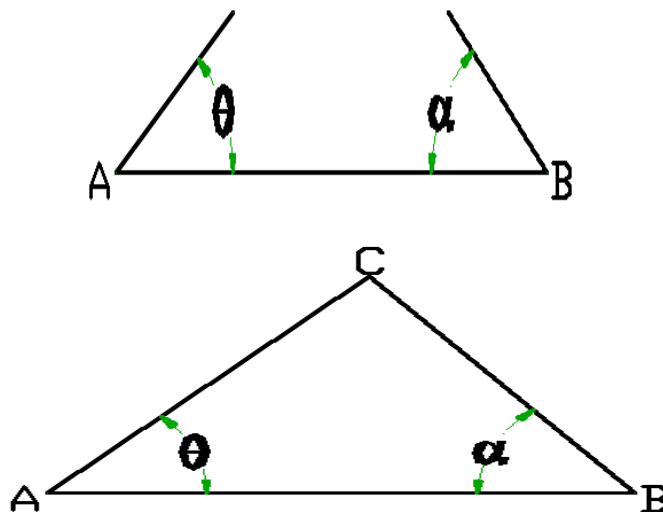


Fig. 4.11 Constructing a triangle given one side and two included angles

B. Quadrilaterals

A quadrilateral is a four-sided polygon. The sum of the interior angles of a quadrilateral is 360° .

Quadrilaterals may be subdivided into:

1. **Parallelogram** is a quadrilateral whose opposite sides are parallel, e.g. square, rectangle, and rhombus.
2. **Square** is a quadrilateral with all the four sides and all the angles are equal.

3. **Rectangle** is a quadrilateral, with all four angles are right angles and opposite sides are equal and parallel.

4. **Rhombus** is a quadrilateral, with all four sides have the same length, and equal opposite angles.

5. **Trapezium** is a quadrilateral having two parallel sides. Some of the construction methods for quadrilaterals are discussed below.

Constructing a square given length of side AB

1. Draw a horizontal line AB.
2. With a T-square and a 45° triangle draw diagonals from A and B at 45° .
3. Draw perpendicular from A and B intersecting the diagonals at C and D.
4. Connect CD the points of intersection.

Note: *The same method can be used to draw a rectangle.*

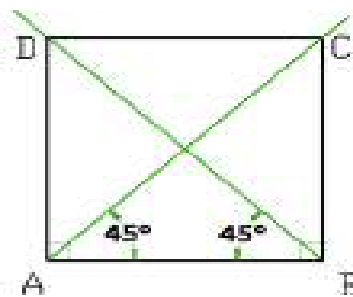


Fig. 4.12 Constructing a square given length

Constructing a square given length of diagonal AB

1. Draw horizontal line AB.
2. Locate O at the midpoint of AB.
3. Draw CD through O, perpendicular to and slightly longer than AB.
4. With T- square and a 45° triangle, draw AF and BE at 45° to AB intersecting CD at E and F.
5. Connect AE and FB.

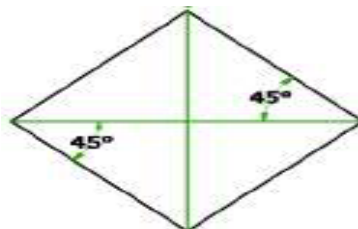


Fig. 4.13 Constructing a square given length of diagonals

Constructing a rhombus given side AB and an included angle θ .

1. Draw a horizontal line AB.
2. Draw lines from points A and B at θ .
3. Lay off distances AD and BC equal to AB.
4. Connect C and D. ABCD is the required rhombus.

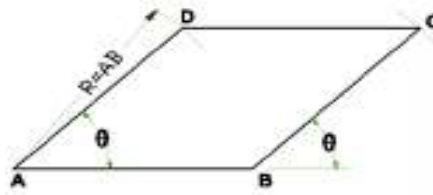


Fig. 4.14 Constructing a rhombus given side and included angle

Constructing a trapezium given sides and two interior angles

Let the sides of the trapezium be AC, AB and BD and the two interior angles be θ and α each.

1. Draw line AB at any convenient angle.
2. Draw two lines through, A and B at α and θ from line AB respectively.
3. Using B as center and radius BD, draw an arc to locate D.
4. Using A as center and radius AC, strike an arc to locate point C.
5. Connect C to D. ABCD is the required trapezium.



Fig. 4.15 Constructing a trapezium given sides and two interior angles

C. Construction of Regular Polygons

A regular polygon is a polygon that has all sides of equal length and all interior angles of equal measure. The simplest regular polygon is the equilateral triangle, which consists three edges of equal length and three equal angles of each 60 degrees. Most of the construction methods for regular polygons are simple and memorable. This is because they can be inscribed in or circumscribed around a circle.

- Construct a regular hexagon if we know side a.

We can break regular hexagon into 6 equilateral triangles with the side a . The vertex O is the center of inscribed and circumscribed circles, and $|AO|=|BO|=|CO|=|DO|=|EO|=|FO|$. First we construct triangle up ABO following the process we used in constructing equilateral triangle. Let's draw $c(O, |AO|)$. Since O is the center of circumscribed circle, we know that hexagon's vertices will be on the circle. Now we just take the length of a into the width of a compass and make 4 arcs on the circle.

Without changing the width of compass we put the needle of compass on the B . make an arc that intersects with the circle $c(O, |AO|)$ giving us the vertex C . Then we put the needle on C and do the same process to get vertex D , and so on. This process will give us the last 4 vertices. It doesn't matter if we start from A , and do it clockwise or from B like we did here, the result will be the same.

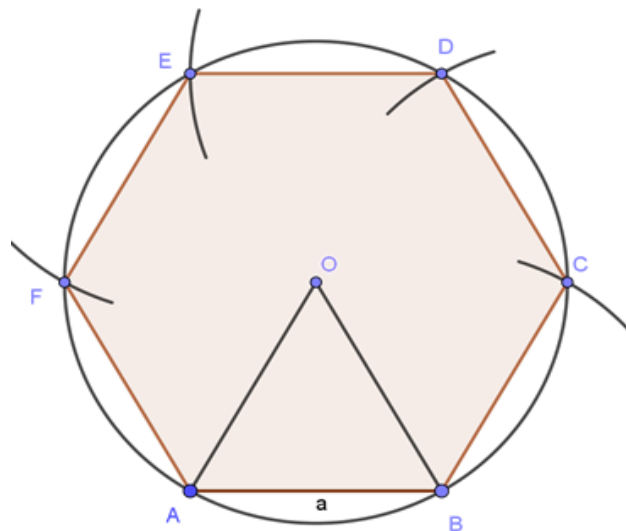


Fig.4.16 regular hexagon

4.2.5 CIRCLE

A circle is a closed curve with all points on the circle at the same distance from the center point. The major components of a circle are the diameter, the radius and circumference.

- *The diameter of the circle* is the straight distance from one outside curved surface through the center point to the opposite outside curved surface.
- *The radius of a circle* is the distance from the center point to the outside curved surface. The radius is

half the diameter, and is used to set the compass when drawing a diameter. A *central angle*: is an angle formed by two radial lines from the center of the circle.

- A *sector*: is the area of a circle lying between two radial lines and the circumference.
- A *quadrant*: is a sector with a central angle of 90° and usually with one of the radial lines oriented horizontally.
- A *chord*: is any straight line whose opposite ends terminate on the circumference of the circle.
- A *segment*: is the smaller portion of a circle separated by a chord.
- A *semi-circle* is half of the circle.

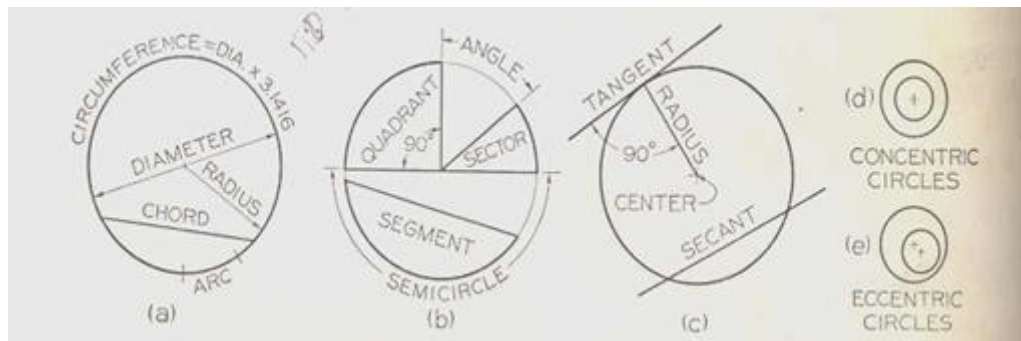


Fig. 4.17 Circle

4.2.6 SOLIDS

They are geometric figures bounded by plane surfaces. The surfaces are called *faces*, and if these are equal regular polygons, the solids are *regular polyhedral*.

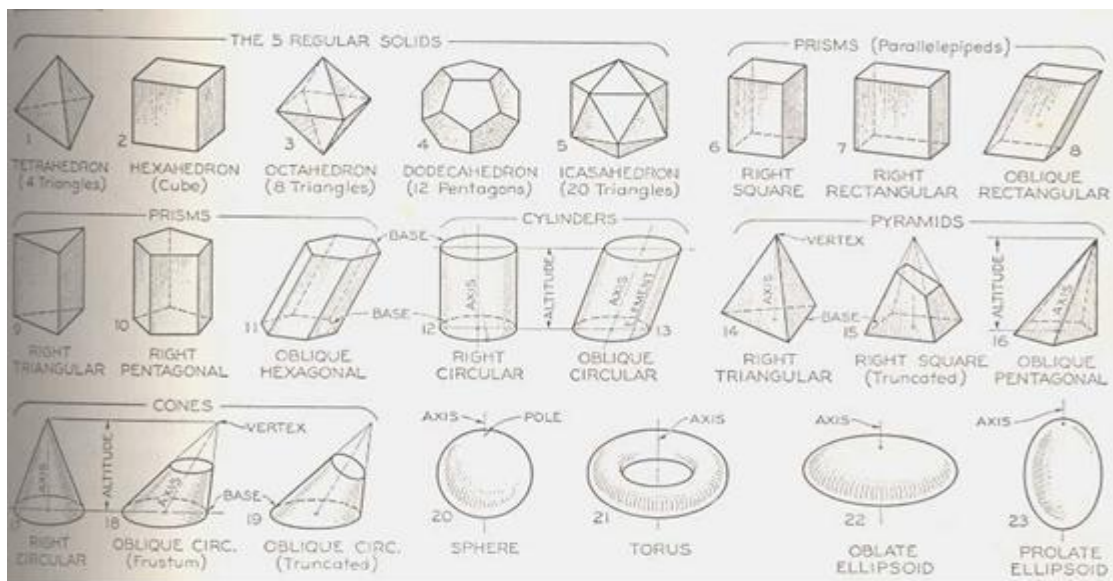


Fig. 4.18 solids

Self check-4

Part I: Answer the following questions

Direction: Give an answer/explain/ to the following lettering styles questions. Time allotted for each item is 6 minute and each question carry 5 point.

1. Geometric construction
2. Point
3. Angle
4. Polygon

Part II: True or false

Direction: say true or false to the following questions. Time allotted for each item is 1 minute and each question carry 3 point.

1. A straight angle is an angle of 90° and appears as a straight line. Inclined letters are also referred to roman letters, regardless of the letter style.
2. Octagon is a polygon with 8 sides.
3. A rectangle is a Parallelogram.

Part III: Fill the blank space

Direction: fill the blank space to the following questions. Time allotted for each item is 1 minute and each question carry 3 point.

1. _____ are angles less than 180° but more than 90° .
2. _____ is a quadrilateral, with all four sides have the same length, and equal opposite angles.
3. _____ form when two angles combine to total 180° .

Note: Satisfactory rating – above 60% Unsatisfactory - below 60%

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

Operation sheet- 4.1: Geometrical shape construction

- **Operation title:** Construction of a triangle
- **Purpose:** To practice and demonstrate the knowledge and skill required in constructing a triangle given three sides.
- **Instruction:** Use the given figure below (Figure), the tools and equipment write the letters given in the fig.. For this operation you have given half an hour
- **Tools and requirement:**
 1. This operation sheet
 2. Ruler,
 3. Compass
 4. Pencil
 5. Drawing paper
- **Precautions:** prepare and use properly the guide lines and the stroke direction before writing the letters
- **Procedures in doing the task**
 - Step-1:** Use the given figure
 - Step-2:** Draw line AB.
 - Step-3:** With center at A and radius AC, draw an arc.
 - Step-4:** With center at B and radius BC, draw another arc that cut the previous arc at

C.

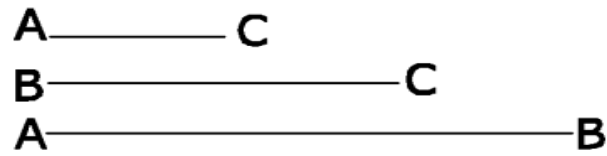


Fig.:4.17 Figure given for operation sheet 4.1

- **Quality Criteria:** radius each arc and side of triangle should be done in neatly and correctly.

Operation sheet- 4.2: Geometrical shape construction

Operation title: Constructing a regular heptagon given the circumscribing circle

- **Purpose:** To practice and demonstrate the knowledge and skill required in constructing a heptagon.
- **Instruction:** Use the given figure below (Figure), the tools and equipment write the letters given in the fig.. For this operation you have given 1 an hour.
- **Tools and requirement:**
 - 6. This operation sheet
 - 7. Ruler,
 - 8. Compass
 - 9. Pencil
 - 10. Drawing paper
- **Precautions:** identify the required materials and procedures before you start the activity.
- **Procedures in doing the task**

Step-1: use the given figure.

Step-2: draw vertical line AB with 10 cm whose length is equal to the diameter of the given circle.

Step-3: Locate the midpoint O of line AB and draw the given circle

Step-4: With B as center and OB as radius, draw an arc to intersect the given circle at C and D.

Step-5: Connect C to D to intersect AB at M.

Step-6: With radius MC=MD, strike arcs around the circle to locate points E, F, G, H, I, and J starting from A.

Step-7: Connect points A, E, F, G, H, I, and J to complete the regular heptagon.

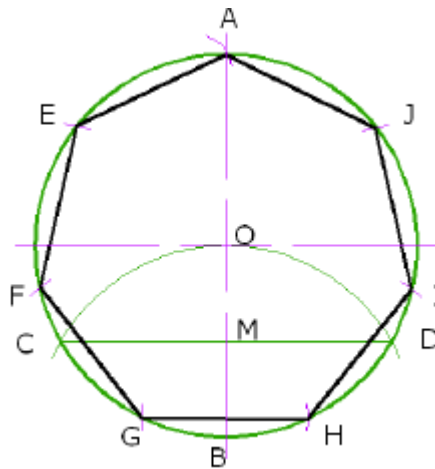


Fig.: 18 Figure given for operation sheet 4.2

- **Quality Criteria:** radius each arc and side of heptagon should be done in neatly and correctly.

Lap Test 4

- Task-1: measure or take the length of each side
- Task-2: draw the arcs based on the given side length
- Task-2: draw the arcs based on the given side length
- Task-3: check each side of the triangle and heptagon.

Reference

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