UNIT-I :- Introduction to Engineering Graphics, Construction of Ellipse, parabola and hyperbola.

Dic Honary

Engineering Drawing :-

→ The Representation of an object containing details like shape, size, features, specifications etc is called Engineering drawing.

→ A Drawing prepared by an engineer for an Engineering purpose is known as Engineering Drawing.

→ It is the graphic representation of physical objects and their relationships which are prepared based on certain principles, symbolic representation, standard conventions, notations etc...

→ It is the only Universal means of communication used by engineers, a language of ever increasing value. Finally Engineering Drawing is called as "the Language of Engineers".

Engineering Drawing Importance :-

Engineering Drawing is a two dimensional representation of a three dimensional) object. It is the graphic language from which a trained person can visualize the object. Drawing prepared in one country may be utilized in any other country, irrespective of the language spoken there. Hence Engineering Drawing is called the "Universal language of Engineers".

Knowledge in Engineering Drawing is equally essential for the persons holding responsible positions in Engineering field. An Engineer without adequate knowledge of this language is considered to be professionally illiterate.

Role of Drawing in Engineering Education

The ability of reading drawings is the most important requirement of all technical people in Engineering Profession.

Classification of Engineering Drawing includes; Building drawing, machine drawing, electrical drawing etc...

While teaching or reading majority of subjects, figures or sketches of related objects, machines or systems are made use of to Explain the principle of operation, relation between the two parts etc. Unless the figures are presented are known to us, to know the required information of subject our reading is useless. Hence, the knowledge in Engineering drawing is useful in understanding the other subjects as well.

Scope of the subject :-

The subject now the 'Engineering Drawing' relates to the basic knowledge of the geometrical drawing and it is the art of representation of geometrical objects on a drawing sheet and is the foundation of all Engineering drawings.

Applications :-

Mechanical Engineering :- Machine Components, Robot Elements, CNC m/c Components, IC Engine Components, Hydraulic Circuits, Power transmission systems, CNC tools, production engineering elements etc.

Civil Engineering :- Roads, Buildings (- Plan & Elevation), Town -

planning, Bridges and Structural Specifications.

Electrical Engineering :- Circuit layouts, pannel designs, wiring diagrams Control systems panels, transmission lines etc.

Instrumentation Engg. :- Design and measuring instruments, sensors, Sensitive elements Specifications etc.

Communication Engg. :- Communication Network, Satellite transmitions pictures, broad casting and telecasting etc.

Space & Air Craft Engg. :- Components of Aeronautical Engg. Space rockets, Jet impulsions etc.

and also in → garment designs in fashion tahnology,
→ Material Specifications in metallurgy,
→ Mining tools, marine Components etc..

(1) Drawing Instruments :-

The drawing instruments are used to prepare drawings easily and accurately. The accuracy of drawings depends largely on the quality of instruments, So student are advised to have good quality of drawing instruments.

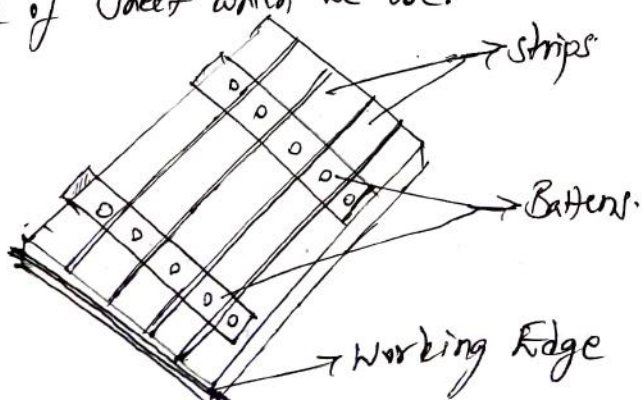
The following is the list of minimum drawing instruments and other drawing materials which every student must possess;

(1) Drawing board.
(2) Mini-Drafter
(3) Instrument box - Containing,
(i) Compass (iii) Spring bow Compass. (v) Bow divider (vii) Inking pen
(ii) Bow-Compass (iv) Divider (vi) Bow-pen

(4) Set Squares :- 30°-60° and 45°-45°
(5) Protractor
(6) Set of Scales - (long & short)
(7) French Curves
(8) Flexible Curve
(9) Templates
(10) Drawing sheet
(11) Paper fasteners (clips)
(12) Pencils
(13) Eraser
(14) Erasing sheild.
(15) Drafting brush
(16) Drawing Ink
(17) Tracing paper
(18) Lettering pens.

Drawing Board :- Drawing boards are usually made of well seasoned soft wood. To prevent warping, narrow strips of wood are glued together. The bottom side is made up of two battens Vertical on which the horizontal strips are attached. The one Edge of the board will be having working edge, made of hard and durable wood for moving while using T-Square in drafting.

This drawing boards are of different size depending upon the size of sheet which we use.

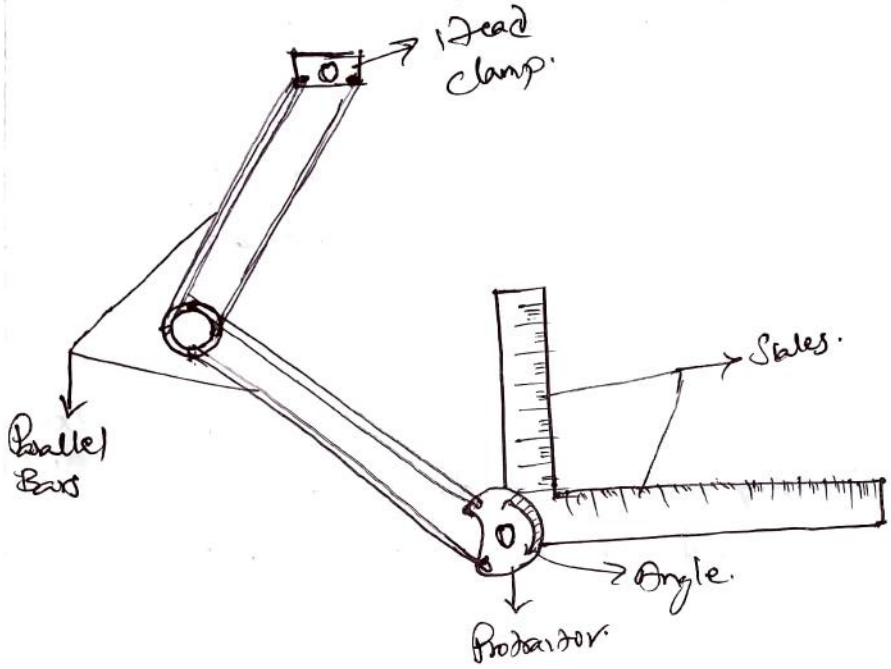


Size of drawing board

Designation	Size (mm)
B0	1250 × 900
B1	900 × 650
B2	650 × 500
B3	500 × 350

Mini - Drafter :- Today in many drawing offices and for Engineering Students minin-drafter is used for drafting and drawings of Engineering. It is designed to combine the functions of T-Square, Set-Squares, Protractor and Scales. The unit when it is used it will save up to 35%. of the time in machine drawing and 50% of time in Structural drawing.

The Mini-drafter Consists of an angles formed by two arms with Scales marked and set Exactly at right angle to each other. The angle is removable and hence a variety of Scales may be used.



Mini - Drafter

Instrument Box :-

(i) **Big Compass** :- The Compass is an instrument used for drawing circles and arcs of circles.

It Consists of two legs, hinged at one end. One leg contains a needle at its end. The other leg is so arranged that it can receive either a lead or a pen. In either case the needle point be at least 1mm longer than the lead or pen point. This is because when in use the needle point penetrates into the paper and the pen or lead touches the paper.

(iii) Bow-Compass :- The bow-compass is used for drawing small circles upto approximately 25mm radius. This operates on jack-screw principle by turning a knurled nut at its centre. In some designs the adjusting nut will be at one side of the compass. The advantages of this compass are that the accuracy with which it can be set to the required radius is more

(iii) Divider :- The divider is used for transferring measurements from one part of the drawing to another part and also for dividing curved or straight lines into any number of ~~parts~~ equal parts. The divider is different from the compass is that, both its legs do not have knee joints but contain needle points at their lower ends. In some designs, a hair-spring provided in one of the legs, is used for minute adjustment, while setting the measurement.

(iv) Bow-Divider :- The bow-divider is similar to the bow-compass except that both the legs contain needle points, and the distance between the legs is adjusted by a knurled nut. It is used for the same purpose and in the same manner as the big divider. Similar to the bow-compass, bow-divider holds a setting pieces and is convenient for marking small and accurate dimensions.

Set-Squares :- Set-squares, normally two in number, are the instruments used to draw lines, inclined with the horizontal. Usually these are used in conjunction with the T-square and these may also be used with the minidrafter. The two common types are 30°-60° set square and 45°-45° set square. These are so called, because of the angles at the corners of each set-square.

These are made of transparent celluloid or other plastic materials and are bevelled on one side. The size of a set-square is designated by the length of the longer side containing the right angle.

The two set-squares may be used in combination to draw a line parallel to any given line, not very far apart and also to draw a line ⊥ar to any given line, either from a point on it or outside it.

Protractor :- It is a device used for measuring and laying off angles, other than those obtained with the set squares. Usually it is semi circular in shape and made of celluloid or other plastic materials. It is bevelled along the curved edge. The divisions provided are usually in degrees and half degrees and are readable from both the ends.

Scales :- Scales are used to transfer the true or relative dimensions of an object on to the drawing. For this, place the scale with its edge on the line on which the dimension is to be marked and with a sharp pencil, mark the point opposite the required graduation mark. Scales are required to make drawings accurately to any desired scale.

Paper fasteners :- For better drawing work, the drawing sheet must be properly fixed on the drawing board. The various means available for the purpose are : thumb tacks, clips and adhesive tape.

Clips are made of steel, with spring action may be used for fixing the sheet on the board. However, small drawing sheets cannot be fixed with them, on all the four corners.

Now-a-days, adhesive tape is preferred for fixing the sheet on the board. Its smooth surface permits mini-drafter, set-squares etc to slide easily over the entire drawing sheet.

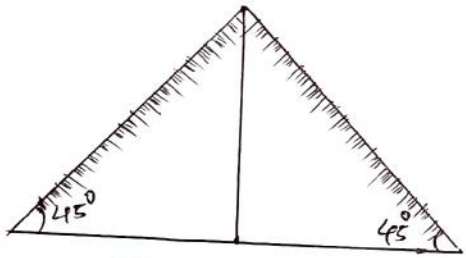
Pencils :- Special quality pencils are normally used in drawing work. Pencils with different degrees of hardness are available in the market.

The selection of a particular hardness or grade, depends upon the line quality desired for the drawing.

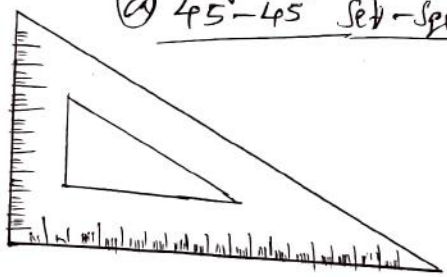
The grade HB denotes medium hardness of the lead. The hardness increases as the value of the numerical put before the letter H increases. Similarly the lead becomes softer as the value of the numerical put before the letter B increased.

Pencils of grades B or H may be used for finishing a pencil drawing, as they give a sharp black line. For sketching and artistic work, softer grade pencils are recommended. HB grade is suitable for lettering. ~~and dimensioning~~.

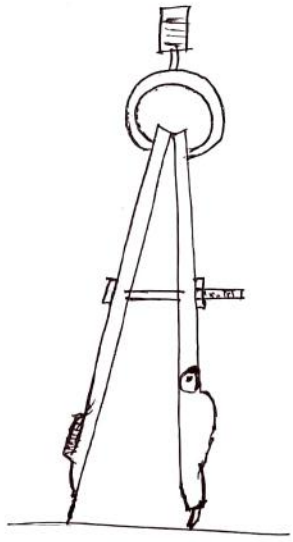
Eraser :- A variety of erasers are available in the market, which are used to remove ink or pencil lines. A soft pencil eraser should be used for erasing pencil lines and cleaning soiled spots on the drawings. To avoid frequent erasing, careful planning in drawing is needed.



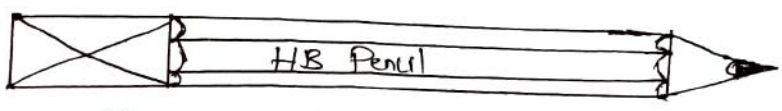
(a) 45°-45° Set-Square



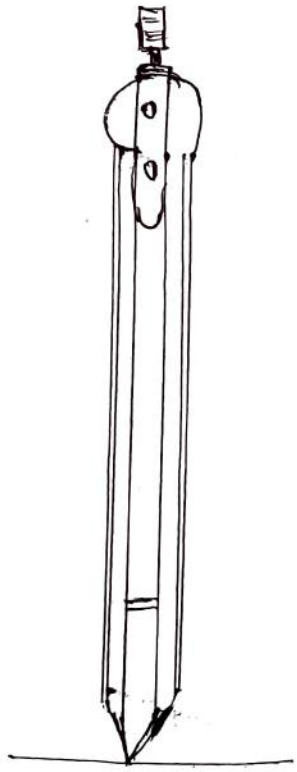
(b) 30°-60° Set-Square.



(c) Bow Compass



(e) HB Pencil



(d) Divider

Figures of Instruments

Lettering :-

Writing of titles, dimensions, note and other important particulars on a drawing is called "Lettering."

It is an important part of a drawing, however may be the drawing accurate and neat. The drawing appearance is spoiled sometimes by poor lettering. Lettering should, therefore be done properly in clear, legible and uniform style. It should be plain and simple style so that it could be done free hand and speedily.

Use of drawing instruments in lettering takes considerable time and hence it should be avoided. Efficiency in the art of lettering can be acheived by careful and continous practice.

Lettering are mainly done in two types.

① Single stroke Letters. ② Gothic letters.

Single Stroke Letters :- The Bureau of Indian Standards B.I.S (IS: 9609 - 1990) recommends Single-stroke lettering for use in Engineering drawing. These are the simplest forms of letters and are usually employed in most of the Engineering drawings.

The word Single Stroke should not be taken to mean that the letter should be made in one stroke without lifting the pencil.

It actually means that the thickness of the line of the letter should be such as it is obtained in one stroke of the pencil. The horizontal lines of the letters should be drawn from left to right and Vertical or inclined lines from top to bottom

Single Stroke Letters are of two types:-

(i) Vertical and (ii) Inclined

Inclined letters are lean to the right, the slope being 75° with the horizontal.

The size of a letter is described by its height. The height of the letters and numerals for Engineering drawing can be selected from 2.5, 3.5, 5, 7, 10, 14 and 20 mm according to the size of drawing.

The Ratio of height to width varies but in case of most of the letters it is '6:5'

Lettering is generally done in 'Capital letters'. Different size of letters are used for different purposes.

The main titles are generally written in 6mm to 8mm size, sub-titles in 3mm to 6mm size, while notes, dimension figures etc in 3mm to 5mm size.

Gothic Letters :- Stems of Single-stroke letters if given more thickness, form what are known as gothic letters. These are mostly used for main titles of ink-drawings.

The out line of these letters are first drawn with the aid of instruments and then filled in with ink.

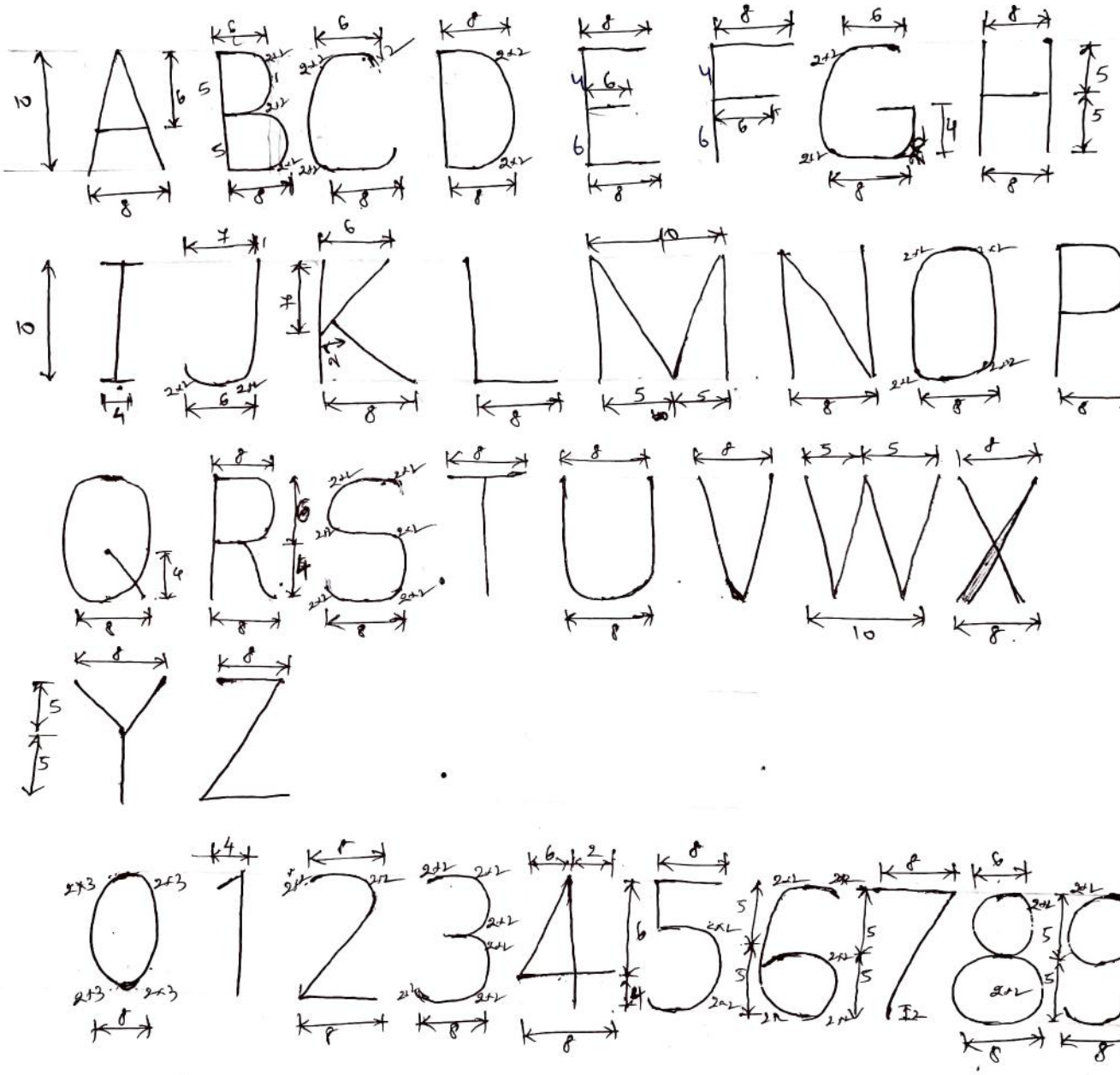
The thickness of the stem may vary from $\frac{1}{5}$ to $\frac{1}{10}$ of the height of Letters.

To do practice of Single-Stroke Capital letters, let us Consider the letter height as 10mm (easy to draw and write in graph sheet).

As height is 10mm and asper Standard 6:5 ratio this implies the letter size as "10:8".

Capitals:- Ratio of height to width → 10:8

But for letters M & W → 10:10



⇒ For our drawing sheets we mainly follows 8mm height for Tittle Block Main Items, like 'College Name' & 'Sheet Name'.

⇒ For our drawing remaining all other Details in tittle Block and the names of the drawings we follow 5mm height.

Sheet Layout :-

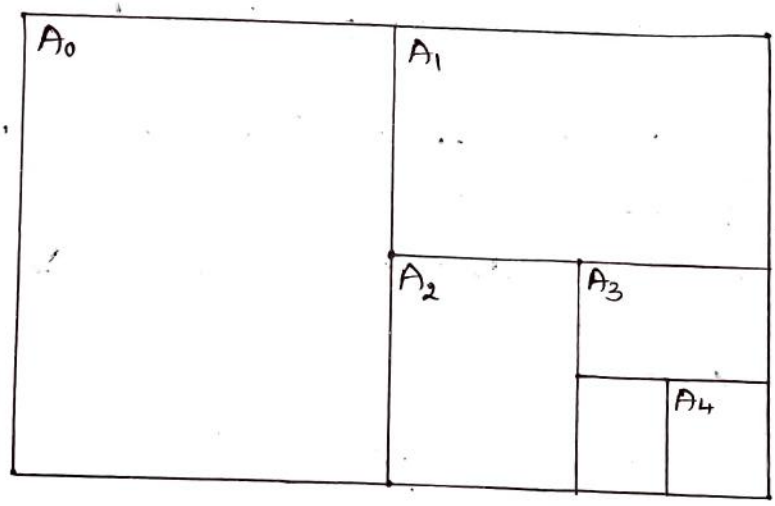
Sheet Sizes :- The preferred sizes of the drawing sheets recommended by the Bureau of Indian Standards (B.I.S) are given below as per standards.

Sheet Designation		Dimension Size (mm)
A_0	→	841 × 1189
A_1	→	594 × 841
A_2	→	420 × 594
A_3	→	297 × 420
A_4	→	210 × 297
A_5	→	147 × 210

In general

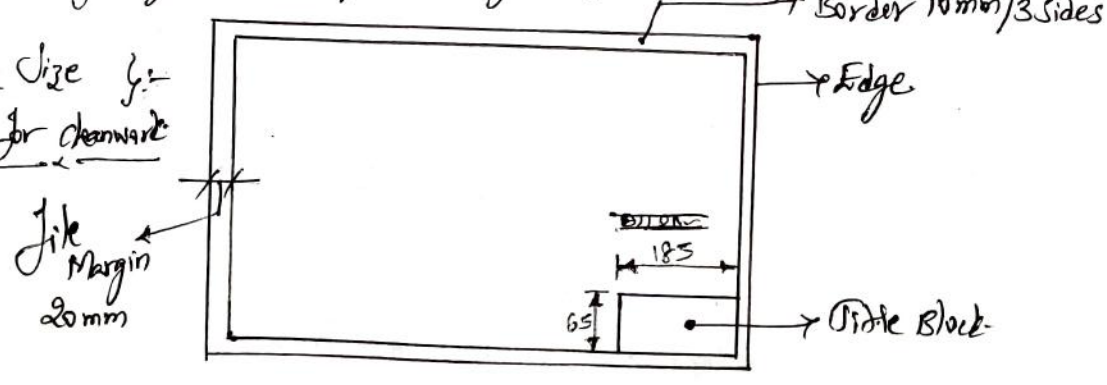
For college

A_1 → the sheet used for our drawing work to students.



Border Lines :- Clear working space is obtained by drawing border lines. More space is kept on the left hand side for the purpose of filing or binding if necessary. When prints are to be preserved or stored in a cabinet without filing, equal space may be provided on all sides.

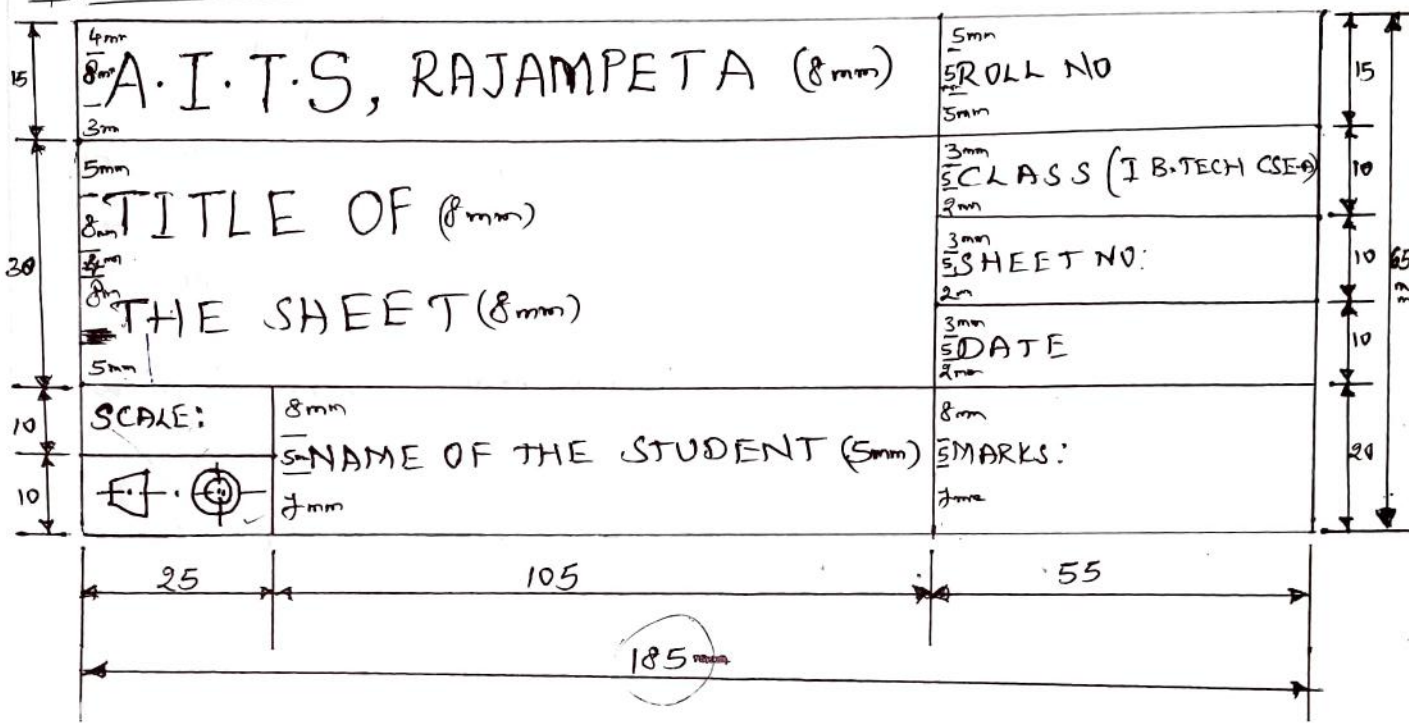
Layout of A_4 size :- drawing sheet for classwork



Title Block :- Space for the title block must be provided in the bottom right hand corner of the drawing sheet with in the border line.

→ The size of the title block as recommended by the B.I.S is "185 mm x 65 mm" for all designations of the drawing sheets

ALL DIMENSIONS ARE IN MM *



Note :-

Scales (or) Scale drawings :- Some times machine parts (or) buildings are required to draw larger or smaller than their actual size as we donot have the drawing sheets as per original dimensions. So we use Scales as Reducing Scales, Enlarging Scales and Full Size Scales.

(i) Reducing Scales :- 1:2 1:5 1:10
1:20 1:50 1:100
1:200 1:300 1:1000

(ii) Enlarging Scales :- 50:1 20:1 10:1
5:1 2:1

(iii) Full Size Scales :- 1:1

⇒ The title blocks should Contain atleast the below particulars,

1. Name of the firm.
2. Title of the drawing.
3. Scale
4. Symbol for method of Projection
5. Drawing No.
6. Initial with date of Person who have designed & approved.

Lines:- Various types of lines used in general engineering drawing are shown below.

	Line	Description	Applications
1)	———	Continous thick	Visible outlines, edges, main representations in diagrams.
2)	———	Continous thin	Imaginary lines, dimension lines, projection lines, Leader lines Hatching
x3)	~~~	Continous thin free hand	Lines of partial view and Sections.
4)	—/\/\/—	Continous thin with zig zags	Long break line
5)	— — — — —	Dashed thin	Hidden outlines & Edges.
6)	—·—·—·—	Chain thin	Centre line lines of symmetry Trajectories.
7)		Chain thin, thick at Ends, changes of direction.	Cutting plane.
8)	—··—··—	Chain thin double-dashed	Outlines of adjacent parts, alternate & Extreme positions of movable parts.

Here discuss

(*Pencils types & Application Here)(which is on after two page)

Dimensioning:- Every drawing whether a Scale drawing or a freehand drawing, besides showing the true shape of an object must supply its Exact length, breadth, height, sizes and positions of holes, grooves etc, and such details relating to the manufacture of that object.

Providing this information on a drawing is called "Dimensioning".

Dimensions are indicated on the drawing to define geometric characteristics such as length, diameter, radius, angles and locations.

Dimensioning terms and notations:

Dimension line:- It is a thin continuous line. It is terminated by arrow heads touching the outlines, Extension lines or centre lines.

Extension line:- An Extension line is also a thin continuous line drawn in extension of an outline. There should be a gap of about 1mm between the Extension line and an outline or the object boundary. It Extends by about 3 mm beyond the dimension line.

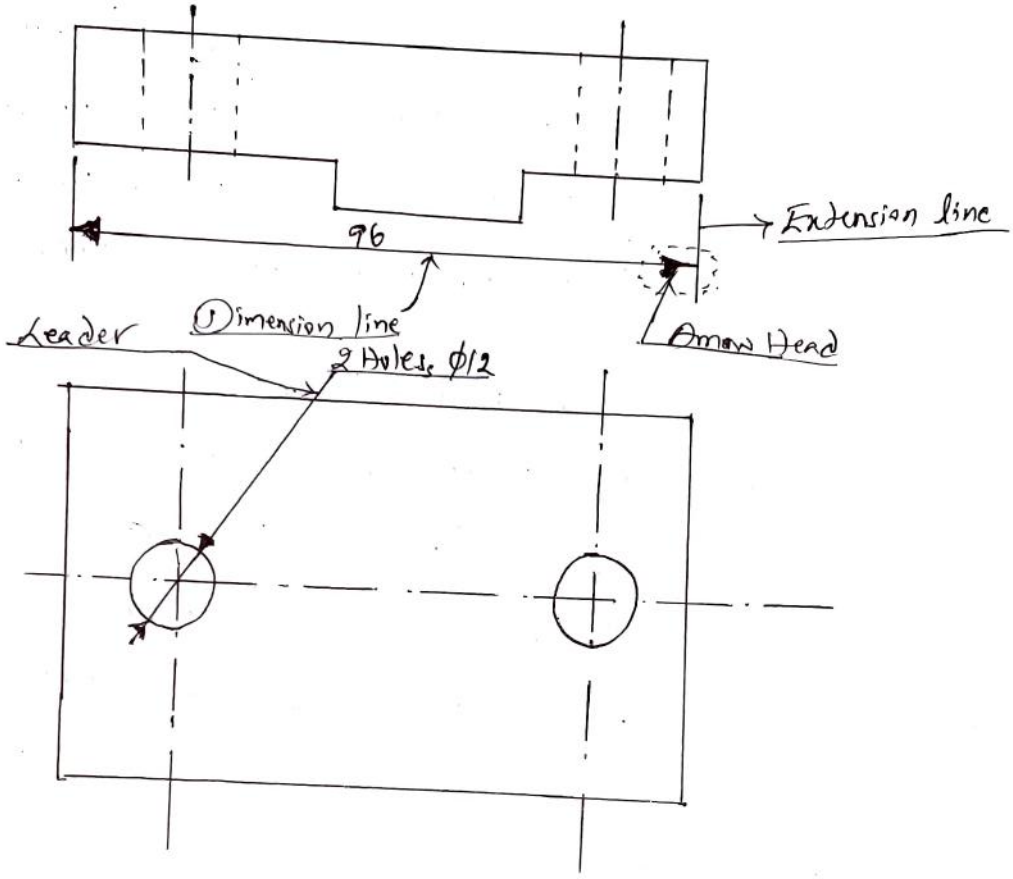
Arrow head:- An arrow head is placed at each end of a dimension line. Its pointed end touches an outline, an Extension line or a Centre line. The size of an arrow head should be proportional to the thickness of the outlines. The length of the arrow head should be about three times its maximum width. It is drawn freehand with two strokes made in the direction of its pointed end. The space between them is neatly filled up.

Generally closed and filled arrow head is widely used in Engineering Drawing.

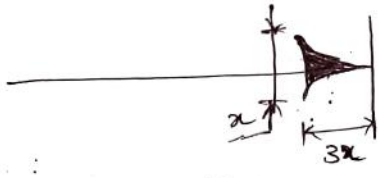
Leader:- A Leader or a pointer is a thin continuous line connecting a note or a dimension figure with the feature to which it applies. One end of the leader terminates either in an arrowhead or a dot. The arrowhead touches the outline, while the dot is placed within the outline of the object.

The other End of the leader is terminated in a horizontal line at the bottom level of the first or the last letter of the note

The leader is never drawn vertical or horizontal or curved. It is drawn at a convenient angle of not less than 30° to the line to which it touches. When pointing to a circle or an arc it is drawn radially. Use of common leaders for more than one feature should never be made.



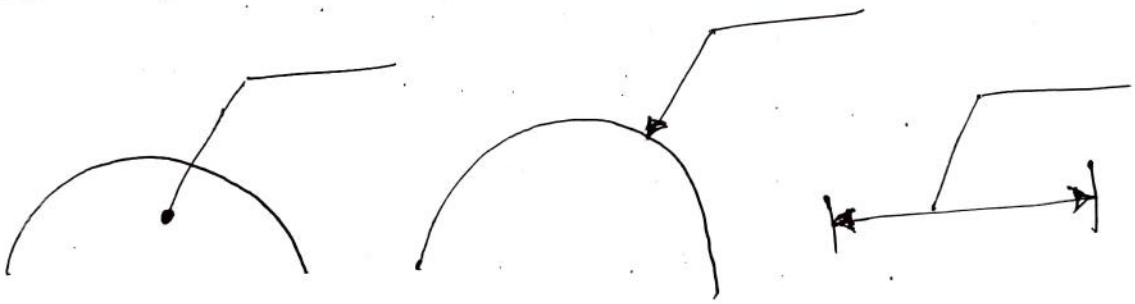
Arrow Head



x : 3x

⇒ 1 : 3

Leaders



Different types of Arrow Heads :-

(i) ← —— Open ($<90°$)

(ii) ← —— Open ($<20°$).

(iii) ⊢ —— closed

(iv) ◀ —— closed and filled

(v) / —— oblique stroke

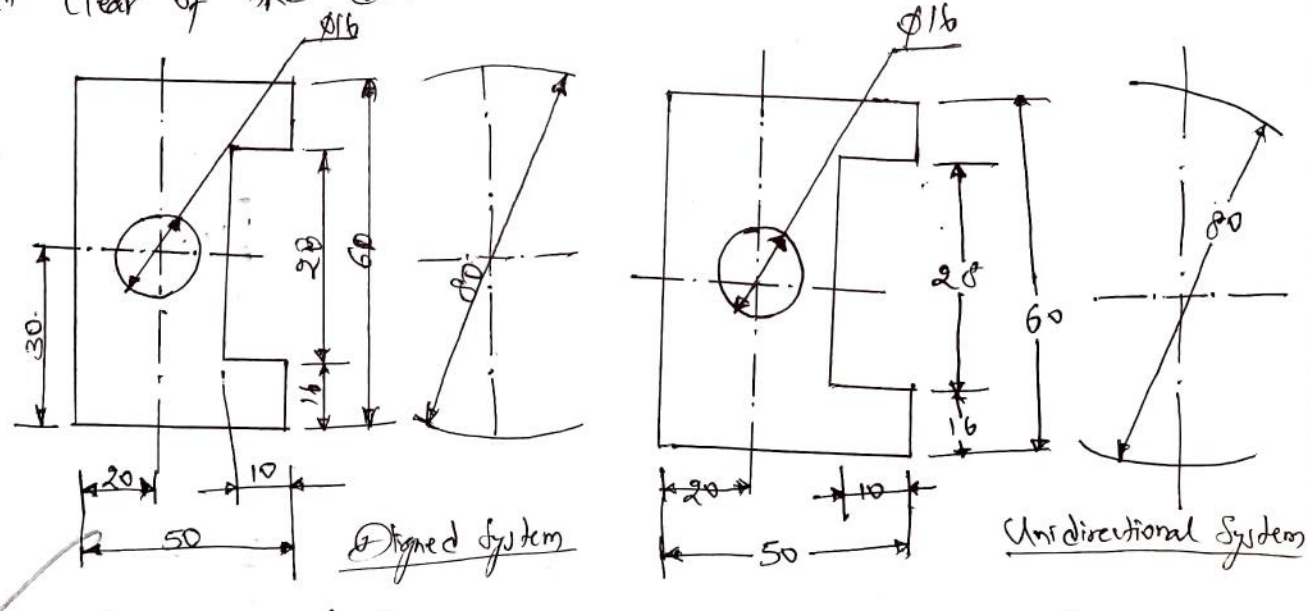
(vi) ○ —— Small open circle.

Placing of Dimensions

The two systems of placing dimensions are;

(1) Aligned system (and) (2) Unidirectional system.

(1) Aligned System :- In the aligned system the dimension is placed perpendicular to the dimension line in such a way that it may be read from the bottom edge or the right-hand edge of the drawing sheet. The dimensions should be placed near and middle and above, but clear of the dimension line.



(2) Unidirectional system :- In Unidirectional system all dimensions are

so placed that they can be read from the bottom edge of the drawing sheet. The dimensional lines are broken near the middle for inserting the dimensions. This system is mainly used in large drawings, like aircrafts, automobiles etc. where it is convinient to read from the right hand side.

General Rules:-

→ Every Dimension must be given, but none should be given more than once.

→ A Dimension should be placed on the view where its use is shown clearly.

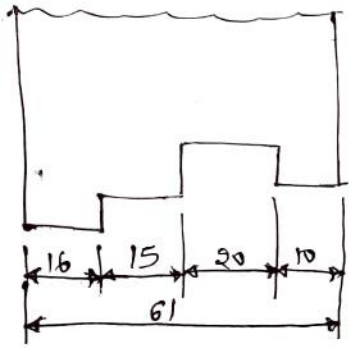
→ Aligned system of dimensioning is recommended.

→ Dimension lines should be drawn atleast 3 to 5mm away from the outlines and from each other.

→ Dimensions in a series may be placed in any one of the following two ways.

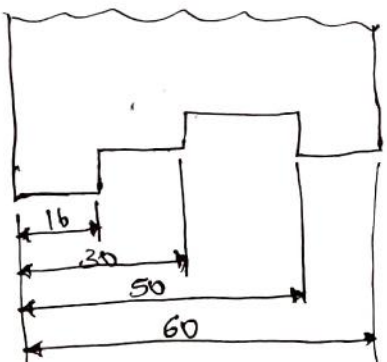
(i) Continuous (or) Chain dimensioning:-

Dimensions are arranged in a st. line. An overall dimension is placed outside the smaller dimensions. One of the smaller dimensions is generally omitted.

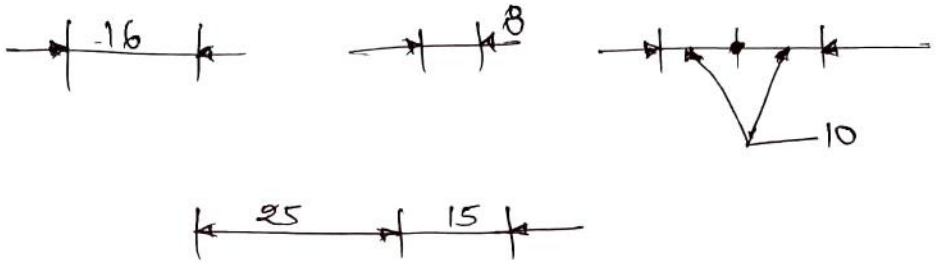


(ii) Progressive or parallel dimensioning:-

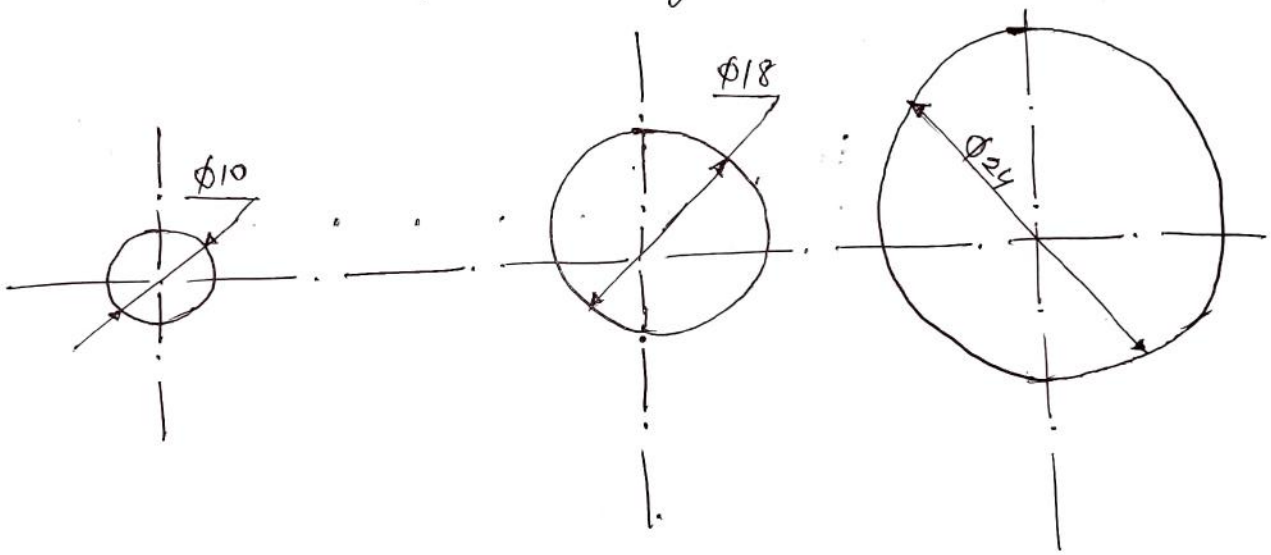
All dimensions are shown from a common base line. Cumulative Error is avoided by this method. This method is preferable.



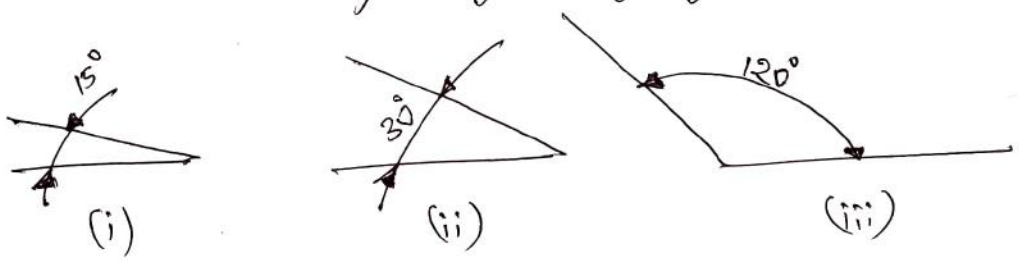
→ Arrow heads should ordinarily be drawn within the limits of the dimensioned feature. But when the space is too narrow they may be placed outside. A dot may also be used to replace an arrow head.



→ The Various methods of dimensioning different sizes of Circles.



→ Angular dimensions may be given by any one of the methods.



→ Dimensioning or Dimension lines should always draw with 2H Pencil

* Pencils : H, 2H, HB

* HB : Main Representations like Border lines and Title Block and Out lines of drawings.

* 2H : Dimension lines, Imaginary lines, Leader lines, Projection lines.

* H : Guide lines or Supporting lines; Construction steps,

Geometrical Construction

An Engineer should be familiar with a number of geometrical constructions as they are frequently occur in Engineering drawing.

In this chapter we shall deal with problems on geometrical construction which are mostly based on a plane geometry and which are essential in the preparation of Engineering drawings.

To divide a line

(Q) Divide a straight line AB of length ~~50mm~~ 100mm into 9 Equal parts. (When odd length or unknown length is given for dividing)

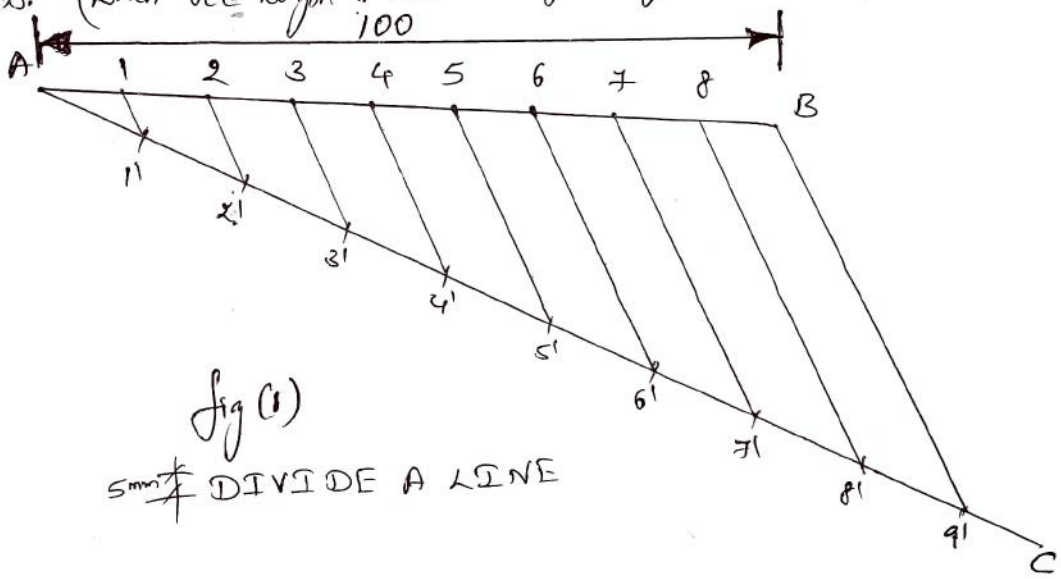


fig (i)

5mm DIVIDE A LINE

Steps:

1) Let AB be the given line to be divided in to 9 equal parts.

2) Draw the line AB of given length 100 mm.

3) Now draw another line AC making an angle less than 30° (or equal to) with AB.

4) With the help of divider or Compass mark 9 Equal parts of any suitable length on line AC and mark them as 1', 2', 3', 4', 5', 6', 7', 8' and 9' as shown in figure (i).

5) Join the last point 9' with point B of the line AB with the help of drafter Scale.

6) Now fix the drafter in position of line 9'B and then from

each of the other marked points 8', 7', 6', 5', 4', 3', 2' and 1', draw lines parallel to 9'B cutting the lin AB at 8, 7, 6, 5, 4, 3, 2, and 1 respectively.

7) Now the line AB has been divided into 9 equal parts. You can verify this by measuring the lengths.

Bisecting a line.

(12) Bisect a straight line AB of length 65 mm.
(When unknown line length is asked to divide into two parts)

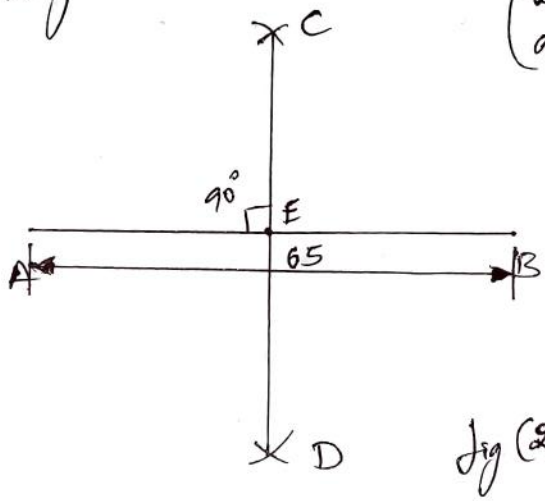


fig (12) BISECTING A LINE 65mm

Steps:

1) Let AB be the given line of length 65 mm.
2) With centre A and radius greaterthan half AB, draw arcs on both sides of AB.
3) With centre B and same radius draw arcs intersecting the previous arcs at C and D.
4) Draw the line joining C and D and cutting AB at E
5) Then $AE = EB = \frac{1}{2} AB$
6) Further, CD bisects AB at right angles.

The drawing of bisecting a line can be seen in fig (12).

To Bisect an Angle

(Q3) Bisect an angle AOB given

(a) Angle AOB = 45°

(b) Angle AOB = 125°

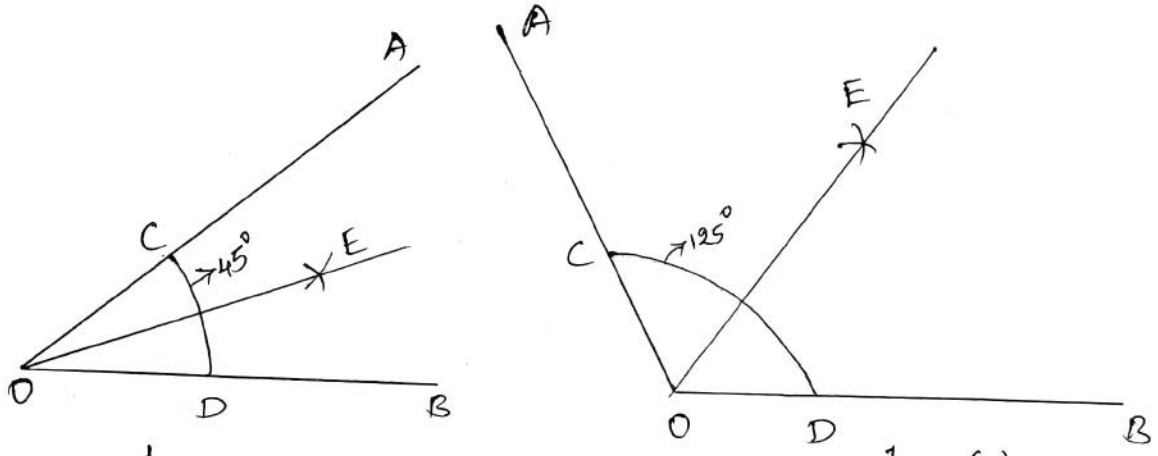


fig 3(a) TO BISECT AN ANGLE fig 3(b)

Steps:-

1) Let AOB be the given angle of 45° and 125°

2) With 'O' as centre and any radius, draw an arc cutting OA at C and OB at D.

3) With centres C and D and the same or any convinient radius, draw arcs intersecting each other at E.

4) Draw the line joining O and E,

5) OE bisects the angle AOB i.e., ∠AOB = 45° and ∠AOB = 125°

Bisecting An Arc

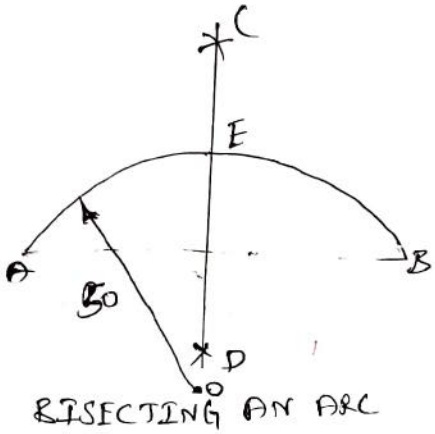
(Q4) Bisect a given Arc of radius 50 mm.

Steps:-

1) Draw an arc AB with radius 50 mm.

2) Now join A & B and with more than half of Arc or line AB draw arc's on top and bottom of the Arc AB with Centres A & B for C & D

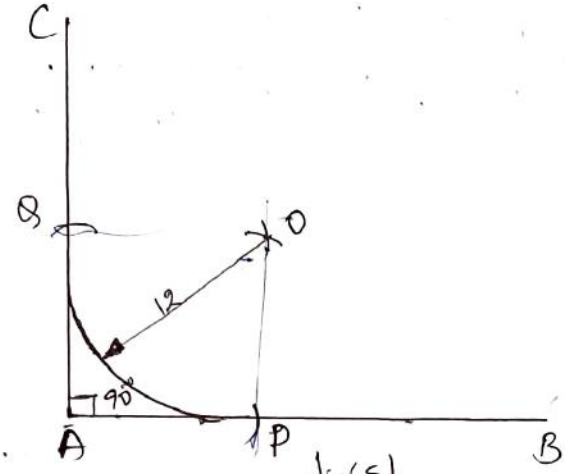
3) Draw Line Joining CD for bisecting Arc AB at point E



BISECTING AN ARC

An Arc touching two Straight Lines at Right Angles

Q5) Draw an arc of radius 12mm touching two straight lines at right angles to each others.



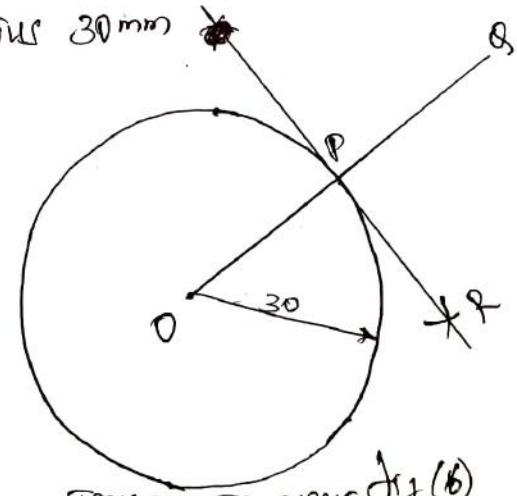
fig(5)
ARC BETWEEN TWO STRAIGHT LINES

Steps:

1) Let AB and AC be the given lines which are at right angles to each other i.e, 90°.
2) With Centre A and radius equal to R = 12mm given, draw arcs cutting AB at P and AC at Q.
3) With P and Q as centres and the same radius, draw arcs intersecting each other at 'O'.
4) With 'O' as centre and radius equal to R = 12mm draw the required arc between the lines AB and AC which are at right angles.

To Draw Tangents

Q6) Draw a tangent to the circle of radius 30mm



TANGENT TO CIRCLE fig(6)

Steps:

1) With Centre 'O' draw the given circle with radius 30mm and mark a point 'P' on it.
2) Draw a line joining O and P
3) Produce OP to Q so that OP = PQ ⇒ (30mm + 30mm = 60mm)

4) With Centres O and Q and with any Convenient radius, draw arcs intersecting each other at R.

5) Draw a line through P and R, then this line is the required tangent. (Extra question here Are passing through 3 points different). which are not in st. line.

TO Construct Equilateral Triangle

Q7) Construct an equilateral triangle, given the side of the triangle is 35 mm.

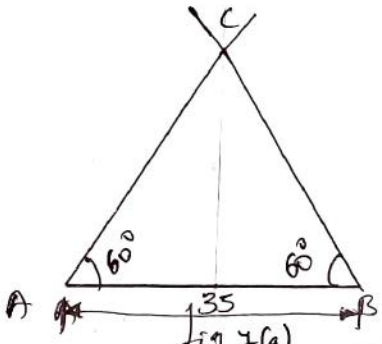


fig 7(a)

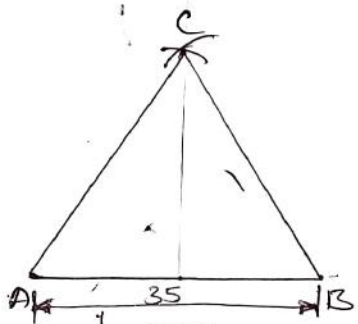


fig 7(b)

EQUILATERAL TRIANGLE

Steps, Can be done in two ways.

(a) With T- Square and Set Square,

(i) With the T- Square draw a line AB = 35 given length.

(ii) With 30°- 60° Set-Square and T- Square draw a line through A making 60° angle with AB.

(iii) Similarly through B, draw a line making the same angle with AB and intersecting the first line at C.

(iv) The ABC is required triangle.

(b) With aid of a Compass,

(i) With Centres A and B and radius equal to AB, draw arcs intersecting each other at C.

(ii) Draw lines joining C with A and B

(iii) Then ABC is the required triangle.

To Construct Square

88) Construct a Square, given the Side of the Square is 35mm.

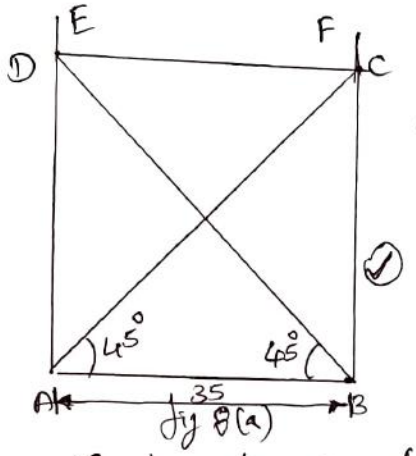


fig 8(a)

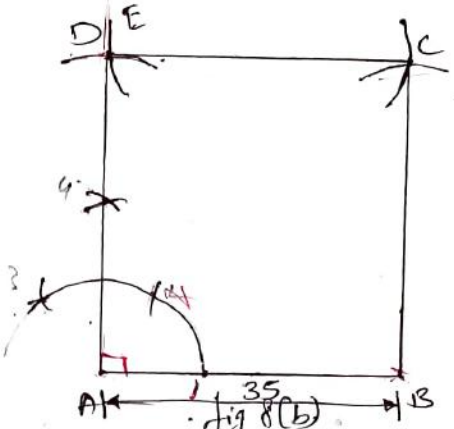


fig 8(b)

TO CONSTRUCT SQUARE

Steps: Can be done in two ways:

(a) With T-Square and Set-Square

(i) With the T-Square draw a line AB = 35mm given length

(ii) At A and B draw Verticals AE and BF

(iii) From point A draw a line inclined at 45° to AB Cutting BF at C.

(iv) From point B draw a line inclined at 45° to AB Cutting AE at D.

(v) Draw a line joining C with D.

(vi) Then ABCD is the required Square as shown in fig 8(a).

(b) With the aid of a compass

(i) Draw a line AB equal to 35mm given length

(ii) At A, draw a line AE perpendicular to AB.

(iii) With Centre A and radius AB, draw an arc Cutting AE at D

(iv) ~~At B, draw a line~~

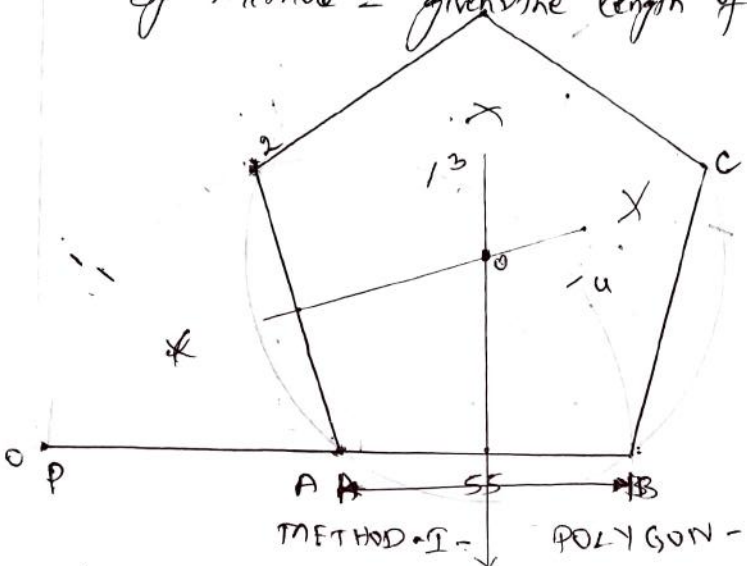
(iv) With Centre B and D and the same radius, draw arcs intersecting at C.

(v) Draw lines joining C with B and D

(vi) Then ABCD is the required Square of 35mm each Side.

To Construct Regular Polygons

89) Construct a regular (i) pentagon (ii) Hexagon by 'Method-I' Inscribe circle method given the length of its side is 55mm.



METHOD-I - POLYGON - PENTAGON - ME

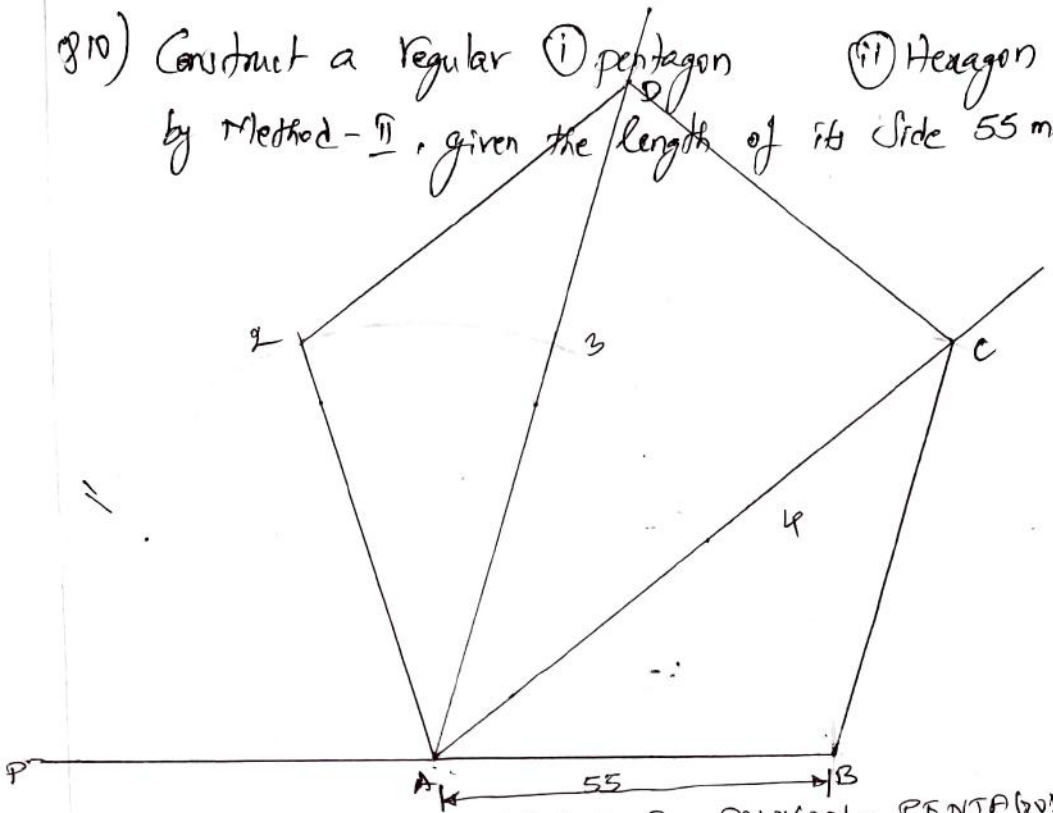
Steps: Method - I : Inscribe Circle Method : (for pentagon)

1) Draw a line AB = 55 mm given length. (for pentagon)
2) With Centre A and radius AB, draw a semicircle BP.
3) With divider or Compass, divide the semicircle in to 5 equal parts (same as the number of sides of polygon) and number 1, 2, 3, 4.
4) Number the division points as 1, 2, etc starting from 'P'.
5) Draw a line joining A with the second division - point 2.
6) Draw perpendicular bisectors of A2 and AB intersecting each other at 'O'.
7) With Centre O and radius OA, describe a circle
8) With radius AB and starting from B, cut the circle at points C, D etc 2.
9) Draw the lines BC, CD etc thus completing the required pentagon.

Method - I Inscribe Circle method : (for Hexagon)

1) Step 1 and 2 are same. (Draw Hexagon as per steps)
2) Divide the semicircle in to 6 equal Parts.
3) Remaining all other steps are same in procedure and Construction.
4) After completing the Construction we can have required Hexagon.

Q10) Construct a regular (i) pentagon (ii) Hexagon by Method - II, given the length of its side 55 mm



METHOD - II - POLYGON - PENTAGON - ARC Method.

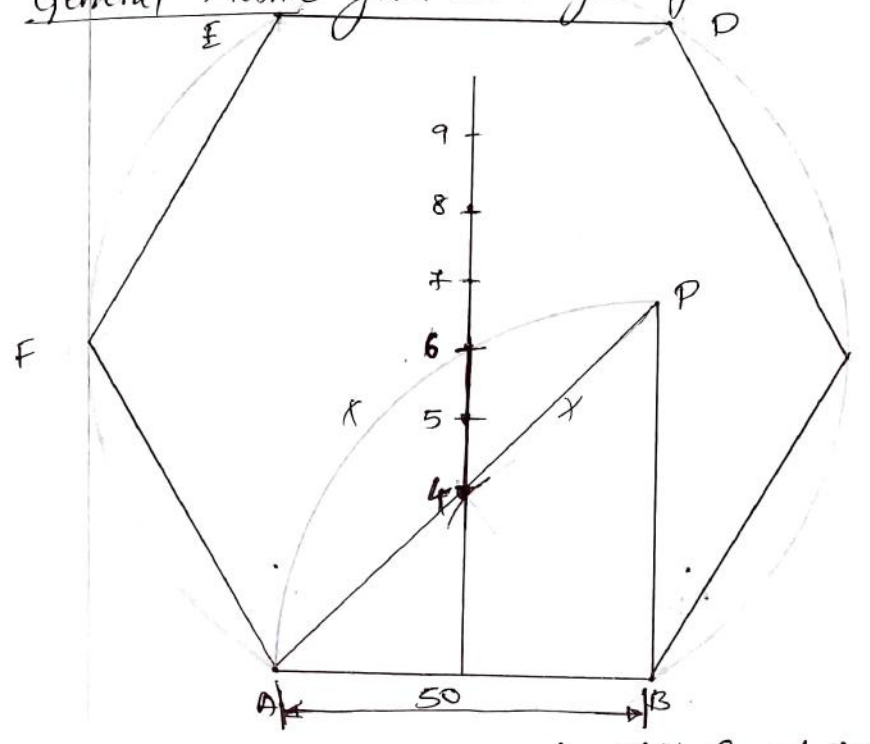
Steps :- Method - II :- Arc method (for pentagon)

1) Draw a line AB equal to 55 mm given length
2) With Centre A and radius AB draw a Semicircle BP
3) With a divider or compass, divide the semicircle into 5 equal parts. (Same as the number of sides of polygon) and number 1, 2, 3, 4.
4) Draw a line joining A with the second division point 2.
5) With Centre B and radius AB, draw an arc cutting the line A4 produced at C.
6) With Centre C and the same radius draw an arc cutting the line A3 produced at D
7) With same manner find the other side from D to 2
8) Draw lines BC, CD etc and D2 to Complete the pentagon.

Method - II Arc method (for Hexagon)

1) Step 1 & 2 are same
2) Step 3, divide the Circle in to 6 equal parts.
3) Remaining all other steps are same for Construction.
4) After Completing the Construction we can have required Hexagon.

Q11) Construct a regular (i) Hexagon (ii) Heptagon by General Method given the length of its side is 50 mm.



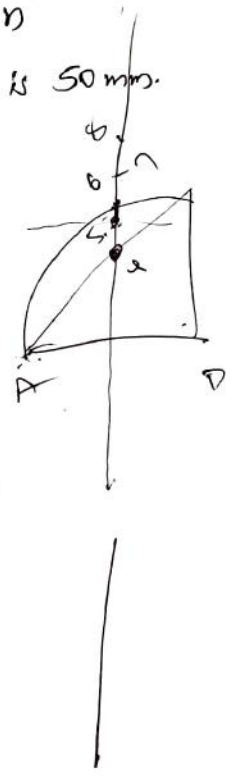


Fig 11(a): General Method: Hexagon

Steps:-

1) Draw a line AB = 50mm given length
2) At B, draw a line BP ⊥ar and equal to AB i.e, 50mm
3) Draw a line joining A with P
4) With Centre B and radius AB, draw a quadrant AP.
5) Draw the ⊥ar bisector of AB to intersect the st. line AP in 4 and the arc AP in 6.
6) Find the middle number 5 of the line 4-6, & locate 7 step off same division 6-7 equal to division 5-6
7) A square of a side equal to AB can be inscribed in the circle drawn with centre 4 and radius A4
8) A regular hexagon of a side equal to AB can be inscribed in the circle drawn with Centre 6 and radius A6.
9) A regular pentagon of a side equal to AB can be inscribed in the circle drawn with Centre 5 and radius A5
10) With Centre 7 and radius equal to A7 draw a circle, starting from B, cut it in seven equal divisions with radius equal to AB.

Draw line BC, CD etc and Complete the heptagon.

ii) Regular polygons of any number of sides can be drawn by this method, inscribing the Circle as per required sides and radius and then cutting the Circle for other sides of polygon with base length AB.

⇒ Now for our question we have to Construct

(i) Hexagon :- for this draw Circle with Centre 6 and radius A6 and then mark C, D, E, F for required Hexagon.

(ii) Heptagon :- for this draw (E) Circle with Centre 7 and radius A7 and then mark C, D, E, F, G for required Heptagon.

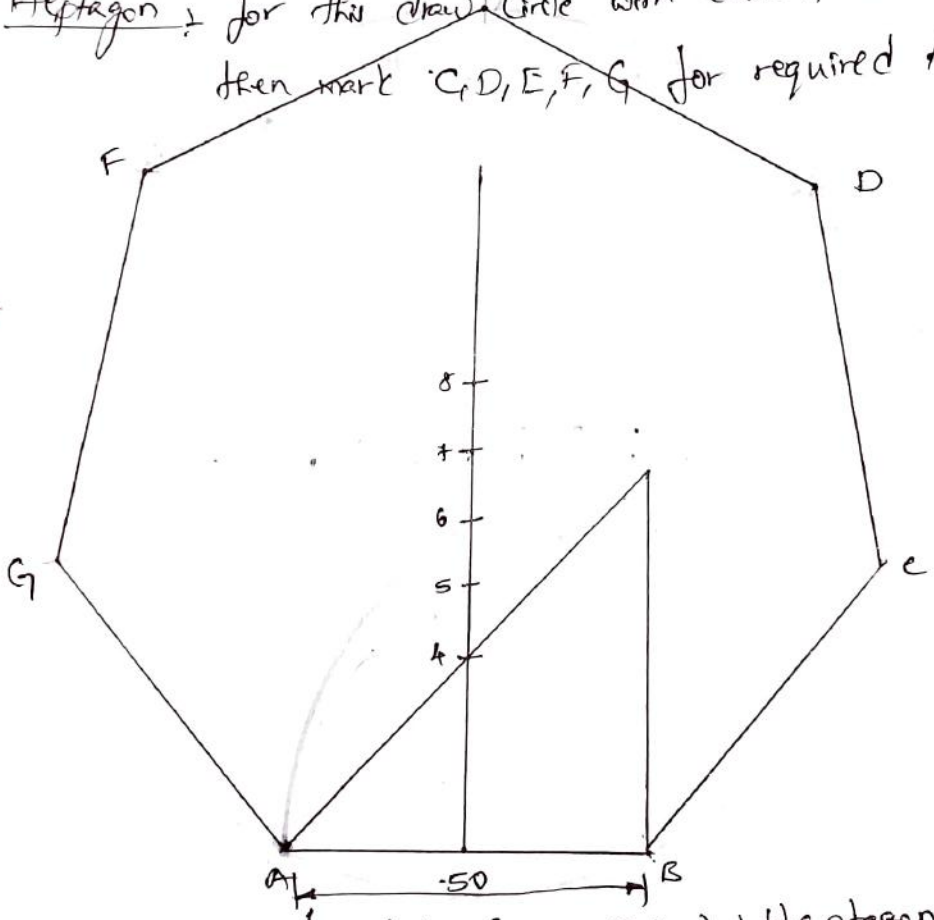


Fig 11 (b) : General Method : Heptagon.

⇒ Assignment Questions :-

(1) (i) Divide a Straight line AB of length 65mms, into 9 equal parts.

(2) Bisect a Straight line AB of length 55mms.

(3) Bisect an angle AOB :- (a) Angle AOB = 57° (b) Angle AOB = 143°

(4) Bisect a given arc of radius 50mm

(5) Construct a equilateral triangle, given the altitude is 30 mm

(6) Construct a regular (i) pentagon (ii) Heaagon
by method-I given the length of its side is 40 mm

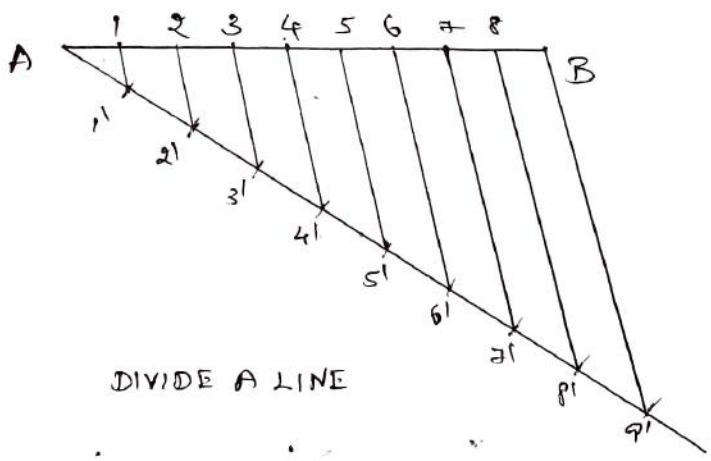
(7) Construct a regular (i) Pentagon (ii) Heaagon
by Method-II given the length of its side is 45 mm

(8) Construct a regular (i) Heaagon (ii) Heptagon
by General Method, given the length of its side is 55 mm

(9) Construct a regular Octagon given the length of its side is 40 mm.
by all three methods above? (i) Method-I (ii) Method II (iii) General Method.

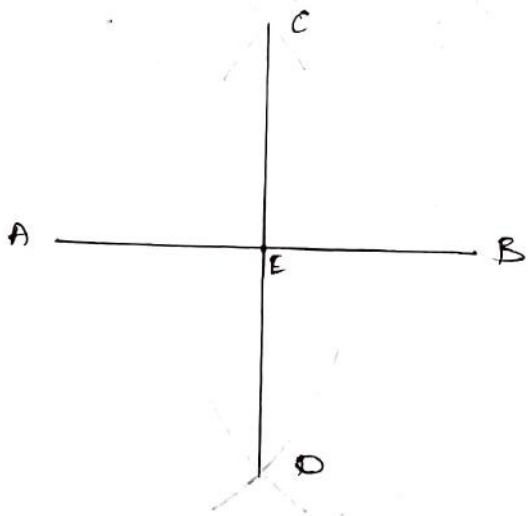
Solutions :-

(1)



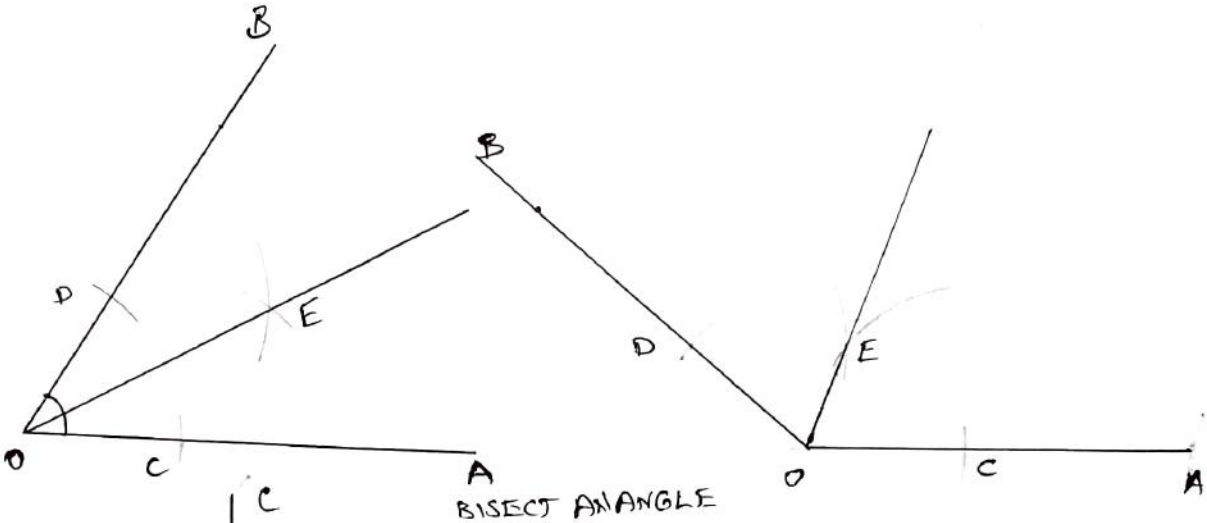
DIVIDE A LINE

(2)



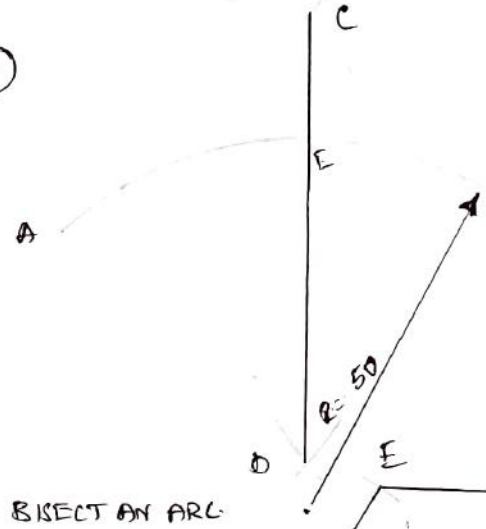
BISECT A LINE

(3)



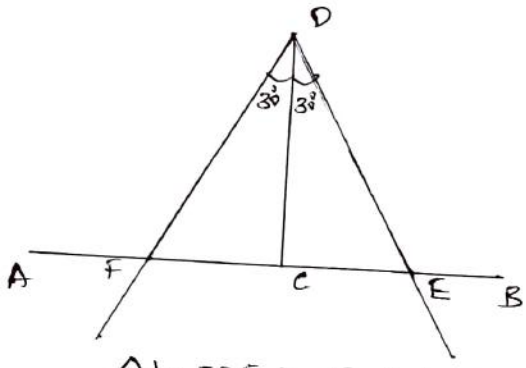
BISECT AN ANGLE

(4)



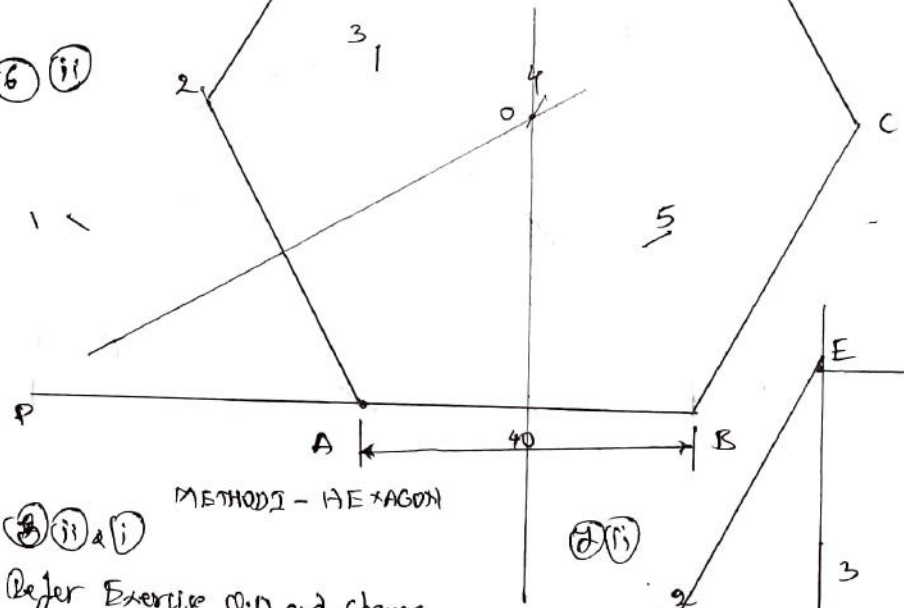
BISECT AN ARC

(5)



Δle EDF is Equilateral Δle.

(6) (ii)



METHOD I - HEXAGON

$\frac{180}{6} = 30°$

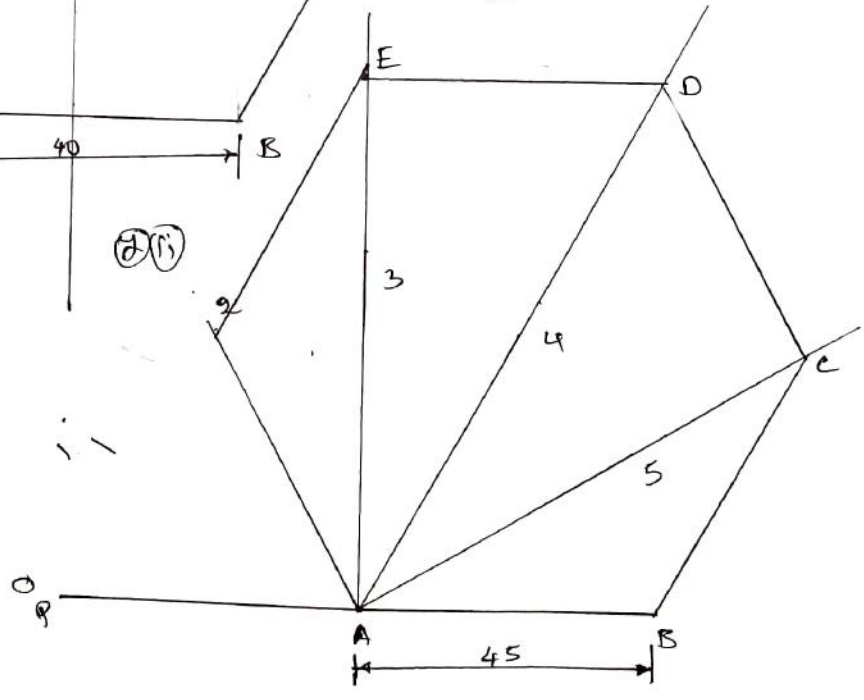
(8) (ii) & (i)

Refer Exercise Q.11 and change dimension.

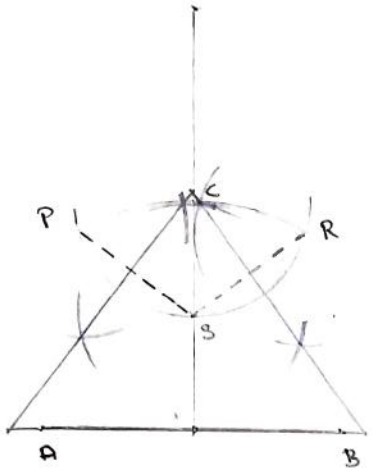
$\frac{180}{6} = 30$

(9) Take dimension 40mm and draw Octagon (8 sides) by procedure in all 3 methods as Explained.

(8) (i)



METHOD II - HEXAGON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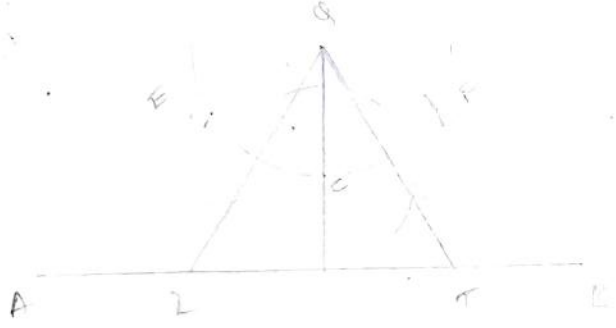

PROJECTIONS OF STRAIGHT LINES-I:

CASE 1: LINE PARALLEL TO BOTH HP TO VP

1.A line AB 50mm long is parallel to both horizontal plane and vertical plane.The line is 30 above HP and 20mm in front of VP ?
ANSWER: https://youtu.be/1f7KdTkJqcE?si=0iW2w_KqQTbL9Ipo

CASE 2: LINE CONTAINED BY ONE PLANE & PARALLEL TO OTHER

2.A Line AB 50mm long is on HP and 30mm in front of VP. Draw its projections?
ANSWER: https://youtu.be/aC6aKgBwZdY?si=guxWOotJ_BTklT7D

CASE 2: LINE CONTAINED BY ONE PLANE & PARALLEL TO OTHER

3. A line AB 50mm long is on VP and 20mm above HP. Draw its projections?
ANSWER: https://youtu.be/QmyjCcLihhs?si=7CChCucMvLx1VQCq

CASE 3: LINE PERPENDICULAR TO ONE PLANE & PARALLEL TO OTHER

4. A line AB 50mm long perpendicular to HP and parallel to VP. The end points A&B are 60 mm and 10mm above HP. The line is 20mm in front of VP. Draw its projections?
ANSWER: https://youtu.be/MYPCFI0BhSo?si=cAt4d3ncv7t4njPp

CASE 3: LINE PERPENDICULAR TO ONE PLANE & PARALLEL TO OTHER

5. A line AB 55mm long is perpendicular to VP and parallel to HP .The End A &B are 65mm and 10mm in front pf VP respectively. The line is 20mm above HP. Draw its projections?
ANSWER**:** https://youtu.be/U3fKQfF9zU0?si=FahBR3SsxqR4Lu8i

SECTIONS OF SOLIDS:

Prisms

Case-1: Section plane parallel to VP

1.A cube of 35mm long edges is resting on HP on one of its faces with a vertical face inclined at 30° to VP. It is cut by a section plane parallel to VP and 9mm away from the axis and further away from the VP. Draw its sectional front view and the top view?

ANSWER: https://youtu.be/fdo1DBCk0ag?si=RP6cZbt4tcrgb1pi

Case-2: Section plane parallel to HP

2.A triangular prism, base 30mm side and axis 50mm long, is lying on the HP on one of its rectangular faces with axis inclined at 30° to VP. It is cut by a horizontal section plane at a distance of 12mm above the ground. Draw its front view and sectional top view?

ANSWER: https://youtu.be/1ZObGkrgM7s?si=xZX__ZyRU-wGb4Mo

Case-3: Section plane perpendicular to HP & inclined to VP

3.A square prism of 30mm long edges is resting on HP one of its faces with a vertical face of height 60mm inclined at 30° to VP. It is cut by a section plane inclined at 60° to VP and perpendicular to HP, so that the face which makes 60° angle with the VP is cut in two equal halves .Draw the sectional front view ,top view and true shape of the section?

ANSWER: https://youtu.be/VRB04YTnhhI?si=uoM23pglspUkyfKR

PROJECTIONS OF SOLIDS-II

1.A square prism having base of 35mm side and a 60mm long axis is resting on an edge of its base on the HP and the axis is inclined at 45° to HP. Draw its projections if the resting edge makes an angle of 30° with the VP?

ANSWER: https://youtu.be/F93uf4oOKQw?si=LzJOHsnfQmb3zwPT

2.A pentagonal prism is resting on one of the corner of its base on HP. The longer edge containing that corner is inclined at 45° to base.The axis of prism makes an angle of 30° to VP .Draw the projections of solid taking side
30mm and axis 70mm?

ANSWER: https://youtu.be/sSHbBPAlbAk?si=4aGCvZI63Ke-pZNy

3.A hexagonal pyramid having a base of 30mm side and a 60mm long axis, has an edge of its base on the ground and the axis is inclined at 30° to HP. The edge of the base on which it rests is inclined at 45° to VP. Draw its projections?
ANSWER: https://youtu.be/bPl66RtBIiU?si=8ywLVgImABYgbOHX

4. A hexagonal prism having a base with 30mm side and an 80mm long axis, rests on one of its base edges in the HP.such that the axis is inclined at 30° to HP and 45° to VP.Draw its projections ?
ANSWER: https://youtu.be/yQH2iqwClhQ?si=P1Q7ODxoVpkplPeo

5.A cyclinder having with a 50mm base diameter and a 70mm long axis has a point of its base circle in the VP .Its axis is inclined at 30° to VP and 45° to HP.Draw its projections ?
ANSWER: https://youtu.be/9QT1e74A7cA?si=Teu1gZhRX_6MfwC4

6.Draw the projections of a cone, having a base with 50mm diameter and a 60mm long axis, when it is resting on the ground on a point of its base circle with,
a) The axis inclined at 30° to HP & 45° to VP.
b) The axis inclined at 30° to HP& its top view inclined at 45° to VP.
ANSWER: https://youtu.be/wpSNg3uxp50?si=FuLHugnSugeuuuAu

7.A pentagonal pyramid, base 25mm side and axis 50mm long has one of its triangular faces in the VP and the edge of the base contained by that faces makes an angle of 30° with the HP. Draw its projections?
ANSWER: https://youtu.be/PLozKQ9sZgU?si=jKwAtsgAmdwIj4jW

Projections of Solids-I

1.Draw the projections of a cyclinder of base 50mm diameter and axis 70 mm long, when it is resting on HP on its base?
ANSWER: https://youtu.be/BxF74D9zsso?si=-JOXn7ft3UEin47z

2. Draw the projections of a cone of base 50mm diameter and axis 70 mm long, when it is resting on HP on its base?
ANSWER: https://youtu.be/BxF74D9zsso?si=aUHkO-lRByQRAA3R

3.A square pyramid having base 40mm side and 60mm long axis is resting on its base on HP. Draw its projections, when
a) A side of base is parallel to VP
b) A side of base is inclined at 30 degrees to VP.
C) All sides of base are equally inclined to VP.
ANSWER: https://youtu.be/ezg4MZ8LuKw?si=iFyIz0Cqzz5T_QoF

4. A square prism having base 40mm side and 60mm height is resting on its base on the ground. Draw its projections, when
a) A vertical face is perpendicular to VP.
b) A vertical face is inclined at 30 degrees to VP.
c) All the vertical faces are equally inclined to VP.
ANSWER: https://youtu.be/H_VciK3BHH0?si=YHQGywV8oMuJfAkp

5.A cube of 40mm side is resting with a face on HP such that when one of its vertical faces is inclined at 30° to VP?
ANSWER: https://youtu.be/TobxHXZGNuE?si=3cG48N5s7MxRW7H8

AXIS PERPENDICULAR TO VP:

6.A pentagonal prism having a base with 30mm side and 60mm long axis has one of its base in the VP. Draw its projections ,when
a) A rectangular face is parallel to 15mm above HP.
b) A rectangular face is perpendicular to HP.
c) A rectangular face is inclined at 45° to HP
ANSWER: https://youtu.be/xRfMi8-xyUU?si=pH-eqzA8Cdr_Nc4A

7.A Hexagonal prism having 30mm long edge of base and a 70mm long axis, has its axis parallel to and 50mm above HP. Its base is parallel to VP and an edge of base is inclined at 45° to HP. Draw its projections?
ANSWER: https://youtu.be/h_oAVBF0338?si=WHtxGP7tJF4ygWkW

8.A Hexagonal prism having base with a 30mm side and 75mm long axis has an edge of its base on the HP. Its axis is parallel to VP and inclined at 45° to HP. Draw its projections?
ANSWER: https://youtu.be/bfk0aEy6QFs?si=15VpurSZ8nkYf1V9

9.A Pentagonal prism, having base with a 30mm side and 75mm long axis, has a corner of its base on the ground and axis is inclined at 60° to HP.Draw its projections if the axis is parallel to VP?
ANSWER: https://youtu.be/l7wlR5rr6CY?si=LgH4HP4ulg9ZRZ1L

10.A Cone having 50mm diameters and 70mm long axis, has a point of its base circle in the VP such that the axis is inclined at 45° to VP and parallel to HP. Draw its projections?
ANSWER: https://youtu.be/VPNsKUr3D8c?si=3IcVFTIGl6aeL7XO

11.A Pentagonal prism having a base with 30mm side and a 75mm long axis has one of its rectangular faces on HP and the axis is inclined at 45° to VP. Draw its projections?
ANSWER: https://youtu.be/1EiHUPWle1Q?si=5lBqLc9erd0y6Sym

12.A Hexagonal pyramid with a base having a 30mm side and 70mm long axis having on a slant edge on the ground with axis parallel to VP. Draw its projections?
ANSWER: https://youtu.be/0dWAymGj5pM?si=9PfAgUBym1SUXjNd

13.A Pentagonal pyramid having base with a 30mm side and 70mm long axis, has triangular face on the ground and the axis is parallel to VP. Draw its projections?
ANSWER: https://youtu.be/cwq3hulPdN4?si=bdt6QwWWCM0QD1ed

PROJECTIONS OF LINES AND PLANES USING AUXILIARY PLANE METHOD:

CASE-1: AUXILIARY PLANES - PROJECTIONS OF LINES USING AUXILIARY PLANES

1.A straight line AB of 75mm length is inclined at 30° to HP. The end of the line is 25mm above HP and 20mm in front VP. Draw its projections by auxiliary plane method?
ANSWER: https://youtu.be/3x1v0BLq1rg?si=01STu_R4xVDgz79T

2. A straight line PQ of 50mm length, is inclined at 45° to VP. The end P of the line is 20mm above HP and 15mm in front VP. Draw its projections by auxiliary plane method?
ANSWER: https://youtu.be/YYfHpUK5KAY?si=Eque_L6RFywfHvxy

3. A line AB 60mm length has its end A at 20 above HP& 25mm in front of VP. The line is inclined at 30° HP and 45° to VP. Draw its Projections by auxiliary plane method?
ANSWER: https://youtu.be/lfFMh_4kLXQ?si=Wt_8AJljM8-Zv9SY

4. A straight line AB of 50mm length is inclined at 30° to HP and its top view make an angle 60° to XY. The end A of the line is 20mm above HP and 15 mm in front of VP. Draw the Projections of the line by auxiliary plane method?
ANSWER: https://youtu.be/jqKIfvQMI4Q?si=jwhHQiEa-ypoiooE

5. A Pentagonal plane with 40mm Side has an Edge on HP. The Surface of the plane is inclined at 45° to HP and Perpendicular to VP. Draw its projections by auxiliary plane method?
ANSWER: https://youtu.be/AkZZzT942b4?si=c5PS3tkkIRtCscLJ

6. A Circular plate with a 60mm diameter is resting on a point of its Circumference on the VP .The center is 40mm above the HP and the Surface is inclined at 45° to VP & perpendicular to the HP. Draw it projections by Auxiliary plane method?
ANSWER: https://youtu.be/h7u75_DFMhc?si=Be2JiHO6FsQ6u3ys

7. A Square lamina ABCD with 50mM Side has its Corner A in the HP. Its diagonal AC is inclined at 45° to HP. While the diagonal BD is parallel to the HP and inclined at 30° to VP. Draw its Projections by auxiliary plane method?
ANSWER: https://youtu.be/LtrVnQU1kZc?si=2-GM-wvHwXPW62D0

8. A Hexagonal plate with a 30mm Side and negligible thickness rests on an edge in the VP. The Surface is inclined at 45° to VP and the Edge resting in the VP is inclined al 30° to HP. Draw ids Projections by auxiliary plane method?
ANSWER: https://youtu.be/g8bZGUnAdZM?si=ZZ-x2KzS4ET_GOfJ

PROJECTIONS OF PLANES INCLINED TO BOTH REFERENCE PLANES:

1.A Square ABCD of 50mm Side has its Corner A in the HP its diagonal AC inclined at 30° to HP and the diagonal BD inclined at 45° to the VP and parallel to HP. Draw its Projections?
ANSWER: https://youtu.be/aybRRBB7pTM?si=aQpu1jROqNgoUV4_

2. Draw the projections of a regular hexagon of 25mm Side having one of its Sides in the HP and inclined at 60° to the VP and its Surface making an angle of 45° with the HP?
ANSWER: https://youtu.be/o1j85KI2akE?si=h5hcbqV35__aK5d9

3. A thin rectangular plate of Sides 60mm×30mm has its Shortest Side in the VP and inclined at 30° to HP. Project its top View if its front view is a Square of 30mm long Sides?
ANSWER: https://youtu.be/kLaDuR-w70A?si=Rv8SS-M9-AdqVZP3

4. A Circular plate of negligible thickness of 50mm diameter appears as an Ellipse in front view having its major axis 50mm long and minor axis 30mm long. Draw its top view when the major axis of the Ellipse is horizontal?
ANSWER: https://youtu.be/YczCvXHGv0w?si=AiFtj45hb8CMHpdH

5. A Rhombus has its diagonals 100mm and 80mm long. Draw the projections of the rhombus, when it is so placed that its top View appears to be a square of diagonal 60mm long and the vertical plane through the longer diagonal makes 30° with VP?
ANSWER: https://youtu.be/bG7s1FVFnNc?si=xqkzZyg3bBMZc-se

6. A Semi-Circular lamina of 64mm diameter has its Straight Edge in VP and inclined at an angle of 45° to HP The Surface of lamina makes an angle 30° with VP. Draw its Projections?
ANSWER: https://youtu.be/fsrQ65iXZbE?si=tB4Lk2BCayu2uixn

7. Draw the projections of a Circle of 50 mm diameter resting in the HP on a point A on the Circumference, its plane inclined at 45° to the HP and
a) The top View of the diameter AB making 30° angle with the VP.

b) The diameter AB making 30°angle with the VP.
ANSWER: https://youtu.be/LJrlLHMYW1I?si=OIqAfjF_8zM2hRr5

PROJECTIONS OF PLANES INCLINED TO ONE REFERENCE PLANE:

1.A Pentagonal Plate of 45mm Side has a Circular hole of 40mm diameter in its Center.The plane Stands on one of its Sides on the HP with its plane perpendicular do VP and 45° inclined to HP. Draw its Projections?
ANSWER: https://youtu.be/8Lx7OZk4whY?si=t6tvp2vNDVzlTin5

2. A Composite Plane ABCD Consists of a Square of 60mm Side, with an additional Semi-Circle Constructed on CD as diameter. Draw the Projections of the plane When the Side AB is Vertical and the plane makes an angle of 45° with HP?
ANSWER: https://youtu.be/ItiOnO72QNw?si=d-DUPxPrDyA0EqZ3

CONVERSION OF VIEWS – ORTHO TO ISO= (2DIMENSIONAL TO 3 DIMENSIONAL):

1.Draw the orthographic views of the given 3Dimensional figure?
ANSWER: https://youtu.be/tBJ8J_pxbFs?si=7z2RwHpbU4wm5GuQ

2. Draw the orthographic views of the given 3Dimensional figure?
ANSWER: https://youtu.be/oyaoJY12XXM?si=ykpHBpHE1mFg1niN

3. Draw the orthographic views of the given 3Dimensional figure?
ANSWER: https://youtu.be/7KS8WukaanI?si=N9mjG3pfhcZTiLCt

4. Draw the orthographic views of the given 3Dimensional figure?
ANSWER: https://youtu.be/S2l0H31VYcI?si=LG5UmzJIUqMJIJcc

5. Draw the orthographic views of the given 3Dimensional figure?
ANSWER: https://youtu.be/7KS8WukaanI?si=N47gQlF9N9kYhlWC

6. Draw the orthographic views of the given 3Dimensional figure?

ANSWER: https://youtu.be/S2l0H31VYcI?si=rps3_3UAgO4VU4ef

CONVERSION OF VIEWS – ISO TO ORTHO= (3 DIMENSIONAL TO 2 DIMENSIONAL):

1. Draw the isometric view of the given 2 dimensional views?
ANSWER: https://youtu.be/zFjnS2IIbJw?si=iVJkEz61aUqDyj8W

2. Draw the isometric view of the given 2 dimensional views?
ANSWER: https://youtu.be/Z7MT_Y2vRTs?si=_jcxICQ16Ffa3Dhy

3. Draw the isometric view of the given 2 dimensional views?
ANSWER: https://youtu.be/ditwFxTOkCw?si=TDncR1TTZ-NIYYMA

4. Draw the isometric view of the given 2 dimensional views?
ANSWER: https://youtu.be/oInydAvwzdw?si=SUdiTEQSHGDVUqg-

5. Draw the isometric view of the given 2 dimensional views?
ANSWER: https://youtu.be/tmTFjV3n4-c?si=hxYWePsCoHR1q39Z

6. Draw the isometric view of the given 2 dimensional views?
ANSWER: https://youtu.be/vKRsjiwR-YE?si=T3U4tW29xrZru9Fh

ISOMETRIC PROJECTIONS:

1. Draw an Isometric Projection of
a) A Straight line of 50mm
b) Square plane of 40mm
C) A rectangle plane of 60mm×8omm, both in Horizontal & Vertical Planes?
ANSWER: https://youtu.be/H6tA1-H1Zdo?si=vDKiYQys_7Wc8e8i

2. Draw the isometric View of an Equilateral triangle of 40mm Side with a Side horizontal and the plane of the triangle being Vertical.
ANSWER: https://youtu.be/7Nigayp4dqs?si=ANL4rmhbUMbrRna3

3. Draw the isometric View of
a) A Pentagon of 50mm Side, Plane Vertical & Horizontal.

b) A Hexagon of 50mm side, Plane Vertical & Horizontal.
ANSWER: https://youtu.be/L_JLDzaVsfg?si=AIGT2EXDzvokS3r5

4. Draw the Isometric View of a Circle of diameter 50mm with its plane horizontal
2Methods=
i)Coordinate Method
ii) Four Center Method
ANSWER: https://youtu.be/pOKxJymEyKA?si=KLVTKgJeYmocU--y

5. Draw the Isometric View of a Square Prism with the Side of the base 40mm and length of axis 70mm when the axis is
1) Vertical
2) Horizontal
ANSWER: https://youtu.be/H6VjN65czpI?si=EIUdIcx8f1_bMiS8

6. Draw the Isometric View of a Hexagonal Prism, with Side of base 25mm and axis 60mm long. The Prism is resting on its base on HP with an Edge of the base Parallel to VP?
ANSWER: https://youtu.be/i_r3mkZhyUY?si=TsQ7Mh2pRaDf-eiP

7. Draw the isometric view of a Pentagonal Pyramid with Side of base 25mm and axis 60mm long .The Pyramid is resting on its base on HP with an Edge of the base Parallel to VP?
ANSWER: https://youtu.be/Cnz8wkXHtcU?si=mderBQeQTaLzTucu

8. A Hexagonal Pyramid with Side of base 30mm & axis 90mm long resting on its base on HP. An Edge of the base is parallel to VP. A Horizontal section plane passing through a point on the axis at a distance of 60mm from the base, draw the isometric view of the frustum of the Pyramid?
ANSWER: https://youtu.be/mWqjlWOF_Ok?si=x6d1VhpiARCDUFhu

9.Draw the isometric of
a) A cyclinder
b) A cone of base diameter 50mm & axis 70mm long.
ANSWER: https://youtu.be/C2cCMLddk-0?si=6x2G6csGn4mBCpbI

10. Draw the isometric projection of

a) A cyclinder
b) A cone of base diameter 50mm & axis 70mm long.
ANSWER: https://youtu.be/C2cCMLddk-0?si=6x2G6csGn4mBCpbI

11. A Square Pyramid of Side 30mm, axis length 50mm is Centrally placed on the top of a Cube of 50mm. Draw the isometric View of Compound Solid?
ANSWER: https://youtu.be/BBBRLVwJmG4?si=DZ4fShb_CP1Wx_jn

12. A Hexagonal Prism shaped Solid of base Edge 20mm and height 40mm lies Centrally on a Cylinder of 60mm diameter and 20mm thick. Draw the isometric View of the Solids if their axis lie on the Same plane?
ANSWER: https://youtu.be/hydM3Hn02EU?si=EKsjIfPWV2_YjYlS