Introduction to AutoCAD

Computer-aided design and drafting (CADD) is the process of using a computer with CADD software to design and produce drawings and models according to specific industry and company standards. The terms computer-aided design (CAD) and computer-aided drafting (CAD) refer to specific aspects of the CADD process. This chapter introduces the AutoCAD CADD system. You will begin working with AutoCAD and learn to control the AutoCAD environment.

AutoCAD commands and options allow you to draw objects of any size or shape. Use AutoCAD to prepare two-dimensional (2D) drawings, three-dimensional (3D) models, and animations. AutoCAD is a universal CADD software program that applies to any drafting, design, or engineering discipline. For example, use AutoCAD to design and document mechanical parts and assemblies, architectural buildings, civil and structural engineering projects, and electronics.

Merits of CAD over manual drafting:

1) Design can be consistently accurate, clear and faster.
2) Drawings are stored in electronic format in computers. With sufficient backup space required for is far lesser that required for storing the man-made paper drawings.
3) Documents can be maintained safely for a longer period. No natural factors such as moisture could spoil the documents.
4) Retrieval of documents is faster than that of manual drawings.
5) Editing and modification of drawing is easy.
6) Directly we can construct and visualise a 3D model. The CAD software can quickly produce the orthographic views of component or assembly.
7) Repetitive and time consuming activities such as cross-hatching, dimensioning can be done much faster care at any time.
8) We can simulate real life situations such as wind, sun light, pressure and temperature and visualise how the model or design would react in a given situation.
9) There is flexibility in design.
10) Design analysis is made
11) Fewer design errors.
12) There is improvement in design with shorter lead time.

Advantages of CAD:

1. Increased and accuracy and productivity compared to traditional method
2. Cost effective and flexible, even small scale fabrication industries can take advantage of it.
3. Can be e-transmitted.
4. Changes can be incorporated very fast.
5. Production drawings can be created very fast
6. Area, Mass properties, Centre of gravity, Moment of Inertia can be calculated.
7. Easy visualisation and hence customer satisfaction.
8. Templates and programming for consistency and drafting standards.
9. See the model before the equipment is actually manufactured.
10. Analysis and tests can be performed on the model like destructive test, heat and cold test etc.
11. Latest version of AutoCAD has the power of interaction of Drawings over the internet.

Select Object Options

a) Single entity.
b) All. (All entities in the drawing)
c) Window. (Totally covered in the window)
d) Crossing. (Cut by the window)
e) Last. (Last selected)
f) Previous. (Object previously stored)
g) Fence. (Range)
h) Window Polygon.
i) Crossing Polygon.

Function keys

F 1 Help
F 2 Toggle (Graphic and Character screen)
F 3 Osnap off (Object Snap)
F 4 Tablet ON/OFF
F 5 Iso-plane change (for isometric view
F 6 Co-ordinate ON / OFF
F 7 Grid ON / OFF
F 8 Ortho ON / OFF
F 9 Snap ON / OFF
F 10 Polar Tracking On/OFF
F 11 toggle Object Snap Tracking on or off

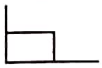
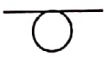
Types of Commands

1. Draw Commands: Commands used to draw new entities.
2. Modify Commands: Commands used to edit the existing entities.
3. Display Commands: Commands used to View the objects.
4. Dimensioning commands: Commands used to dimension or annotate the objects.
5. Transparent Commands: These commands are used when we are in the middle of another command, like zoom, view, pan, redraw, resume, grid. A command started while another is in progress. Precede transparent commands with an apostrophe. Many commands can be used transparently: that is, they can be entered on the command line while you use another command. Transparent commands frequently change drawing settings or display options. In the Command Reference, transparent commands are designated by an apostrophe in front of the command name.

Important Commands in AutoCAD

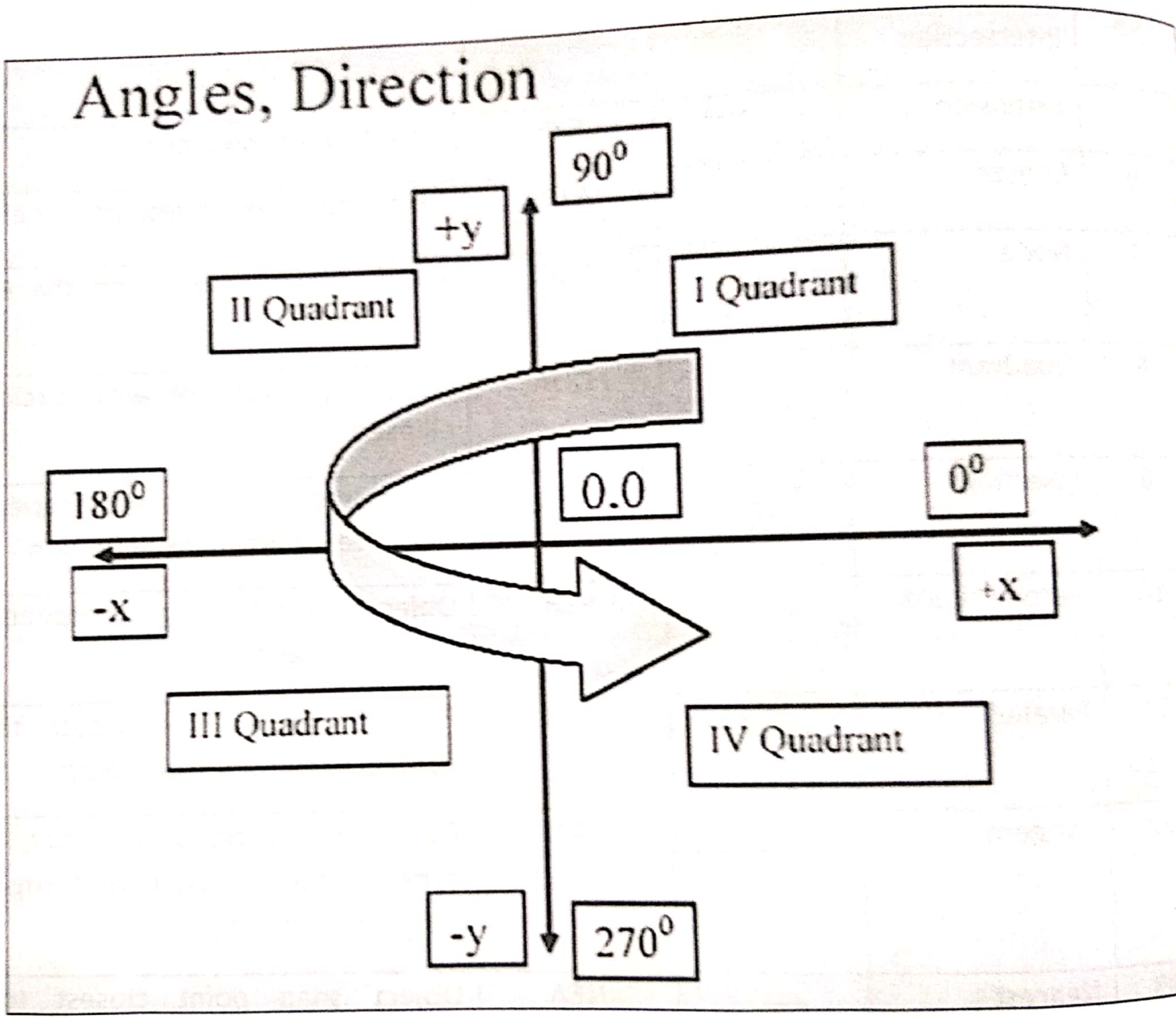
Draw Commands:	Modify Commands	View Commands & Others
LINE	MOVE	REDRAW
CIRCLE	COPY	REGEN
ARC	OFFSET	ZOOM
PLINES	TRIM	PAN
RECTANGLE	EXTEND	3DORBIT
ELLIPSE	ROTATE	HIDE
MLINE	SCALE	SHADE
XLINE	CHAMFER	RENDER
RAY	LENGTHEN	VIEWPORT
DONUT	ARRAY	DDEDIT
SPLINE	BREAK	SNAP
MLSTYLE	MEASURE	GRID
MLEDIT	DIVIDE	OSNAP
POLYGON	MIRROR	LIMITS
TEXT	PROPERTIES	EXPLODE
DTEXT	ERASE	LIST
MTEXT	FILLET	AREA
LINETYPE	BLOCK	TIME
LTSCALE	WBLOCK	STATUS
HATCH	INSERT	DIM
LAYERS	PEDIT	PLOT

Object Snaps:

S. No.	*Object snap*	Symbol	Command line	Snaps to
1	Endpoint		END	Object endpoints
2	Midpoint		MID	Object midpoints
3	Intersection		INT	Object intersections
4	Apparent Intersection		APP	Apparent intersection of objects
5	Extension		EXT	Object extension paths
6	Center		CEN	Center points of circles, arcs, or ellipses
7	Node		NOD	Point objects drawn with the POINT command
8	Quadrant		QUA	Closest quadrant of arcs, circles, or ellipses
9	Insertion		INS	Insertion point of a block, shape, text, attribute, or attribute definition
10	Perpendicular		PER	Object points forming a perpendicular (normal) alignment
11	Parallel		PAR	Point on an alignment path that is parallel to the selected object
12	Tangent		TAN	Point on a circle or arc that, when connected to the last point, forms a line tangent to the object
13	Nearest		NEA	Object snap point closest to the selection point
14	None		NON	Turns off object snaps for the next point selection
15	From		FRO	Snap from a distance of existing object

Coordinate systems in AutoCAD

1. Cartesian absolute coordinate system (x, y)
2. Cartesian relative coordinate system (@ x, y)
3. Polar relative Coordinate system (@ r<θ)
4. Direct distance entry system (x)



SHEET NO 7- INTRODUCTION TO AUTOCAD

(AS PER SYLLABUS, THIS IS IN SHEET NO.7, BUT SHOWN HERE AFTER INTRODUCTION TO AUTOCAD)

Draw the following figures using AUTOCAD

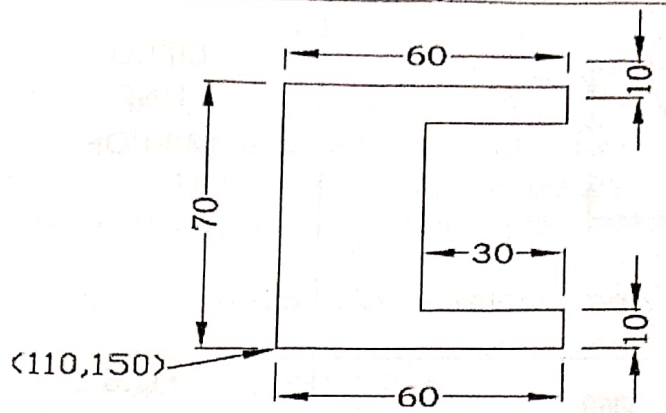


FIG.1
COMMANDS

LINE
(Cartesian Absolute Coordinate system)
Entry is based on (x,y)

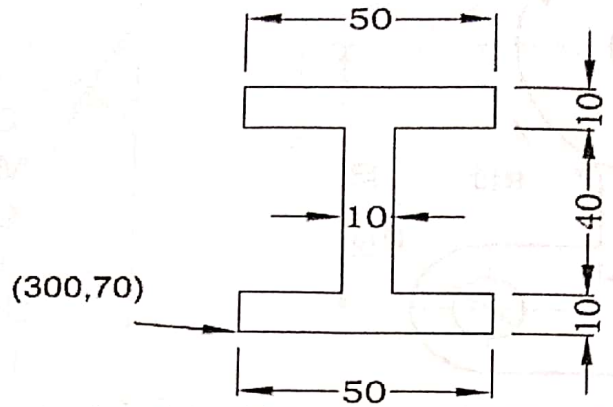


FIG.2
COMMANDS

LINE
(Direct distance entry system)
Entry is based on direct values with 'Ortho On' mode and direction of line.

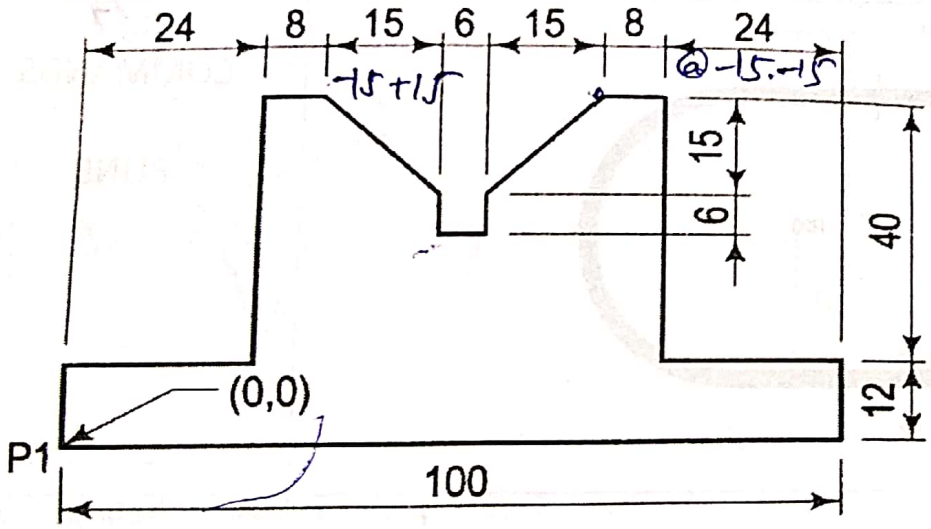


FIG.3
COMMANDS

LINE
(Cartesian relative Coordinate system): entry is based on entry of coordinates in format (@x, y) from each point.

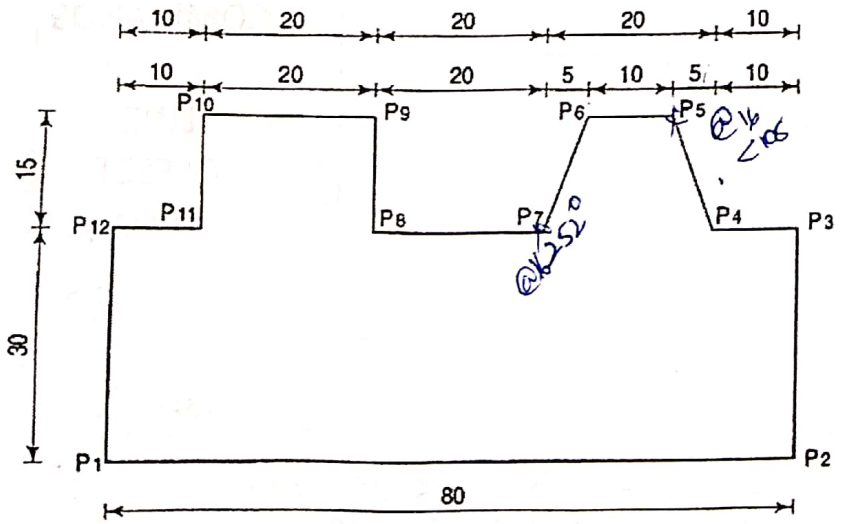


FIG.4
COMMANDS

LINE
(Polar relative system): Format is @r<θ.

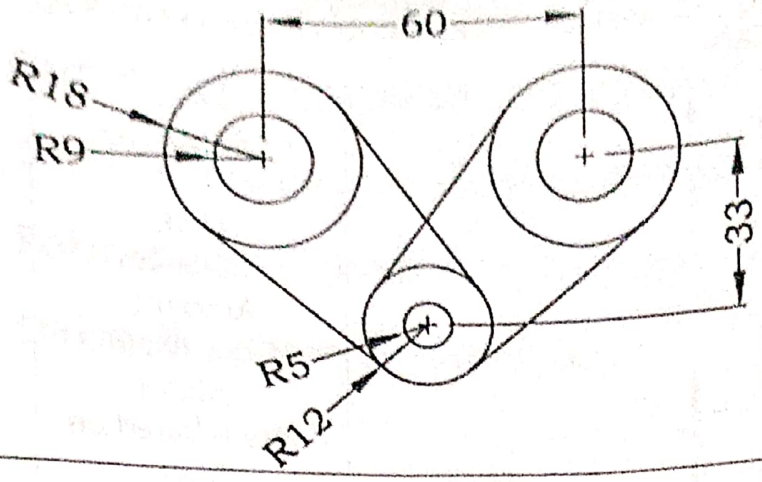


Fig. 5
COMMANDS

CIRCLE
LINE
MIRROR

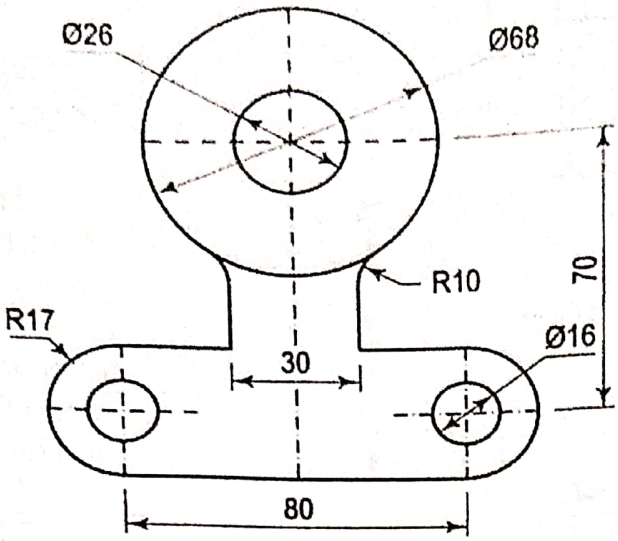


Fig.6
COMMANDS

LINE
CIRCLE
MIRROR
OFFSET
FILLET
LINETYPE
LTSCALE

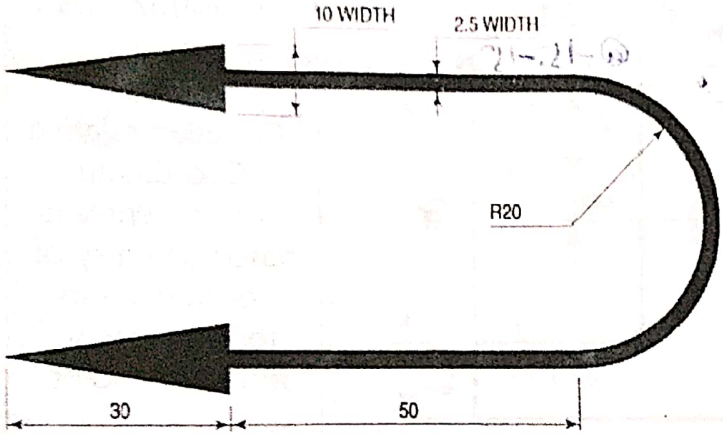


Fig.7
COMMANDS

PLINE

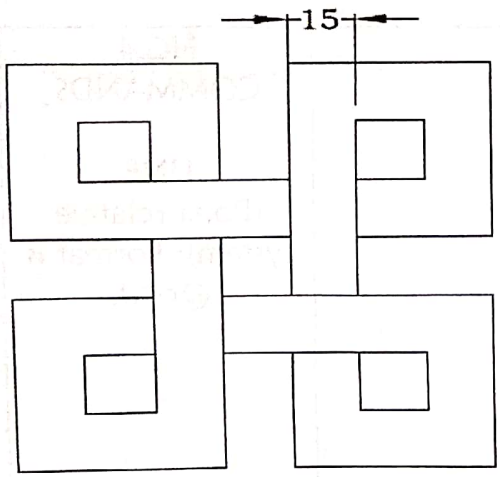


Fig.8
COMMANDS

LINE
OFFSET
TRIM

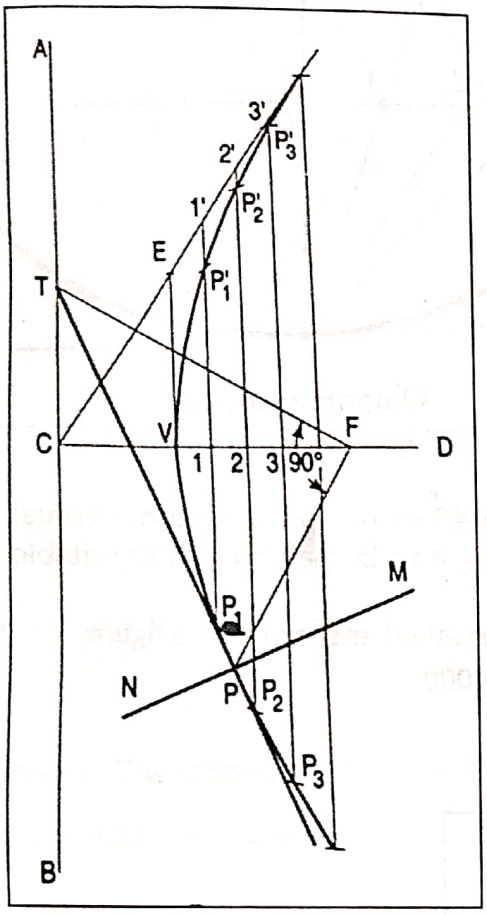
SHEET NO- 2

CONIC SECTIONS-I

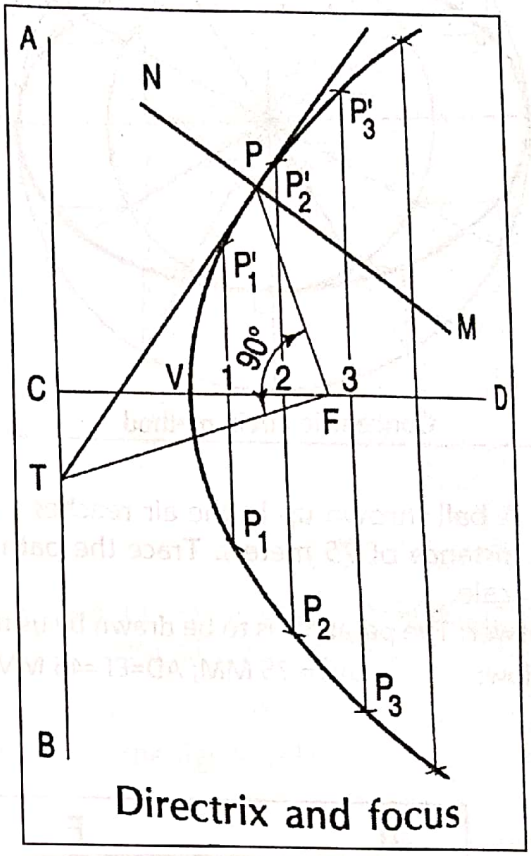
1. A fixed point is 50 mm away from a fixed line. Draw the path traced by a point P moving such that its distance from the fixed point is
   (i) 3/2 times its distance from the fixed line. (e = PF/PD = 3/2; hyperbola)
   (ii) Equal to its distance from the fixed line. (e = PF/PD = 1; parabola)
   (iii) 2/3 times its distance from the fixed line. (e = PF/PD = 2/3; ellipse)
   Also draw tangent and normal to the curve at a point 40 mm from the directrix.

Answer: Use the foci-eccentricity method to generate the required curves as shown below:

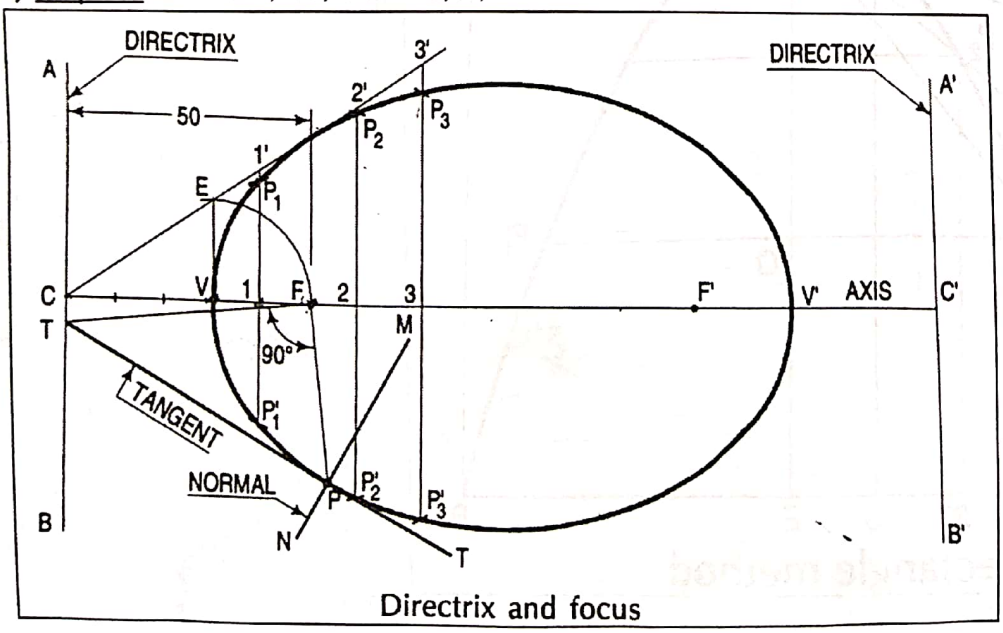
(i) Hyperbola: CF=50; VF/VC=3/2



(ii) Parabola: CF=50; VF/VC=1



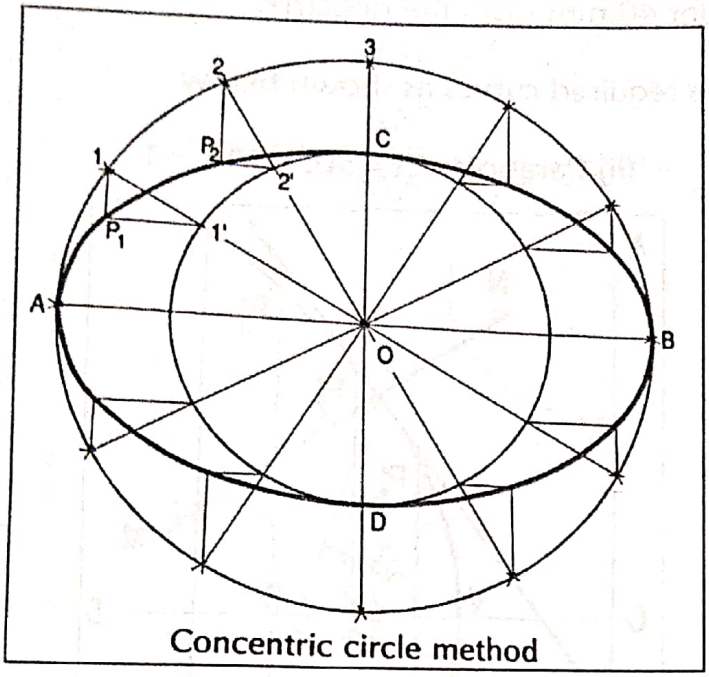
(iii) Ellipse: CF = 50; VF/VC = 2/3;



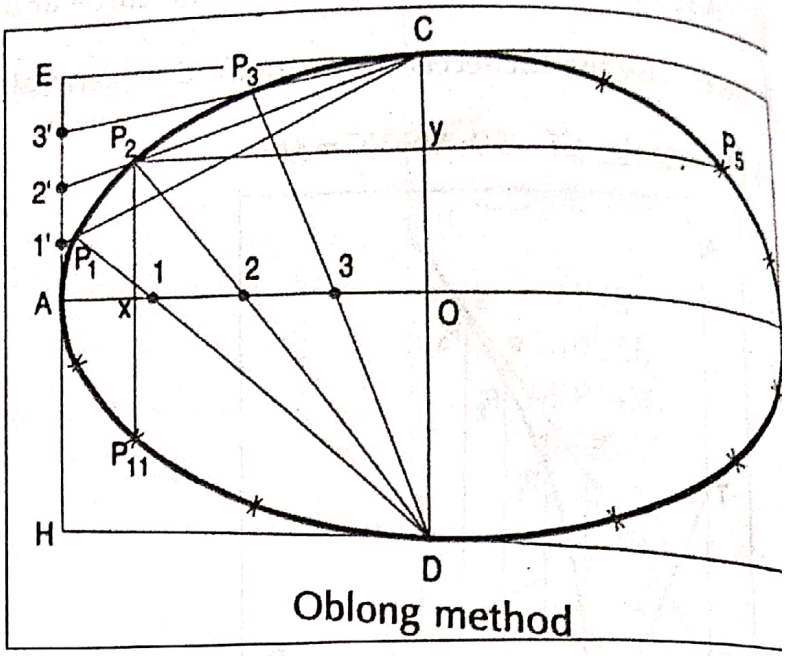
CONIC SECTIONS-II

1. Draw an ellipse whose major axis is 150 mm & minor axis is 100 mm by (i) Concentric circles method. (ii) Rectangle (Oblong) method.

Answer: The ellipse is to be drawn as shown in the figure below:
(i) Concentric Circles Method: AB= 150MM; CD = 100 MM. (ii) Oblong Method:



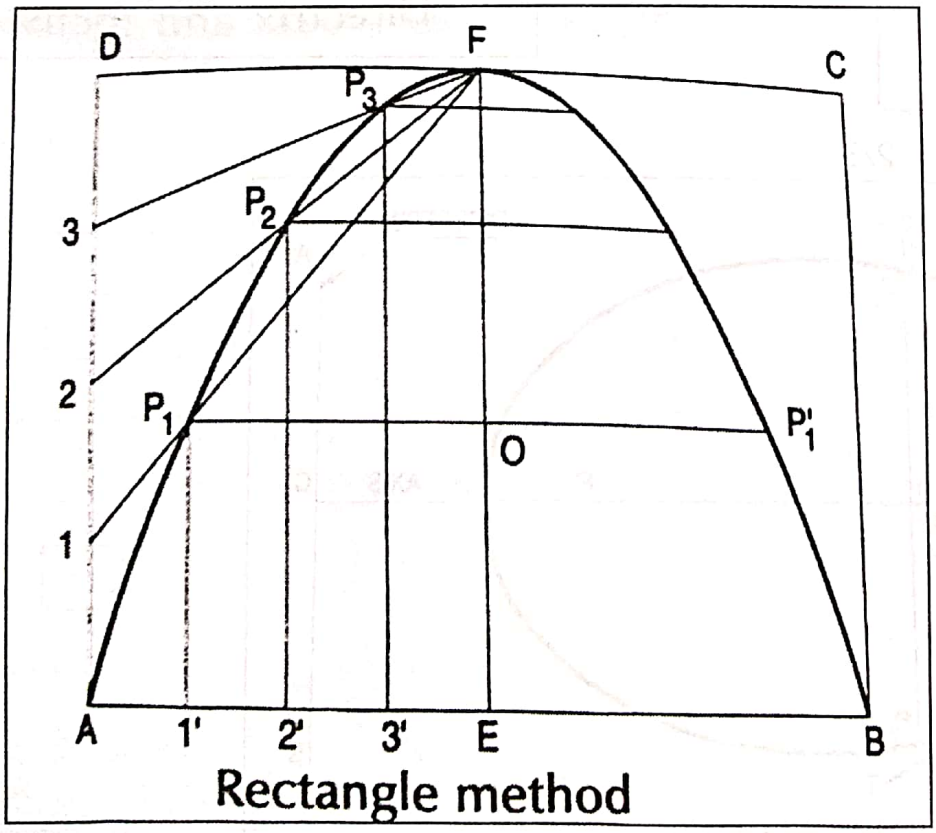
Concentric circle method



Oblong method

2. A ball thrown up in the air reaches a maximum height of 45 meters & travels a horizontal distance of 75 meters. Trace the path of the ball, assuming it to be parabolic. Use suitable scale.

Answer: The parabola is to be drawn by using rectangle (oblong) method as shown in the figure below: AB = 75 MM; AD=EF=45 MM; SCALE FACTOR = 1:1000

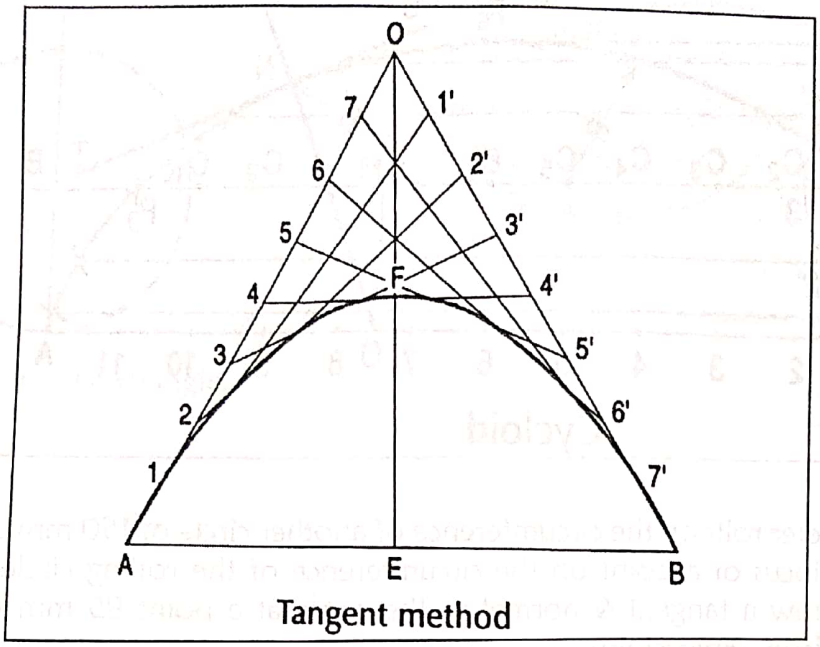


Rectangle method

3. A fountain jet discharges water from the ground level at an angle of 45° to the ground. It travels a maximum horizontal distance of 8.5 meters from the point of discharge and falls on the ground. Trace the path of the jet, assuming it to be parabolic.

Answer: The parabola is to be drawn by using tangent method as shown in the figure below:

AB = 85 MM. <ANGLE OAE = ANGLE OBE = 45°; SCALE FACTOR = 1:100

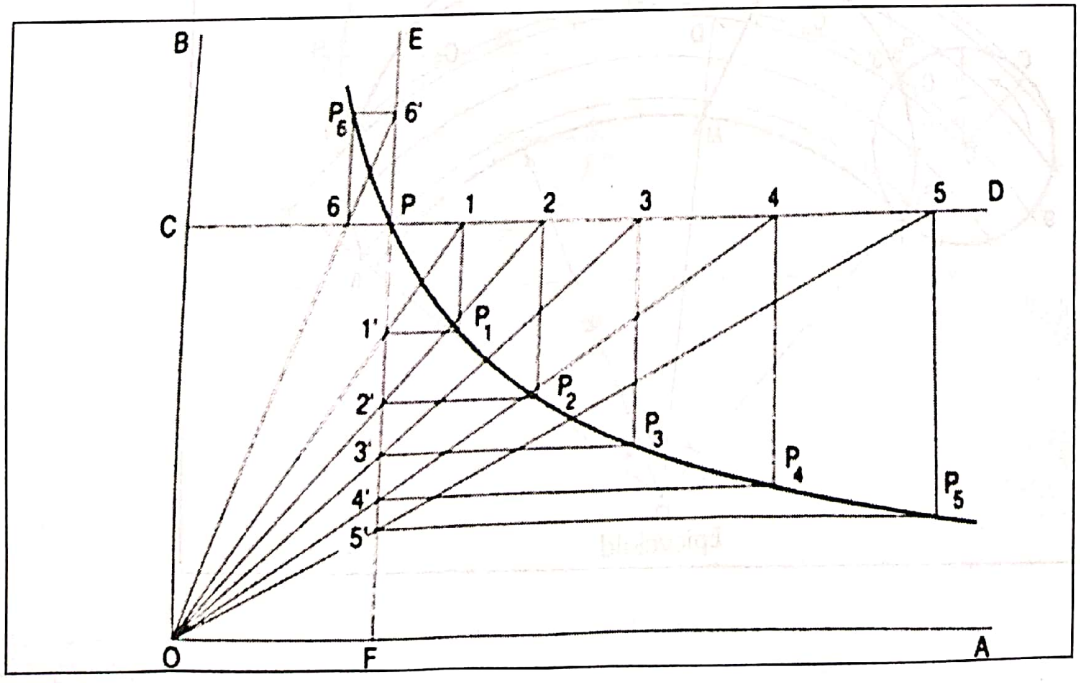


Tangent method

4. A point P is 40 mm and 50 mm respectively from two straight lines which are at right angles to each other. Draw a rectangular hyperbola through P showing at least 8 points.

Answer: The rectangular hyperbola is to be drawn as shown in the figure below:

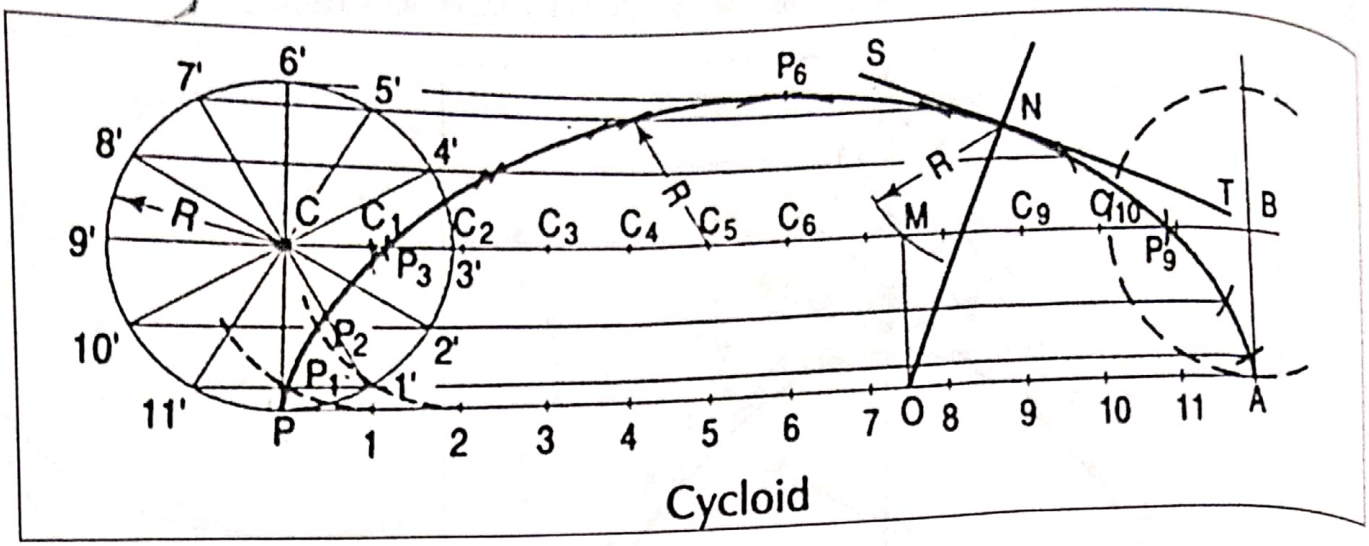
PF = 50 MM; CP = 40 MM;



SHEET NO- 4: CYCLOIDS

1. A circle of 50 mm diameter rolls along a straight line without slipping. Draw the locus of a point P on the circumference of the circle for one complete revolution. Name the curve. Draw a tangent and normal to the curve at a point on it 40 mm from the line. (Cycloid)

Answer: The cycloid is to be drawn as shown in the figure below:
The length PA = circumference of the circle = Π x D = 3.14 x 50 = 157 mm; CP =25 MM



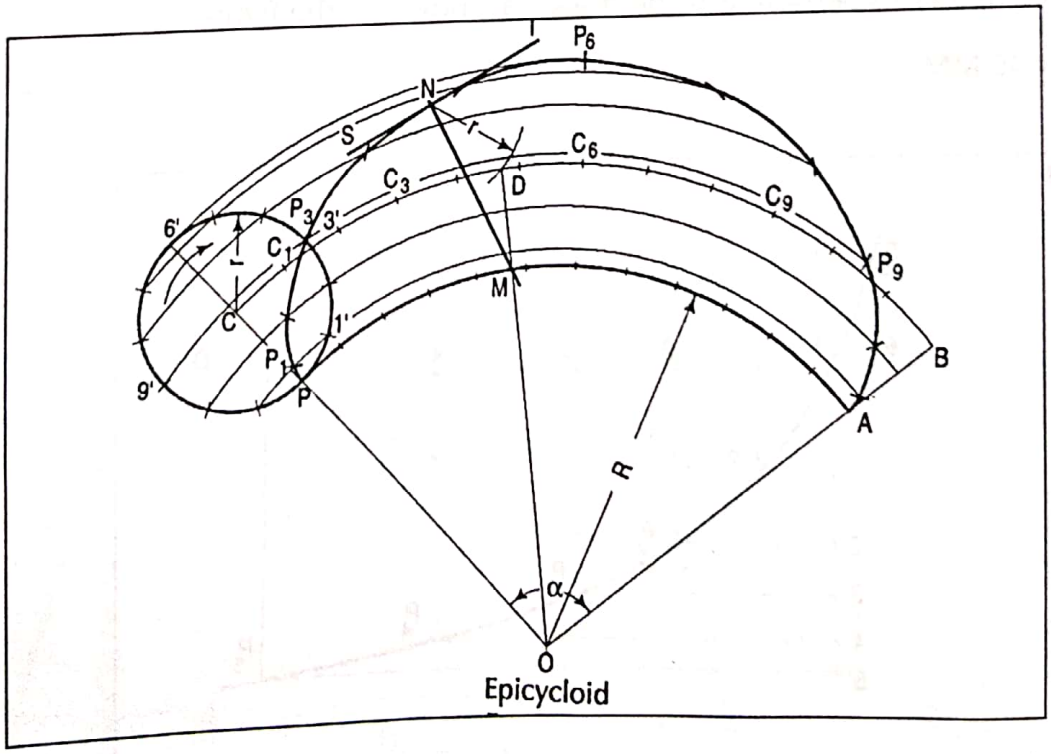
Cycloid

2. A circle of 50 mm diameter rolls on the circumference of another circle of 150 mm diameter & outside it. Trace the locus of a point on the circumference of the rolling circle for one complete revolution. Draw a tangent & normal to the curve at a point 85 mm from the centre of the directing circle. (Epicycloid)

Answer: The Epicycloid is to be drawn as shown in the figure below:

The subtended angle α is given by the formula α = 360° x (r/R) = 360° x (25/75) = 120°.

CP= r =25 MM; PO = R = 75 MM;



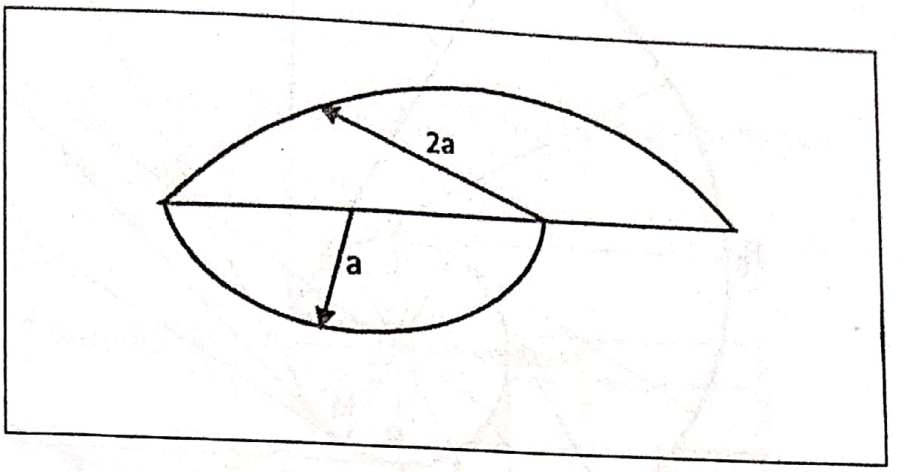
Epicycloid

SHEET NO- 5: INVOLUTES

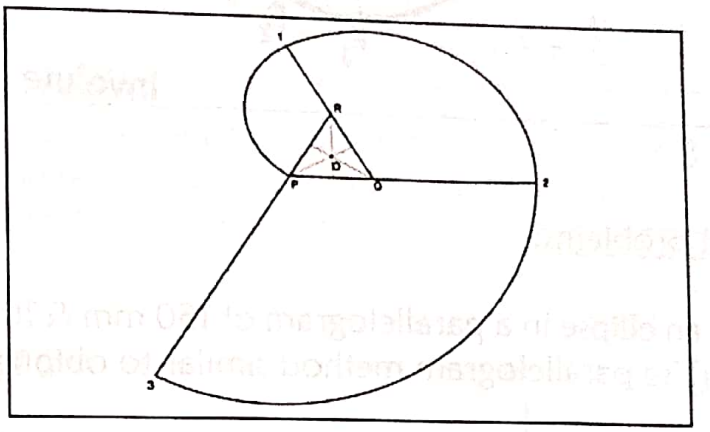
1. Draw the involute of the following:
   (i) Line of 40 mm length. (ii) Triangle of 20 mm sides. (iii) Square of 30 mm sides.
   (iv) Circle of 50 mm diameter.

Answer: The involutes are to be drawn as shown in figures below:

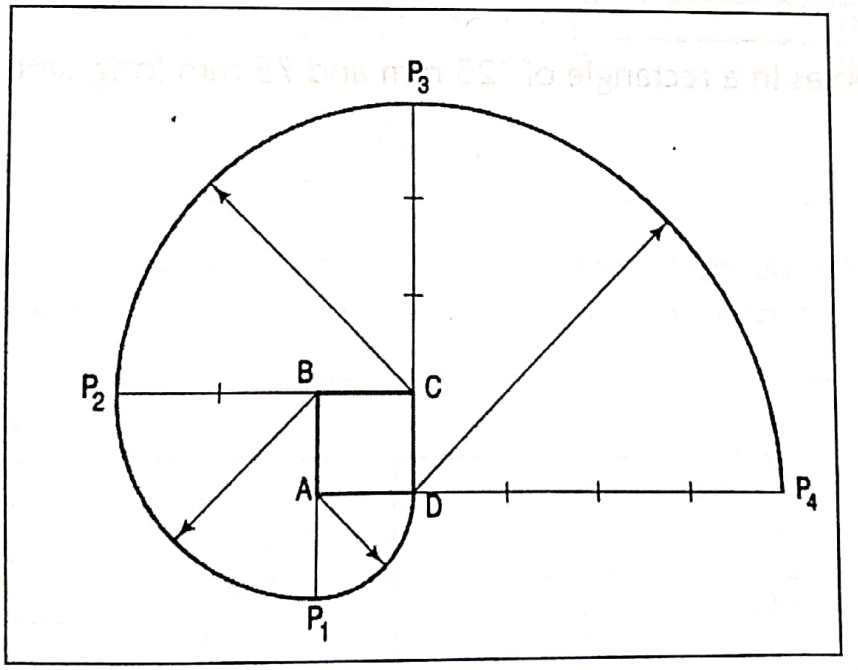
(i) Involute of a line:



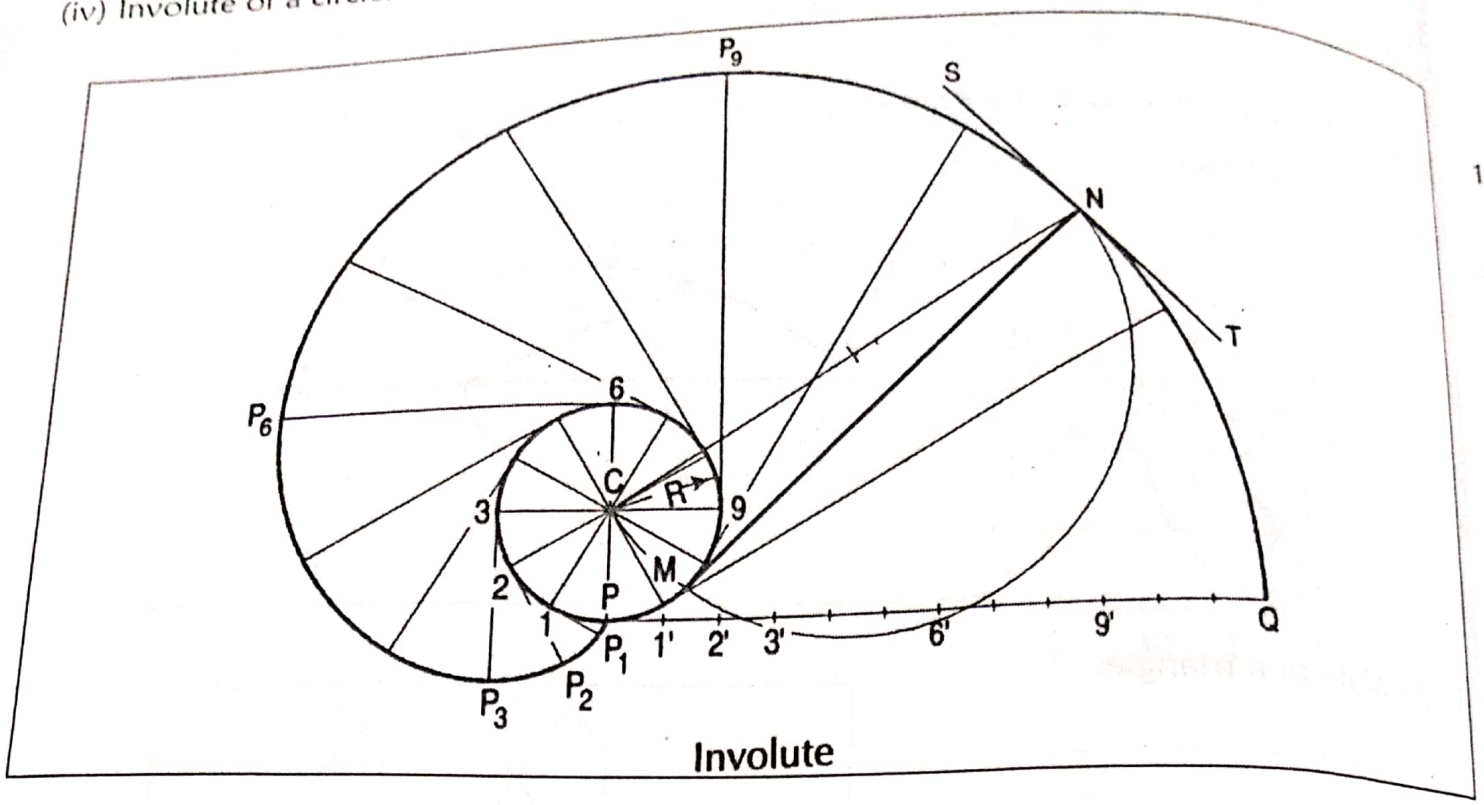
(ii) Involute of a triangle:



(iii) Involute of a square:



(iv) Involute of a circle:



Assignment problems:

1. Inscribe an ellipse in a parallelogram of 150 mm & 100 mm long sides with an included angle of 120^0 (Use parallelogram method-similar to oblong method)

2. Draw the involute of the following: (i) Pentagon of 40 mm sides. (ii) Hexagon of 40 mm sides.

3. Inscribe two parabolas in a rectangle of 125 mm and 75 mm long with their axes bisecting each other.

SCALES

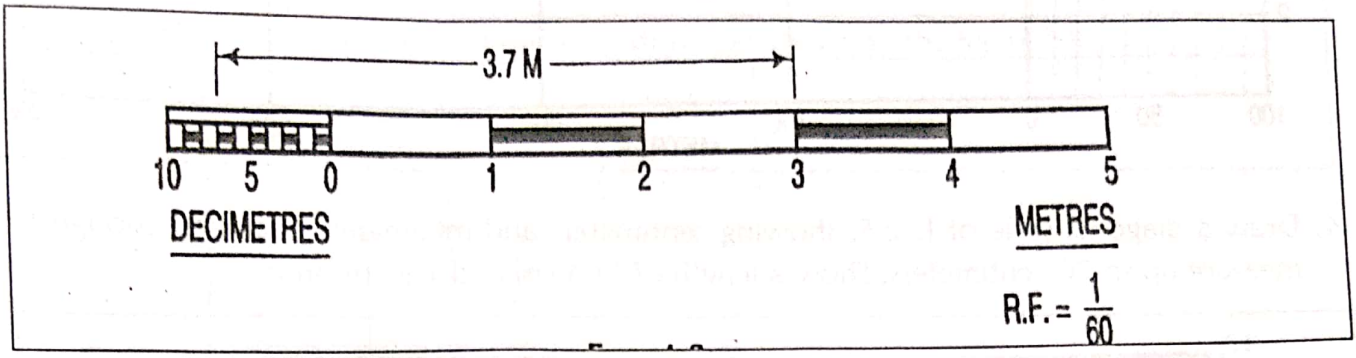
1. Draw a plain scale of 1:60 showing meters & decimeters & to measure up to 6 meters. Show the length of 3.7 m and 4.9 m on it.

Answer: Length of scale = R.F x Maximum Length = (1/60) x 6 x 100 = 10 cm;

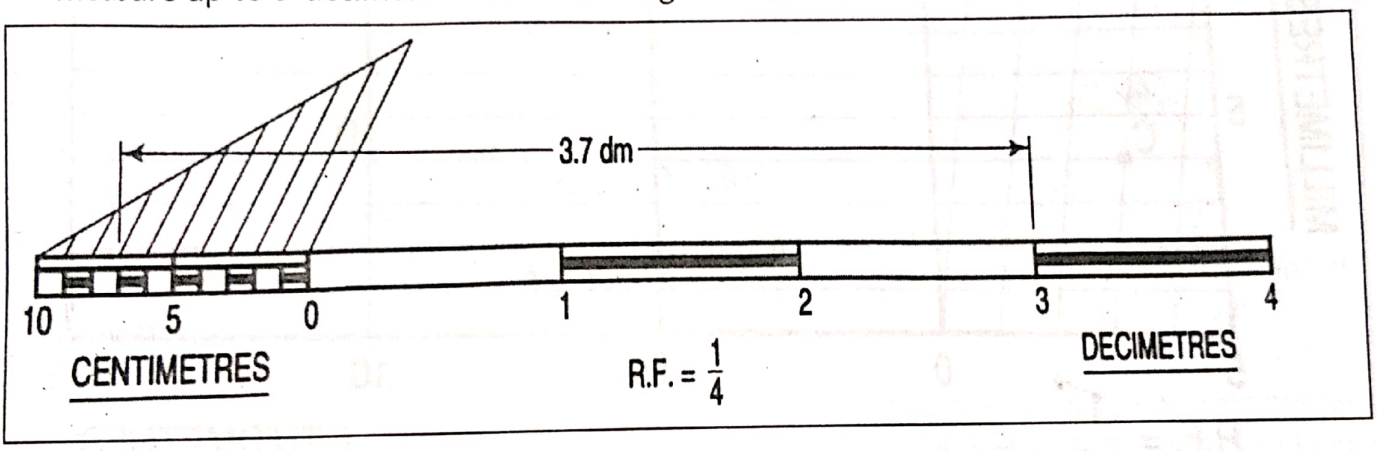
No. of main scale divisions = 6.

The height of plain scale may be taken between 3 cm to 10 cm as per convenience.

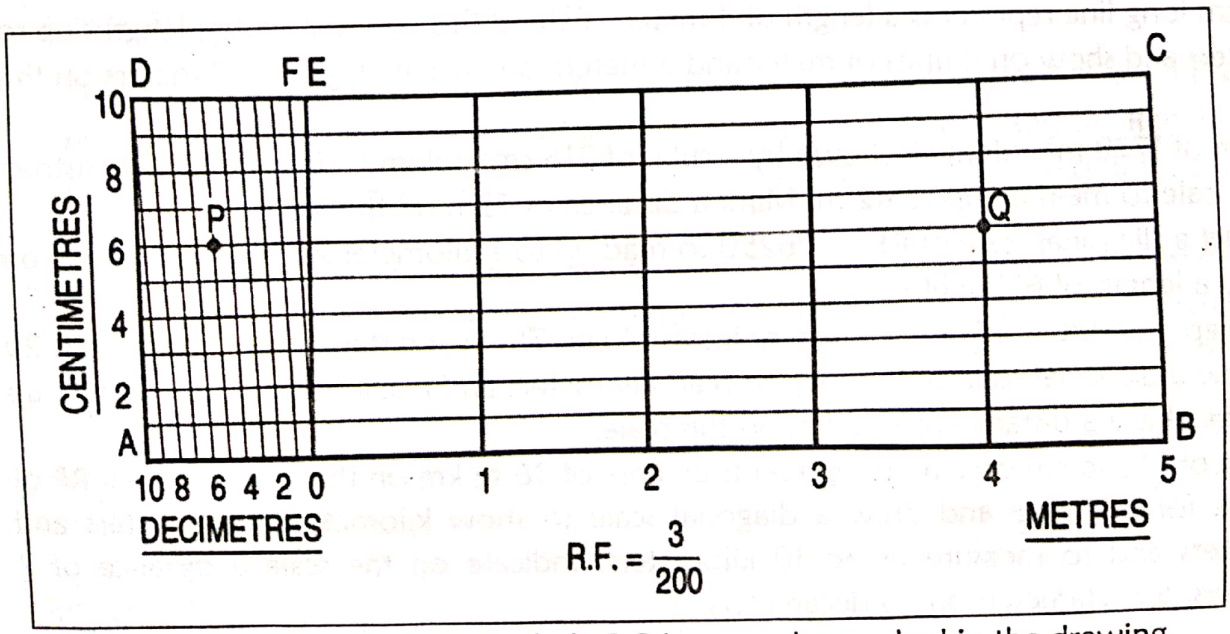
The plain scale is to be drawn as shown in the figure below:



2. Construct a plain scale of 1: 4 to show centimeters and decimeters and long enough to measure up to 5 decimeters. Show the length of 3.7 dm and 2.4 dm on it.

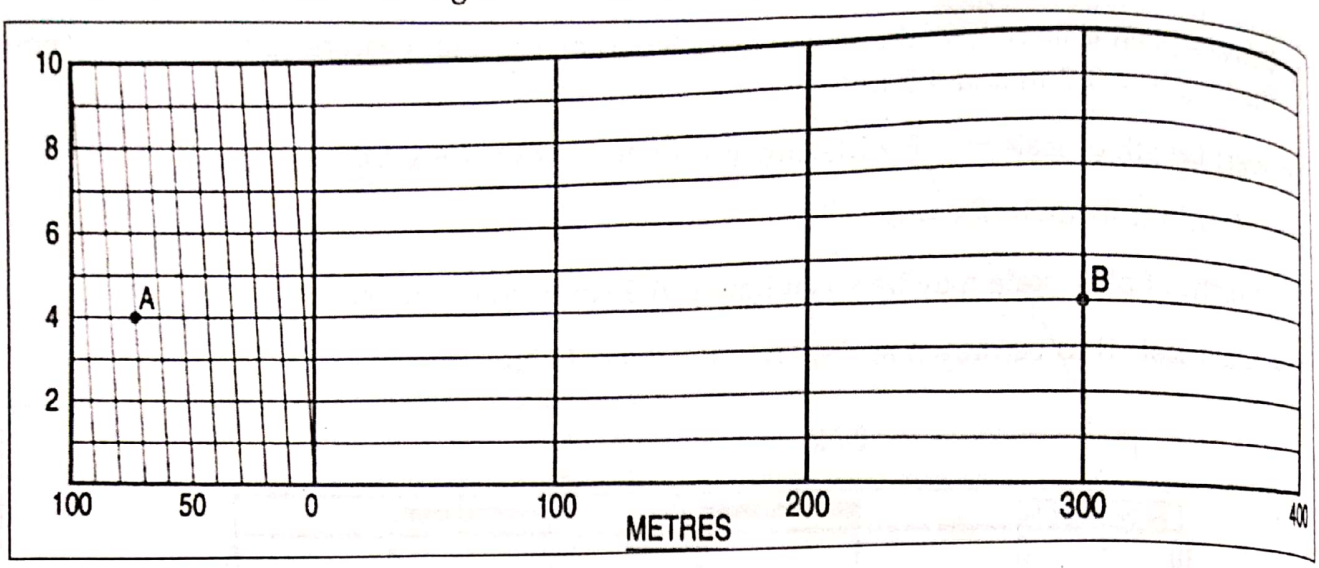


3. Construct a diagonal scale of 3: 200, showing meters, decimeters and centimeters and to measure up to 6 meters. Show length of 4.56 m and 2.34 m on it.

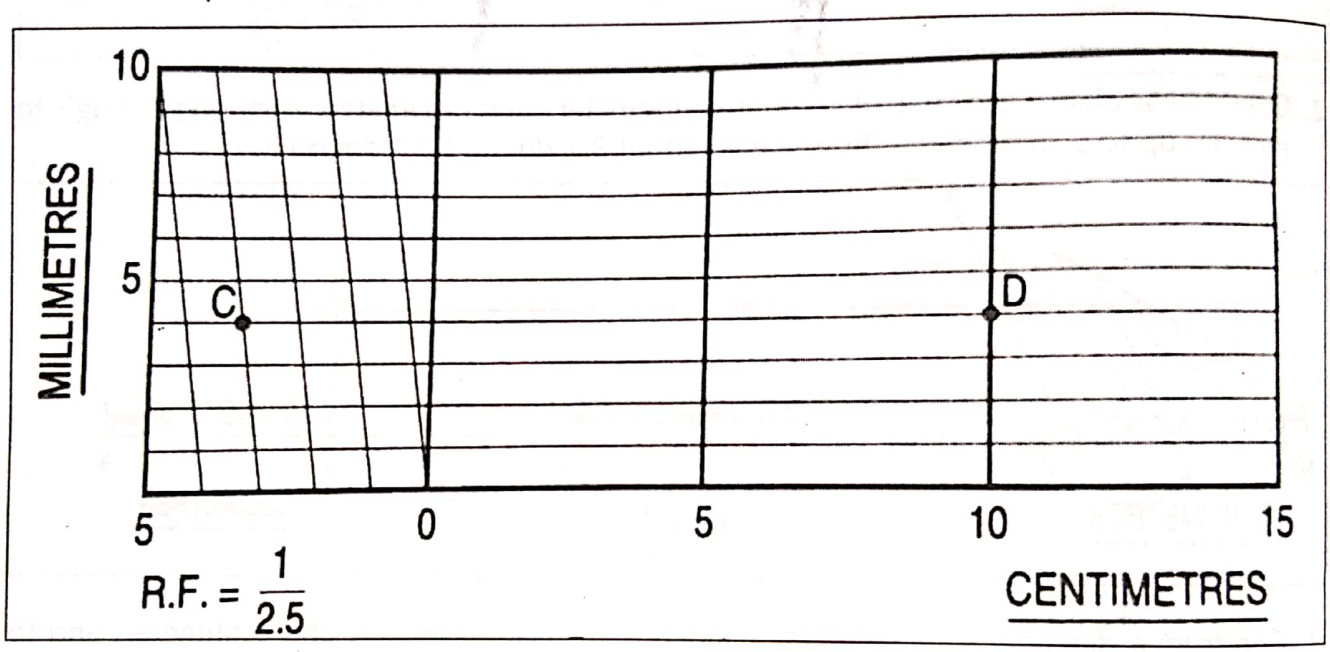


PQ = 4.46 m. Similarly 2.34 m may be marked in the drawing.

Construct a diagonal scale of R.F = 1/4000 to show meters and long enough to measure up to 500 meters on it. Show a length of 374 m and 256 m on it.



4. Draw a diagonal scale of 1: 2.5, showing centimeters and millimeters and long enough to measure up to 20 centimeters. Show a length of 13.4 cm and 7.8 cm on it.



Assignment Problems:

1. A 3.2 cm long line represents a length of 4 meters. Extend this line to measure lengths up to 25 meters and show on it units of meter and 5 meters. Show the length of 17 meters on this line.
2. A room of 1728 m^3 volume is shown by a cube of 216 cm^3 volume. Find the RF & construct a plain scale to measure up to 42 m. Mark a distance of 22m on this scale.
3. Construct a diagonal scale of RF = 1/6250 to read up to 1 kilometer and to read meters on it. Show a length of 653 meters on it.
4. On a map, the distance between two points is 14 cm. The real distance between them is 20 km. Draw a diagonal scale of this map to read kilometers and hectameters & to measure up to 25 km. Show a distance of 17.6 km on this scale.
5. An area of 144 sq cm on a map represents an area of 36 sq km on the field. Find the RF of the scale for this map and draw a diagonal scale to show kilometers, hectameters and decameters and to measure up to 10 kilometers. Indicate on the scale a distance of 7 kilometers, 5 hectameters and 6 decameters.

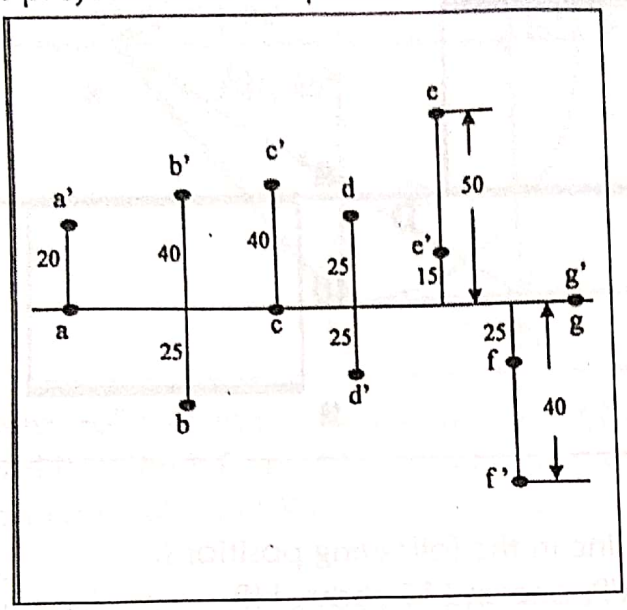
NOTE: SHEET NO 7 IS GIVEN IN INTRODUCTION TO AUTOCAD AT THE BEGINNING

SHEET NO- 8

PROJECTIONS OF POINTS

1. Draw the projections of the following points on the same ground line, keeping the projectors 40 mm apart.
   A is in the HP, 20 mm behind VP;
   B is 40 mm above HP, 25 mm in front of VP.
   C is in the VP, 40 mm above HP.
   D is 25 mm below HP, 25 mm behind VP.
   E is 15 mm above HP, 50 mm behind VP;
   F is 40 mm below HP, 25 mm in front of VP;
   G is in both HP & VP.

Answer: The projections of the points are drawn as shown in the figure below:



2. A point P is 50 mm away from both the reference planes. Draw its projections in all possible positions.

3. A point P is 15 mm above HP and 20 mm in front of VP. Another point Q is 40 mm below HP and 25 mm behind VP. The distance between their projectors is 90 mm. Draw lines joining their (i) top views. (ii) front views

Assignment problems:

1. Two points A and B are in the HP. The point A is 30 mm in front of the VP while B is behind the VP. The distance between their projectors is 75 mm and the line joining their top views makes an angle of 45^0 with the x-y line. Find the distance of B from the VP.

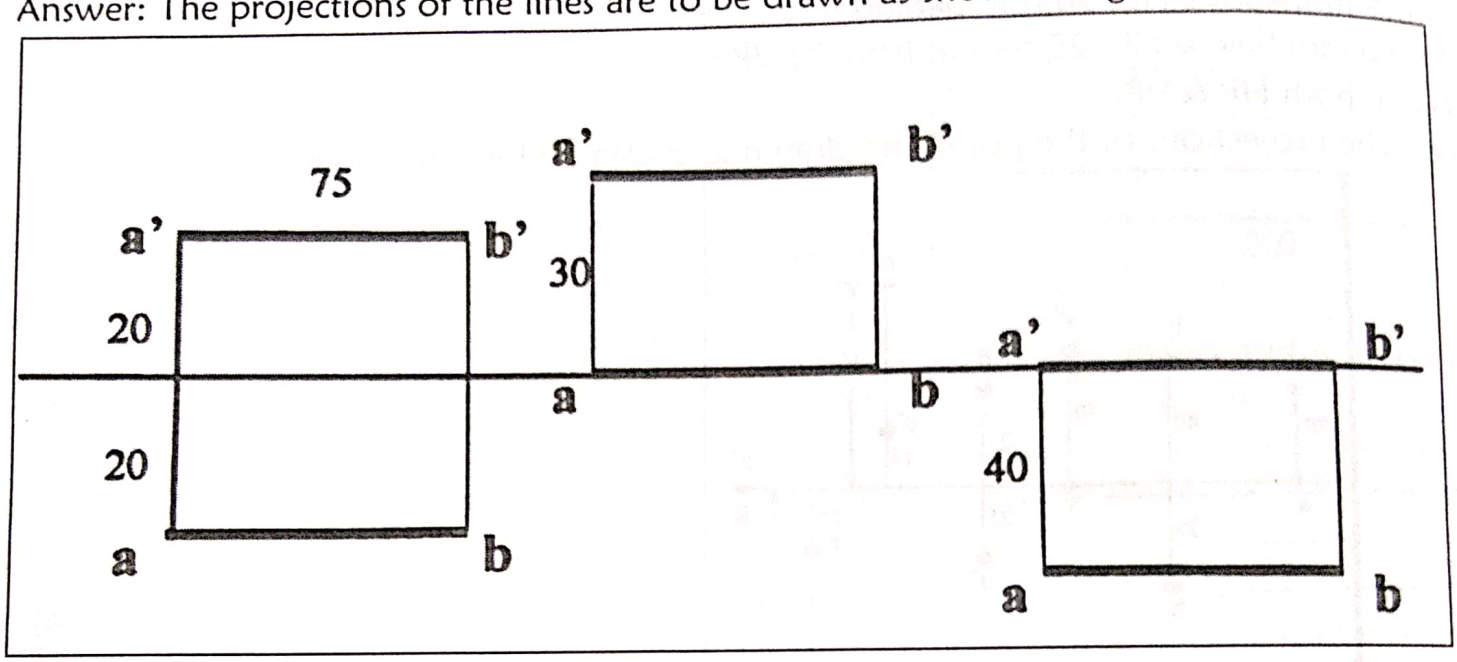
2. A point 30 mm above x-y line is the plan-view of two points P and Q. The elevation of P is 45 mm above the HP while that of Q is 35 mm below the HP. Draw the projections of the points and states their positions with reference to the principal planes and the quadrants in which they lie.

SHEET NO- 9

PROJECTIONS OF STRAIGHT LINES-I

1. Draw the projections of a 75 mm long line in the following positions:
   (i) Parallel to both HP and VP and 20 mm away from each;
   (ii)Parallel to HP, 30 mm above it &in VP;
   (iii) Parallel to & 40 in front of VP and in HP.

Answer: The projections of the lines are to be drawn as shown in figure below:



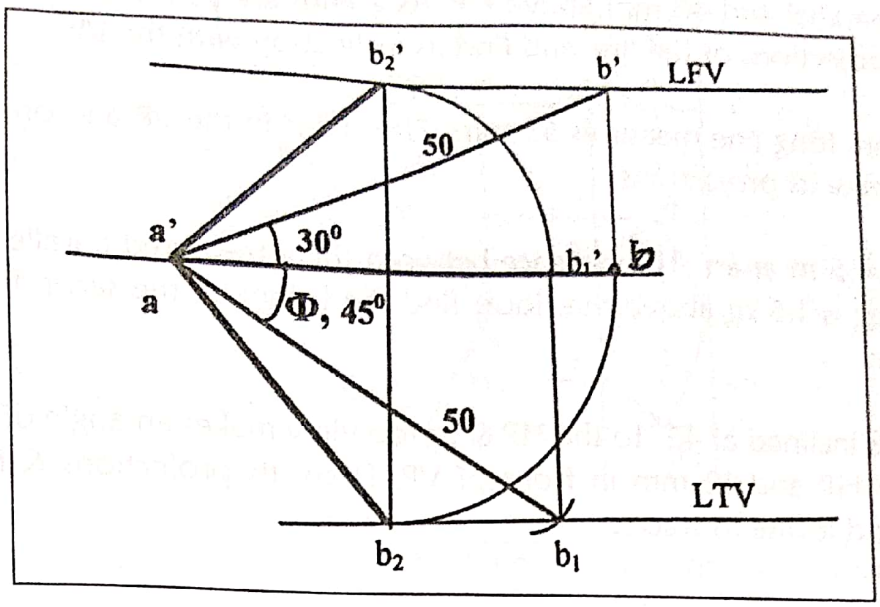
2. Draw the projections of a 75 mm long line in the following positions:
   (i) Perpendicular to HP, 20 In front of VP, one end 15 above HP.
   (ii) Perpendicular to VP; 25 above HP, one end in VP.
   (iii) Perpendicular to HP; in the VP and one end in HP.

3. Draw the projections of a 75 mm long line in the following positions:
   (i) Inclined at 45^0 to VP, in the HP and one end in VP.
   (ii) Inclined at 30^0 to HP, one end 20 above HP; parallel to and 30 in front of VP;
   (iii) Inclined at 60^0 to VP, one end 25 in front of VP; parallel and 15 above HP;
   Locate the traces for these lines.

SHEET NO- 10
PROJECTIONS OF STRAIGHT LINES-II

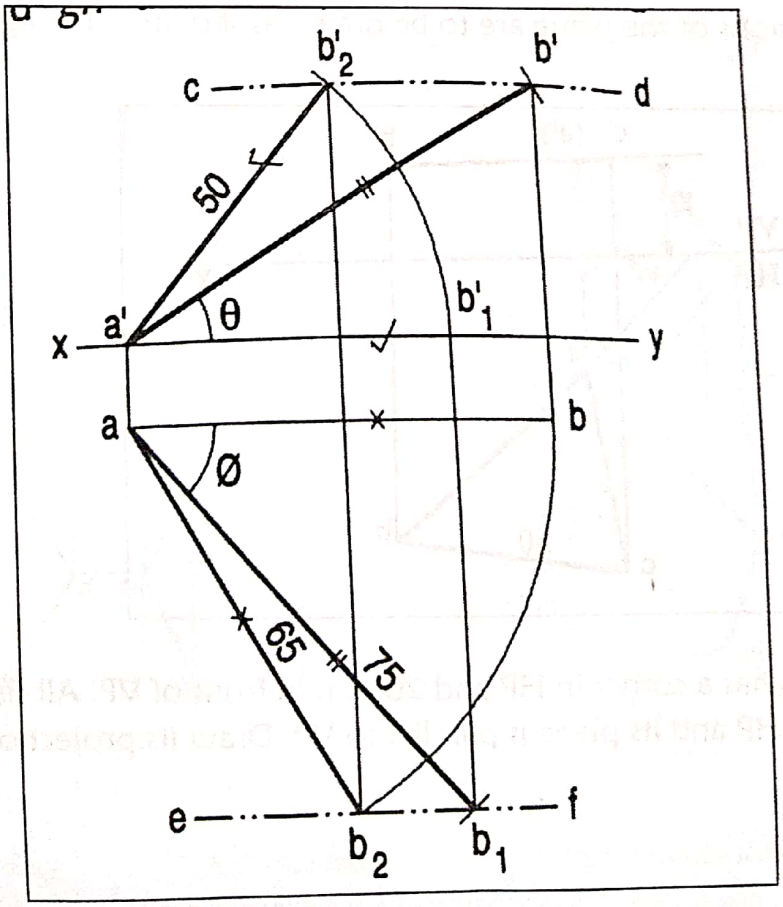
1. A line AB 50 mm long is inclined at 30° to the HP & 45° to VP. Its end A is in both HP & VP. Draw its projections and find its inclinations α & β and locate its traces.

Answer: The projections of the lines are to be drawn as shown in figure below:



2. The top view of a 75 mm long line measures 65 mm and its front view measures 50 mm. Its one end is in the HP and 12 mm in front of VP. Draw its projections and find its inclination with HP and VP and locate its traces.

Answer: The projections of the lines are to be drawn as shown in figure below:



3. A line AB 65 mm long has its end A 20 mm above HP and 25 mm in front of VP. The end B is 40 mm above HP and 65 mm in front of the VP. Draw its projections and find its inclination with the HP &VP and locate its traces.

Assignment problems:

1. A 100 mm long line is parallel and 40 mm above HP. Its 2 ends are 25mm and 50 mm in front of VP. Draw the projections of the line and find its inclination with the VP.

2. The top view of a 75 mm long line measures 55 mm. The line is in the VP and one end is 25mm above the HP. Draw its projections.

3. Two pegs on a wall are 4.5 m apart. The distance between them measured parallel to the floor is 3.6 m. If one peg is 1.5 m above the floor, find the height of the second and its inclination with the floor.

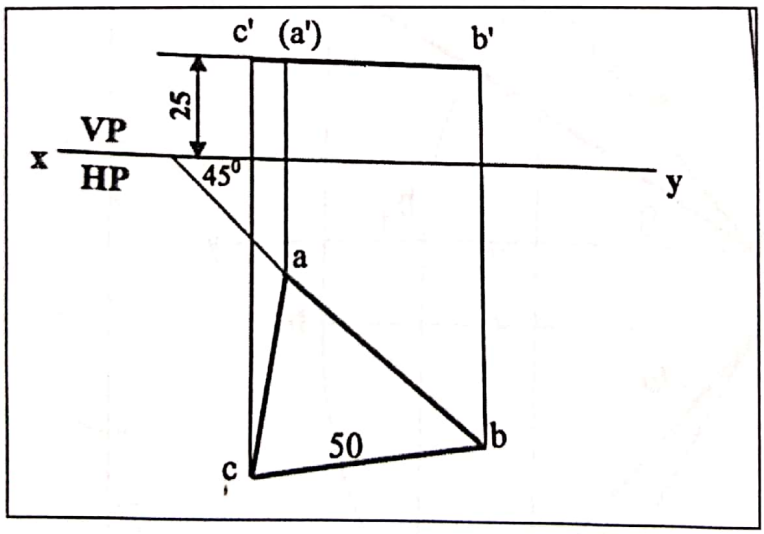
4. A line AB, 90 mm long is inclined at 45^0 to the HP & its top view makes an angle of 60^0 to the VP. The end A is in HP and 12 mm in front of VP. Draw its projections & find its inclination with the VP and locate its traces.

SHEET NO- 11

PROJECTIONS OF PLANES-I

1. An equilateral triangle of 50 mm sides has its plane parallel to HP and 25 mm above x-y. Draw its projections if one of its sides is inclined at 45^0 to the VP.

Answer: The projections of the plane are to be drawn as shown in the figure below:

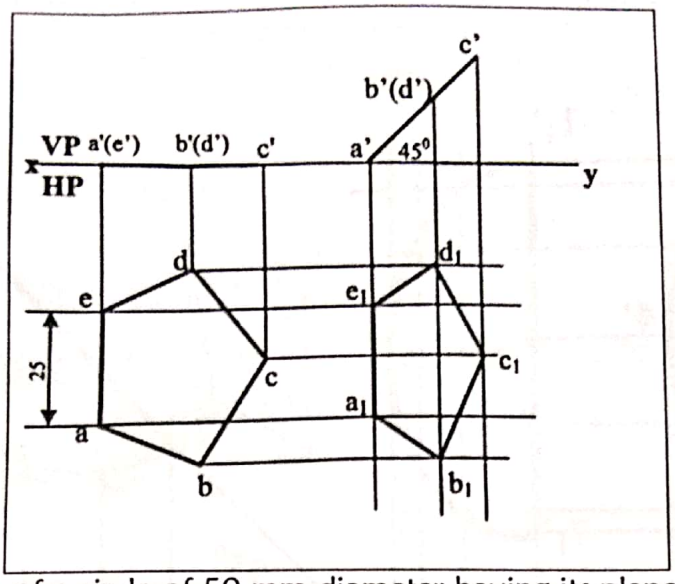


2. A square of 40 mm has a corner in HP and 20 mm in front of VP. All sides of the square are equally inclined to HP and its plane is parallel to VP. Draw its projections

SHEET NO- 12
PROJECTIONS OF PLANES-II

1. A regular pentagon of 25 mm sides has a side on the ground. Its plane is inclined at 45° to HP & perpendicular to VP. Draw its projections.

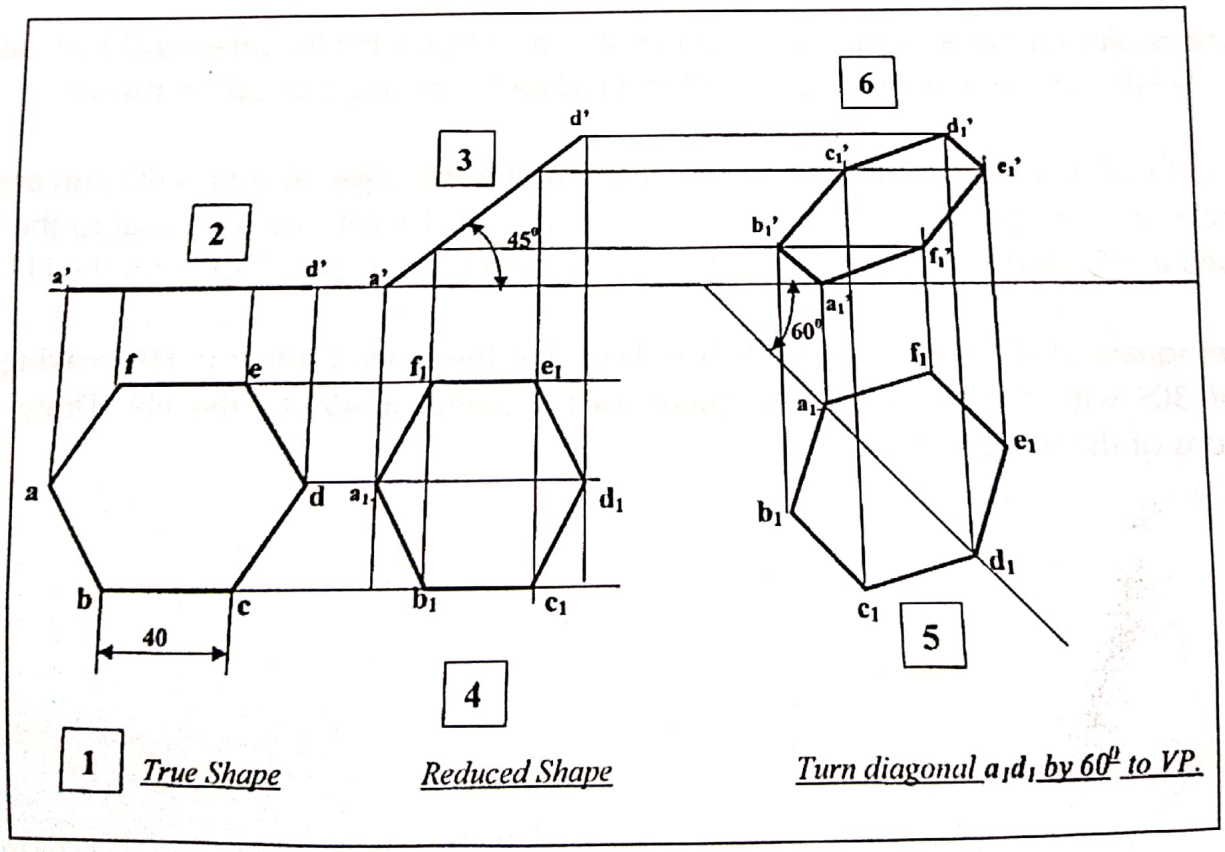
Answer: The projections of the plane are to be drawn as shown in the figure below:



2. Draw the projections of a circle of 50 mm diameter having its plane vertical and inclined at 30° to VP. Its centre is 30 mm above HP and 20 mm in front of VP.

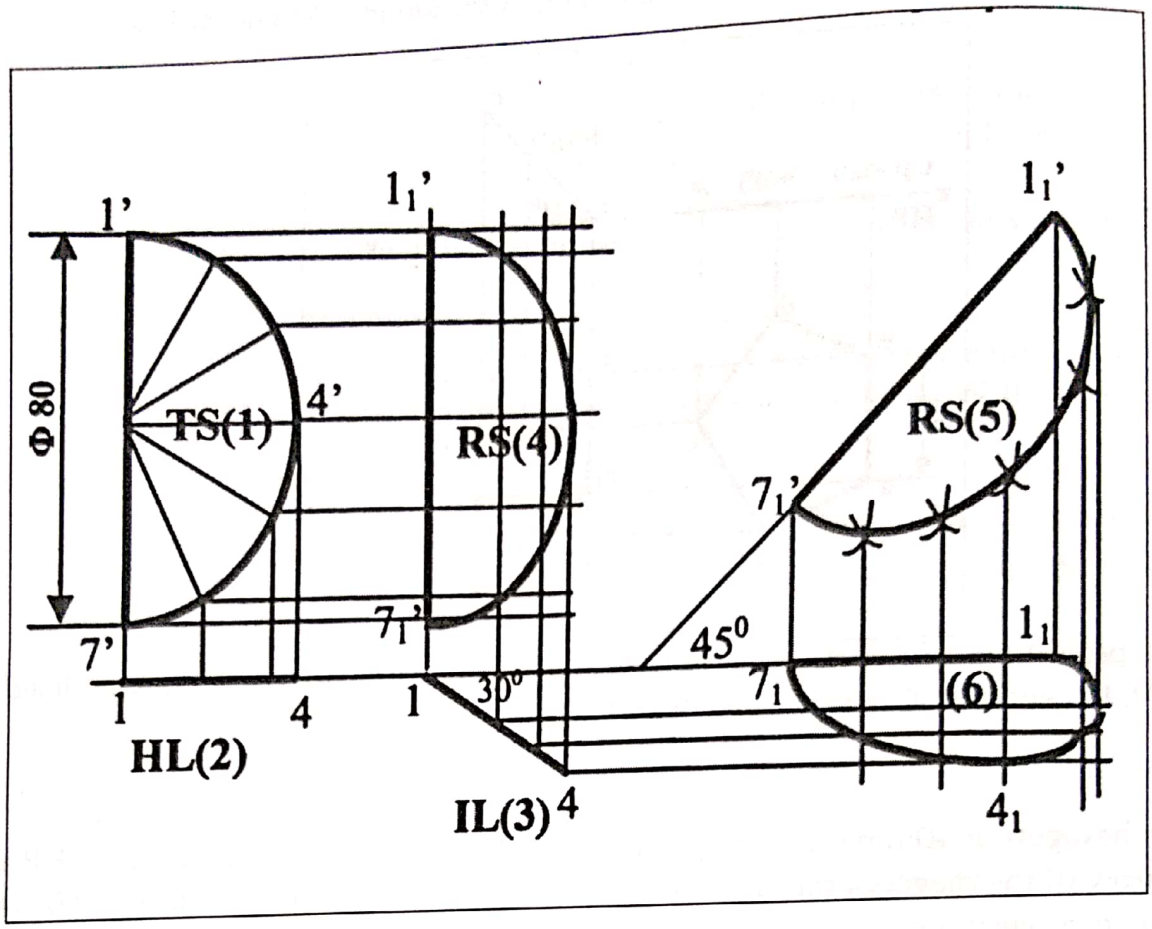
3. A regular hexagon of 40mm sides has a corner on HP. Its surface is inclined at 45° to HP and the top view of the diagonal through the corner which is in HP makes an angle of 60° with VP. Draw its projections.

Answer: The projections of the plane are to be drawn as shown in the figure below:



4. A semi circular plate of 80 mm diameter has its straight edge in the VP and inclined at 45° to HP. The surface of the plate makes an angle of 30° to VP. Draw its projections.

Answer: The projections of the plane are to be drawn as shown in the figure below:



Assignment problems:

1. Draw the projections of a regular pentagon of 40 mm side, having its surface inclined at 30° to the HP and a side parallel to the HP and inclined at an angle of 60° to the VP.

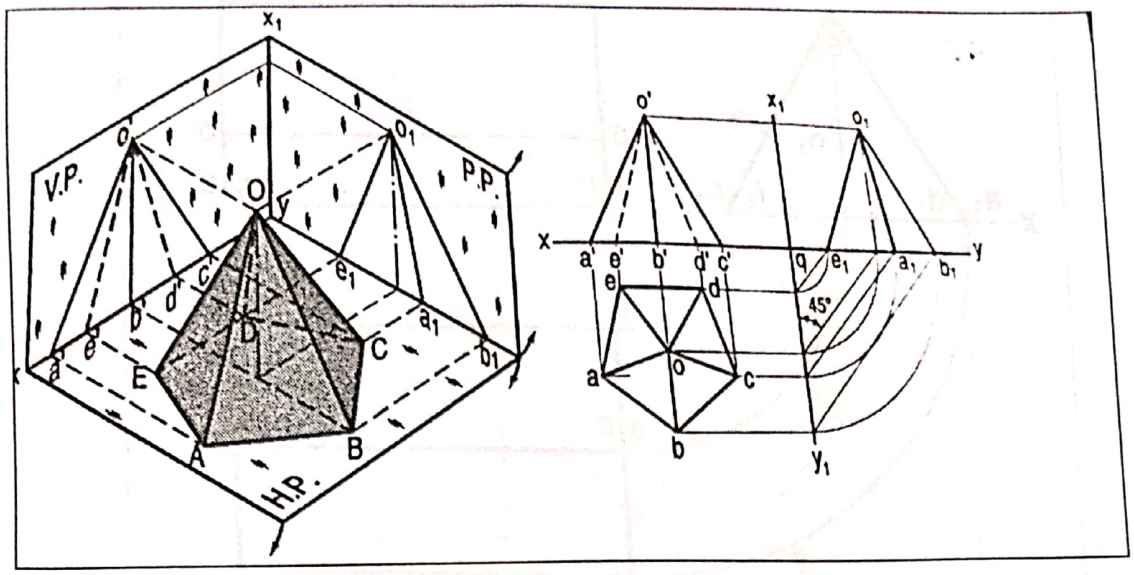
2. A composite plate of negligible thickness is made up of a rectangle 60 mm X 40 mm and a semi circle on its longer side. Draw its projections when the longer side is parallel to the HP & inclined at 45° to the VP, the surface of the plate making an angle of 30° with the HP.

3. A 60° set-square of 125 mm longest side is so kept that the longest side is in HP, making an angle of 30° with the VP & the set-square itself inclined at 45° to the HP. Draw the projections of the set square.

SHEET NO- 13
PROJECTIONS OF SOLIDS-I

1. Draw the projections of a pentagonal pyramid, base 30 mm edge and axis 50 mm long, having its base on the HP and edge of the base parallel to the VP. Also draw its side view.

Answer: The projections of the solid are to be drawn as shown below:
ab=bc = ed = 30 mm; b'o'=50 mm



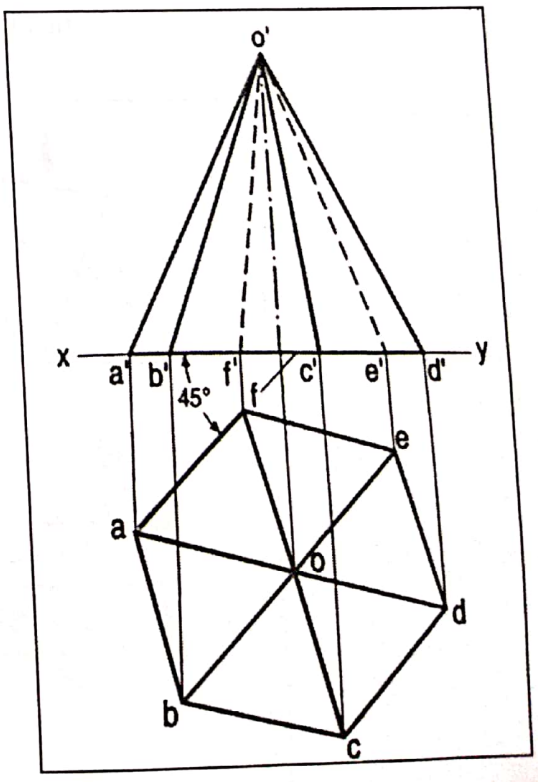
2. A cube of 50 mm long edges is resting on the HP with its vertical faces equally inclined to the VP. Draw its projections.

3. Draw the projections of a (i) Cylinder of base 40 mm diameter and axis 50 mm long ; (ii) Cone of base 40 mm diameter and axis 50 mm long; when they are resting on their respective bases on HP.

4. Draw the projections of a hexagonal pyramid of base 30 mm side and axis 60 mm long, having its base on the HP and one of the edges of the base inclined at 45° to the VP.

Answer: The projections of the solid are to be drawn as shown in the figure below:

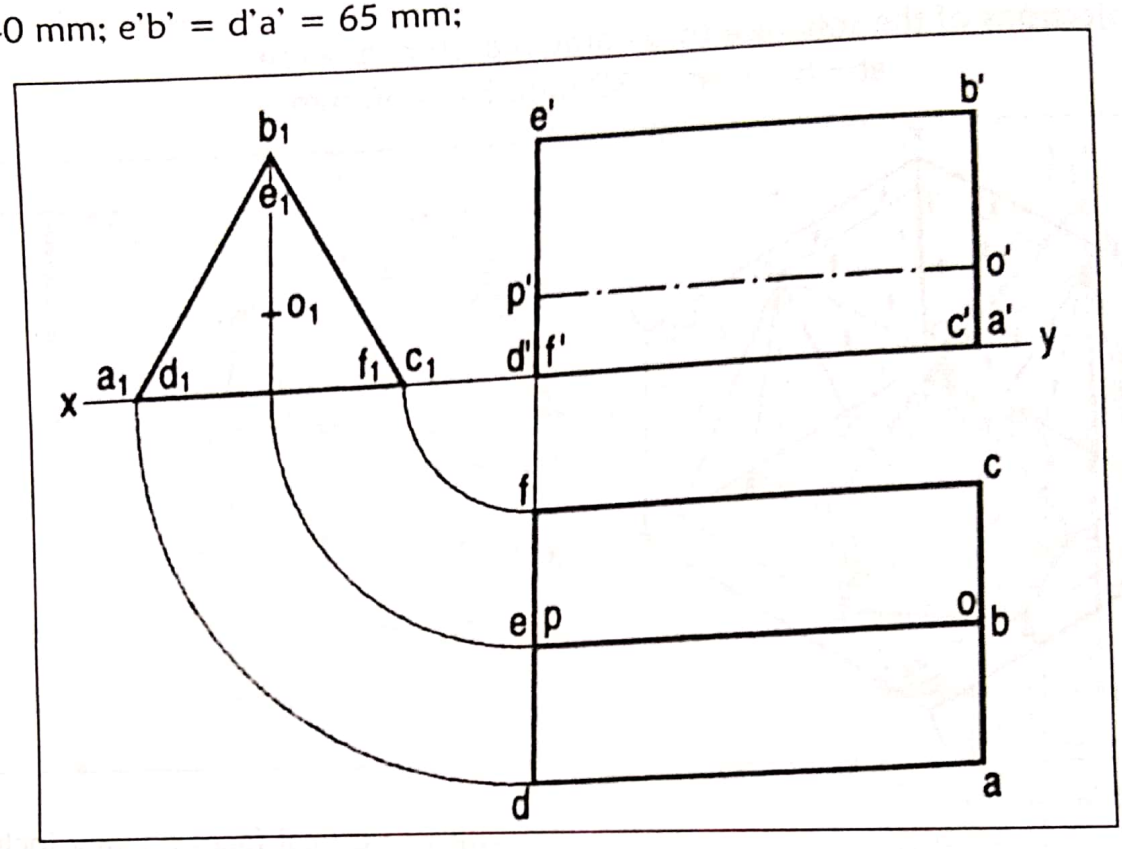
ab=bc=30mm; height of o' from xy line ($o'o_1'$) = 60 mm;



5. A triangular prism, base 40 mm side and height 65 mm is resting on the HP on one of its rectangular faces with the axis parallel to the VP. Draw its projections.

Answer: The projections of the solid are to be drawn as shown in the figure below:

$a_1c_1 = d_1f_1 = 40$ mm; e'b' = d'a' = 65 mm;



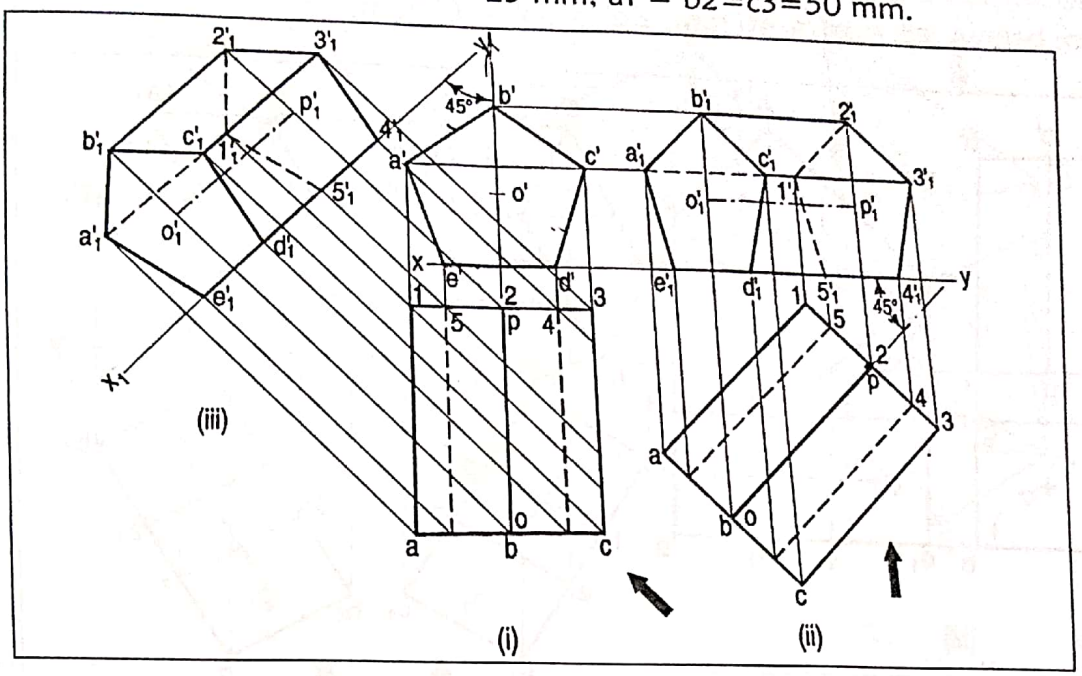
6. A hexagonal prism of base 25 mm sides and axis 50 mm long has one of its rectangular faces parallel to the HP. Its axis is perpendicular to the VP and 35 mm above the ground. Draw its projections when the nearer end is 20 mm in front of the VP.

SHEET NO- 14
PROJECTIONS OF SOLIDS-II

1. Draw the projections of a pentagonal prism of base 25 mm side and axis 50 mm long, resting on one of its rectangular faces on the HP with the axis inclined at 45° to the VP.

Answer: The projections of the solid are to be drawn as shown in the figure below:

a'b' = e'd' = 25 mm; a1 = b2=c3=50 mm.

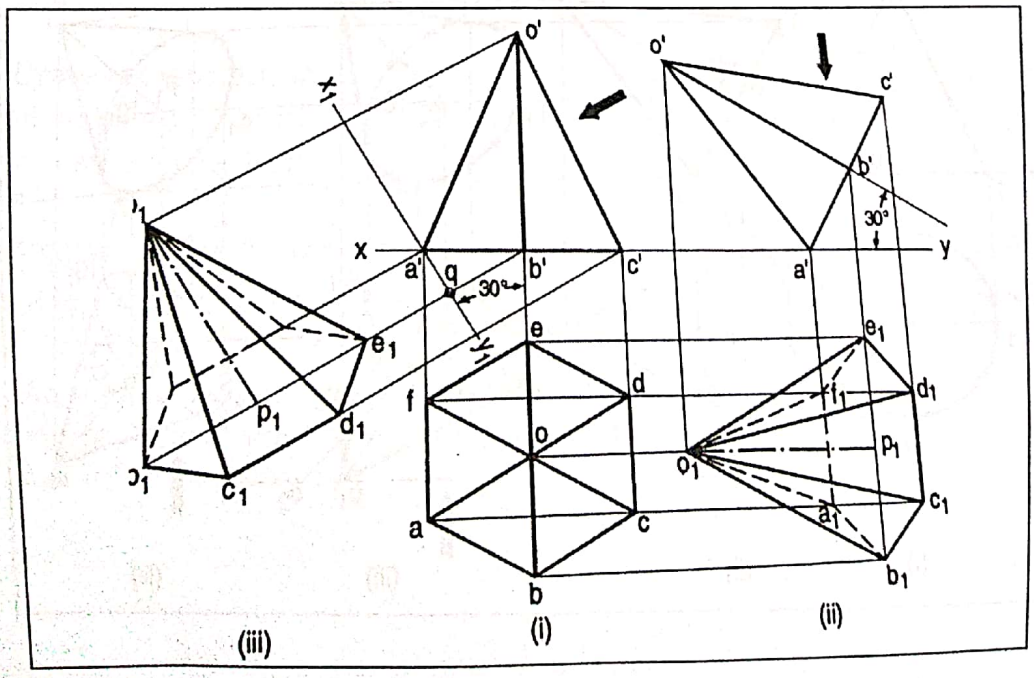


2. Draw the projections of a cylinder of base 75 mm diameter and axis 100 mm long, lying on the ground with its axis inclined at 30° to the VP and parallel to the ground.

3. A hexagonal pyramid of base 25 mm side and axis 50 mm long, has an edge of its base on the ground. Its axis is inclined at 30° to the ground and parallel to the VP. Draw its projections.

Answer: The projections of the solid are to be drawn as shown in the figure below:

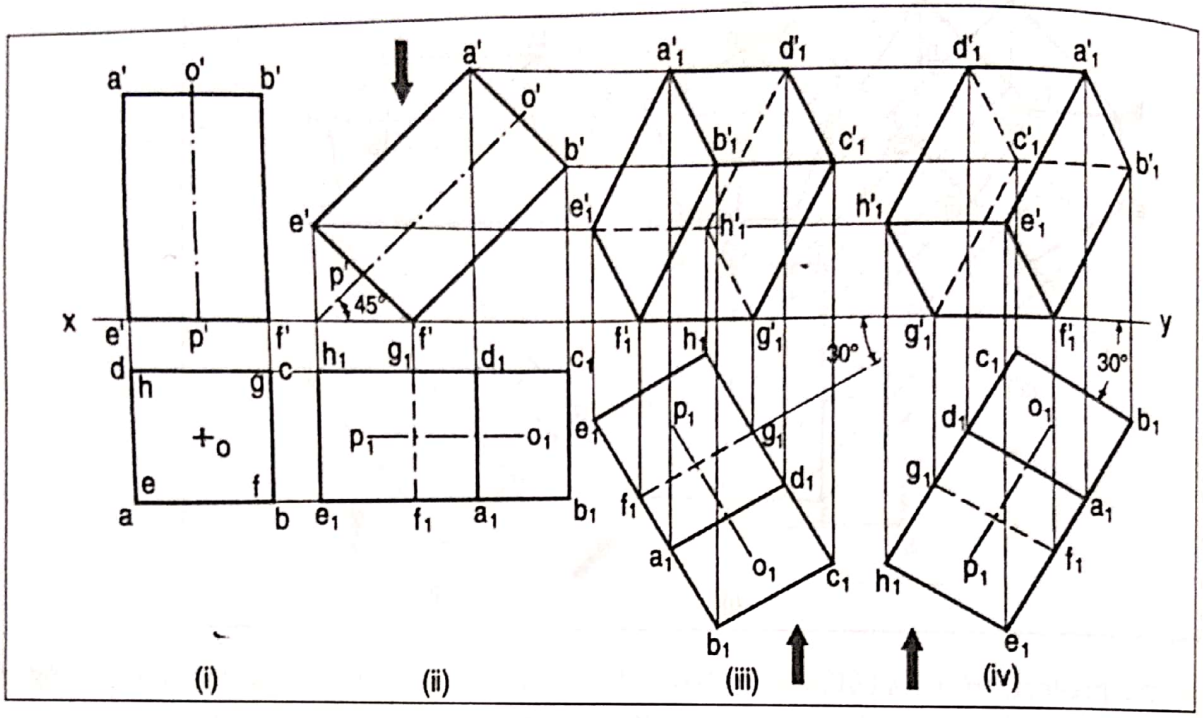
ab = bc = af = 25 mm; b'o' = 50 mm.



4. Draw the projections of a cone of base 75 mm diameter and axis 100 mm long, lying on the HP on one of its generators with the axis parallel to the VP.

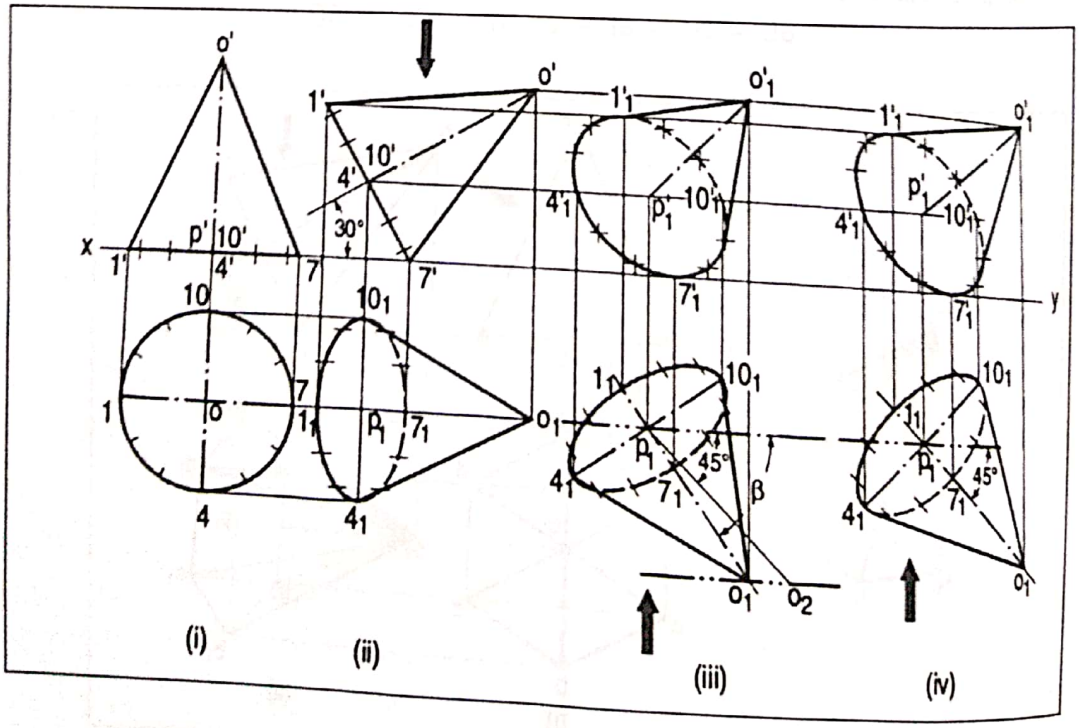
5. A square prism of base 40 mm side and height 65 mm long has its axis inclined at 45° to the HP and has an edge of its base, on the HP and inclined at 30° to the VP. Draw its projections.

Answer: The projections of the solid are to be drawn in three stages (i, ii & iii) or (i, ii, iv) as shown in the figure below: ab = bc = 40 mm; a'e' = b'f' = 65 mm;



6. Draw the projections of a cone of base 45 mm diameter and axis 50 mm long, when it is resting on the ground on a point on its base circle with its axis making an angle of 30° with the HP and (a) the top view of the axis making 45° with the VP; (b) the axis makes 45° to VP.

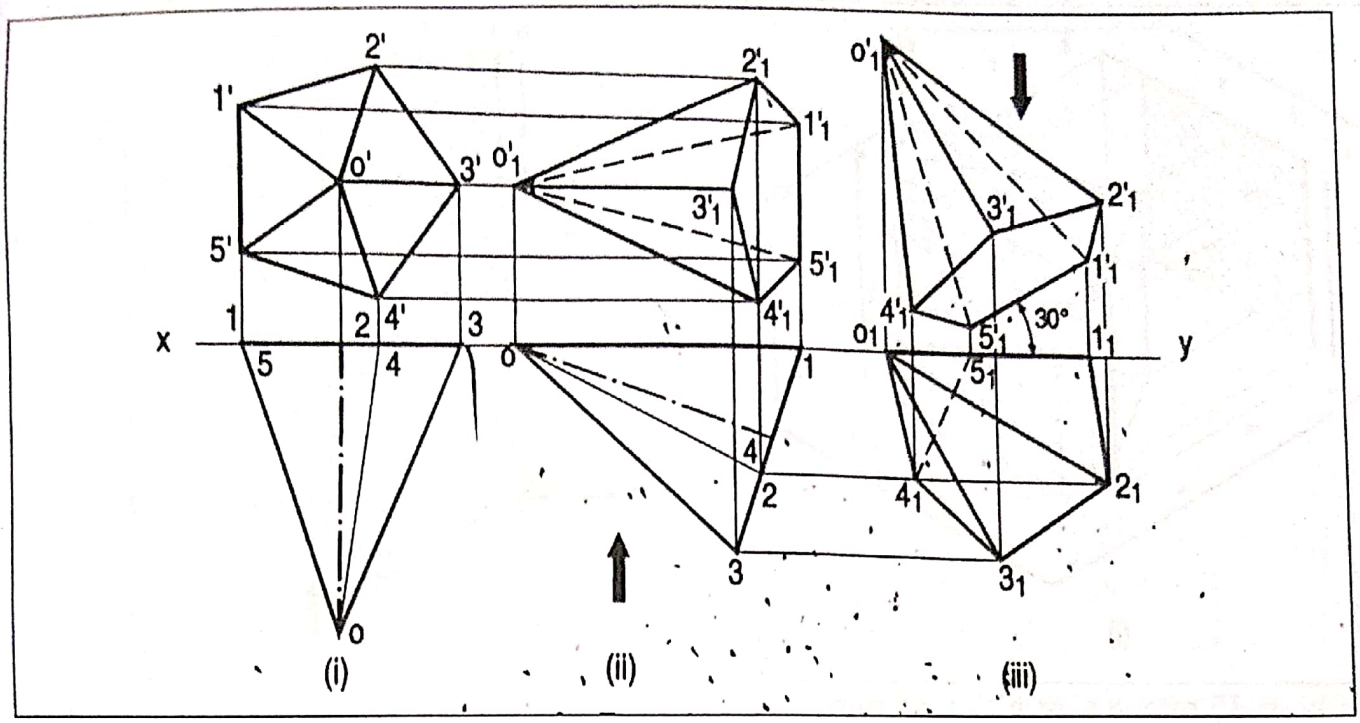
Answer: The projections of the solid are to be drawn in three stages (i), (ii), (iii) for (b) and (i), (ii) , (iv) for (a) as shown in the figure below: o1 = 07 = 22.5 mm (radius); 4'o' = 50 mm (axis).



7. A pentagonal pyramid, base 25 mm side and axis 50 mm long has one of its triangular faces in the VP and the edge of the base contained by that face making an angle of 30° with the HP. Draw its projections.

Answer: The projections of the solid are to be drawn in three stages as shown in the figure below:

1'5' = 25 mm; distance of o from xy (axis) = 50 mm.



Assignment problems:

1. Draw the projections of a square prism, base 40 mm long sides and axis 65 mm long when a side of the base is inclined at 30° to the VP and the axis is 50 mm in front of the VP.

2. Draw the projections of a cylinder of base 50 mm diameter and axis 65 mm long when its axis is perpendicular to the VP and 40 mm above the HP and one end of the cylinder is 20 mm in front of the VP.

3. Draw the projections of a square pyramid of base 40 mm sides and axis 65 mm long when all edges of the base are equally inclined to HP and the axis is parallel to and 50 mm away from both the HP and VP.

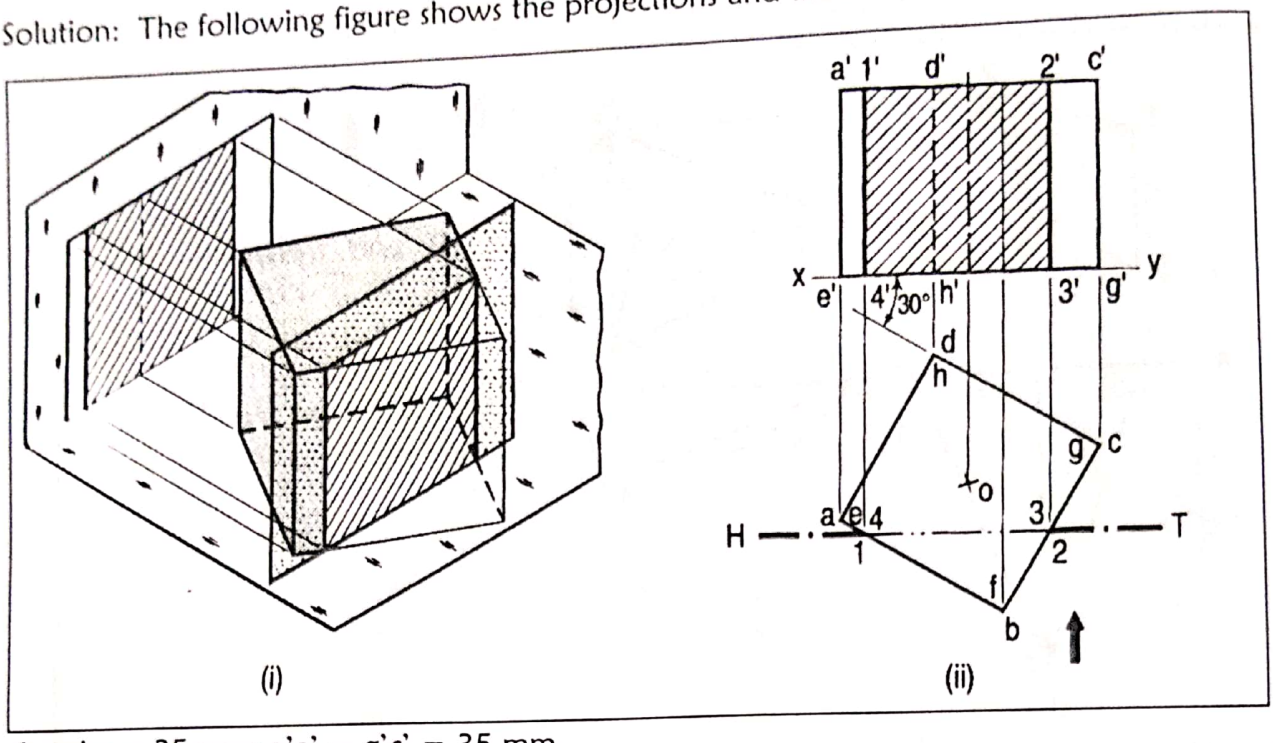
4. A cone of base 40 mm diameter & axis 60 mm long is resting on one of its generators on the HP & the axis makes an angle of 30^0 with the VP. Draw its projections.

5. An equilateral triangular pyramid of base side 40 mm and axis 65 mm rests in HP on one of its base sides. Draw the projections if the axis makes 25° and 40° with the HP and VP respectively.

SHEET NO- 15
SECTIONS OF SOLIDS-I

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

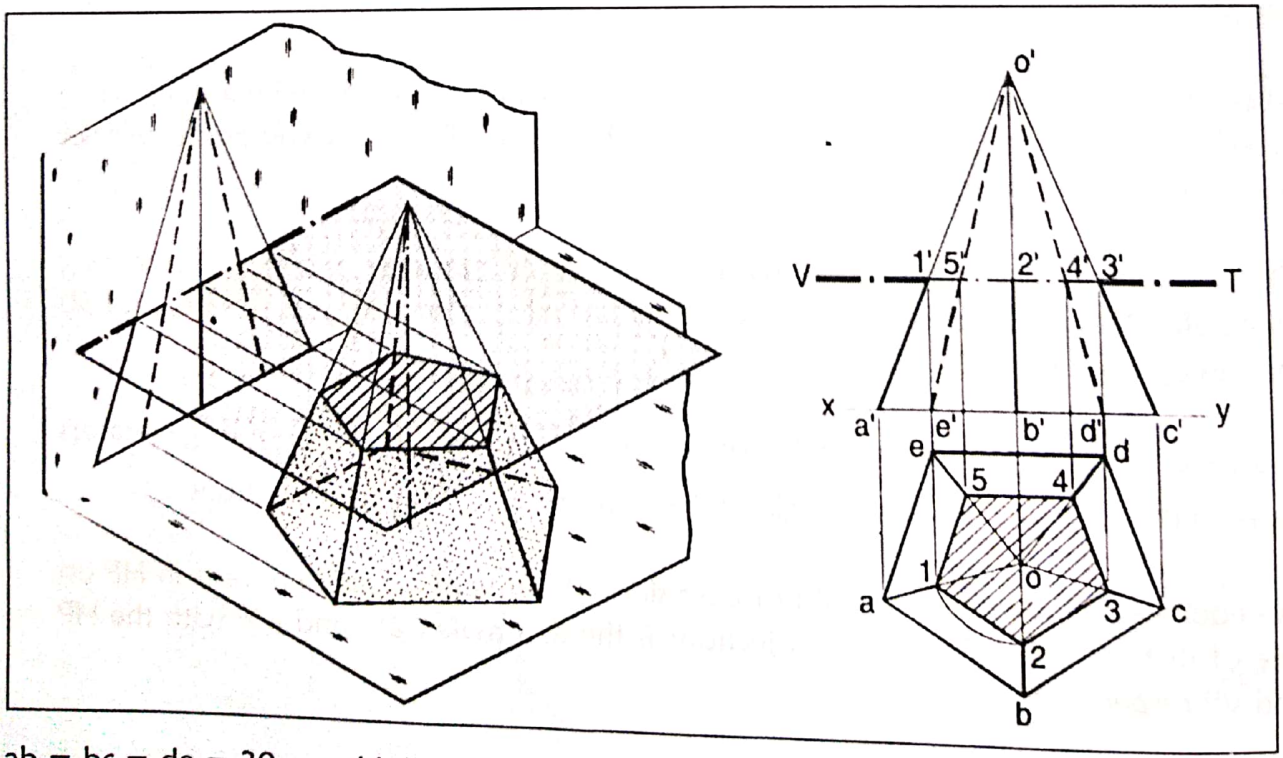
Solution: The following figure shows the projections and the sectional front view



ab = bc = 35 mm; a'e' = g'c' = 35 mm.

2: A pentagonal pyramid of base 30 mm side and axis 65 mm long has its base horizontal and an edge of the base parallel to the VP. A horizontal section plane cuts it at a distance of 25 mm above the base. Draw its front view and sectional top view.

Answer: The following figure shows the projections, the sectional view and its true shape.

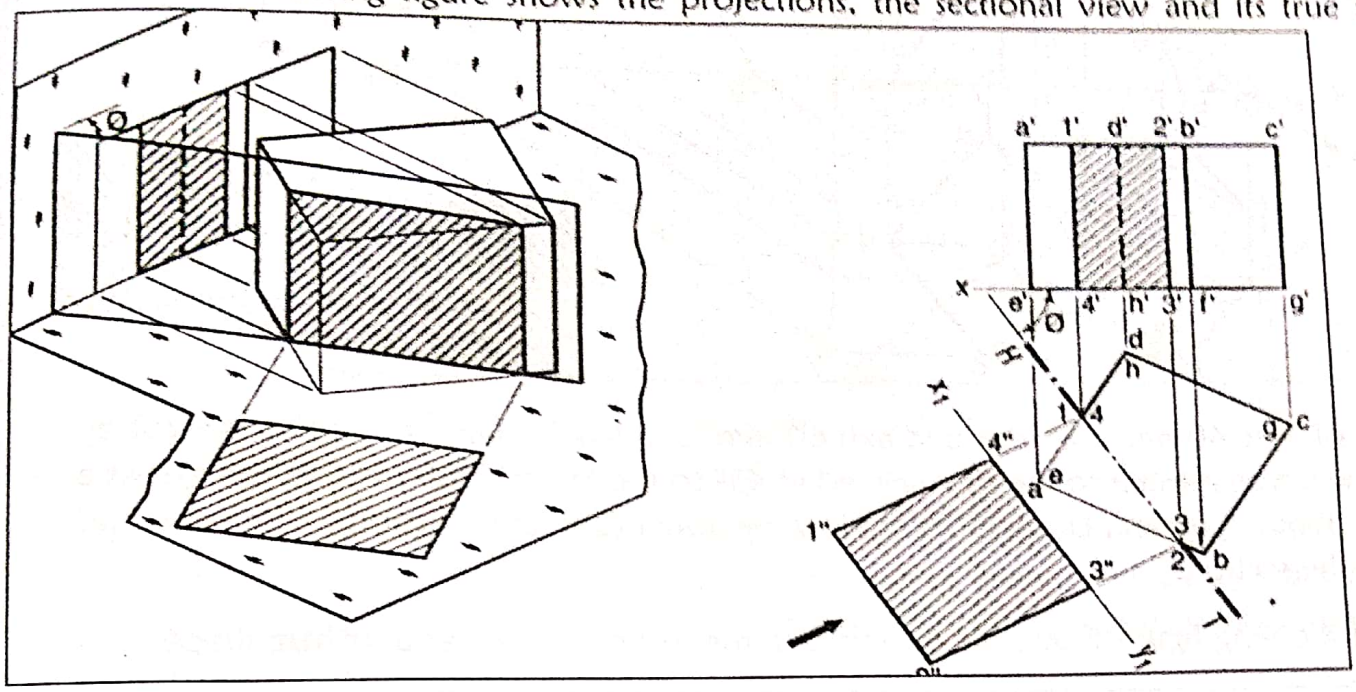


ab = bc = de = 30 mm; b'o' = 65 mm; Distance of VT from xy line = 25 mm

SHEET NO- 16
SECTIONS OF SOLIDS-II

1: A cube of 35 mm long edges is resting on the HP on one of its faces with a vertical face inclined at 30° to the VP. It is cut by a section plane inclined at 60° to the VP and perpendicular to the HP so that the face which makes an angle of 60° with the VP is cut into two equal halves. Draw the sectional front view, top view and true shape of the section.

Answer: The following figure shows the projections, the sectional view and its true shape.

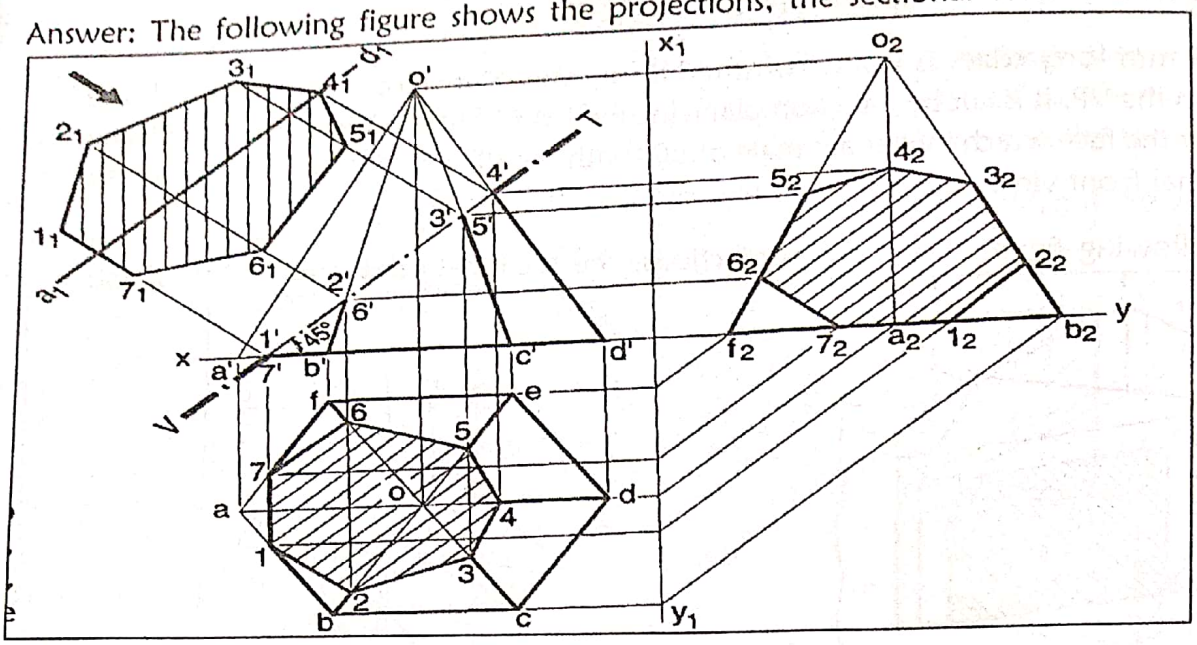


2: A cube of 35 mm long edges is resting on the HP on one of its faces with a vertical face inclined at 30° to the VP. It is cut by a section plane inclined at 45° to the HP and perpendicular to the VP and passing through the top end of the axis. Draw the front view, sectional top view and true shape of the section.

3: A square pyramid of base 40 mm side and axis 65 mm long has its base on the HP and all edges of the base equally inclined to the VP. It is cut by a section plane perpendicular to the VP, inclined at 45° to the HP and bisecting the axis. Draw its front view, sectional top view, sectional side view and true shape of the section.

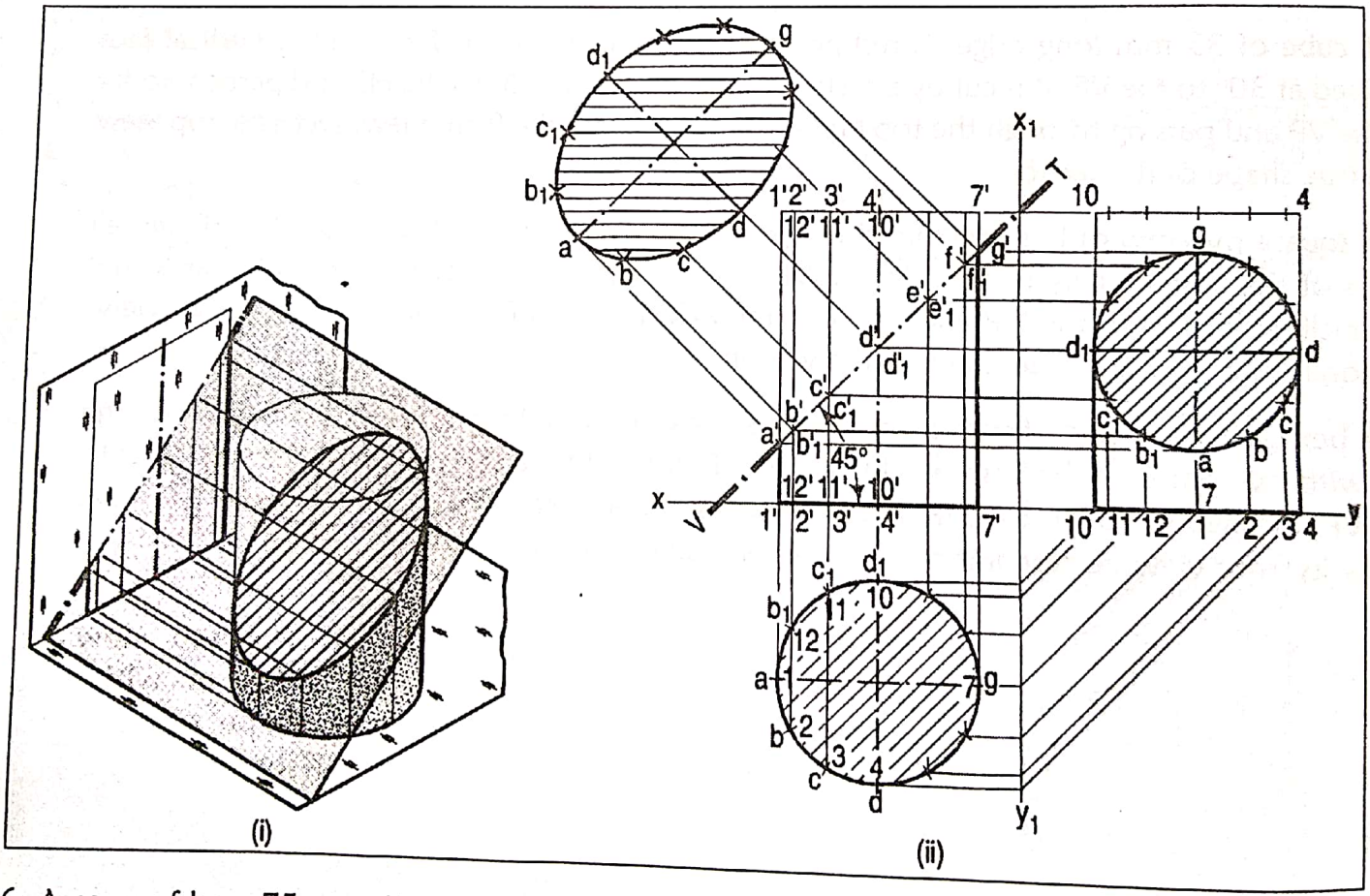
4: A hexagonal pyramid of base 30 mm side and axis 65 mm long is resting on its base on the HP with two edges of the base parallel to the VP. It is cut by a section plane perpendicular to the VP, inclined at 45° to the HP and intersecting the axis at a point 25 mm above the base. Draw its front view, sectional top view, sectional side view and true shape of the section.

Answer: The following figure shows the projections, the sectional view and its true shape.



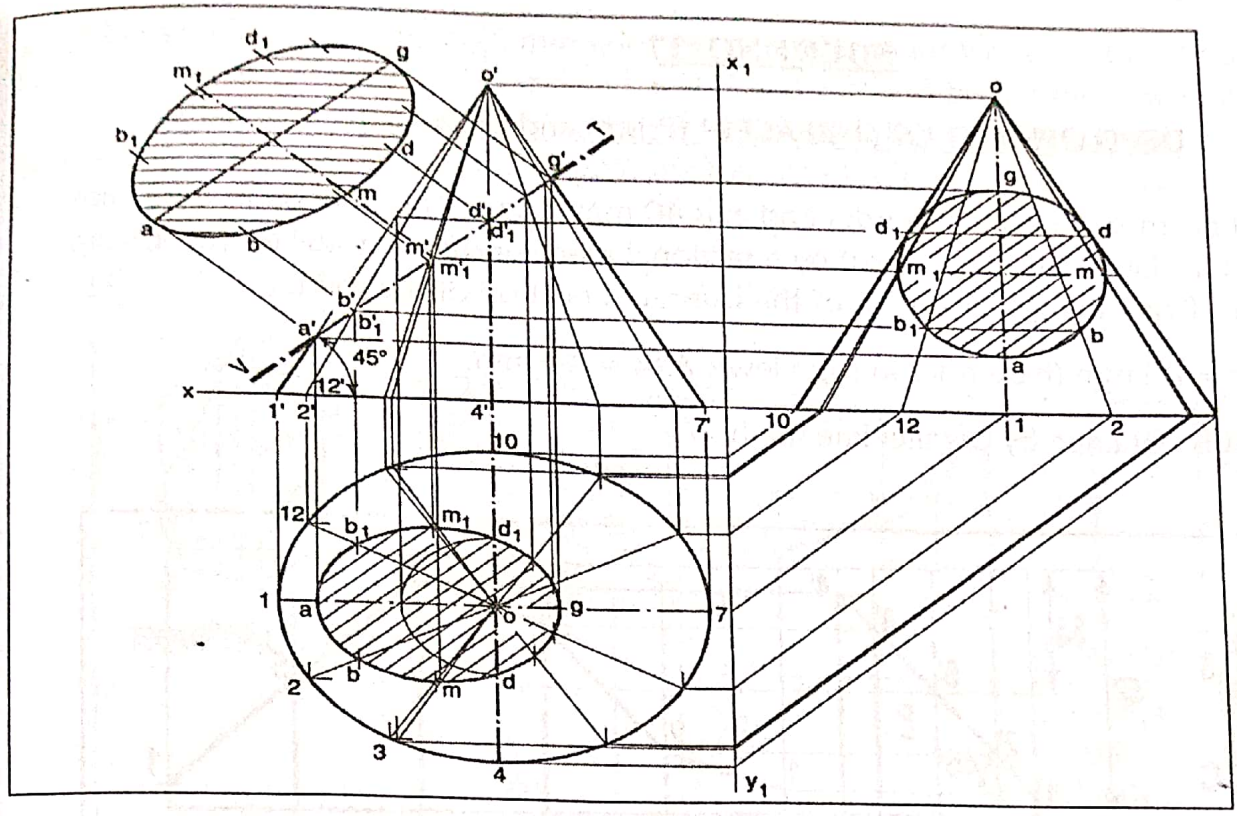
5: A cylinder of base 40 mm diameter and axis 60 mm long has its base on the HP. It is cut by a section plane perpendicular to the VP, inclined at 45° to the HP and intersecting the axis at a point 32 mm above the base. Draw its front view, sectional top view, sectional side view and true shape of the section.

Answer: The following figure shows the projections, the sectional view and its true shape.



6: A cone of base 75 mm diameter and axis 80 mm long is resting on its base on HP. It is cut by a section plane perpendicular to the VP, inclined at 45° to the HP and cutting the axis at a point 35 mm from the apex. Draw its front view, sectional top view, sectional side view and true shape of the section.

Answer: The following figure shows the projections, the sectional view and its true shape.



7: A cone of base 75 mm diameter and axis 80 mm long is resting on its base on HP. It is cut by a section plane perpendicular to the VP and parallel to and 12 mm away from one of its end generators. Draw its front view, sectional top view, sectional side view and true shape of the section.

Assignment problems:

1. A triangular prism, side of base 40 mm and length of axis 70mm, is lying on one of its rectangular faces in HP. Its axis is parallel to both HP and VP. It is cut by section plane parallel to and at a distance of 20 mm from the HP. Draw its front view and sectional top view.
2. A pentagonal pyramid of base 30 mm side and height 50 mm stands with its base on HP such that an edge of its base is parallel to VP. It is cut by a plane, normal to VP, makes 45° to the HP and passing through a point on the axis, 30 mm above the base. Draw its sectional top view, sectional side view and true shape of the section.
3. A cylinder of base 40 mm diameter & 60 mm height, having its axis vertical is cut by a plane perpendicular to VP and inclined at 450 to the HP, intersecting the axis 30 mm above the base. Draw the sectional side view, sectional top view and obtain the true shape of the section.
4. A cone of base 50 mm diameter & axis 80 mm long is lying on one of its generators with the axis parallel to the VP. A horizontal section plane bisects the axis of the solid. Draw the projections showing its sectional top view.

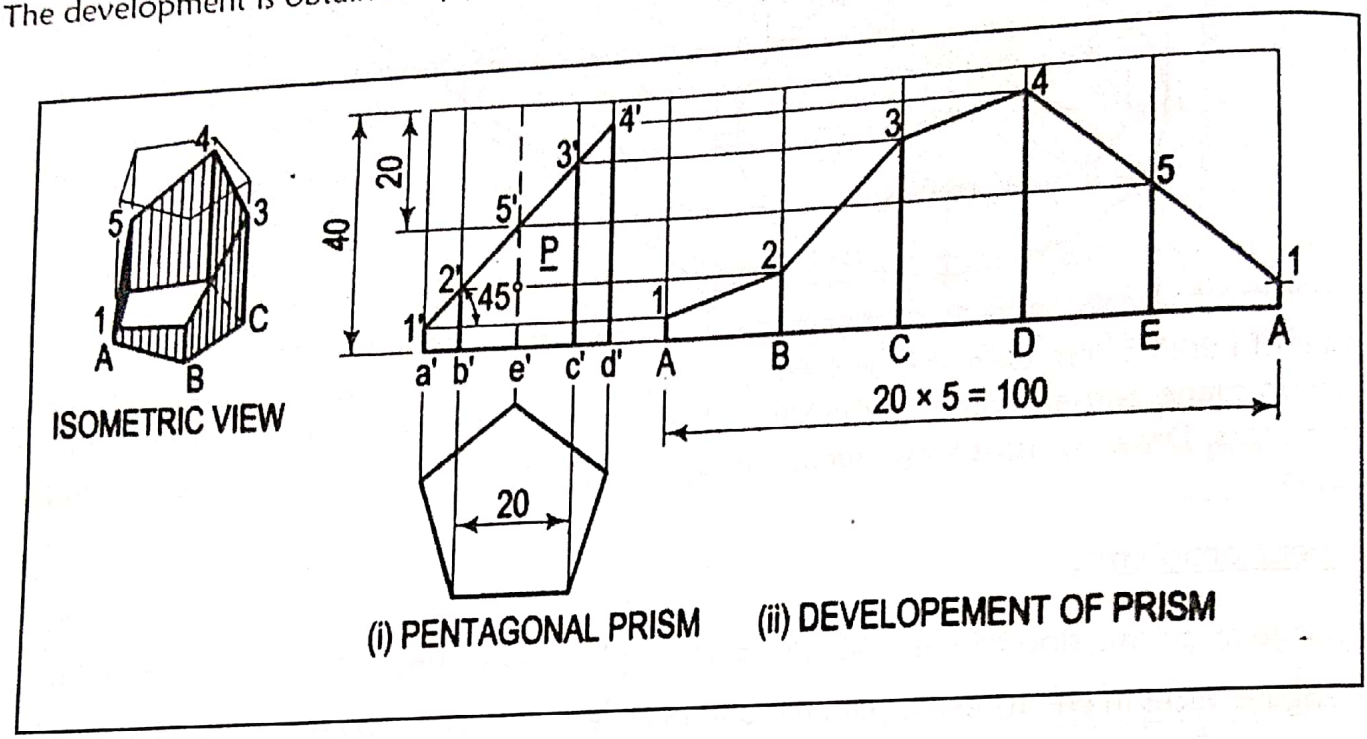
SHEET NO- 17

DEVELOPMENT OF SURFACES-I (Prisms and Cylinders)

1. A pentagonal prism of base 20 mm sides and axis 40 mm long rests on HP on its base with its axis perpendicular to the HP. It is cut by a sectional plane, inclined at 45⁰ to the HP and bisects the axis. Draw the development of the truncated portion of the solid.

Answer: ab = bc = 20 mm (base sides in top view); Axis = 40 mm;

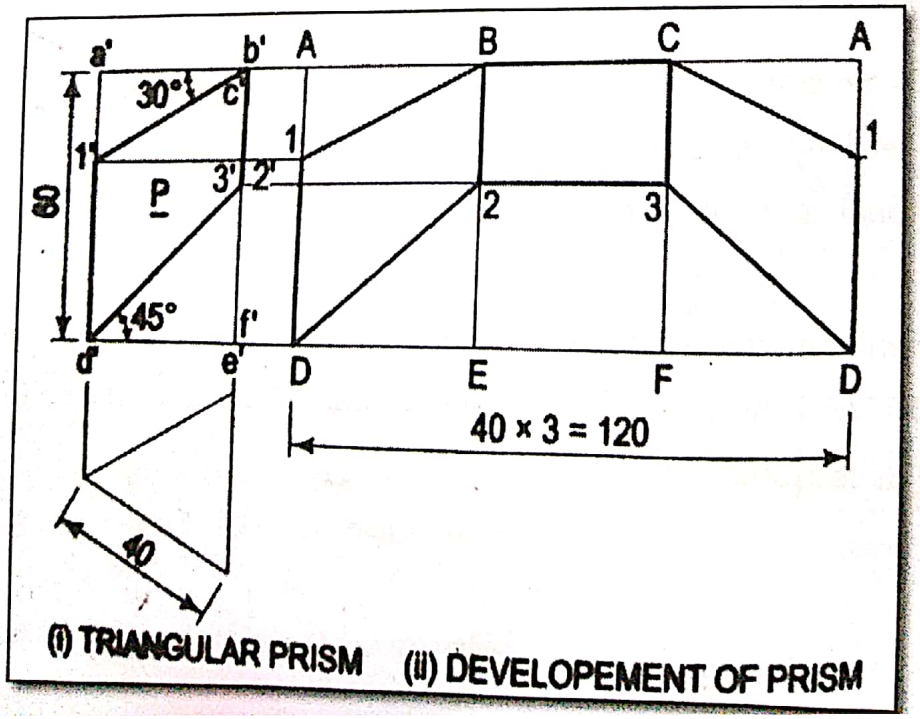
The development is obtained by parallel line method.



2. A triangular prism of base 40 mm sides and axis 60 mm long rests on HP on its base with an edge of base perpendicular to VP. It is cut by two section planes, one inclined at 30⁰ to the HP and other inclined at 45⁰ to the HP as shown in the figure below. Draw the development of the prism.

Answer: ab = bc = 40 mm (base sides in the top view); a'd' = b'e' =60 mm.

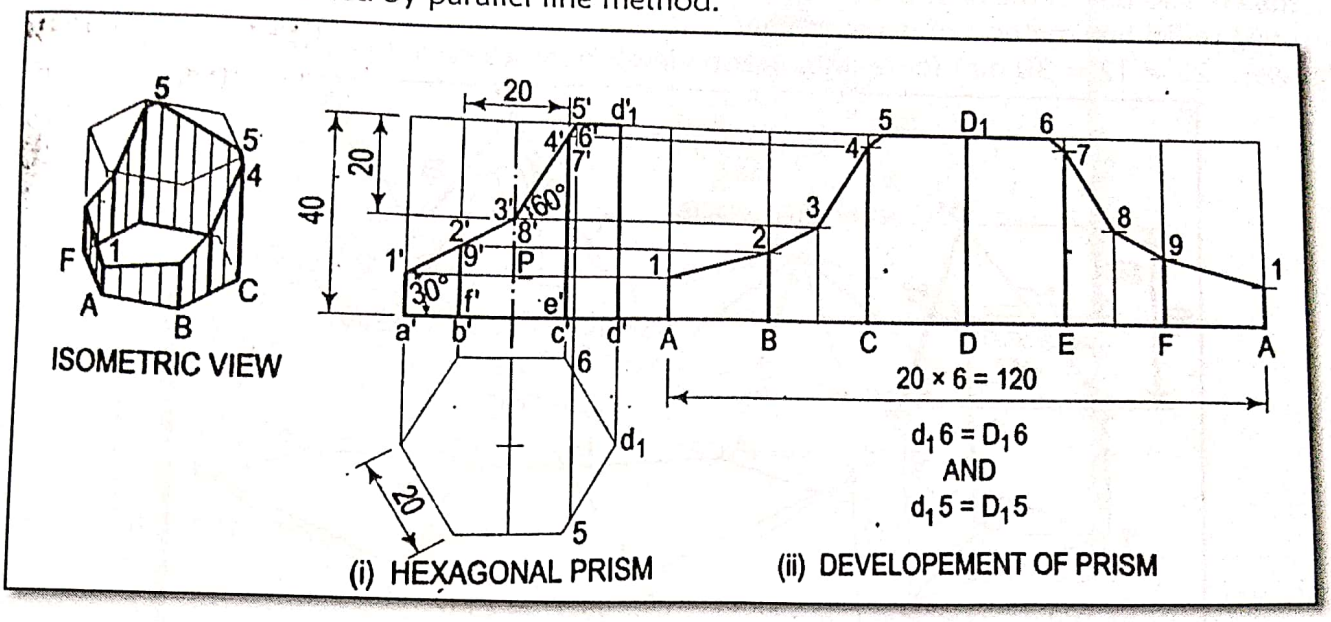
The development is obtained by parallel line method.



3. A hexagonal prism of base 20 mm sides and axis 40 mm long rests on the HP on its base. It is cut by two sectional planes inclined at 30° and 60° and bisects the axis as shown in the figure below. Draw the development of the truncated portion of the prism.

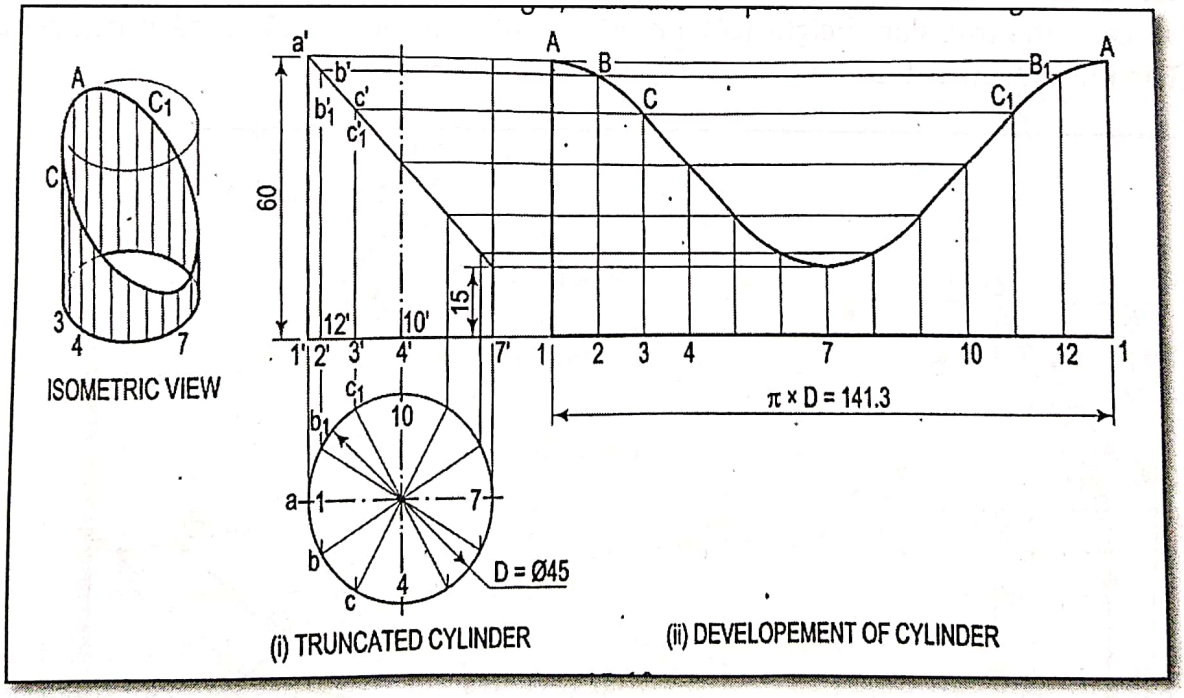
Answer: ab = bc = 20 mm; (base sides in the top view); d'd_1' = 40 mm (axis).

The development is obtained by parallel line method.



4. A cylinder of base 45 mm diameter and axis 60 mm long rests on the HP on its base and its axis is perpendicular to the HP. It is cut by a section plane inclined at some angle to HP such that it cuts the cylinder at 15 mm above HP on one side and ends at the top of the cylinder at the other end as shown in the figure below. Draw the development of the truncated portion of the cylinder by parallel line method.

Answer: a7 = 45 mm (diameter); 1'a' = 60 mm (axis);



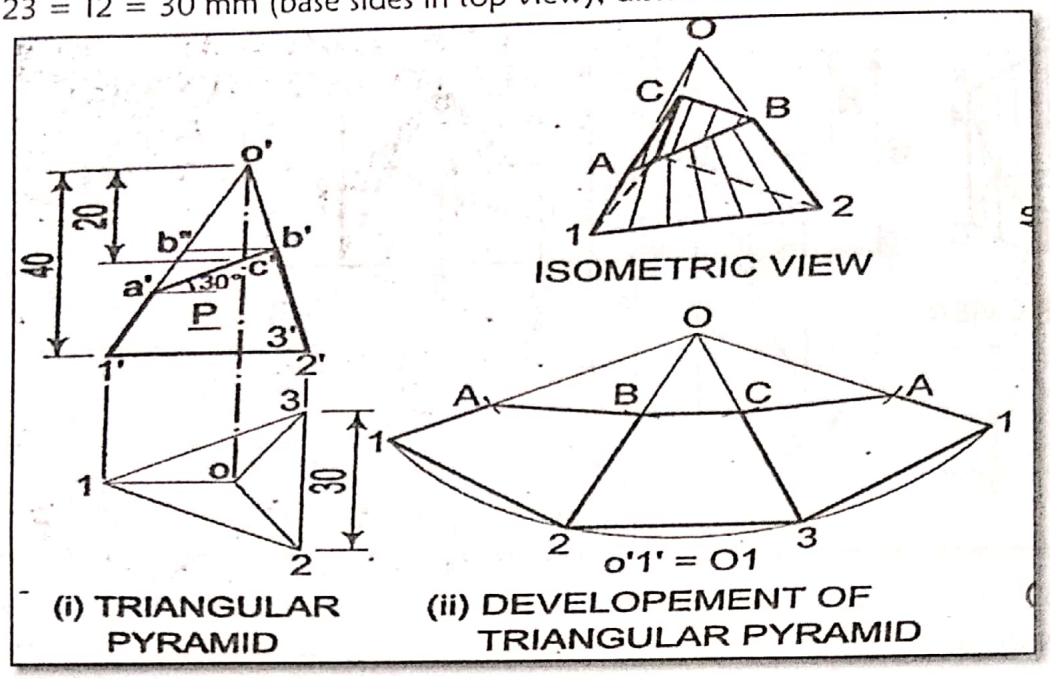
5. A cylinder of base 40 mm diameter and axis 60 mm long rests on HP on its base with its axis perpendicular to the HP. It is cut by three section planes inclined at 30°, 45° and 30° to the HP as shown in the figure below. Draw the development of the cylinder.

SHEET NO- 18

DEVELOPMENT OF SURFACES-II (Pyramids and Cones)

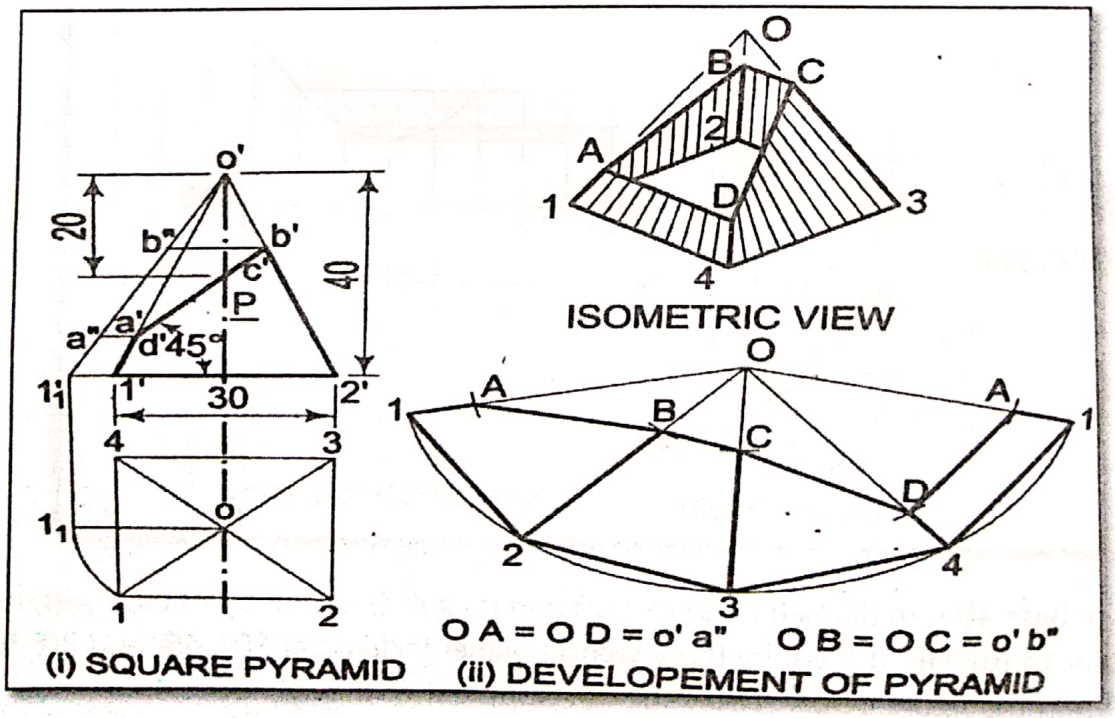
1. A triangular pyramid of base 30 mm sides and axis 40 mm long rests on HP on its base with an edge of the base perpendicular to the VP. It is cut by a section plane inclined at 30° to the HP and bisects the axis. Draw the development of the truncated portion of the pyramid using radial line method of development.

Answer: 23 = 12 = 30 mm (base sides in top view); distance of o' from xy = 40 mm (axis).



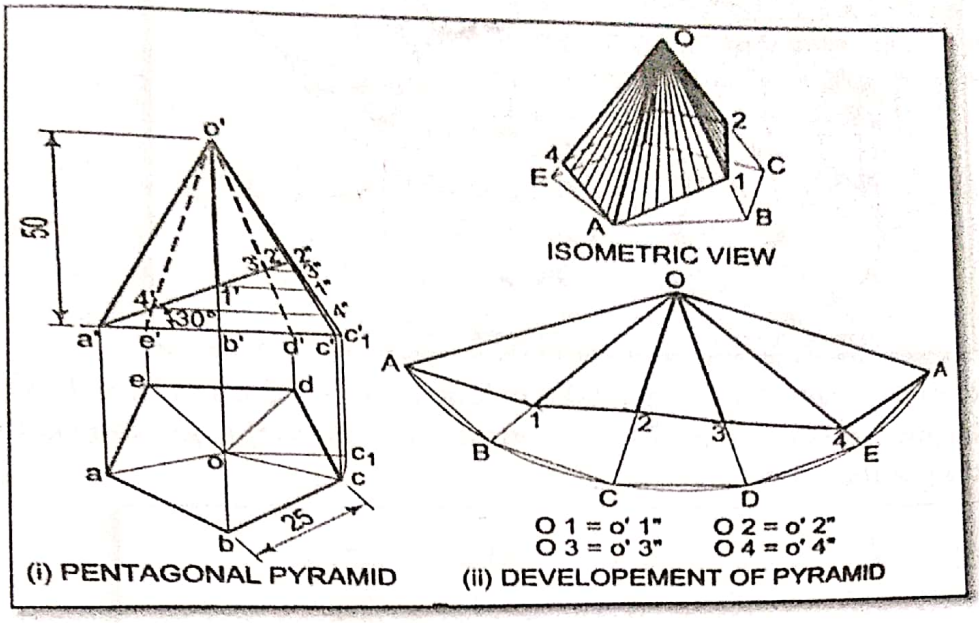
2. A square pyramid of base 30 mm sides and axis 40 mm long rests on HP with an edge of base parallel to the VP. It is cut by a section plane inclined at 45° to the HP and bisects the axis. Draw the development of the truncated portion of the solid.

Answer: sides 12=23=30 mm (base sides in top view); distance of o' from xy line = 40 mm (axis). In this case, the true slant height ($o'1_1'$) must be obtained first as o1 or o2 is not parallel to xy line. Then development is to be done as per radial line method.



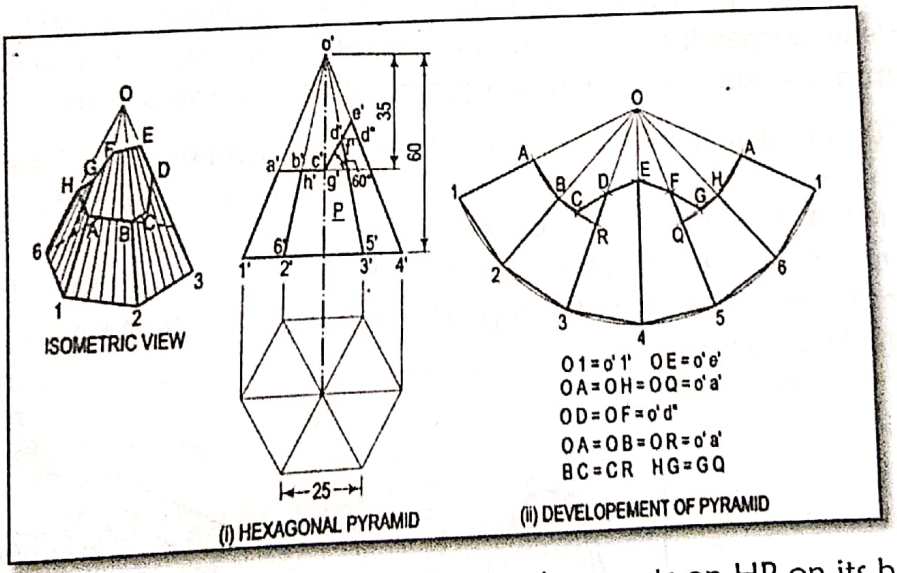
3. A pentagonal pyramid of base 25 mm sides and axis 50 mm long rests on HP on its base with an edge of its base parallel to the VP. It is cut by a section plane inclined at 30° to the HP and starts from the left bottom corner of the base. Draw its development.

Answer: ab = bc = 25 mm; b'o' = 50 mm; true slant height =c_1'o'. Use radial line method.



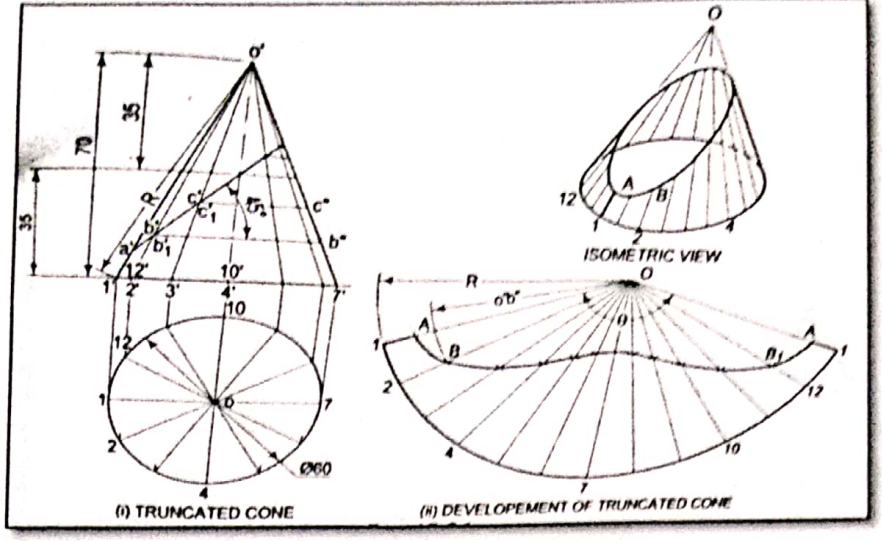
4. A pentagonal pyramid of base 30 mm sides and axis 60 mm long rests on HP on its base with an edge of base perpendicular to the VP. It is cut by a section plane inclined at 60° to the HP and bisects the axis. Draw its development of the truncated portion.
5. A hexagonal pyramid of base 25 mm sides and axis 60 mm long rests on HP on its base. It is cut by two section planes, one being parallel to HP and other at 60° to the HP and cuts the axis at a point 35 mm from the apex. Draw the development of the truncated solid.

Answer: side 23(=12=34) =25 mm (base sides); o' from xy = 60 mm (axis). 1'o' = true slant height. Development is to be done by radial line method.



6. A cone of base 60 mm diameter and axis 70 mm long rests on HP on its base. It is cut by a section plane inclined at 45° to the HP and bisects the axis. Draw the development of the truncated portion of the cone.

Answer: The angle of sector in the cone (θ) is obtained as θ = 360° x (r/R) where r is the radius of the base of cone (30 mm) and R is the true slant height of the cone (o'1' ~= 76mm) as measured from the drawing. θ = 360° x (30/76) ~= 142°. The development is by radial line method.



7. A cone of base 50 mm diameter and axis 60 mm long rests on HP on its base. It is cut by a section plane inclined at 60° to the HP and bisects the axis. Draw the development of the truncated portion of the cone.

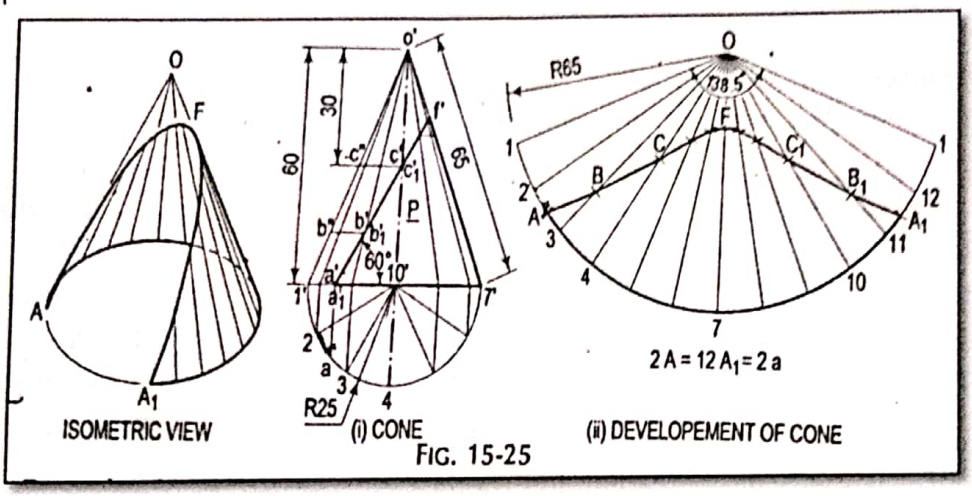


FIG. 15-25

8. A cone of base 50 mm diameter and axis 60 mm long rests on HP on its base. It is cut by a vertical section plane, perpendicular to both the VP and HP and cuts the cone at a distance of 10 mm away from its axis. Draw the development of the truncated cone.

9. A cone of base 50 mm diameter and axis 60 mm long rests on HP on its base. It is cut by two section planes, one is parallel to its base and cuts the cone at 20 mm from the apex and the other is inclined at 30° to the HP and starts from the left bottom corner of the cone. Draw the development of the truncated portion of the cone using radial line method. Answer: A full circle is to be drawn in the top view and true slant height (o'1' = 65) to be used in calculation of the sector angle (angle θ = 360° x (25/65) ~= 138.5).

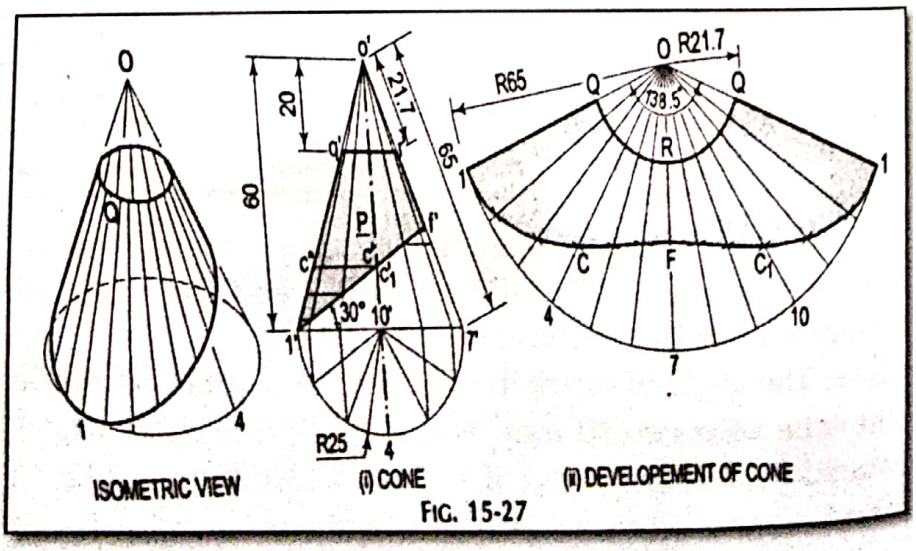


FIG. 15-27

SHEET NO- 19

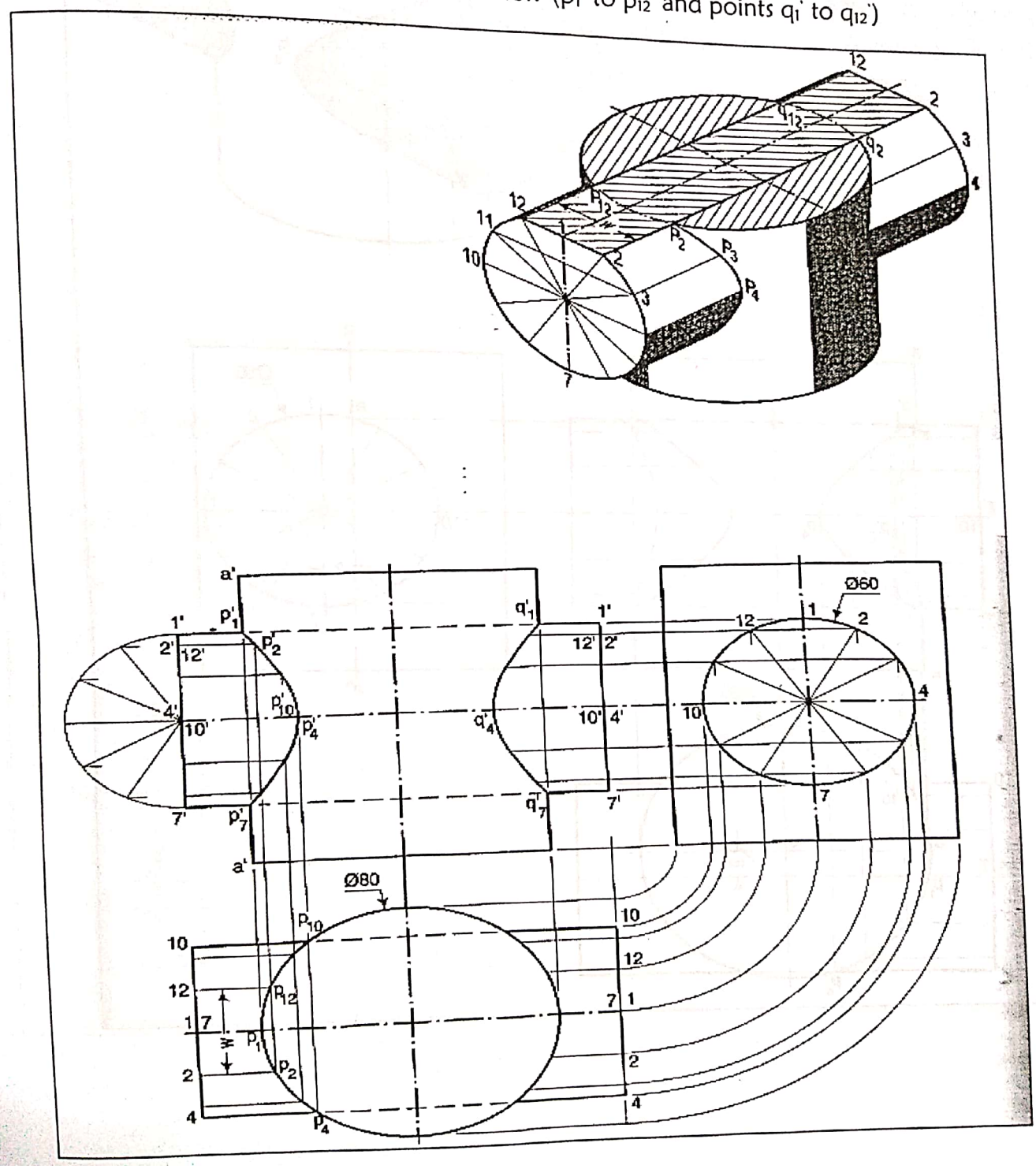
INTERSECTION OF SURFACES-I (CYLINDER VS CYLINDER)

1. Cylinder intersecting a cylinder with no axis offset.
A vertical cylinder of 80 mm diameter is completely penetrated by another cylinder of 60 mm diameter, their axes bisecting each other at right angles. Draw their projections showing the curves of penetration, assuming the axis of the penetrating cylinder to be parallel to the VP. Assume suitable lengths of the axis for both the cylinders.

Answer: The curves of intersection are obtained as shown below.

Steps of construction:

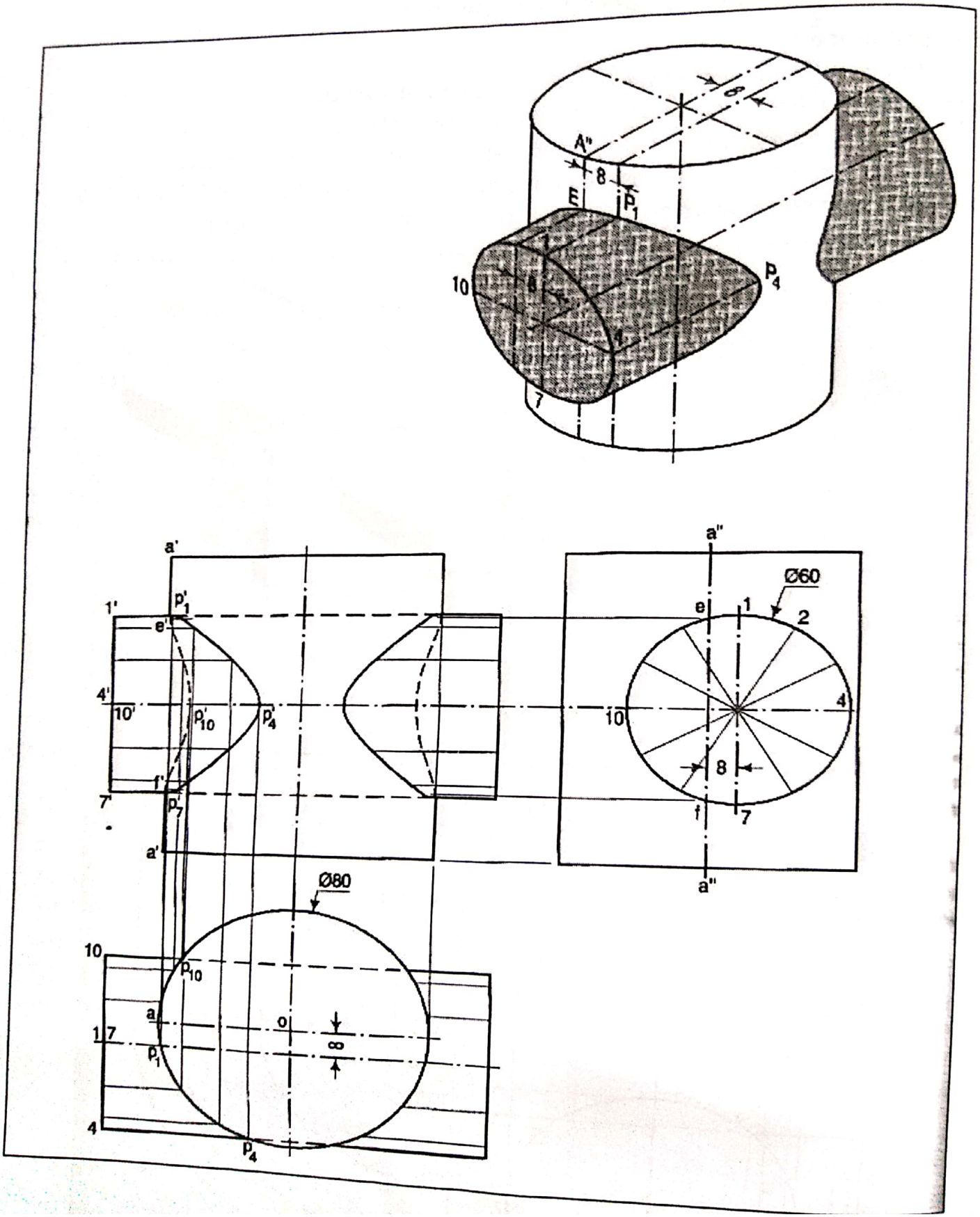
1. Draw the top view, front view and side view of the vertical cylinder.
2. Draw the side view, front view and top view of the horizontal cylinder.
3. Mark the points of intersection of the two cylinders in the top view and side view.
4. Project the points of intersection from the top view (p_1 to p_{12}) and side view (1'' to 12'') to get the curves of intersection in the front view (p_1' to p_{12}' and points q_1' to q_{12}')



Cylinder intersecting a Cylinder with axis offset in side view and top view.

A vertical cylinder of 80 mm diameter is penetrated by another cylinder of 60 mm diameter, the axis of which is parallel to both the HP and VP. The two axes are 8 mm apart. Draw the projections of the solids showing the curves of intersection. Assume suitable lengths for the axes of the cylinders.

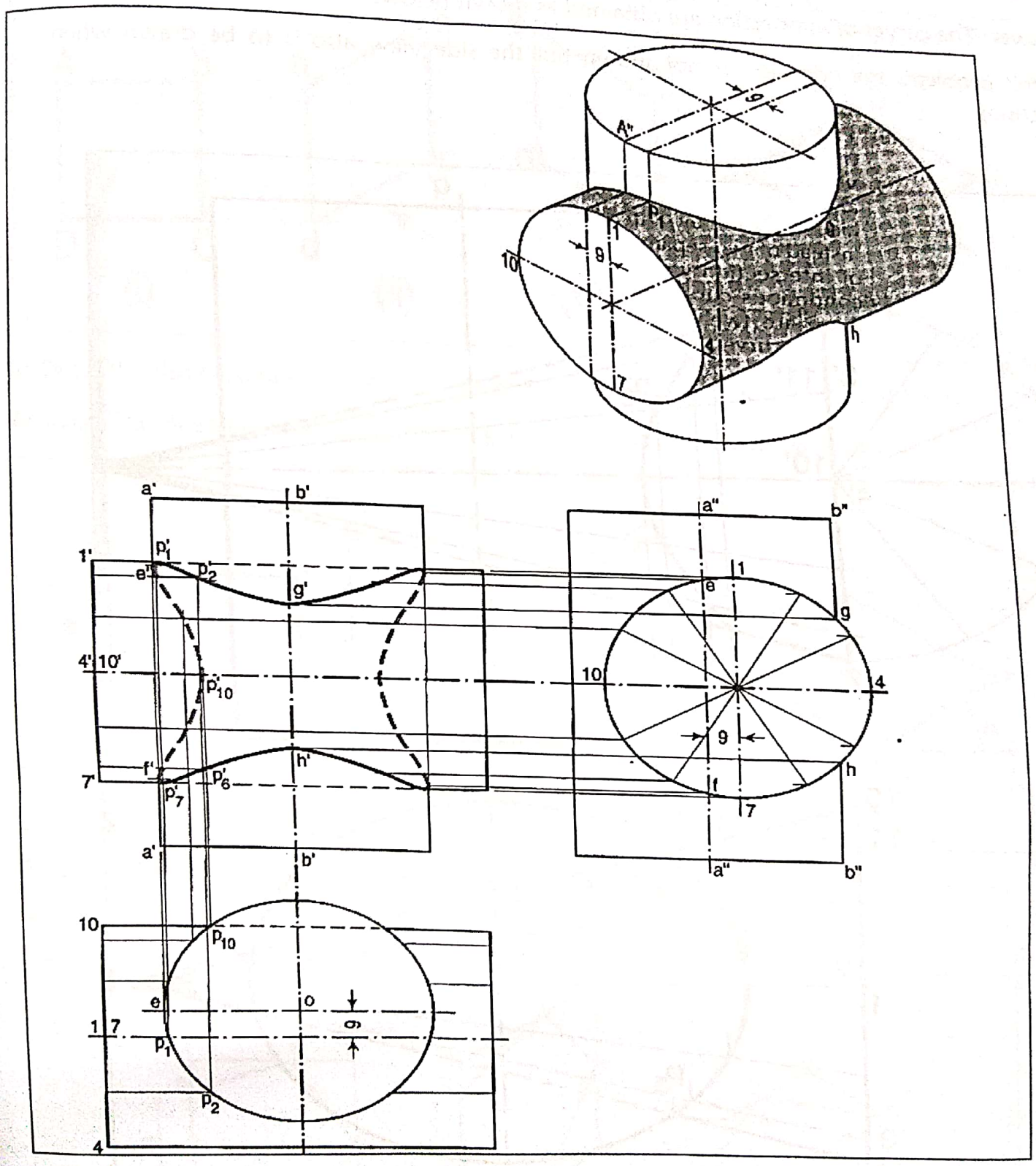
Answer: The curves of intersection are obtained as shown below.



2. Cylinder intersecting a Cylinder with axis offset and horizontal cylinder outside the vertical cylinder.

A vertical cylinder of 75 mm diameter is penetrated by another cylinder of the same size. The axis of the penetrating cylinder is parallel to both the HP and VP and is 9 mm away from the axis of the vertical cylinder. Draw the projections of the solids showing the curves of intersection. Assume suitable lengths for the axes of the cylinders.

Answer: The curves of intersection are obtained as shown below.



SHEET NO- 20

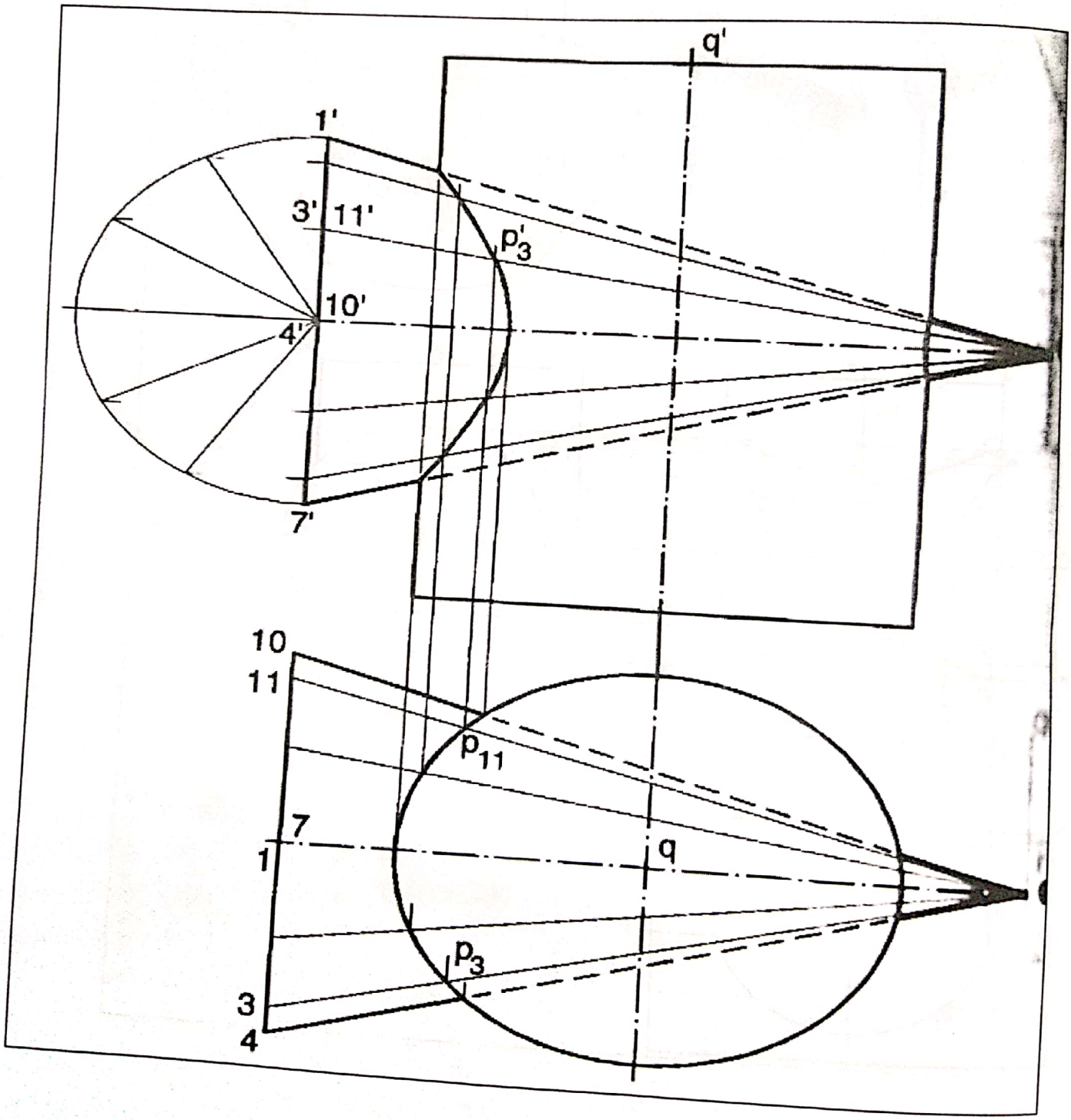
INTERSECTION OF SURFACES-II (CYLINDER VS CONE)

1. Vertical Cylinder intersecting a Horizontal Cone.

A vertical cylinder of 75 mm diameter is penetrated by a cone of base 75 mm diameter and axis 110 mm, the two axes bisecting each other at right angles. Draw the projections of the solids showing the curves of intersection. Assume suitable length for the axis of the cylinder.

Answer: The curves of intersection are obtained as shown below.

In this problem, the side view is not shown but the side view also is to be drawn when practising.



SHEET NO- 21

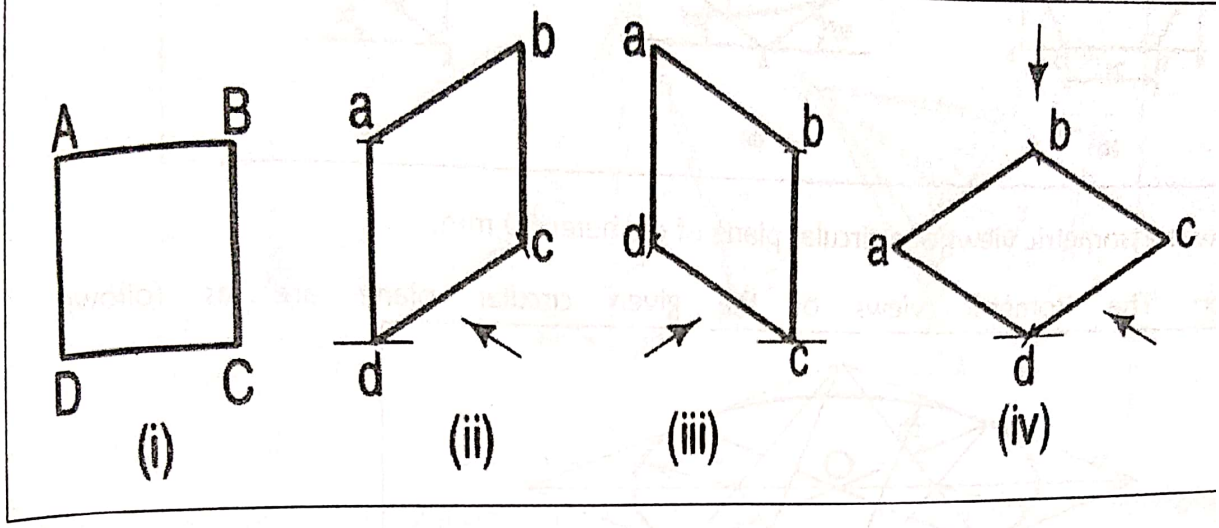
ISOMETRIC PROJECTION-I (PLANE AND SIMPLE SOLIDS)

In isometric drawings, the three reference angles used for drawing are 30°, 30° and 90°.

Isometric Views of planes:

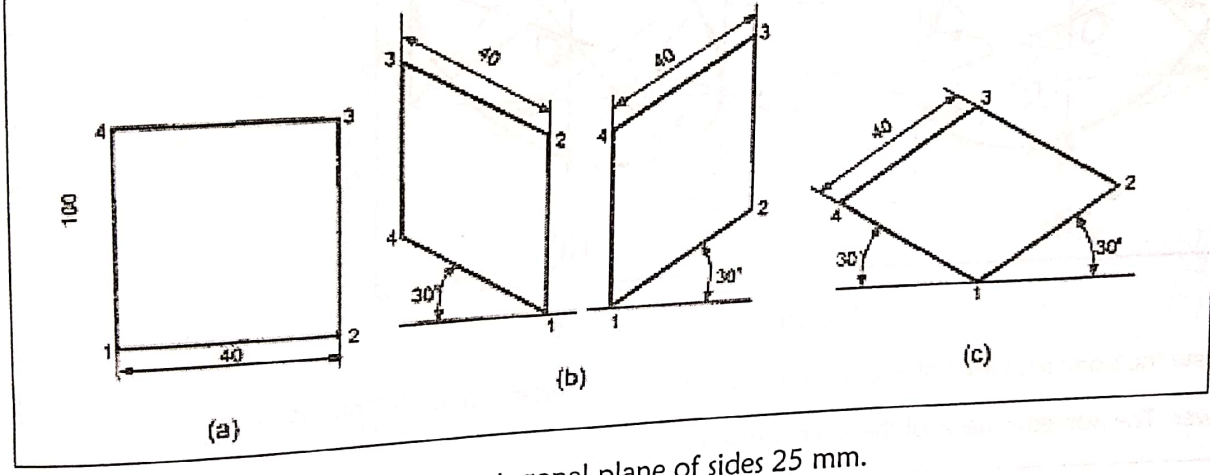
1: Draw the three isometric views of a square plane of sides 40 mm.

Answer: The three isometric views of the given square plane are as follows:



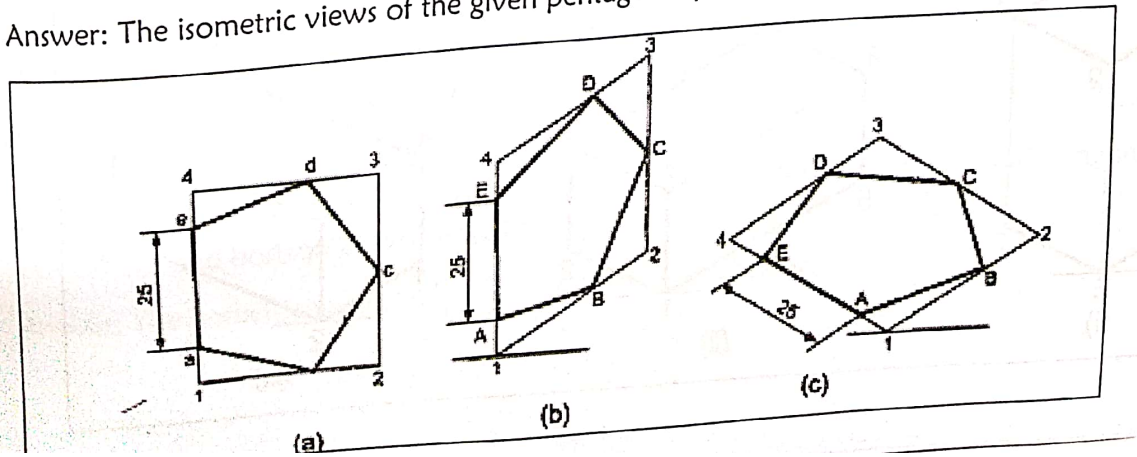
2: Draw the three isometric views of a rectangular plane of sides 100 mm and 40 mm.

Answer: The three isometric views of the given rectangular plane are as follows:



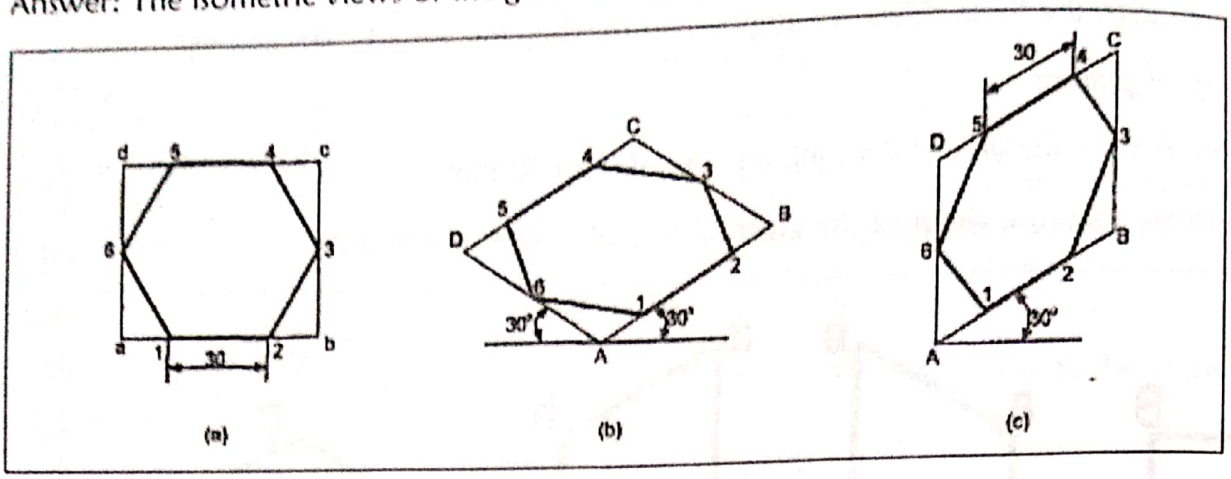
3: Draw the isometric views of a pentagonal plane of sides 25 mm.

Answer: The isometric views of the given pentagonal plane are as follows:



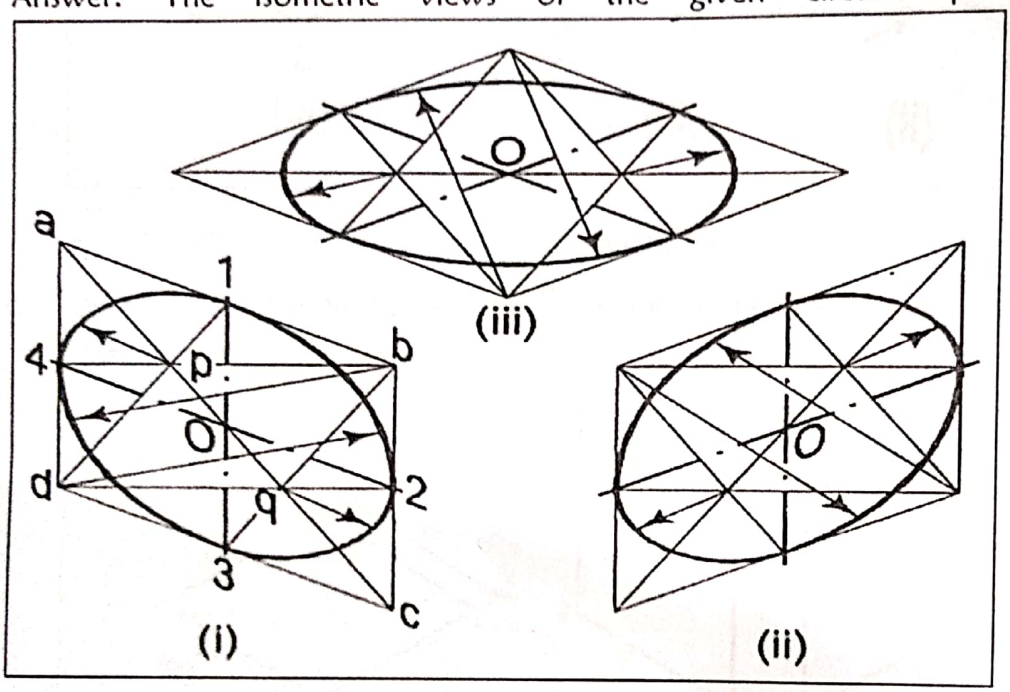
4: Draw the isometric views of a hexagonal plane of sides 30 mm.

Answer: The isometric views of the given hexagonal plane are as follows:



5: Draw the isometric views of a circular plane of diameter 50 mm.

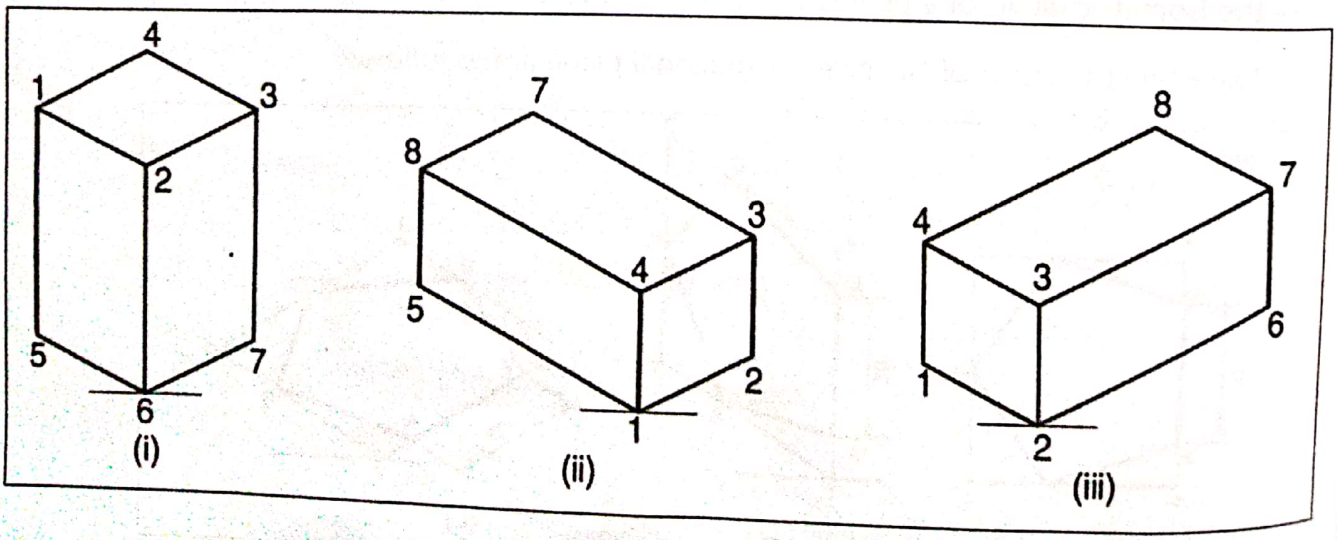
Answer: The isometric views of the given circular plane are as follows:



Isometric Views of Simple Solids:

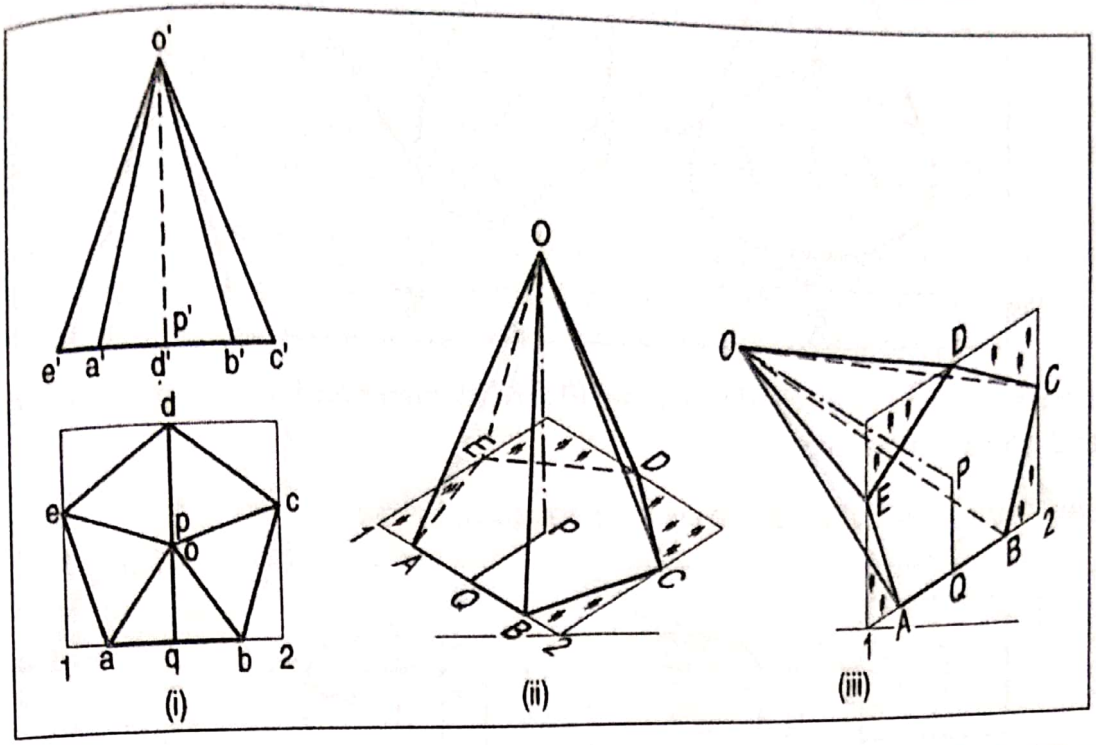
1. Draw the isometric views of a square prism of base 40 mm sides and axis 80 mm long.

Answer: The isometric views of the given square prism are as follows:



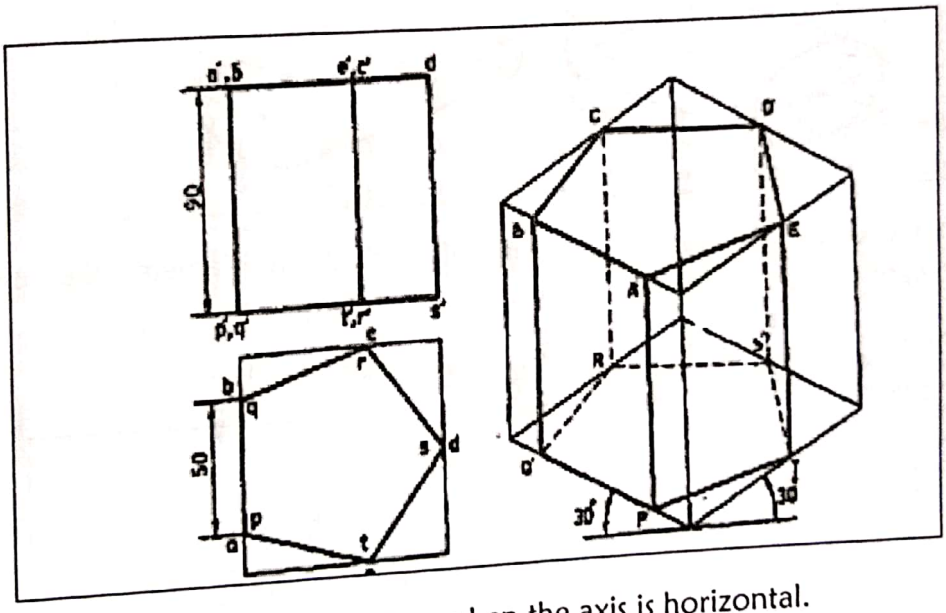
2. Draw the isometric views of a pentagonal pyramid of base 30 mm sides and axis 50 mm long.

Answer: The isometric views of the given pentagonal pyramid are as follows:



3. Draw the isometric views of a pentagonal prism of base 50 mm sides and axis 90 mm long when the axis is (i) Vertical; (ii) Horizontal

Answer: The isometric view of the given pentagonal prism in vertical axis position is given below.

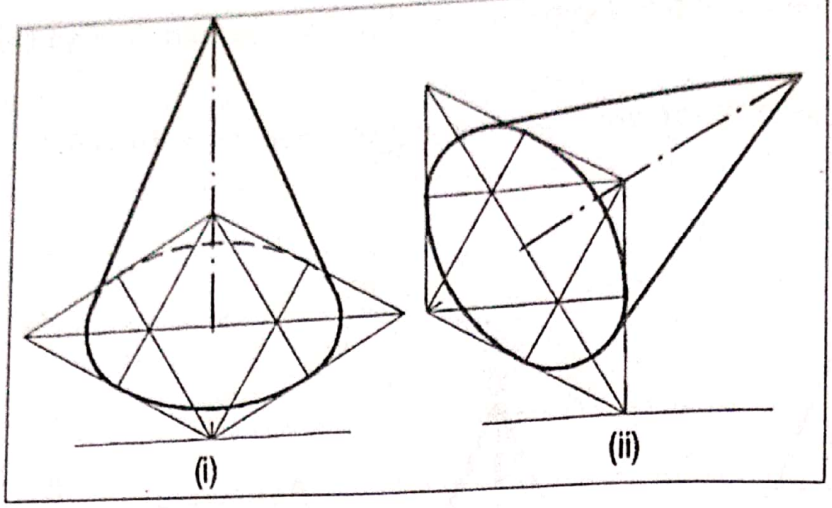


In similar method, draw the isometric view when the axis is horizontal.

4. Draw the isometric views of a hexagonal prism of base 30 mm sides and axis 80 mm long when the axis is (i) Vertical; (ii) Horizontal

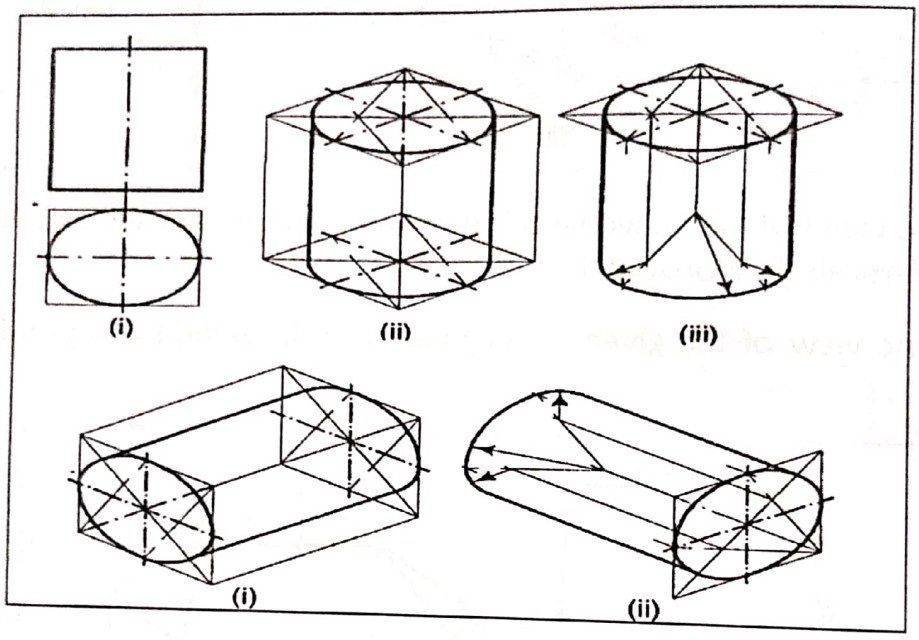
5. Draw the isometric views of a cone of base 40 mm diameter and axis 80 mm long in the vertical axis and horizontal axis condition.

Answer: The isometric views of the given cone are given below.



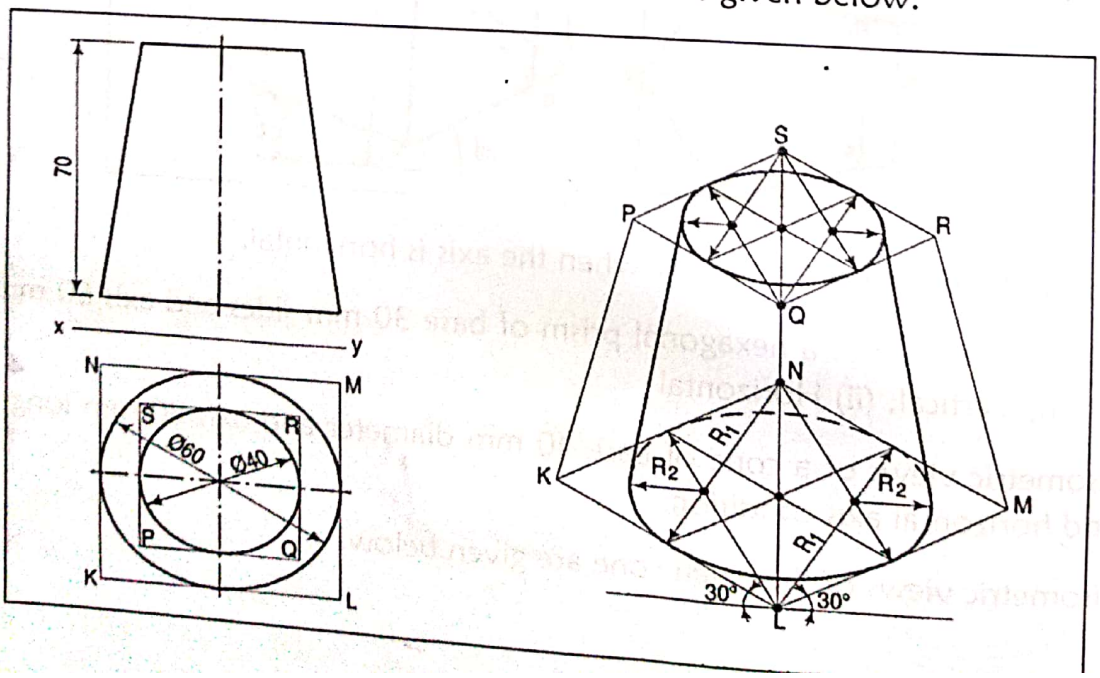
6. Draw the isometric views of a cylinder of base 40 mm diameter and axis 80 mm long in the vertical axis and horizontal axis condition.

Answer: The isometric views of the given cylinder are given below.



7. Draw the isometric views of a frustum of a cone of base 60 mm diameter, diameter at the top 40 mm and height of frustum 70 mm in the vertical axis condition.

Answer: The isometric view of the given frustum of cone is given below.



SHEET NO- 22

ISOMETRIC PROJECTION-I (COMBINATION OF TWO OR THREE SOLIDS)

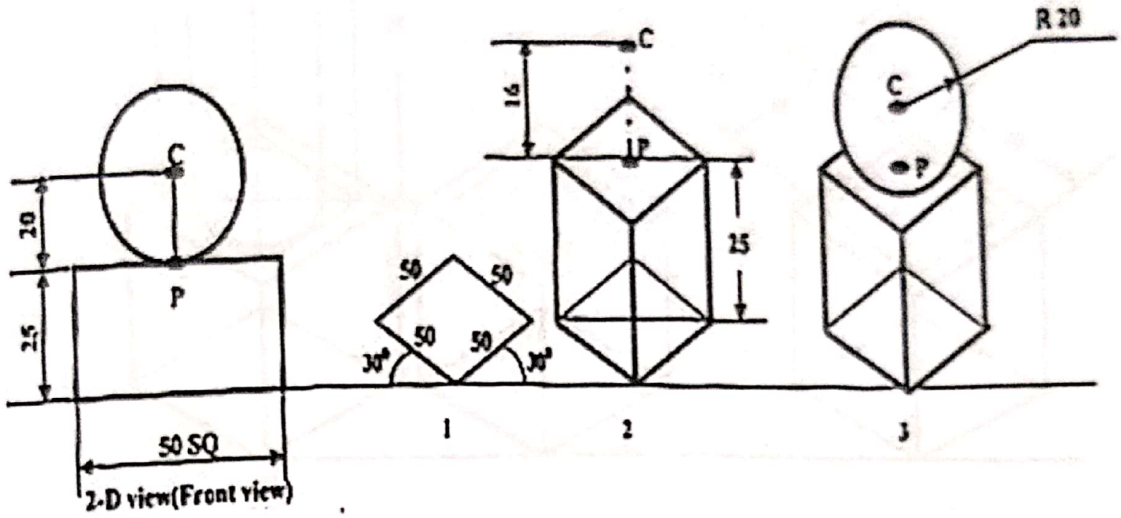
In combination of solids, two or more solids are usually placed one upon the other centrally with their vertical axes coinciding.

To draw their isometric projections, we start with the base solid (1st solid) and then after completely drawing the 1st solid, the 2nd solid is drawn upon it at the centre.

1. A sphere of 40 mm diameter rests centrally upon a square prism of base 50 mm sides and axis 25 mm long. Draw the isometric projection of the combination of the solids.

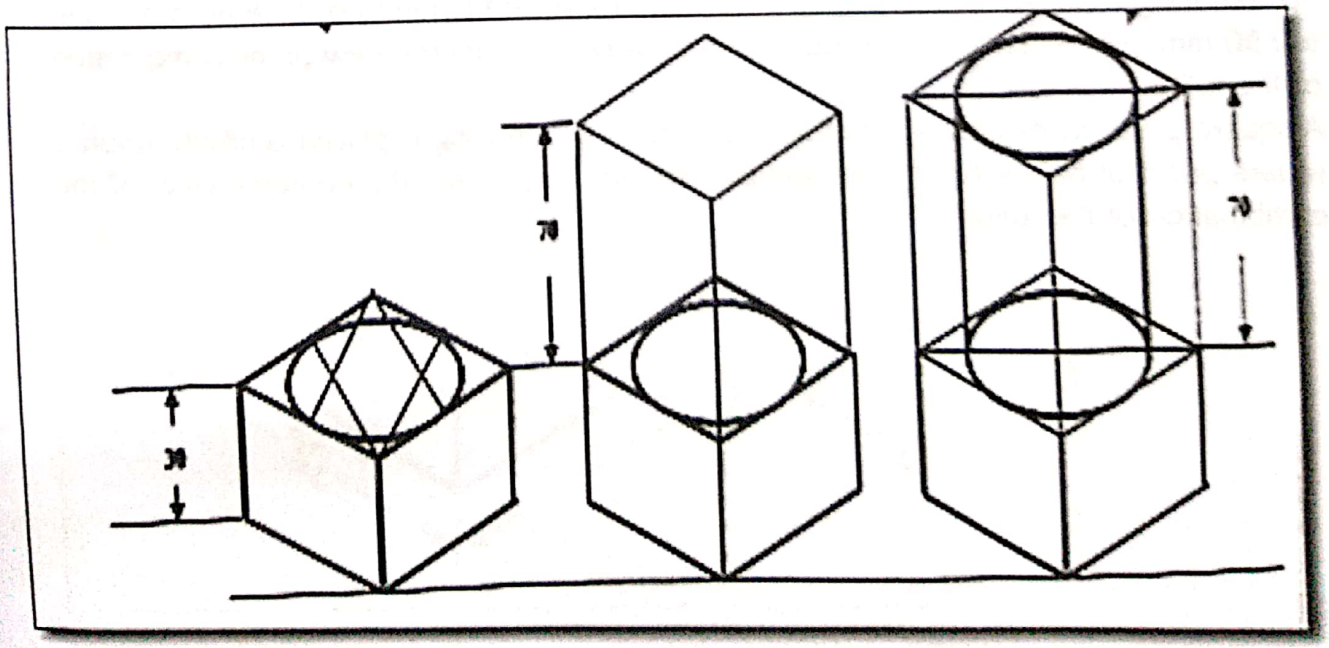
Answer: The height of the centre of the sphere is equal to its isometric radius.

$$CP = 0.8 \times R = 0.8 \times 20 = 16 \text{ mm.}$$



2. A cylinder of 50 mm base diameter and axis 70 mm long rests centrally upon a square prism of base 50 mm sides and axis 30 mm long. Draw the isometric view of the combination of the solids.

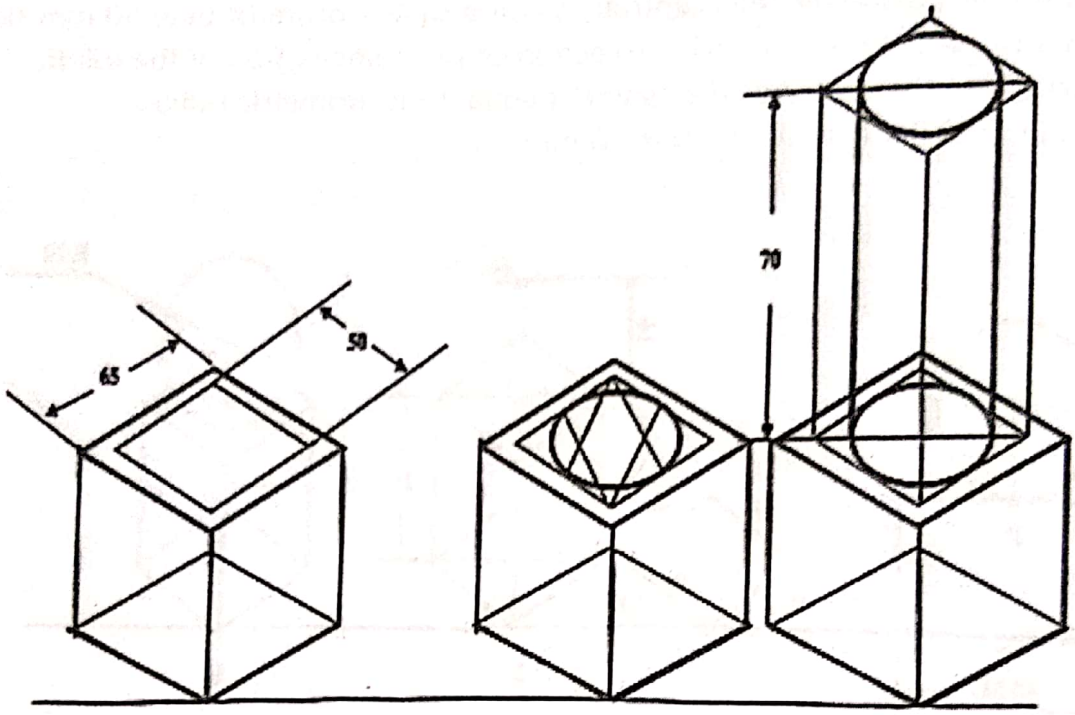
Answer: The square prism is drawn at the base and using 4-center-V method, the cylinder is drawn centrally upon the square prism.



3. A frustum of a square pyramid of base 60 mm sides, top 40 mm sides and height of frustum 30 mm long is surmounted by a square pyramid of base 30 mm sides and axis 70 mm long, with their axes coinciding. Draw the isometric view of the combination of the solids.

4. A cylinder of base 50 mm diameter and axis 70 mm rests centrally upon a cube of 65 mm long edges. Draw the isometric view of the combination of the solids.

Answer: The cylinder is to be drawn on the top of the cube by 4 center V method.



Assignment problems:

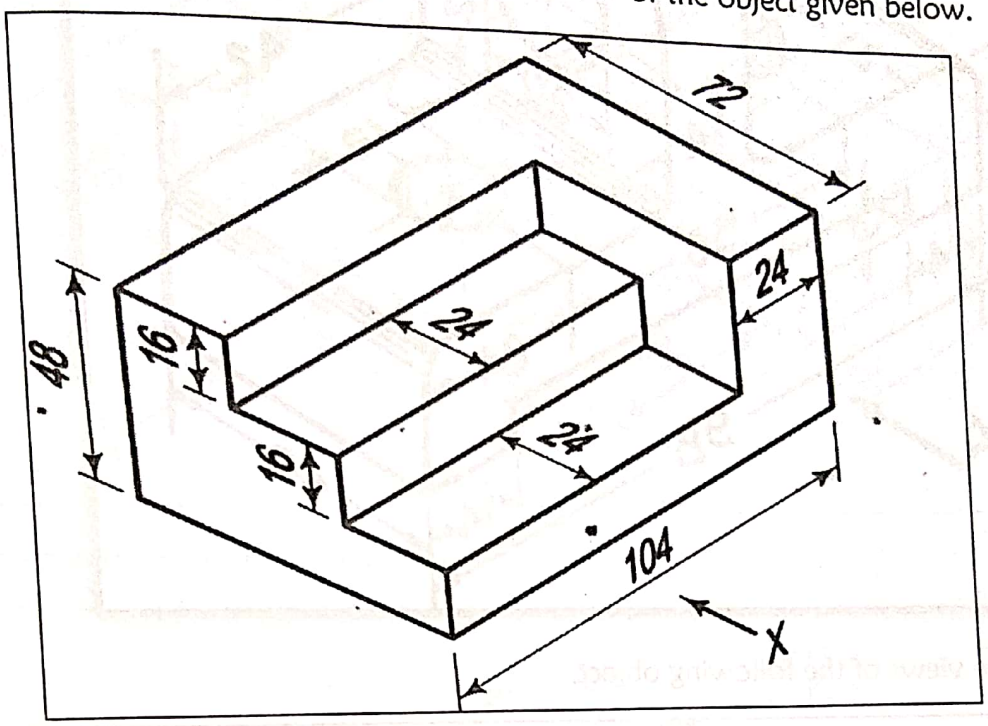
1. A sphere of diameter 60 mm rests centrally upon a frustum of cone with base 60 mm diameter, top 40 mm diameter and height of frustum 70 mm long. Draw the isometric projection of the combination of the solids.
2. A frustum of a cone of base 50 mm diameter, top 30 mm diameter and height of frustum 70 mm long is placed centrally upon a frustum of a square pyramid of base 60 mm sides, top 50 mm sides and height of frustum 40 mm. Draw the isometric view of the combination of the solids.
3. A square pyramid of base 40 mm sides and axis 70 mm long is placed centrally upon a square prism of base 40 mm sides and axis 40 mm long. Draw the isometric view of the combination of the solids.

SHEET NO- 23

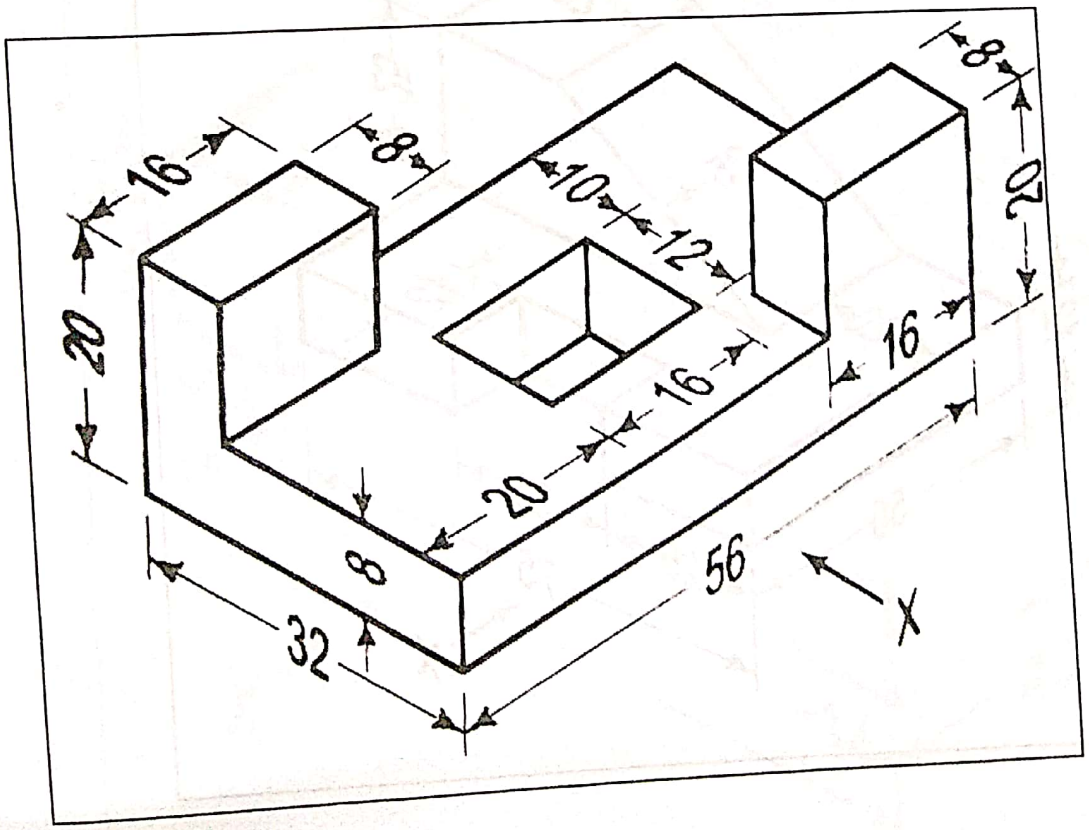
CONVERSION OF ISOMETRIC VIEWS INTO ORTHOGRAPHIC VIEWS

Pictorial views of objects are shown in the following figures given below. Draw full scale size views (front view, top view and side view) of each object as stated below. The front view in each case should be drawn as seen in the direction of arrow X. Use only first-angle projection method. Insert all dimensions in the views.

1. Draw the front view, top view and the left side view of the object given below.

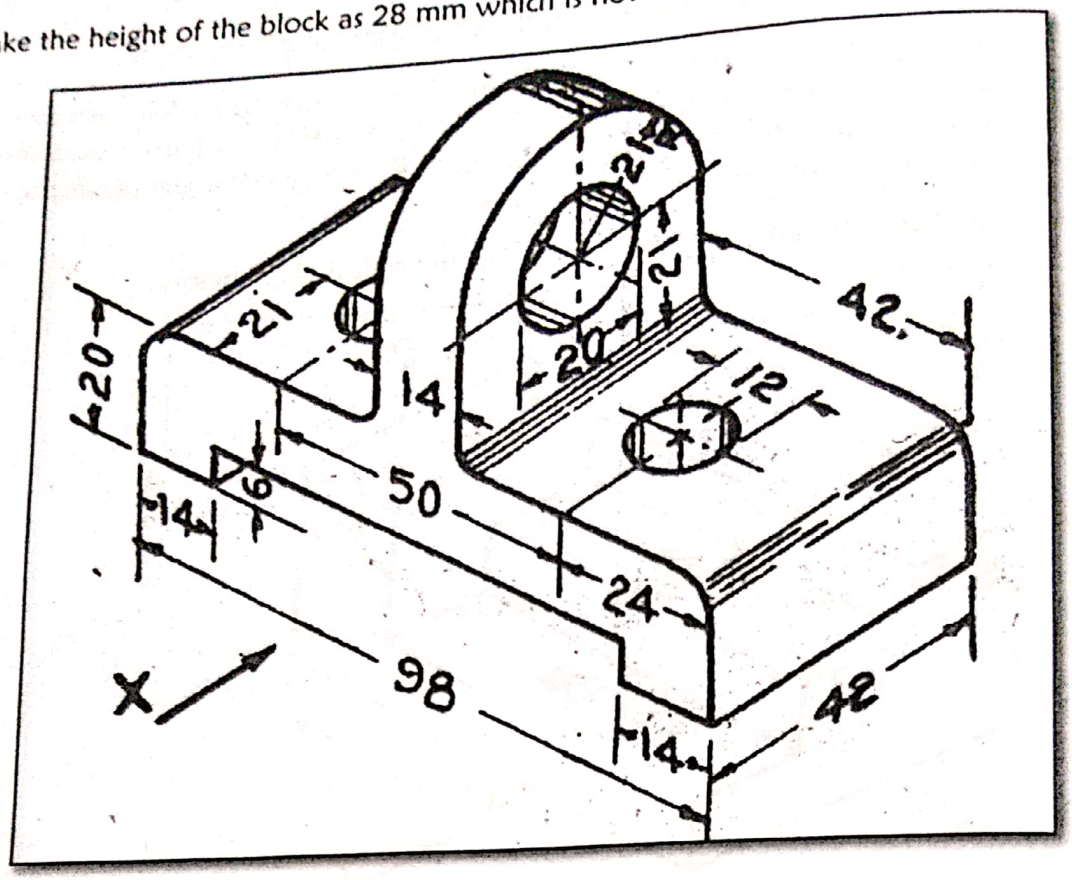


2. Draw the front view, top view and the left side view of the following object.

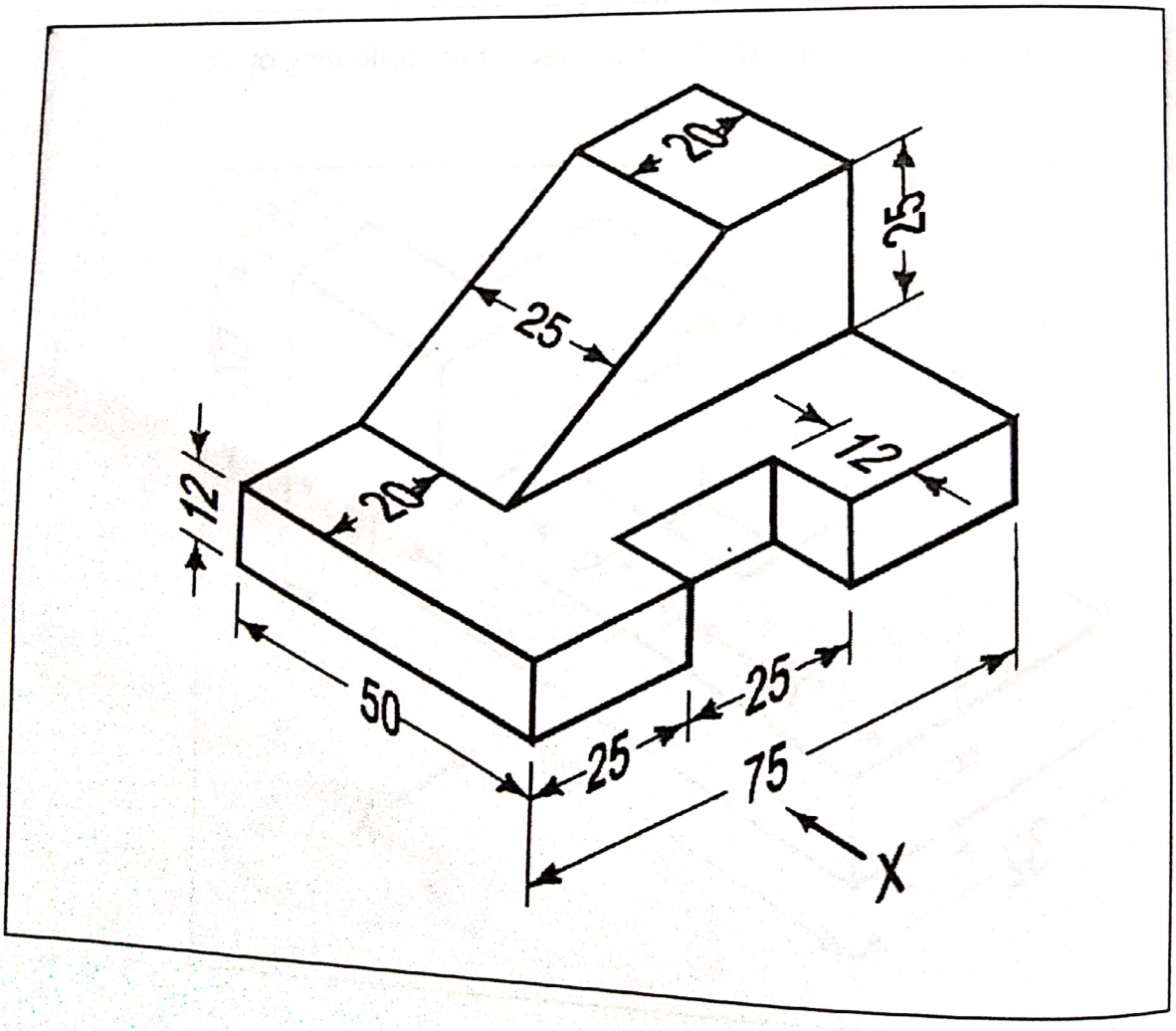


3. Draw the three views of the following object.

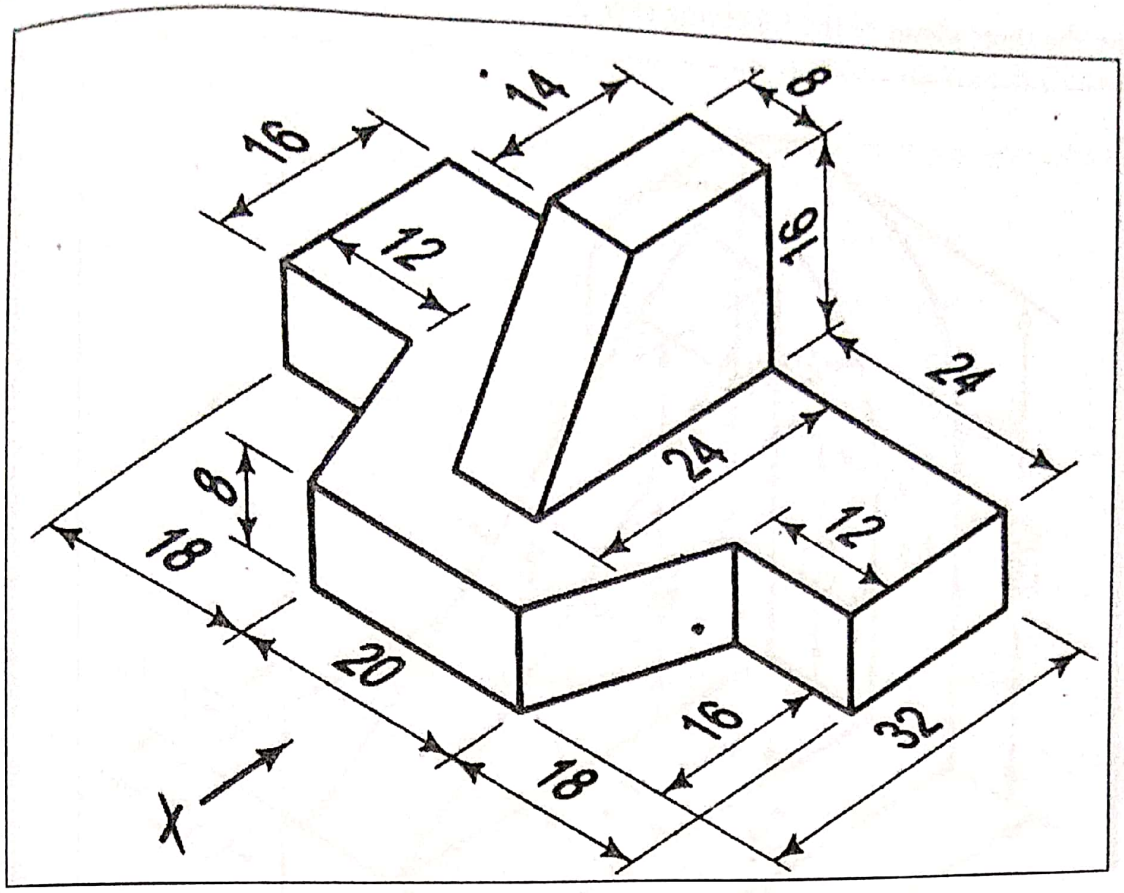
(Take the height of the block as 28 mm which is not clear in the dimensions)



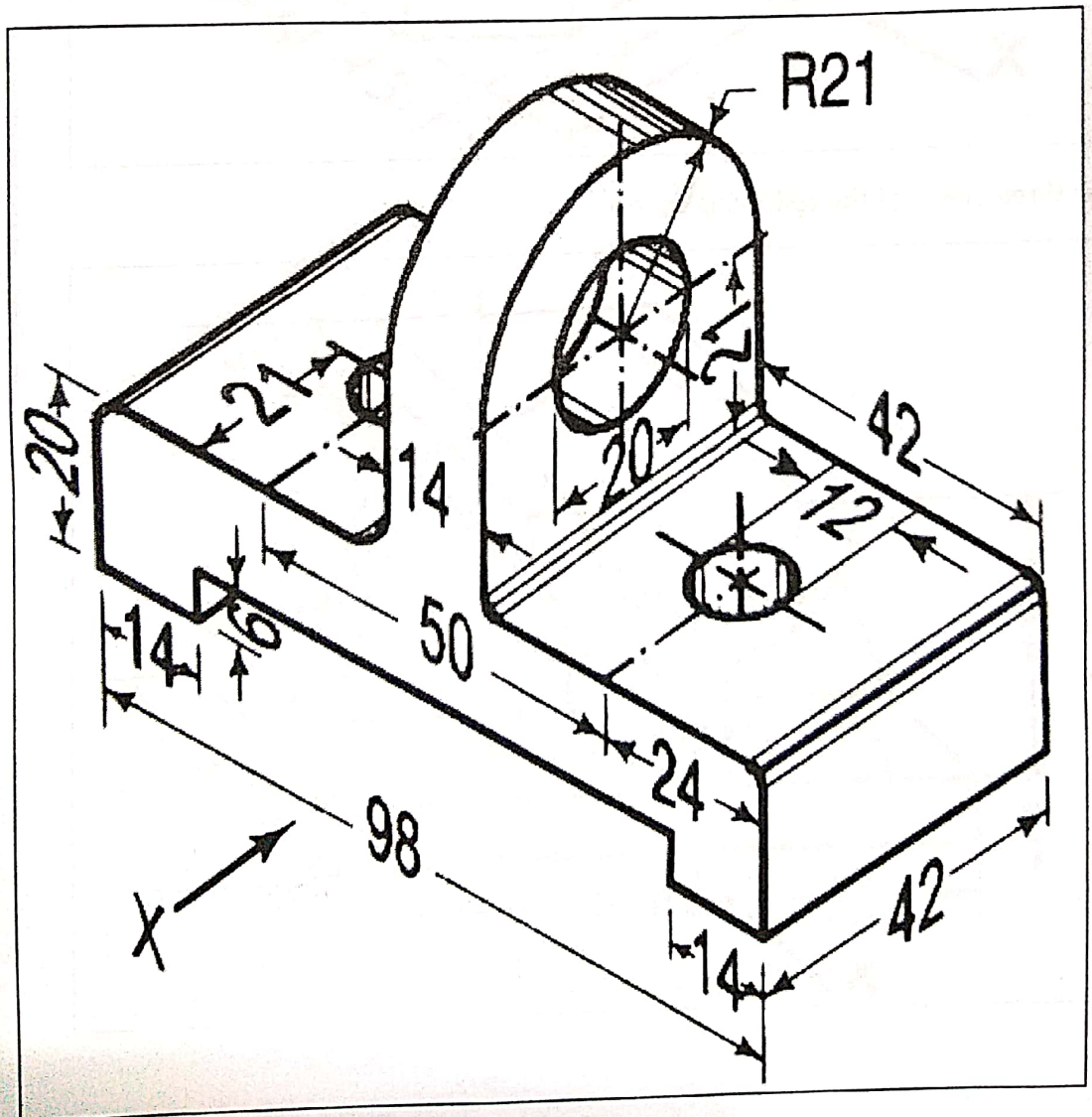
4. Draw the three views of the following object.



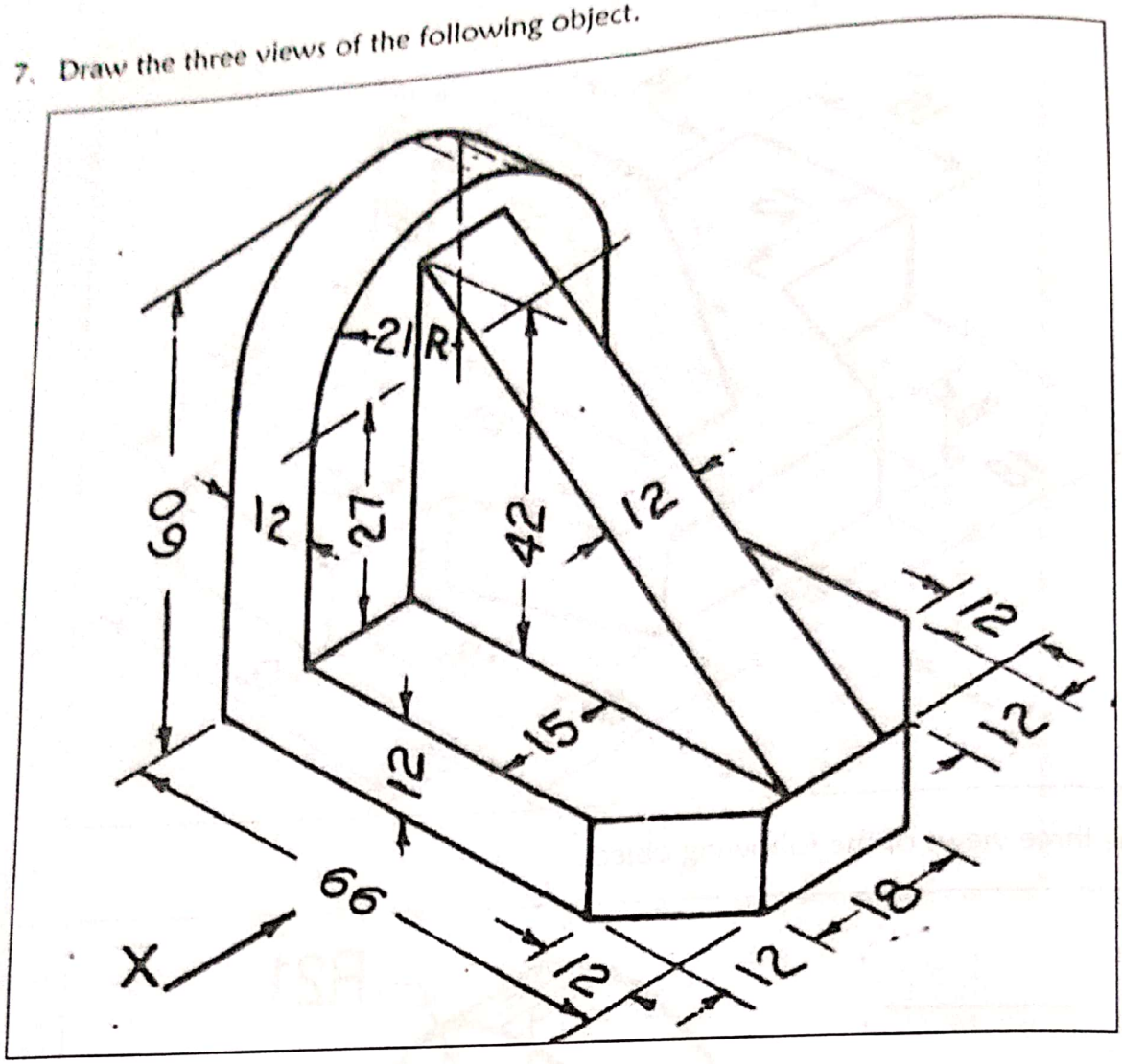
5. Draw the three views of the following object.



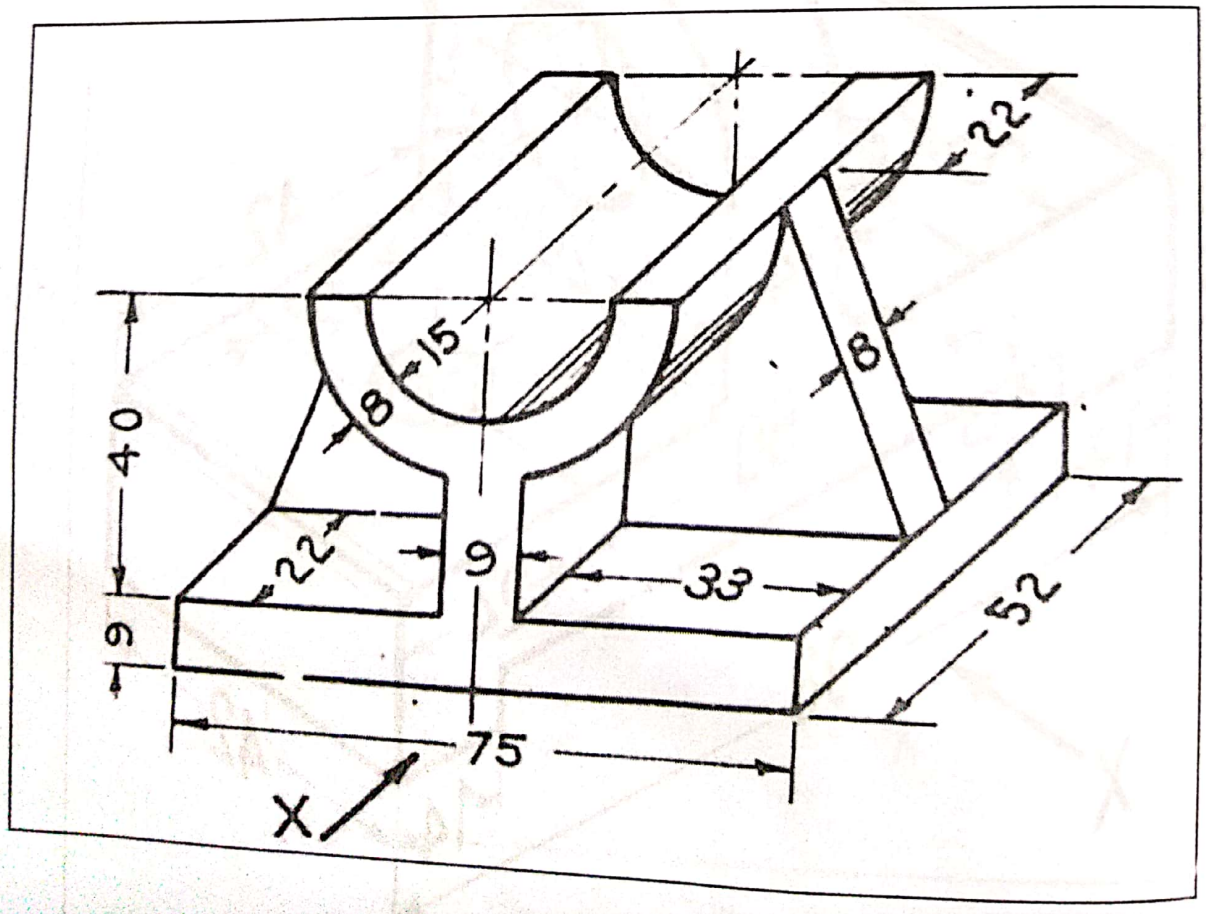
6. Draw the three views of the following object.



7. Draw the three views of the following object.



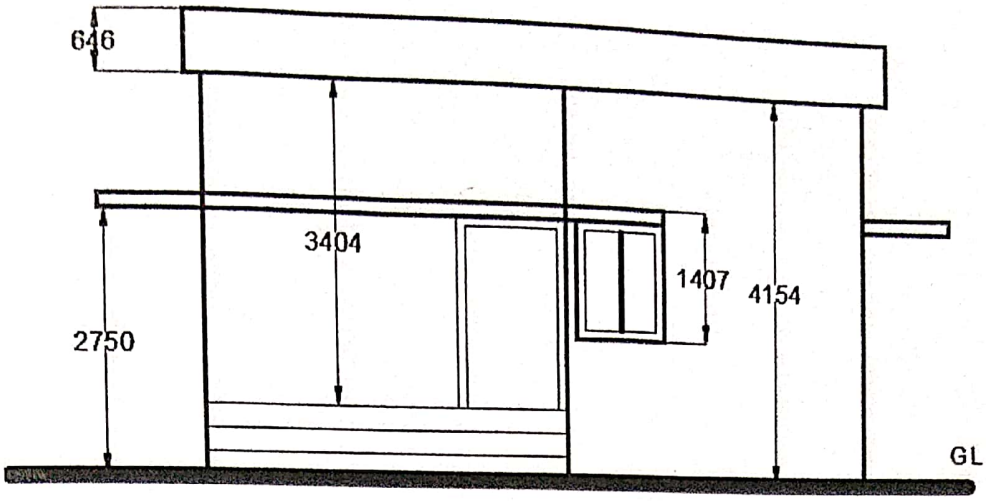
8. Draw the three views of the following object.



SHEET NO- 24

Floor plans of 2 or 3 rooms including windows, doors, and fixtures such as WC, bath, sink, shower, etc.

1. Draw plan and elevation of the given house plan with dimensions. Assume parameters as needed. (All dimensions in mm). All wall thickness is 230 mm.



ELEVATION