ANNAMACHARYA UNIVERSITY

EXCELLENCE IN EDUCATION; SERVICE TO SOCIETY
(ESTD UNDER AP PRIVATE UNIVERSITIES (ESTABLISHMENT AND REGULATION) ACT, 2016)
RAJAMPET-516126:A.P; INDIA

DEPARTMENT OF MECHANICAL ENGINEERING

LECTURE NOTES

ENGINEERING DRAWING

[24MEC21T]

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ANNAMACHARYA UNIVERSITY

(ESTD UNDER AP PRIVATE UNIVERSITIES (ESTABLISHMENT AND REGULATION) ACT, 2016)

Title of the Course:	Engineering Drawing	
Category:	ESC	
Semester:	I Semester	II Semester
Couse Code:	24AMEC11T	24AMEC21T
Branch/es:	CE, ME, EEE, ECE, CSE-AI, AI&DS & CSE-ICB	CSE, CSE-DS, CSE-AIML & AIML

Lecture Hours	Tutorial Hours	Practice Hours	Credits
1	0	4	3

Course Objectives:

1. To enable the students with various concepts like dimensioning, conventions and standards related to Engineering Drawing.
2. To impart knowledge on the projection of points, lines and plane surfaces.
3. To improve visualization skills for better understanding of projection of solids.
4. To develop the imaginative skills of the students required to understand Section of solids and Developments of surfaces.
5. To make the students understand the viewing perception of a solid object in Isometric and Perspective projections.

Course Outcomes:

At the end of the course, the student will be able to

1. Apply the appropriate annotations and geometric techniques to draw the conic sections, Cycloidal Curves and Involutes
2. Apply the principles of orthographic projection for engineering problems involving inclined lines to create drawings that represent real-world objects.
3. Apply the principles of orthographic projection for solving engineering problems of planes with respect to both reference planes.
4. Apply the principles of orthographic projection for solving engineering problems of solids.
5. Apply the conversion techniques to solve problems related to orthographic projections and isometric projection views.

Unit 1 **5**

Introduction: Lines, Lettering and Dimensioning, Geometrical Constructions and Constructing regular polygons by general method.

Engineering Curves:

Construction of Ellipse, Parabola and Hyperbola by General Method - Normal and tangent

Cycloid & Epicycloid curves (basic problem) - Normal and tangent

Involute of Square, Pentagon - Normal and tangent

Unit 2 **3**

Orthographic Projections: Reference plane, importance of reference lines or Planes, Projections of a point situated in any one of the four quadrants.

Projections of Straight Lines: Projections of straight lines parallel to both reference planes, perpendicular to one reference plane and parallel to other reference plane, inclined to one reference plane and parallel to the other reference plane, Projections of Straight Line Inclined to both the reference planes.

Unit 3 **5**

Projections of Planes (Square, Circle, Pentagon, Hexagon): A Plane perpendicular to one reference plane and parallel to other, A plane Perpendicular to both reference planes, A plane perpendicular to one reference plane and inclined to the other, A plane inclined to both the reference planes.

Unit 4 **5**

Projections of Solids: Projections of solids (Prism, Pyramid, Cylinder and Cone): Axis perpendicular to Horizontal reference plane and parallel to other, Axis inclined to Horizontal reference plane and parallel to another plane.

Development of Surfaces: Simple Developments of a prism, cylinder, Pyramid and Cone

Unit 5 **5**

Isometric Projections / Views: Principles of Isometric Projection – Isometric Scale – Isometric Views of Lines, Planes, Conversion of orthographic views to isometric views (simple problems) and
Conversion of isometric views to orthographic views (simple problems)

Prescribed Textbooks:

1. N. D. Bhatt, Engineering Drawing, Charotar Publishing House
2. Engineering Drawing, K.L. Narayana and P. Kannaiah, Tata McGraw Hill

Reference Books:

1. Engineering Drawing, M.B.Shah and B.C. Rana, Pearson Education Inc
2. Engineering Drawing with an Introduction to AutoCAD, Dhananjay Jolhe, Tata McGraw Hill

CO-PO Mapping:

Course Outcomes	Engineering Knowledge	Problem Analysis	Design/Development of solutions	Conduct investigations of complex problems	Modern tool usage	The engineer and society	Environment and sustainability	Ethics	Individual and team work	Communication	Project management and finance	Life-long learning
24AMEC11T/21T.1	3	2	1	2	-	-	-	1	-	1	-	1
24AMEC11T/21T.2	3	2	1	2	-	-	-	1	-	1	-	1
24AMEC11T/21T.3	3	2	1	2	-	-	-	1	-	1	-	1
24AMEC11T/21T.4	3	2	1	2	-	-	-	1	-	1	-	1
24AMEC11T/21T.5	3	2	1	2	2	-	-	1	-	1	-	1

Engineering:-

"Scientists study the world as it is!
Engineers create the world that never has been!!"

Engineer is derived from the Greek work Ingenious!
Ingenious means intelligent/ imaginative/ innovative/ creative!!

Engineering means Applied science, i.e. Technology; Technology is the technical aspects and concepts of man-made machines, structures, sky-rise buildings, electrical and high-tech electronic machines, robotics, aeronautics, instruments etc.

Engineering Drawing:-

Engineering drawing is the language of engineers. An engineer seeks a medium to express and to develop his engineering imagination for the creation of a successful design.

(or)

The representation of an object containing details like shape, size, features, specifications etc is called Engg., drawing.

(or)

Engineering drawing is a type of drawing used to fully and clearly convey graphically the ideas and information necessary for engineered items.

1. Alphabets - capital letters (A to Z) and small letters (a to z)
2. Write your name and complete home address
   Name, father
3. Write your college name
4. Write a " Engineering drawing is language of engineers"
5. Write a " strength is fine, weakness is

Engineering Drawing Applications:-

Engineering Drawing is a core subject for all the branches of engineering. It is used in different engineering disciplines to design and draw.

mechanical and Production Engg:- machine components, Transmission Systems, CNC machine tools, mechanics of solids, Robotics

civil and Architectural Engg:- structures, Plan of buildings, multi-storeyed complex, Bridges, Stadium, Town Planning, mapping, Contour Plotting, layouts

Electrical Engineering :- circuit layouts, Electrical wiring diagrams, Panel Design, Control schematics

Instrumentation Engg:- measuring instruments, sensors

Computer Science Engg and Electronics:- schematic diagrams of Printed circuits, micro Processors, Integrated circuits

Communication Engg:- communication network, Satellite transmitting Pictures, TV telecasting

Automobile Engg:- Internal combustion Engines, Kinematics, Steering, Hydraulic circuits

Aeronautical Engg:- Spacecraft, Jet Propulsion, Flight Simulator, Lofting

Textile Technology:- Fashion design of garments

metallurgical Engg., mining Engg., marine Engg.,

List of Drawing Instruments:-

The drawing instruments are used to produce drawings quickly and more accurately. The accuracy of the drawings depents largely on the quality of instrments. The following is the list of a majority of drawing tools used for manual drawing.

1. Drawing board.
2. mini-draughter/ Junior drafter
3. Set- squares 45°-45° and 30°-60°
4. Drawing instruments box [compasses - [Bow, Large ; Dividers - [Bow, Large]
5. Scale
6. Protractor -360° (or) 180°
7. Eraser
8. Drawing Pencils
9. U-clamps (or) U-clips
10. Drawing sheets
11. French curves
12. Sandpaper
13. Knife (or) Blade cutter
14. Sharpener

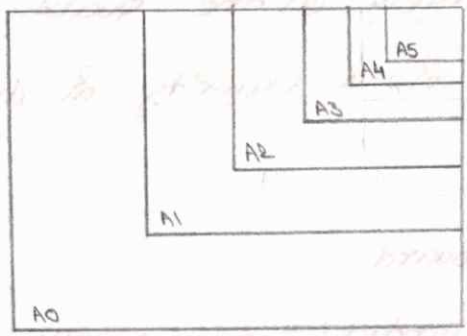
Classification of Pencils:-

Grand of Pencil	Hardness	Remarks
10H to 4H	Extremely hard	not useful for engineering drawing
3H	very Hard	General Purpose Pencils
2H	Hard	
H	moderately hard	
F	firm	
HB	medium	
B	moderately Hard and soft	
2B	soft and black	Too soft for engineering drawing
3B	very soft and black	
4B to 8B	very soft and very black	

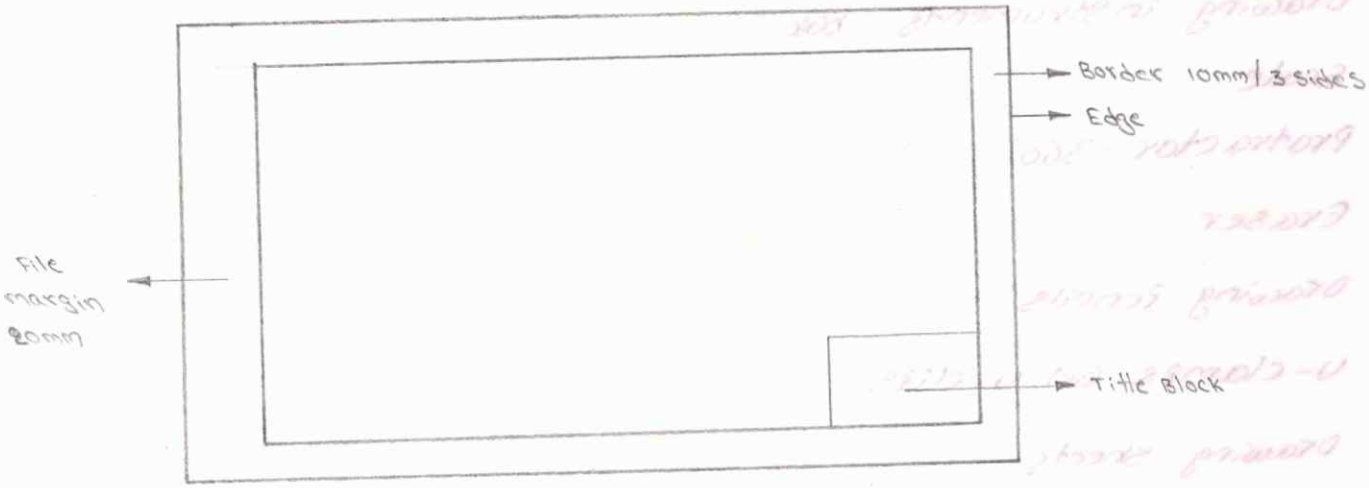
Drawing sheet:-

Designation	Size(mm)
A5	210×148
A4	297×210
A3	420×297
A2	594×420
A1	841×594
A0	1189×841

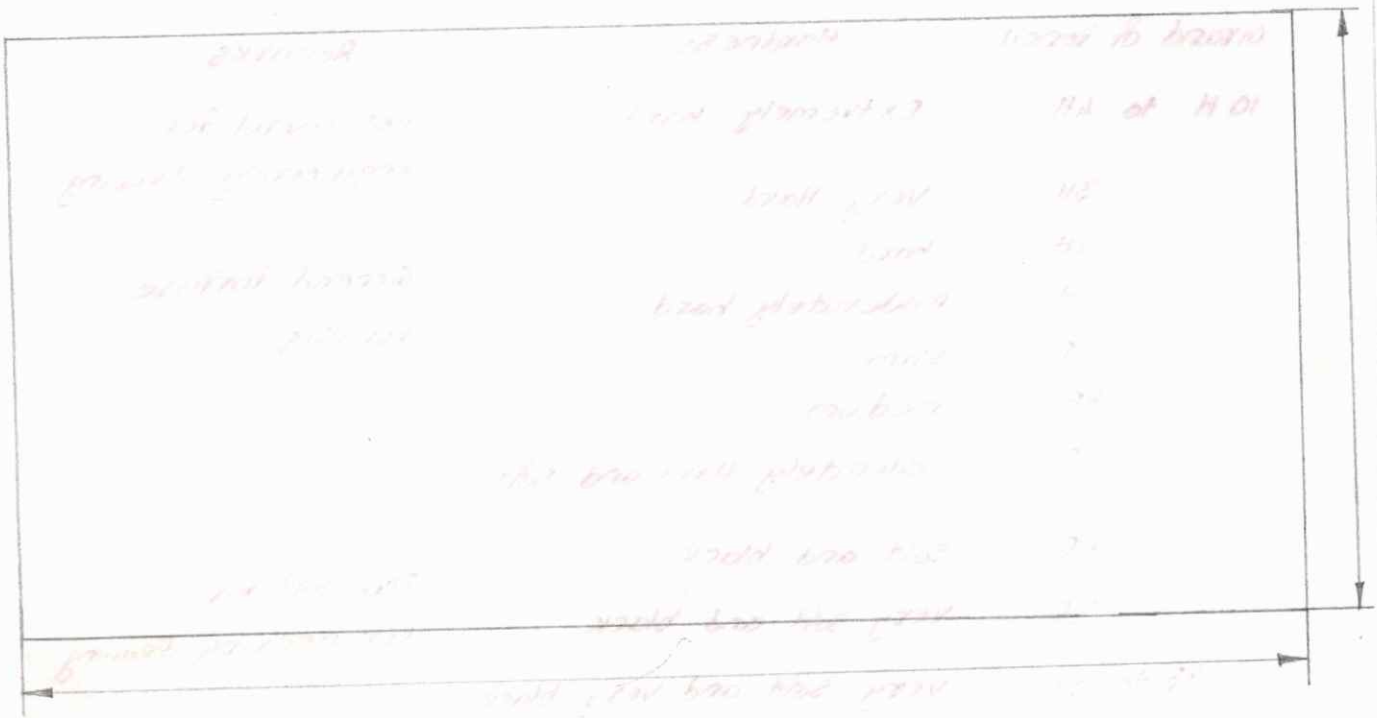
Drawing sheets are available in six preferred standard sizes, as specified by the Bureu of Indian Standards (BIS).



Layout of A2 size drawing sheet for class work:-



Title Block:-



Lines:-

For better under standing & drawing, the contrast between the various lines must be good. i.e, the details of various objects have been drawn by different types of lines. Each of line hay a definite meaning and sence to convey.

S.No	Line Description and Representation	General Applications
1.	Continuous thick	visible outlines, edges, main representations, in diagrams, maps.
2.	Continuous thin	Dimension Lines, Imaginary Lines, Extension Lines, Hatching, Leader with reference line, Projection Lines, short center Lines, framing of details, construction Lines, Guide Lines.
3.	Continuous narrow Freehand thin 	Partial or interrupted views, cuts and sections if the limit is not a line of symmetry or a center line
4.	Continuous narrow line with zigzags 	Long break Line, Preferably mechanically represented termination of Partial or interrupted views cuts and sections.
5.	Dashed narrow Line	Hidden outlines and edges.
6.	Long dashed dotted narrow Line (or) chain thin	center lines / Axes, Line of symmetry, Trajectories.
7.	Long dashed Dotted wide Line (or) chain thik	Indication of ~~surface finish~~, Lines or surfaces to which a special req., applies
8.	chain thin, thick at ends and changes of direction 	Cutting Plane
9.	Chain double dashed	outlines of Adjecent Parts, Alternative and extreme, Position of movable Parts, centroidal lines.

How to Begin your Drawing:-

1. Clean the drawing board
2. Fix your drawing sheet over a padding sheet on the drawing board.
3. Fix the mini-drafter on the drawing board on it's left top corner and set it to zero angle position so that the longer scale is parallel to the bottom edge of the drawing board.
4. Draw the Border lines and the Title Block on the drawing sheet using HB Pencil.
5. Print the problem number on the left top side of the figure. Enclose the number in a small circle of about 10mm diameter. Then commence your drawing work.
6. Captions like the name of the object, views etc., should be written below the drawing.

Lettering:-

Lettering is an important feature of all engineering drawings, meant for indicating notes, dimensions and other details are indicated on the drawing. The most important requirement for lettering on engineering drawings are legibility, uniformity and ease of execution. thes requirements are satisfied by the following rules:

1. The characters are to be clearly distinguishable from each other in order to avoid any confusion between them, even in the case of slight mutilations.
2. Photographic reproductions required the distance between two adjacent lines (or) the space between letters to be at least equal to twice the line thickness.
3. The line thickness for lower-case and capital letters shall be the same in order to facilitate lettering.

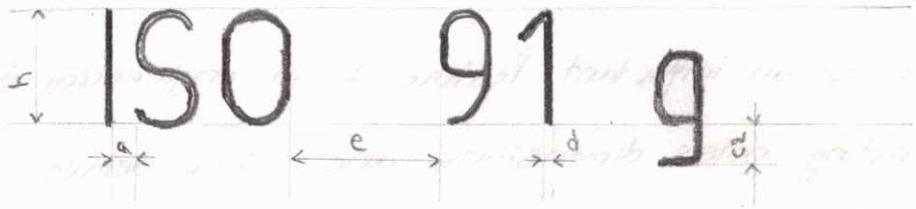
Single Stroke Letters:-

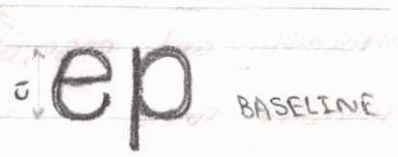
The Bureau of indian standards (IS: 9609: 2001) recommends single stroke lettering for use in engineering drawing. These are the simplest forms of letters and are usually employed in most of the engineering drawing.

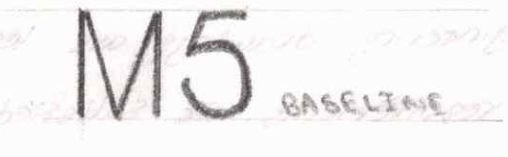
The word single-stroke should not be taken to mean that the letter should be made in one stroke without lifting the pencil. It means that the thickness of the letter should be uniform such as is obtained in one stroke of the pencil.

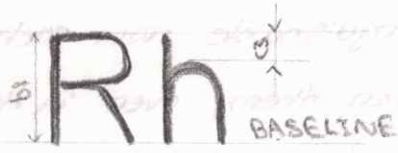
(i) Vertical- The lettering in which the direction of alphabets is vertically upward is known as vertical letters.

(ii) Inclined- The lettering in which the direction of alphabets is inclined to the horizontal line is known as inclined or italic lettering.









Lettering height (h) $[\frac{10}{10}]$ - 10

Height of lower-case letters (c_1) $[\frac{7}{10}]$ - 7

Tail of lower-case letters (c_2) $[\frac{3}{10}]$ - 3

Steam of lower-case letters (c_3) $[\frac{3}{10}]$ - 3

Spacing between characters (a) $[\frac{2}{10}]$ - 2

min. spacing b/w baselines' (b_1) $[\frac{15}{10}]$ - 15

min. spacing b/w baselines' (b_2) $[\frac{13}{10}]$ - 13

Spacing b/w words (e) $[\frac{6}{10}]$ - 6

Line width (d) $[\frac{1}{10}]$ - 1

ABCDEFGHIJKLMNOPQR

STUVWXYZ

abcdefghijklmnopqr

stuvwxyz

0123456789

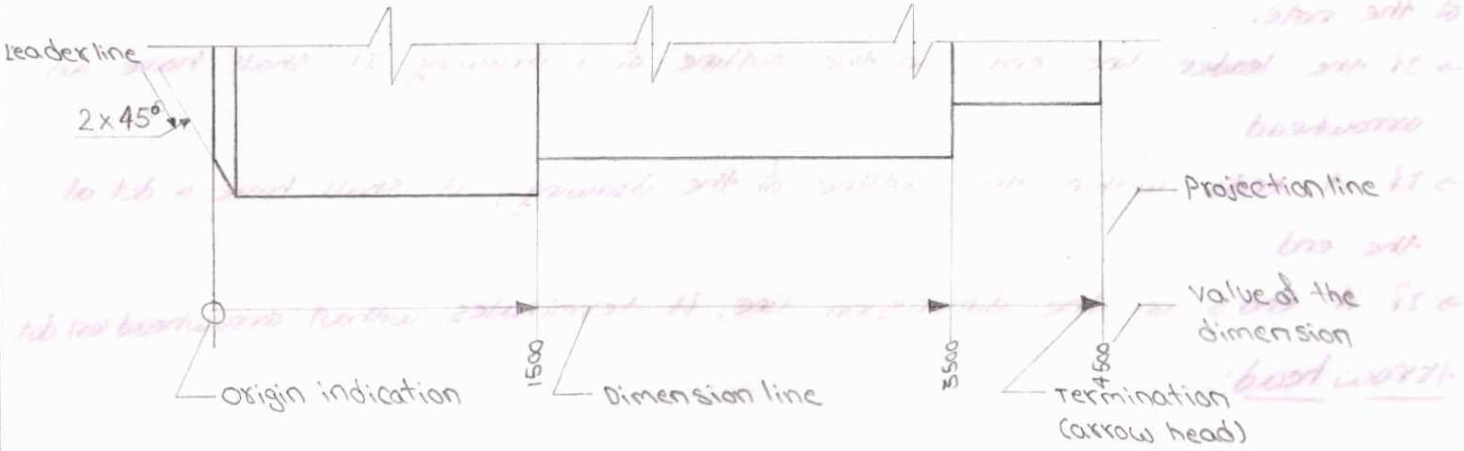
DIMENSIONS:-

Dimensioning:-

Indicating the various sizes of an object such as length, width, thickness, diameter of holes, angles, grooves etc. and such other details relating to the manufacture on the drawing is called Dimensioning.

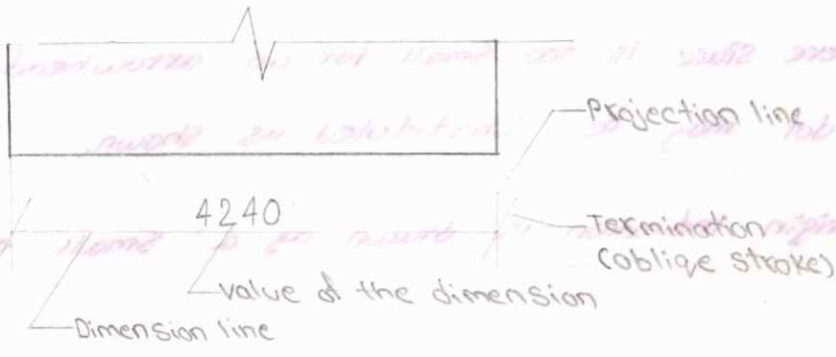
Dimensions on the drawing must represent the actual dimensions of the object but not the dimensions used for drawing.

Elements of Dimensioning:-

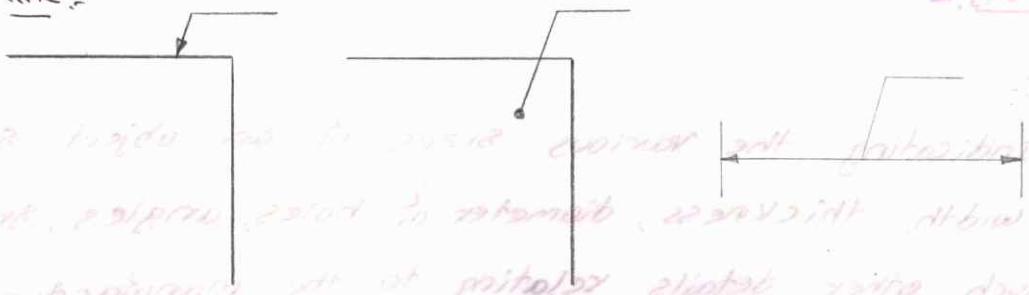


Dimension Line (D.L):- Dimension line is thin continuous line. It is terminated by arrowheads touching the outlines, extension lines, or centre line. Dimension line is placed at least 6 to 10 mm away from the outline of the drawing.

Projection Line (P.L):- Projection Line (or) Extension Line is a continuous narrow thin line drawn perpendicular to the outline to be dimensioned and without leaving a gap from the outline. It is drawn extending slightly beyond the dimension line by about 2mm.



Leader line:-



Leader line 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.

→ If the leader line ends on the outline of a drawing, it shall have an arrowhead

→ If it ends within the outline of the drawing, it shall have a dot at the end

→ If it ends on the dimension line, it terminates without arrowhead (or) dot

Arrow head:-

An arrowhead is placed at each end of a dimension line. The arrowhead may be open, closed (or) closed and filled in.

→ Length of an arrowhead is about three times the width

Oblique Stroke:-

→ Instead of arrowheads, the ends of the dimension lines may be marked by oblique stroke drawn as a short line inclined at an angle of 45°

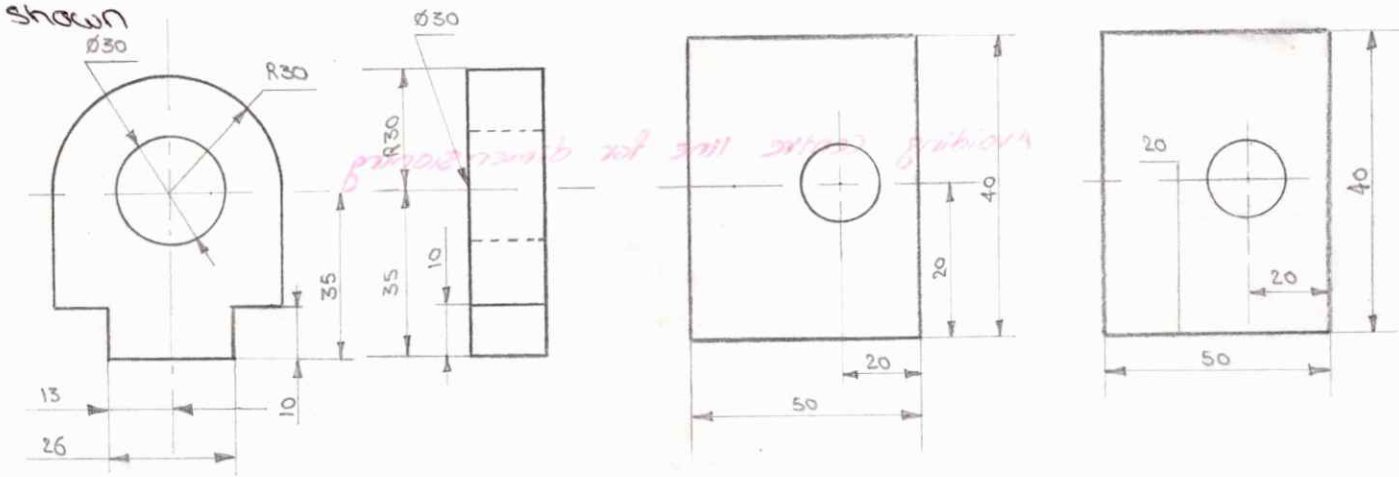
→ Where space is too small for an arrowhead, the oblique stroke (or) a dot may be substituted as shown.

→ Origin indication is drawn as a small circle of about 3mm diameter.

Principles of Dimensioning:-

The following are some of the principles to be applied while dimensioning:

1. Any dimension given, must be clear and permit only one interpretation.
2. Dimensions indicated in one view need not be repeated in another view, except for the purpose of identification, clearity (or) both.
3. Dimensions shall be placed on the view, where the shape is best shown



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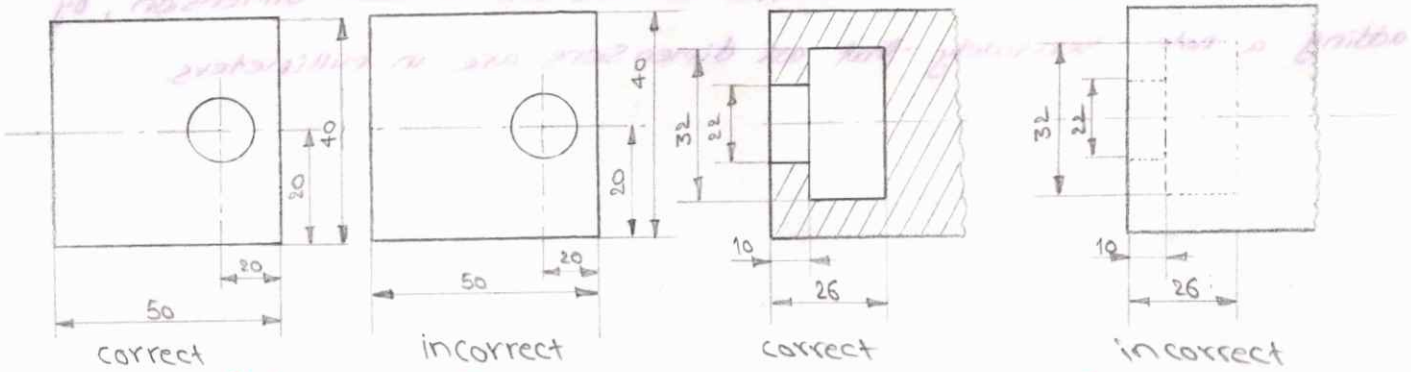
Dimensioning where the shape is best shown — Placing dimensions outside the view

4. As far as possible, dimensions should be placed outside the view
5. Dimensions should not be placed very near to the parts being dimensioned
6. Dimensions should be marked from visible outlines rather than from hidden lines



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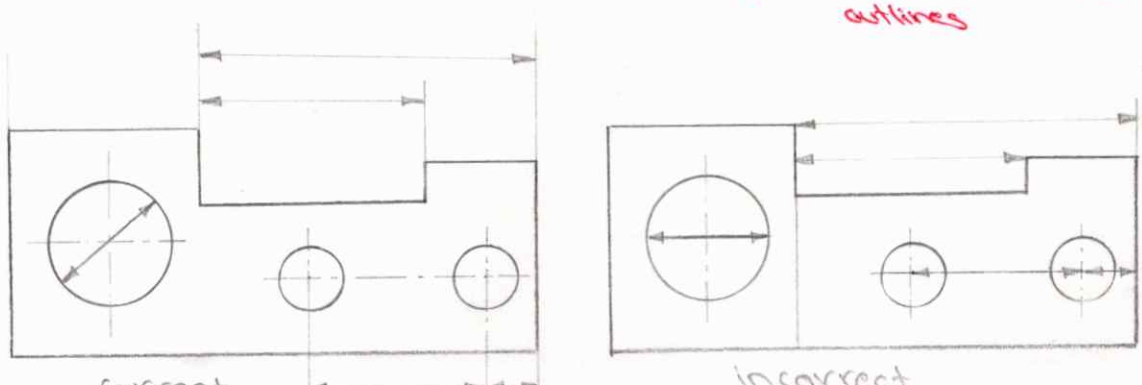
Spacing of dimension lines — Placing dimensions from the visible outlines



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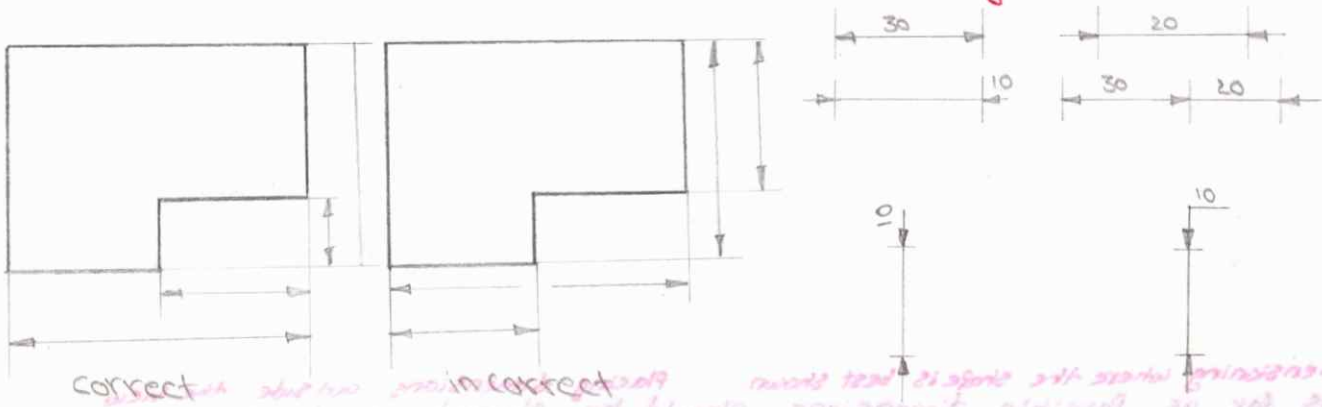
Avoiding contour lines for dimensioning

Avoiding centre line for dimensioning



Avoiding crossing of dimension lines

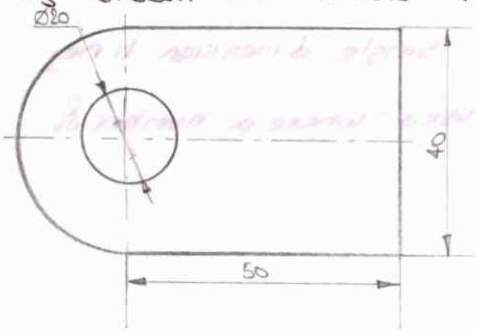
Different methods of Dimensioning a length.

7. Dimensions should be expressed in one unit only, preferably in millimeters. The unit "mm" can then be dropped at the end of each dimension, by adding a note separately that all dimensions are in millimeters.

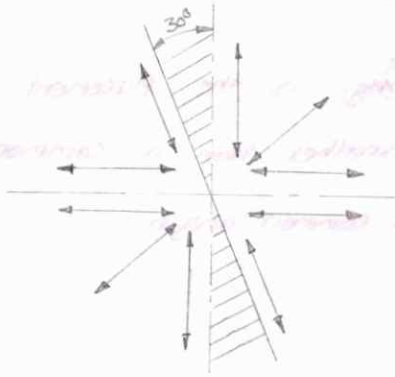
Placing of dimensions:-

Dimensions may be placed according to either of the following recommended systems:

→ Aligned System:- In an aligned system, all the dimensions are placed above the dimension lines such that, they may be read either from the bottom (or) from the right hand side of the drawing. Dimensions on oblique dimension lines shall be oriented as shown in below figure and except where un avoidable, they should not be placed in the 30° zone. Angular dimensions may be oriented as shown in below figure.



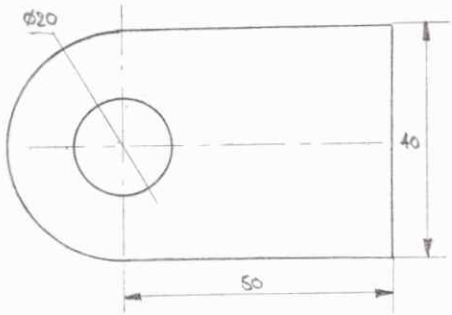
Dimensioning - Aligned System



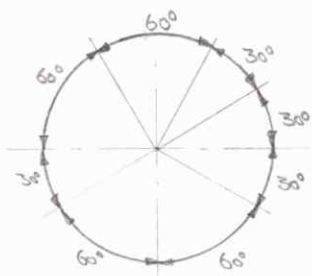
Dimensioning on oblique dimension lines

Angular dimensioning - Aligned System.

→ Uni-directional System:- In uni-directional system, all the dimensions are placed in one direction such that they may be read from the bottom of the drawing only.



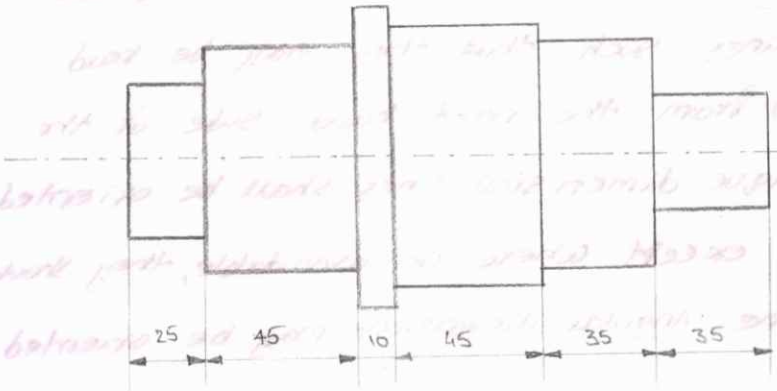
Uni directional System for Linear Dimensioning



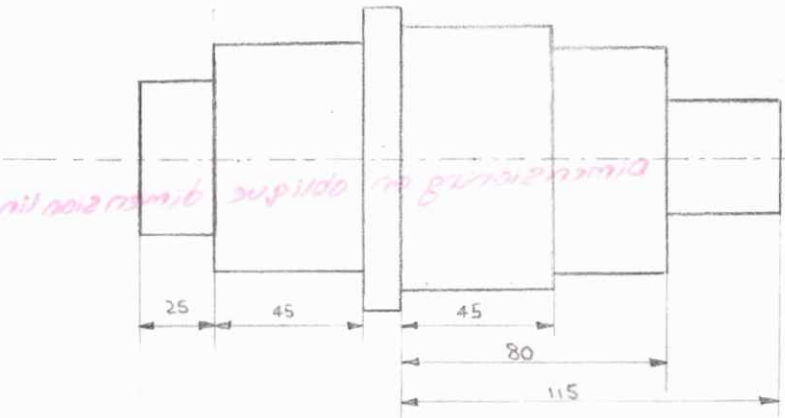
Uni directional system for angular Dimensioning.

Arrangement of dimensions:-

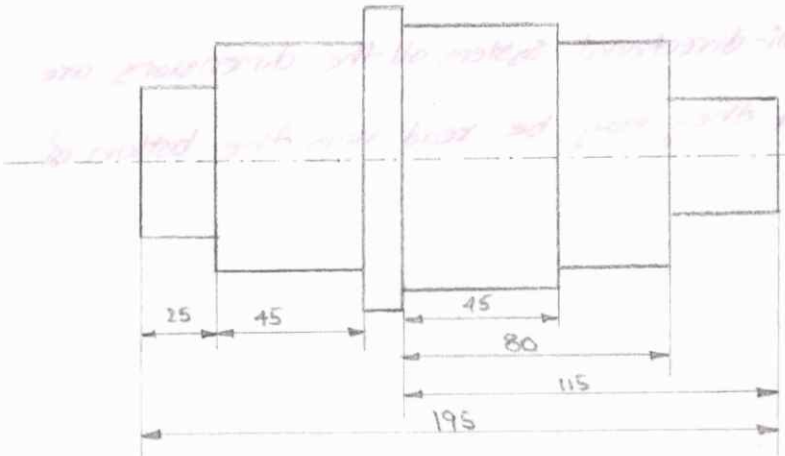
Chain dimensions:- When successive dimensions are arranged in a straight line, the method is known as "chain dimensioning". All chain should be arranged in a continuous straight line.



Parallel Dimensions:- is the placement of a number of single dimension lines parallel to one another from a common origin. It is used where a number of dimensions have a common origin.



Combined dimensions:- When chain dimensioning and parallel dimensioning are used in a single drawing, it is called combined dimensioning.



GEOMETRICAL CONSTRUCTIONS

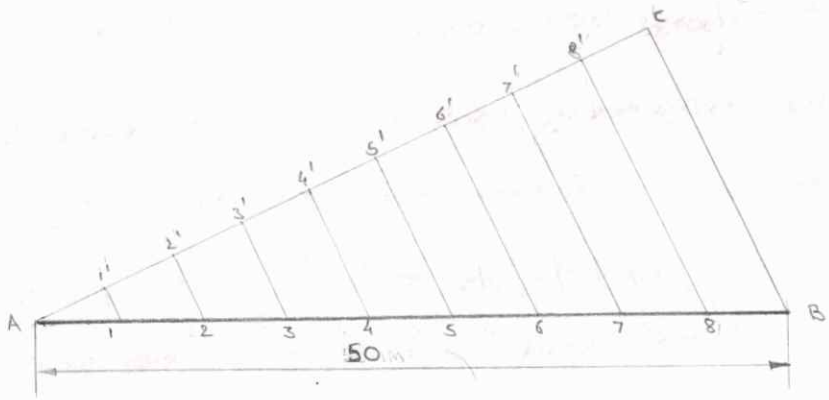
The engineers should be familier with the principles of plane and solid geometry. A thorough knowledge of these principles is a prerequisite to solve engineering graphics problems. Plane figures such as circles, triangles, and different polygons frequently constitute a part of various objects for preparing engineering drawings.

Geometrical constructions deals with problems which are mostly based on plane geometry and which are very essential in the preparation of engineering drawings. They are described as under:

1. Bisecting a line
2. To divide a line into equal parts.
3. To bisect an angle
4. To find the centre of an arc
5. Draw tangent to circle
6. To construct an equilateral triangle
7. To construct a square
8. To bisect an arc
9. To construct regular polygons
10. Special methods for drawing regular polygons

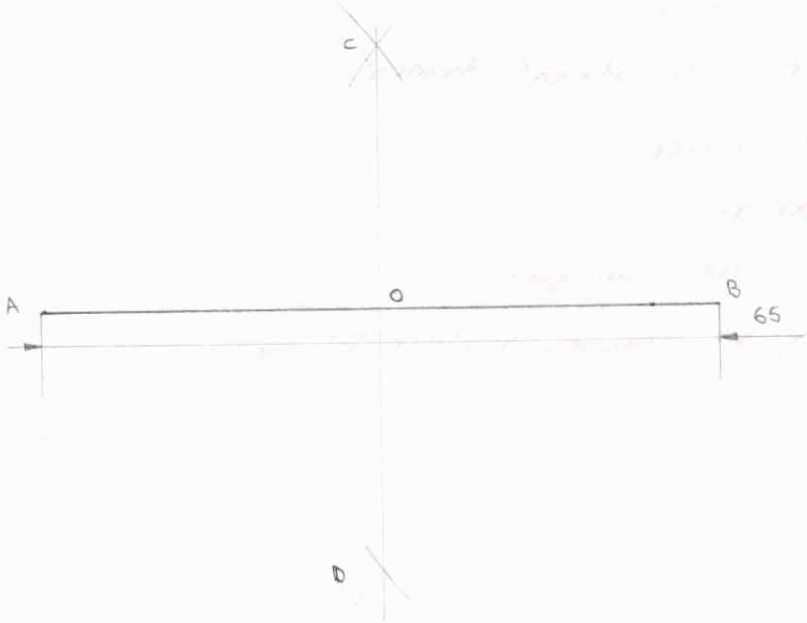
Plane geometry construction:-

① Divide a stright line AB of length 50mm into 9 equal parts?



1. Draw a line AB of 50mm length.
2. Through A draw a line AC, making any convenient angle with AB
3. From A and along AC, step off 9 equal parts of any convenient length using divider. Join C and B
4. Draw lines parallel to CB through 1', 2', 3', 4', 5', 6', 7' and 8' to cut AB at 1, 2, 3, 4, 5, 6, 7 and 8. The points 1 to B divide the line AB into 9 equal parts.

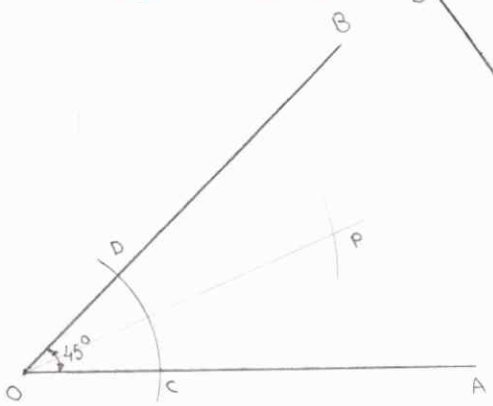
② Bisect a stright line AB of length 65 mm?



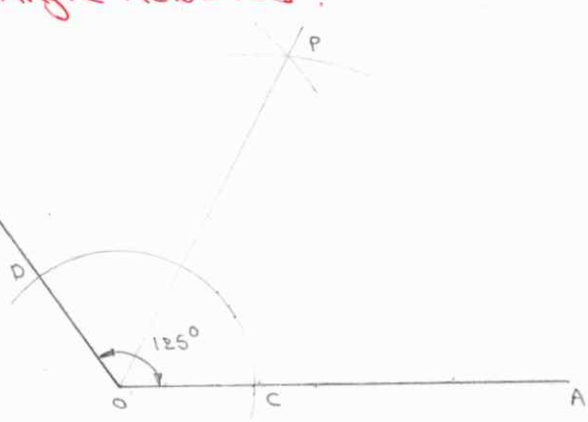
1. Draw a line AB of 65 mm length.
2. Set the compass to a radius greater than one-half the length of AB
3. Set the needle point of the compass at ends A and B respectively. Strike arcs to intersect at C & D.
4. Draw a line from C and D. The line CD is the perpendicular bisector of AB. Also, the intersecting point O is the midpoint of line AB.

3. Bisect an angle AOB given

a. Angle AOB = 45°



b. Angle AOB = 125°.

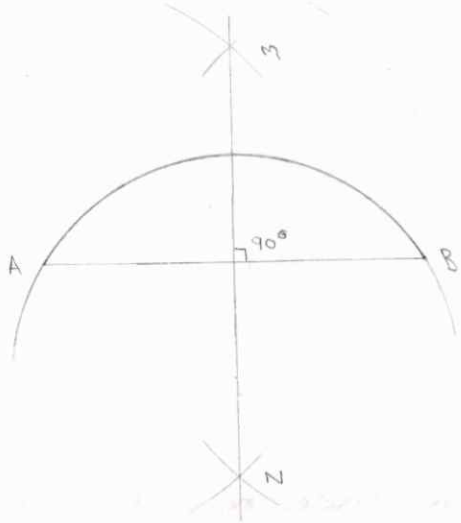


1. Let the given angle be AOB between two given lines OA and OB

2. With O as centre and with any convenient radius draw an arc cutting OA at C and OB at D.

3. With C and D as centres and any convenient radius, draw arcs to intersect each other at P.

4. Bisect a given arc of radius 30 mm?

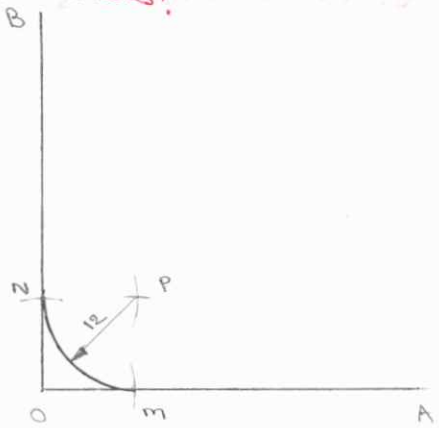


1. Draw an arc AB with an radius of 30 mm

2. With A and B as centres and radius grater than half of AB, draw arcs intersecting each other at m and N respectively.

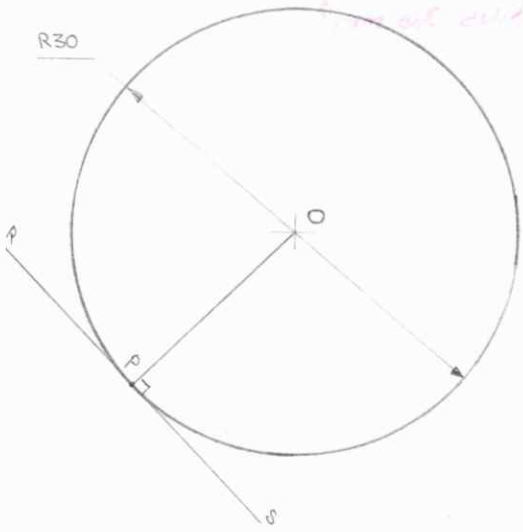
3. Join m and N which bisects the given line (or) arc AB

5. Draw an arc of radius 12 mm touching two straight line at right angles to each others?



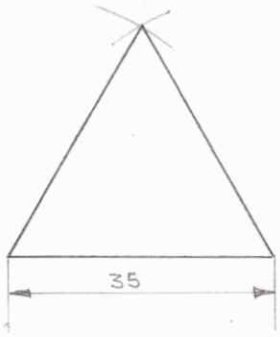
1. Draw Lines OA and OB with convenient length.
2. With O as centre and radius 12 mm, draw arcs cutting OA at m and OB at N.
3. With same radius and m and N as centres, draw arcs to intersect at P.
4. With P as centre and radius 12 mm, draw the required arc mN.

6. Draw a tangent to the circle of radius 30 mm.



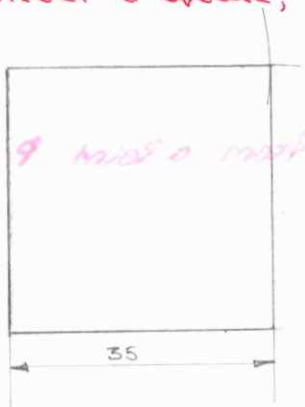
1. O as centre draw the given circle. mark point P on the circumference of the circle at any position.
2. Join OP. Through P draw line RS perpendicular to PO. RS is the tangent at P.

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



Draw a given line AB. With A and B as centres and radius equal to AB, draw arcs intersecting each other at C. Join AC and BC. Then ABC is the required equilateral triangle.

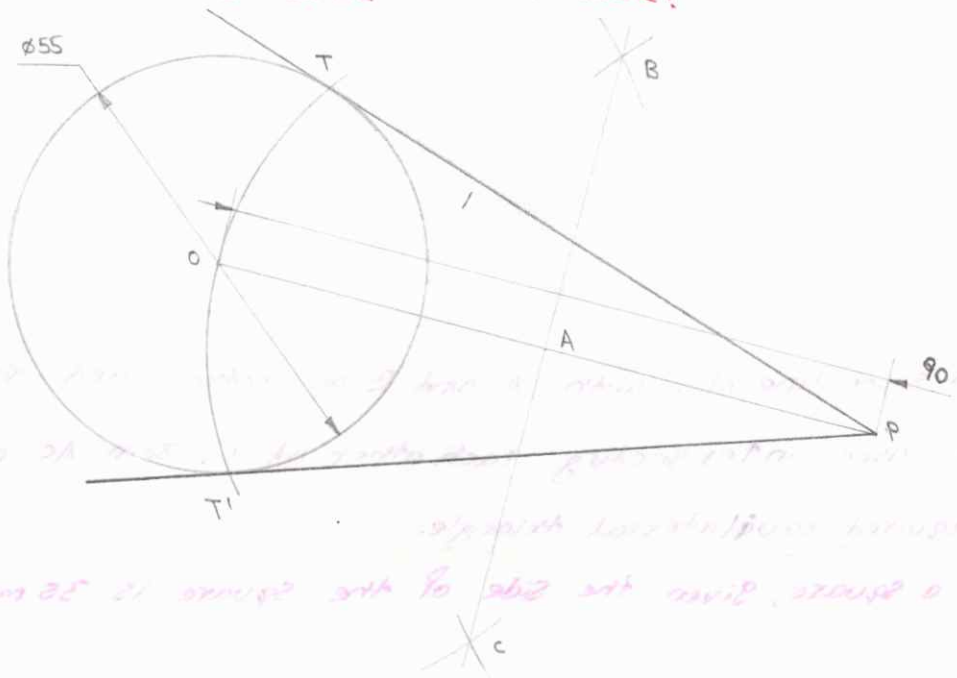
8. Construct a square, given the side of the square is 35 mm



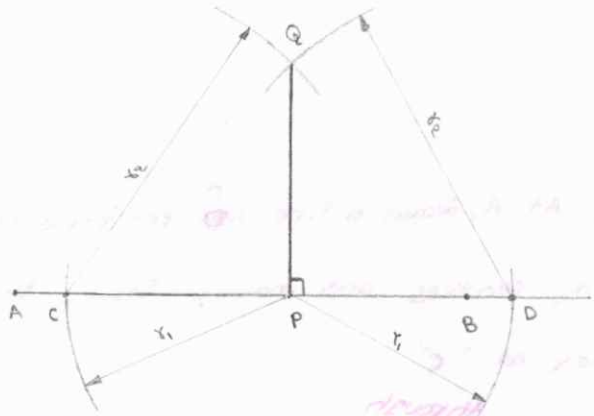
Draw a given line AB, At A, draw a line AD perpendicular to AB with same length. With B and D as centres and having same radius i.e AB, draw arcs intersecting each other at 'C'.

9. Construct an arc passing through any three points not in a straight line

(10.) Draw a tangent to a circle having a 55mm diameter through point P lying 90 mm from the centre of the circle?

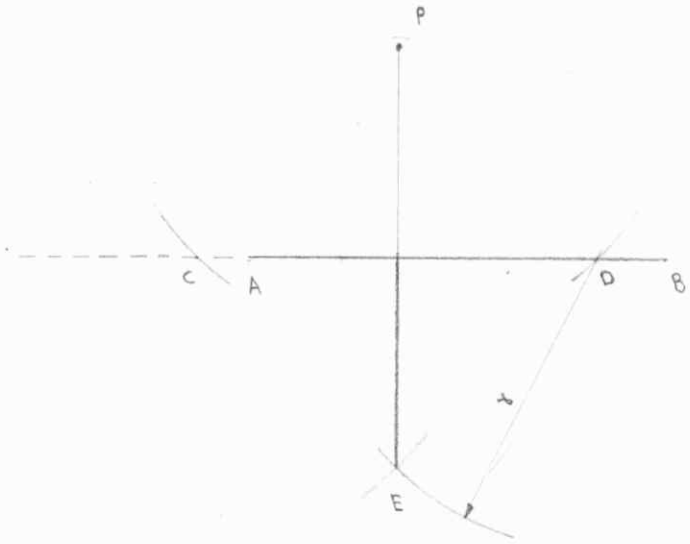


(11) To draw a perpendicular to a given line AB from a point P anywhere on it.



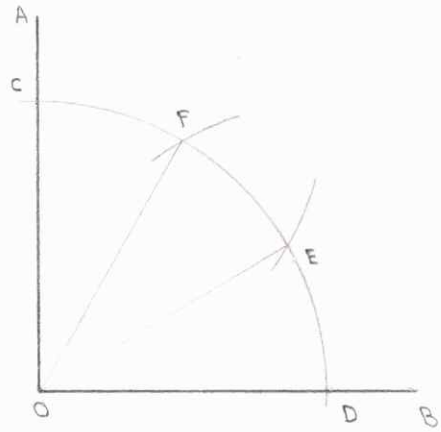
$\because r_2 > r_1$

(12) To draw a perpendicular to a given line AB from a point P outside it



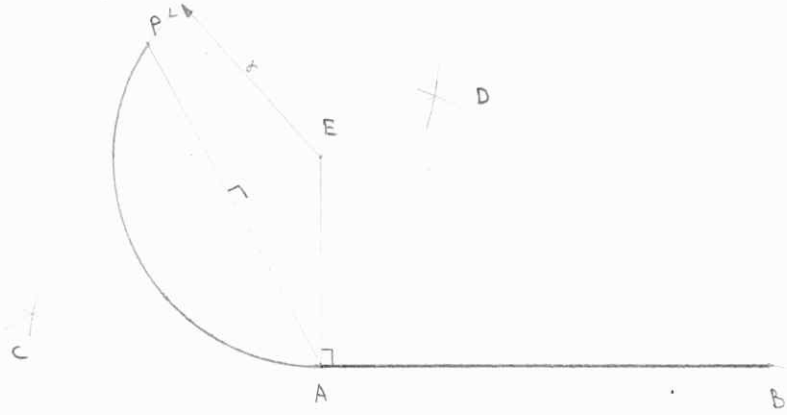
$\because r > \frac{CD}{2}$

(13) To trisect a given right angle AOB

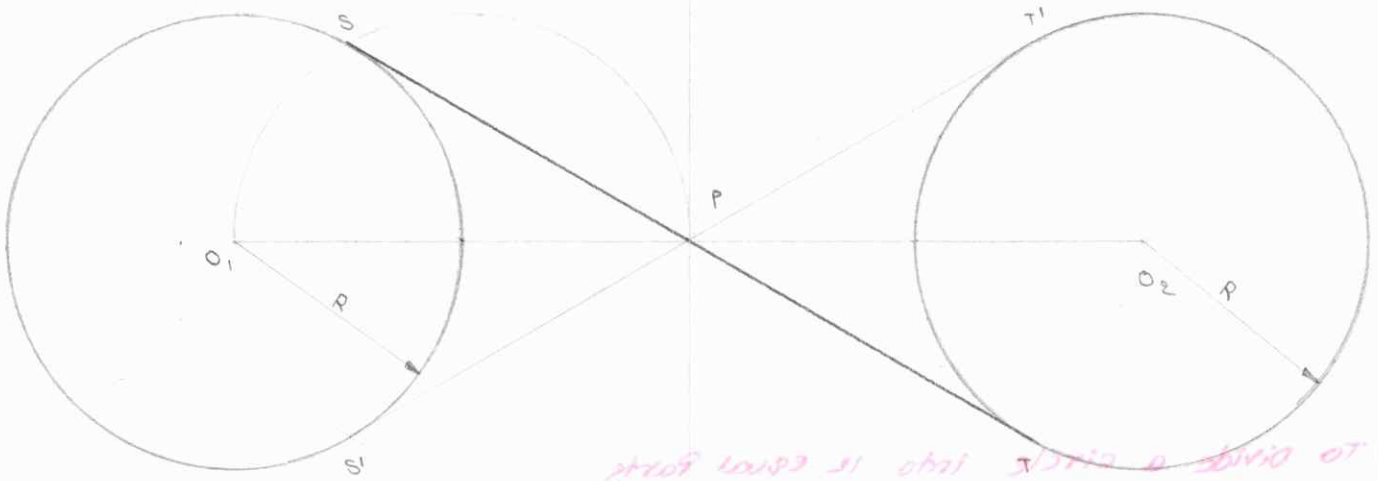


(14) To Divide a circle into 12 equal Parts

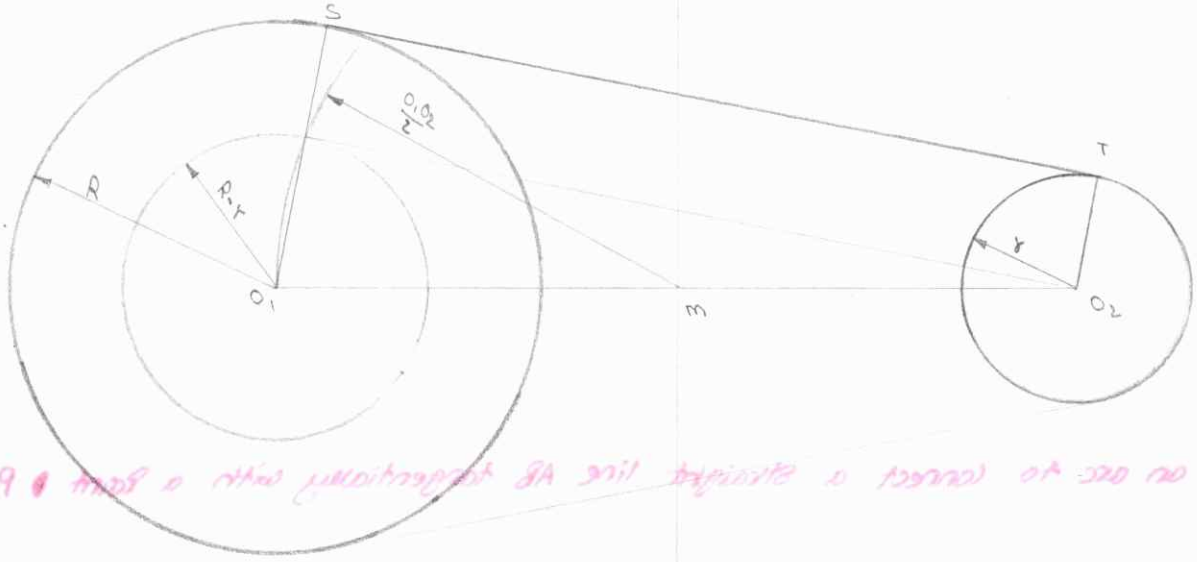
(15) Draw an arc to connect a straight line AB tangentially with a Point P



(16) To draw a common tangent to two given arcs AB and CD (or two circles) of equal radius R.



(17) To draw a common tangent to two given arcs AB and CD (or two circles) of un equal radius R and r



For External Tangent = R - r

For Internal Tangent = R + r

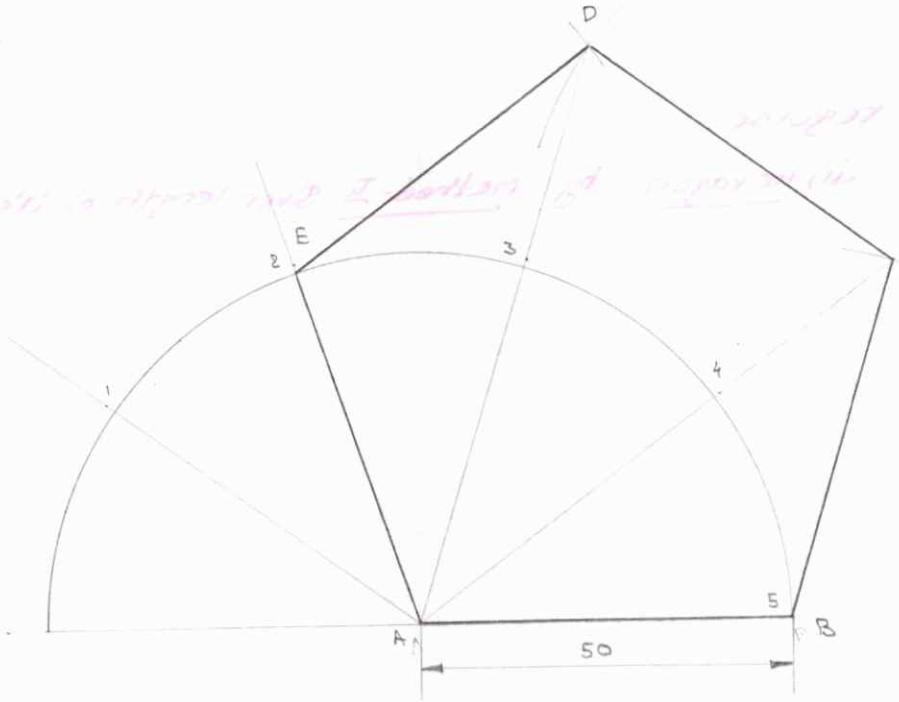
POLYGONS:-

A Polygon is a plane figure, bounded by straight edges. When all the edges are of equal length, the Polygon is said to be a regular Polygon.

The simplest Polygons are → Triangles - Three sides
→ Quadrilaterals - Four sides
→ Pentagons - Five sides
→ Hexagon - Six sides
→ Heptagon - Seven sides
→ Octagon - Eight sides
→ Nepagon - Nine sides

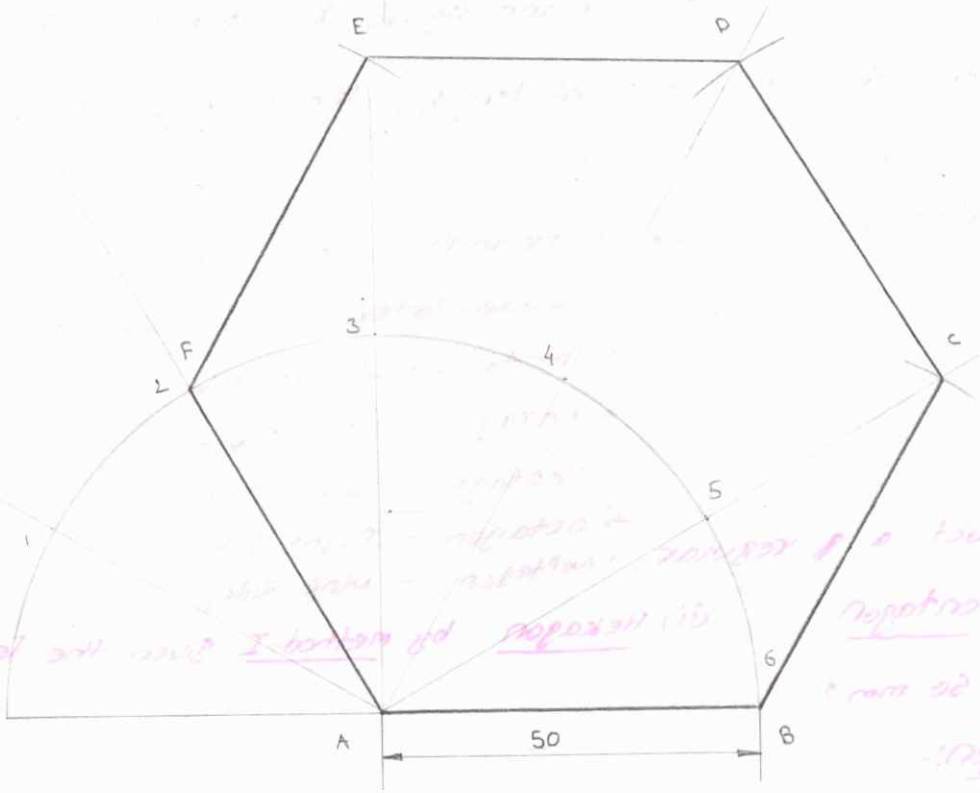
① Construct a regular (i) Pentagon (ii) Hexagon by method-I given the length of its side is 50 mm?

Ans (i) Pentagon:-



1. Draw a line AB equal to the length of the side
2. With centre A and radius AB, draw a semi-circle
3. Divide the semi-circle into the same number of equal parts, as the number of sides ie. Say 5.
4. Draw radial lines through 2, 3, 4 etc (second division point 2 will always be a vertex of the polygon).
5. With centre B and radius equal to the side, draw an arc intersecting the radial line through 4 at C.
6. Repeat the procedure. The figure obtained by joining the points A, B, C etc is the required polygon.

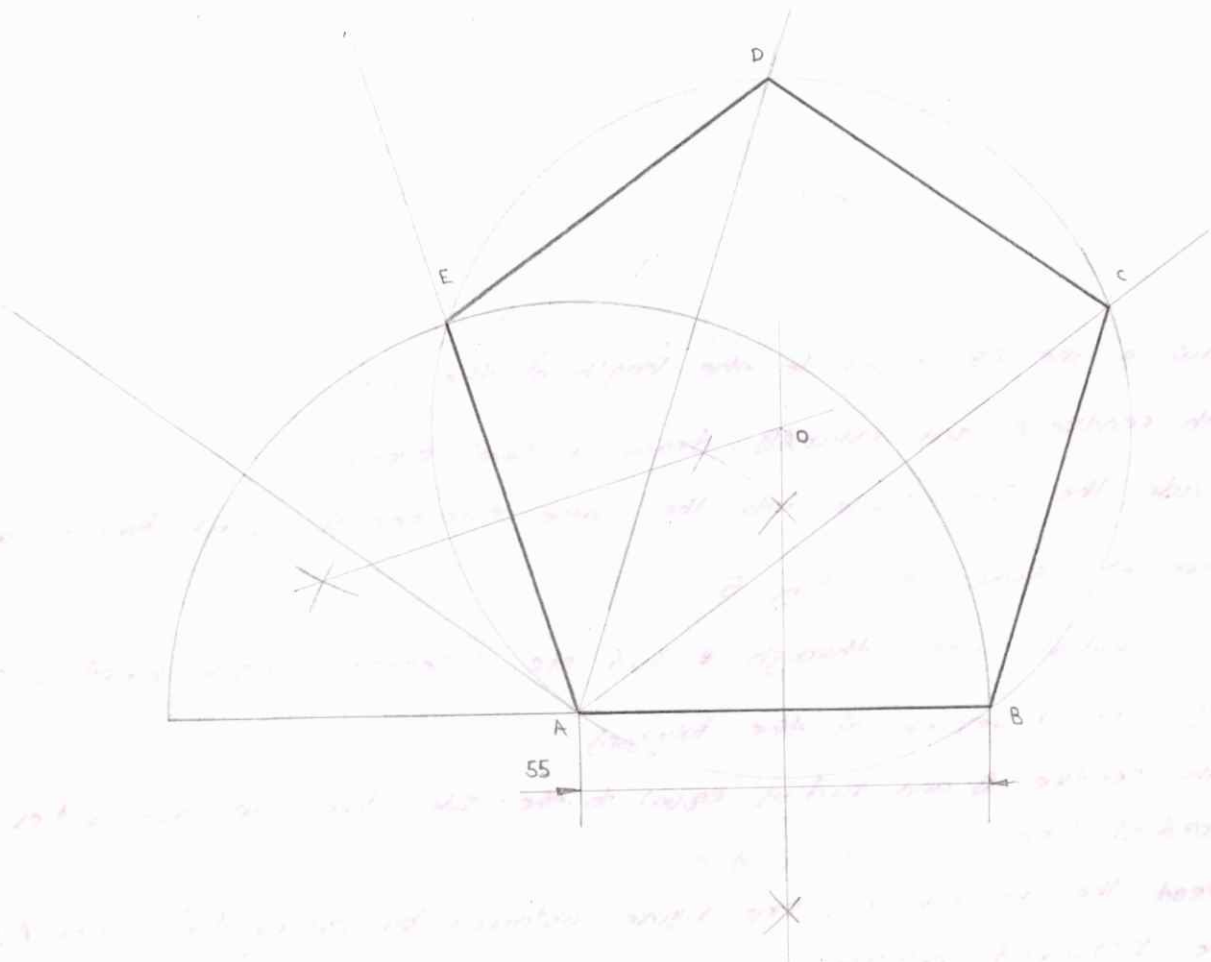
(ii) Hexagon!-



② Construct a regular

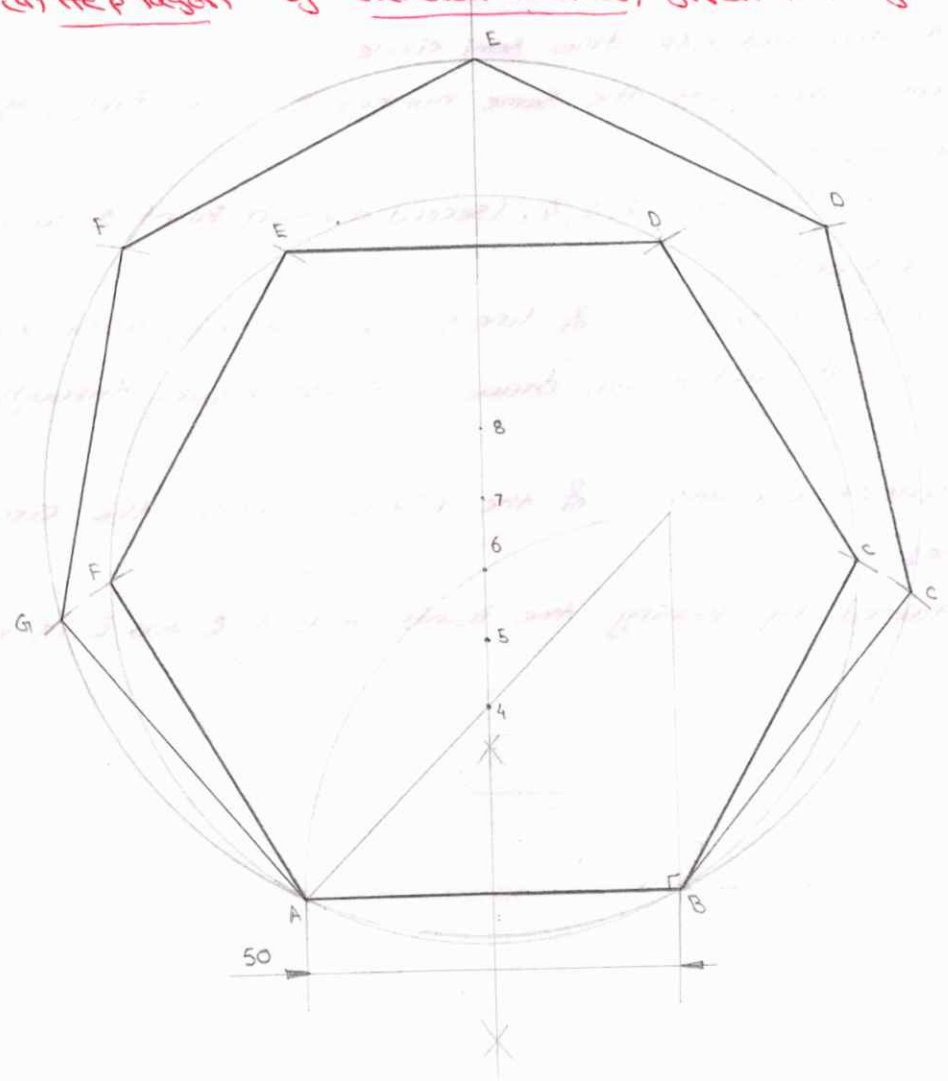
i) Pentagon ii) Hexagon by method-II given length of it's side is 55 mm.

(i) Pentagon!-



3. Construct a regular

(i) Hexagon (ii) Heptagon by General method, given the length of it's side is 50mm



Construction:-

1. Draw a line AB equal to the given length of side.
2. At B, erect a perpendicular BC of length AB.
3. Join A, C
4. With centre B and radius BA draw the Arc AC.
5. Draw a perpendicular bisector to AB, intersecting the line AC at 4 and ~~the~~ AC at 6.
6. Locate the mid-point of the line 4-6 and number it as 5.
7. Along the bisector, locate the points 7, 8, ---- N such that the distances 4-5 = 5-6 = 6-7, etc.
8. A ~~Pentagon~~ Hexagon of side equal to AB can be inscribed in a circle drawn with centre 6 and radius 6A.

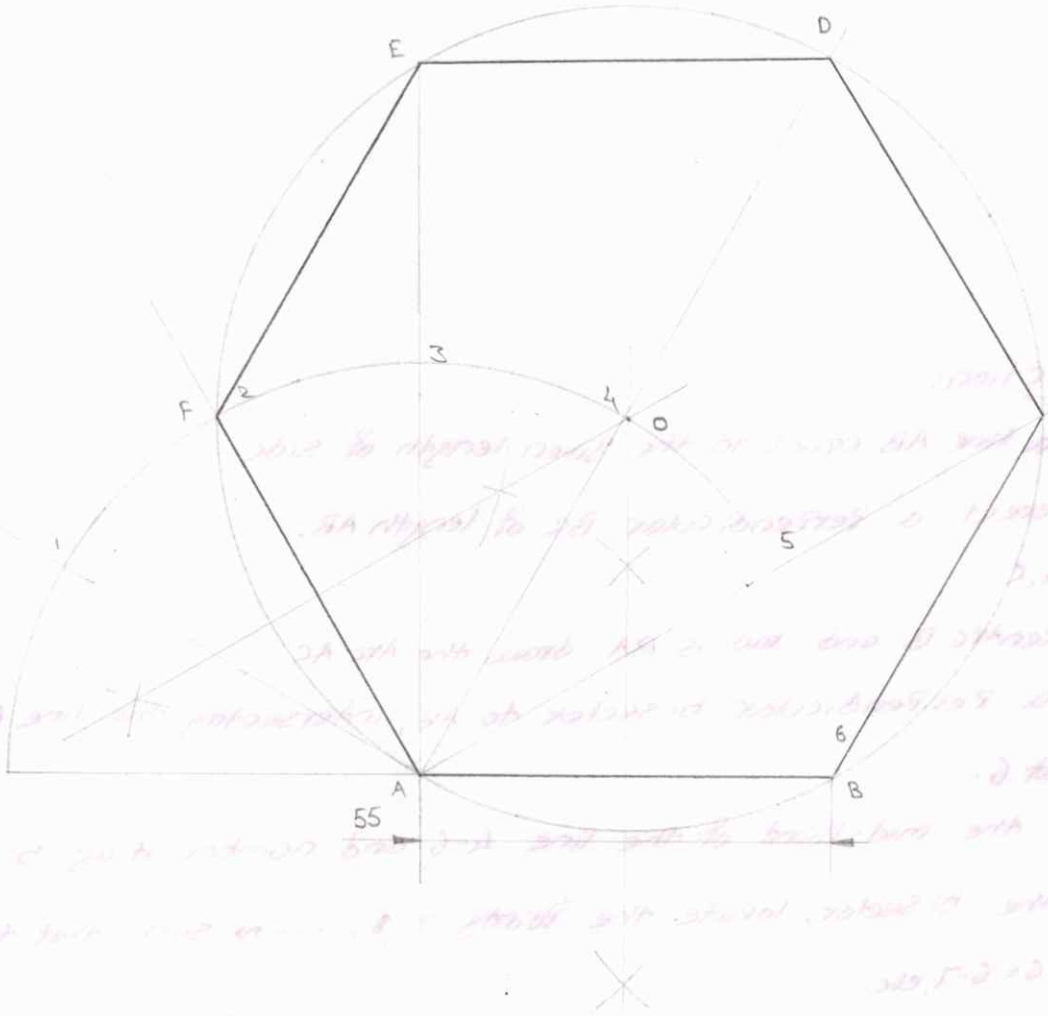
Simply by following above procedure, N sides of Polygon will be constructed by using 'N' point as a centre.

Construction:-

1. Draw a line AB equal to the length of the side
2. With centre A and radius AB, draw semi circle
3. Divide the semi-circle into the same number of equal parts, as the number of sides N, say 5.
4. Draw radial lines through 2, 3, 4. (second division point 2 will always be a vertex of the polygon).
5. Draw perpendicular bisectors of lines 2A and AB, intersecting at 'O'.
6. With centre 'O' and radius OA, draw a circle passing through the points 2 and B.
7. Locate the corners C, D and E of the polygon, where the circle meets the radial lines.

The figure obtained by joining the points A, B, C, D and E is req. polygon.

(ii) Hexagon:-

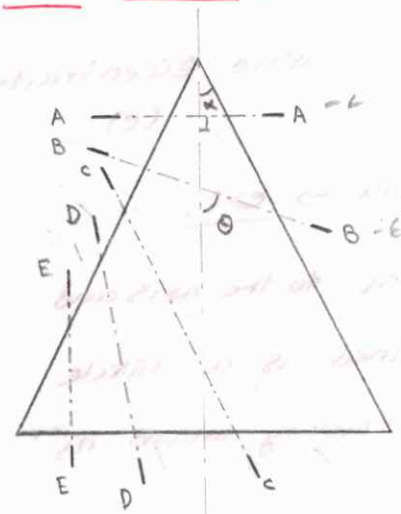


CONIC SECTIONS

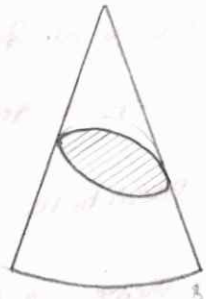
In engineering practice, the profiles of some of the objects contain regular curved features. some are obtained by intersections, when a plane passes through a cone and some are obtained by tracing the locus of a point moving according to the mathematical relationship, applicable to that particular curve. the following types of curves are considered

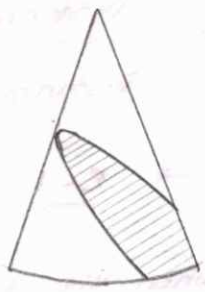
- → conic sections
- → cyclodical curves
- → involutes
- → Helices, etc.

conic sections:-

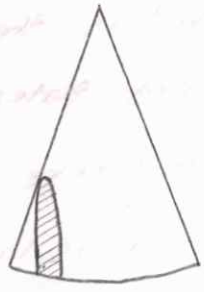


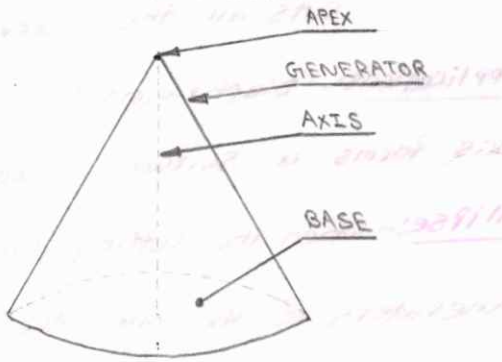

CIRCLE


ELLIPSE


PARABOLA


HYPERBOLA


RECTANGULAR HYPERBOLA



A cone is a surface generated by the rotation of a straight line whose one end is in contact with a fixed point while the other end is in contact with a closed curve, not lying in the plane of the curve.

'Apex' or 'Vertex' is the top point of the cone.

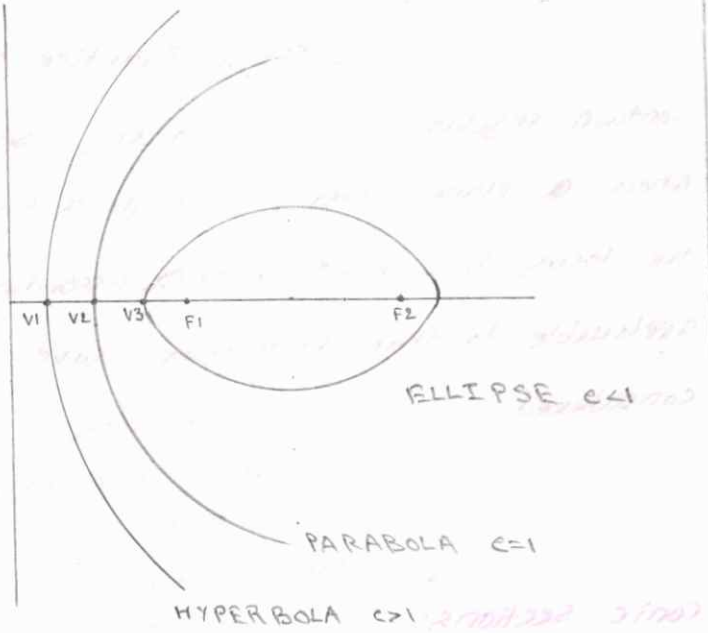
'Axis' is imaginary line joining apex & centre of base.

'Generator' is the straight line which is generating the surface of the cone

Base of the cone is the closed curve.

CONSTRUCTION OF CONICS - ECCENTRICITY METHOD:-

The conic may be defined as the locus of a point moving in a plane in such a way that the ratio of it's distances from point and a fixed straight line is always constant. The fixed point is called the focus and the fixed line, the directrix



Eccentricity

The ratio $\frac{\text{Distance of the point from the focus}}{\text{Distance of the point from the directrix}}$ is called eccentricity. (e)

Ellipse → e<1, Parabola → e=1, Hyperbola → e>1.

Circle:- When the cutting plane A A is perpendicular to the axis and cuts all the generators, the section obtained is a circle.

Applications:- Diaphragms, Discs, rings, plates etc. A circle revolving around it's axis forms a surface called a sphere.

Ellipse:- When the cutting plane BB is inclined to the axis and cuts all the generators of the cone, the section is an ellipse. The inclination of the cutting plane for an ellipse must be greater than half of the apex angle i.e $\theta > \alpha$

Applications:- Arches, stone bridges, dams, glands, stuffing box. A Planet travels around the sun in an elliptical orbit with the sun at one of its foci.

Parabola:- When the cutting plane is inclined to the axis and is parallel to one of the generators of the cone, the section is a parabola. The inclination of the cutting plane is equal to half of the apex angle i.e $\theta = \alpha$

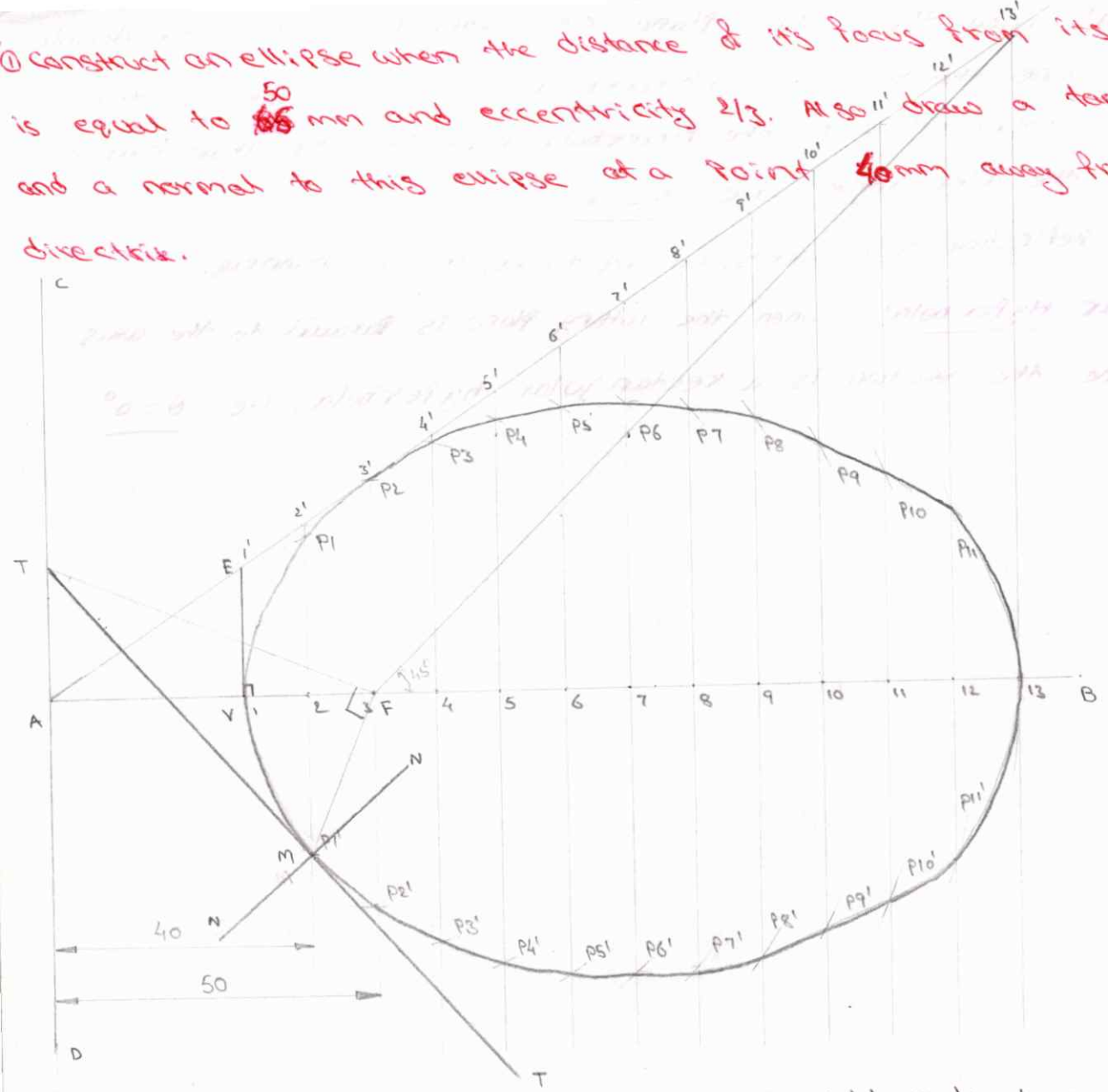
Applications:- Bridges with parabolic supports, headlamps, Torches, telescopes, solar furnace and solar cooker

Hyperbola:- when the cutting plane cuts both the parts of the double cone, the section is a hyperbola. The inclination of the cutting plane for the hyperbola must be less than half of the apex angle i.e $\theta < \alpha$

Applications:- Reflecting telescopes, cooling tower, water channels.

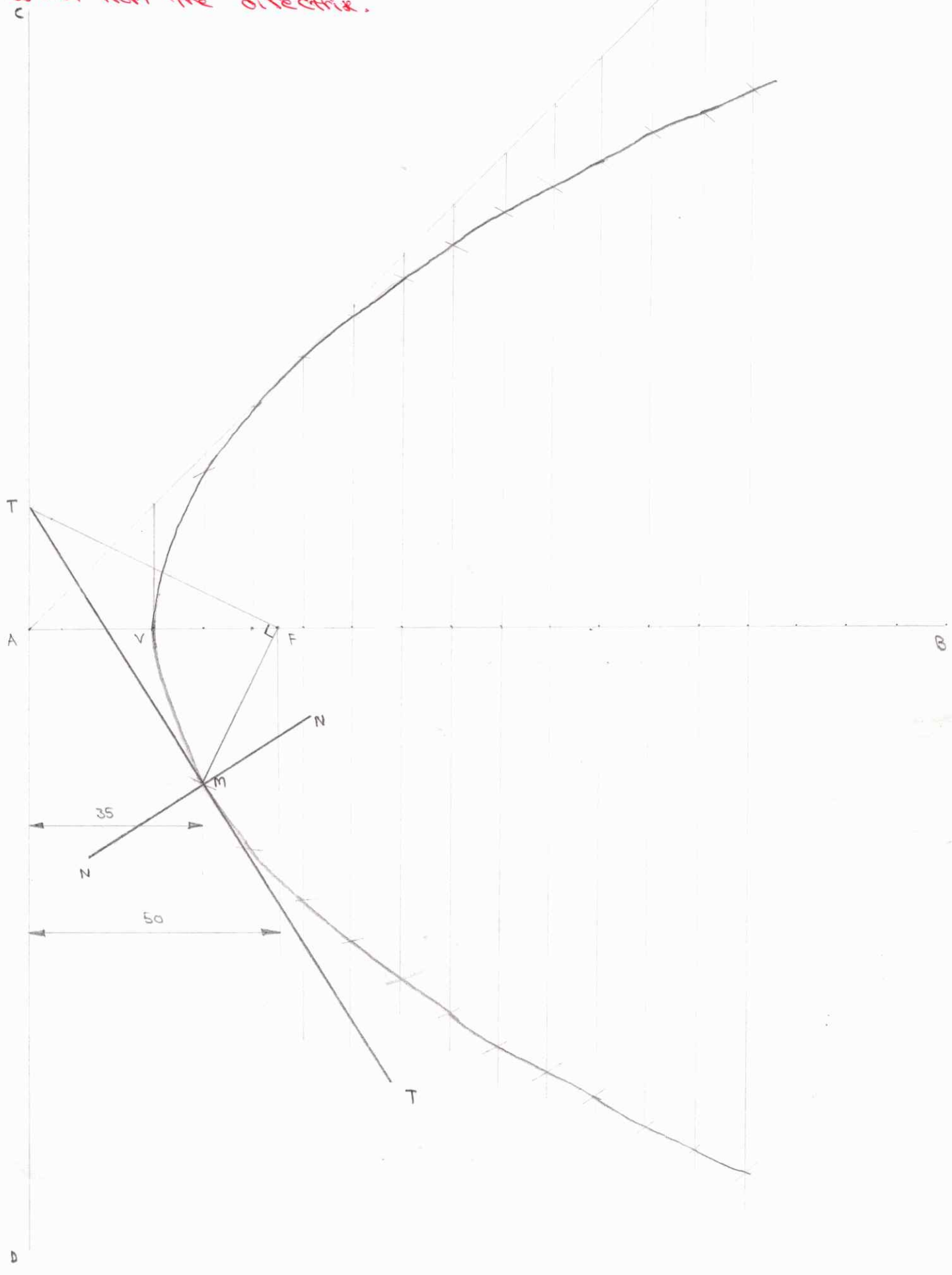
Rectangular Hyperbola:- when the cutting plane is parallel to the axis of the cone, the section is a rectangular hyperbola. i.e $\theta = 0°$

① Construct an ellipse when the distance of its focus from its directrix is equal to ~~55~~ 50 mm and eccentricity 2/3. Also draw a tangent and a normal to this ellipse at a point 40 mm away from the directrix.

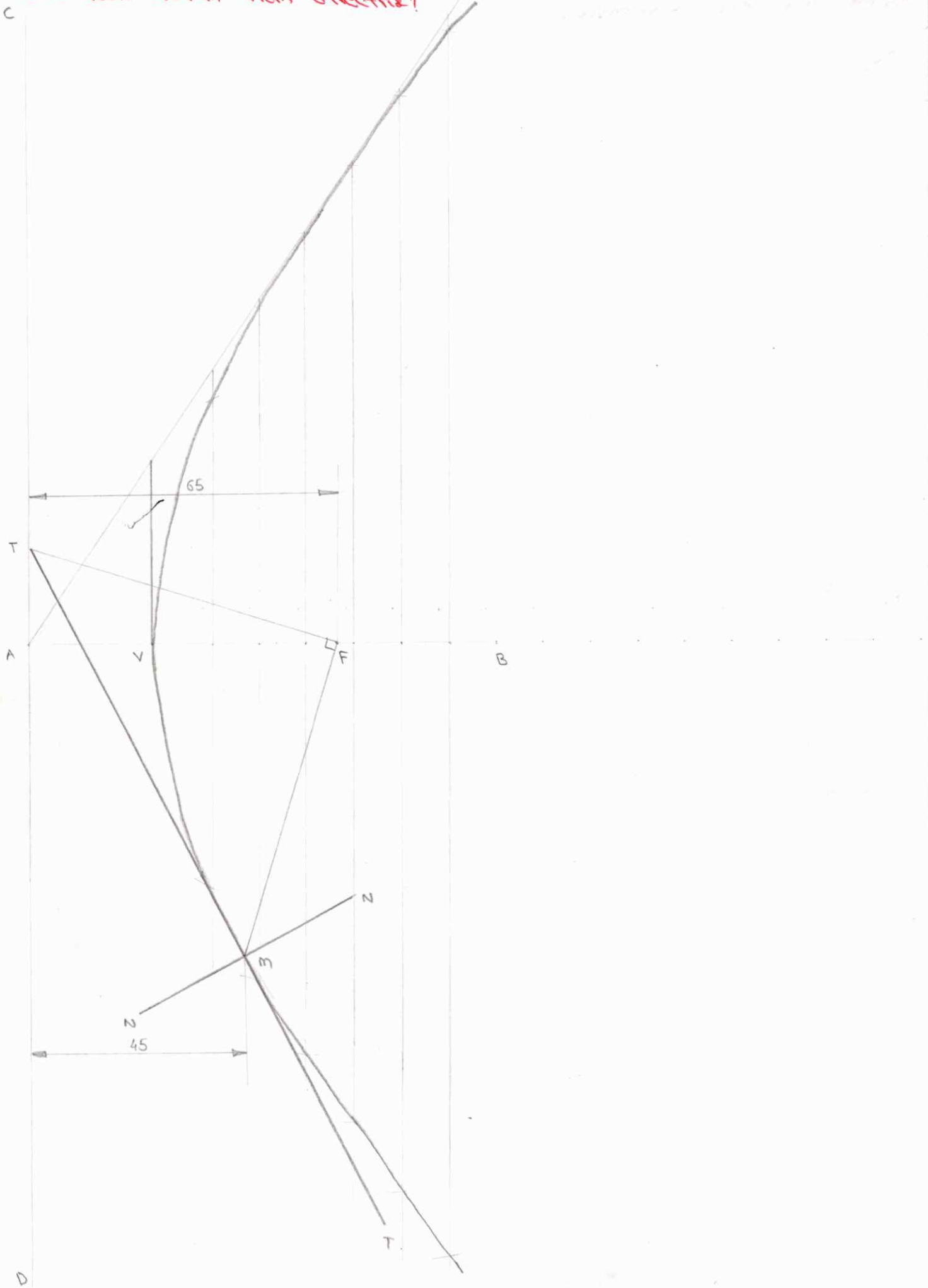


1. Draw the axis AB and the directrix CD, at right angles to each other.
2. Make focus F on the axis such that AF=50.
3. Divide AF into 5 equal parts. Locate the vertex V on 3rd division from A.
4. Draw a line VE, perpendicular to AB such that VE=VF
5. Join A, E and Extend. By construction $\frac{VE}{VA} = \frac{VF}{VA} = \frac{2}{3}$
6. Mark a number of points 1, 2, 3 ---- etc to the right of V on the axis AB, which need not be equidistant.
7. Through the points 1, 2, 3 etc draw lines perpendicular to the axis and to meet the line AE extended at 1', 2', 3' etc.
8. With centre F and radius 1-1' draw arcs intersecting the line through 1 at P1 and P1'.
9. Similarly locate the P2, P2'; P3, P3' etc on either side of the axis.
10. Join the points by a smooth curve, forming the required ellipse.
11. Locate point 'm', which is 40mm distance from the directrix. Join 'F' and 'm'. Through 'F' draw perpendicular to 'mF' meeting the directrix at 'T'. The line joining T and m and extend (T-T) is the tangent.

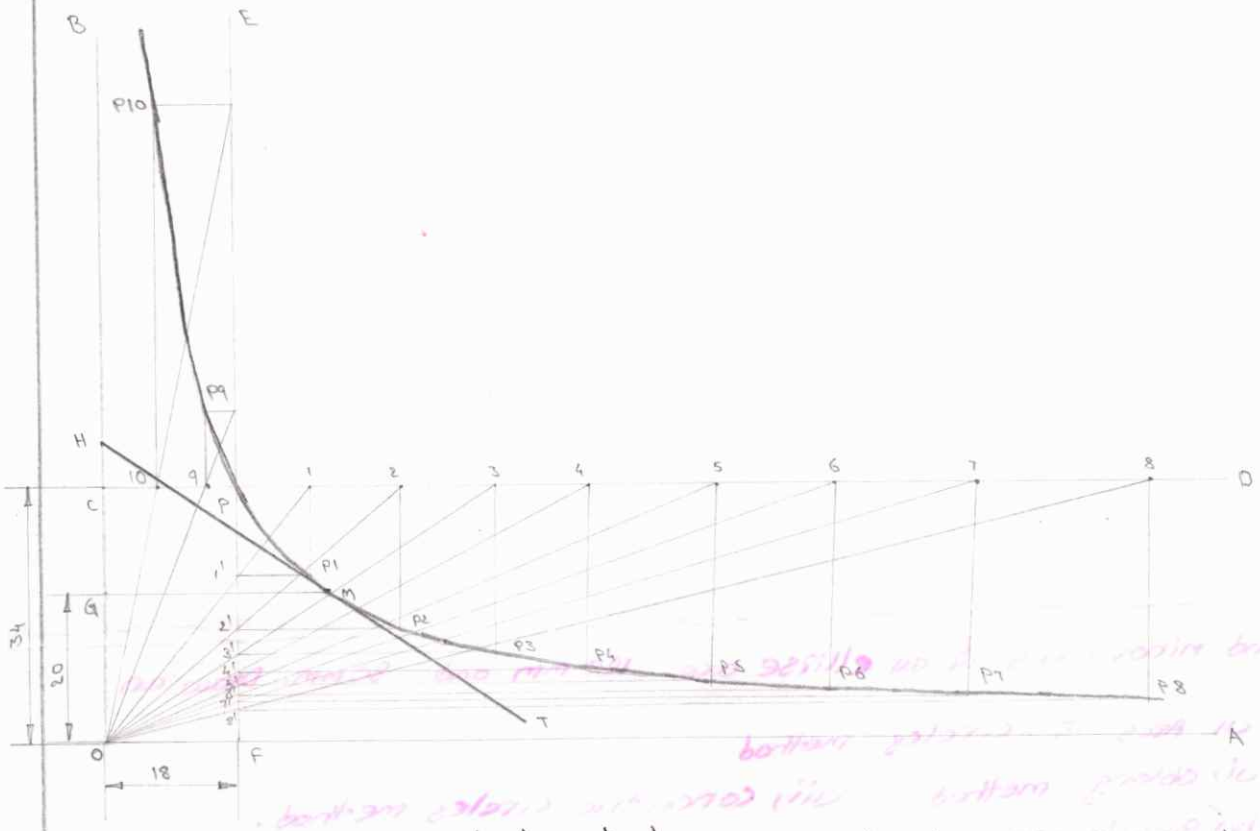
2. Construct a parabola, when the distance of the focus from the directrix is 50 mm. Also draw tangent and normal to the curve at a point 35 mm from the directrix.



3. Construct a hyperbola, when the distance of the focus from the directrix is 65 mm and eccentricity is 3/2. Also draw tangent and normal to the curve as a point 45 mm from directrix?



4 Construct a rectangular hyperbola, when a point 'P' on it is at distances of 18 and 34 from two asymptotes. Also, draw a tangent to curve at a point 20 from an asymptote!

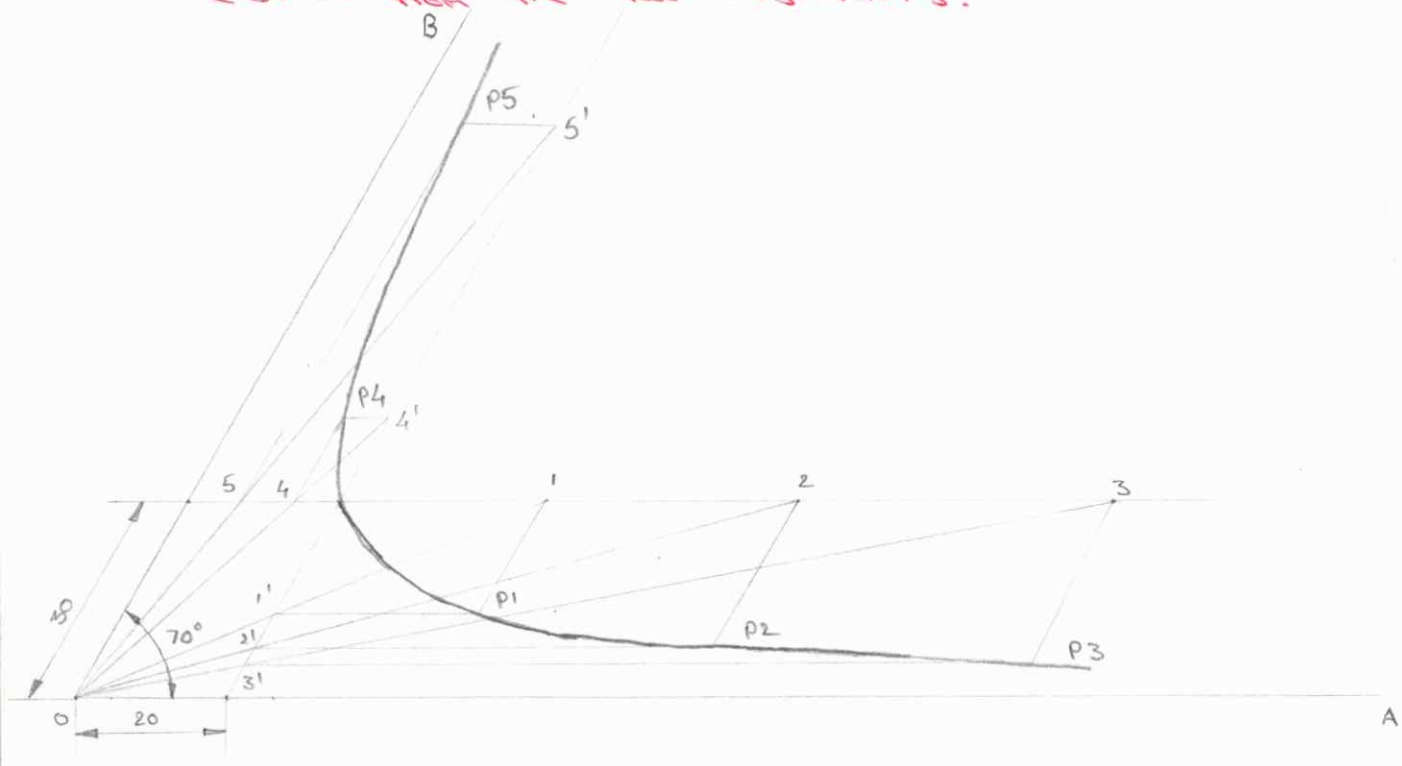


1. Draw the asymtotes 'OA' and 'OB' at right angles to each other and locate the given point 'P'.
2. Draw the lines 'CD' and 'EF' passing through P and parallel to OA and OB.
3. Locate a number of points 1,2,3 etc., along the line CD, which need not be equi-distant.
4. Join 1,2,3 etc to 'O' and extend if necessary, till these lines meet the line 'EF' at point 1', 2', 3' etc.
5. Draw lines through 1,2,3 etc parallel to EF and through 1', 2', 3' etc parallel to CD, to intersect at P1, P2, P3 etc.

A smooth curve passing through these points is the required rectangular hyperbola.

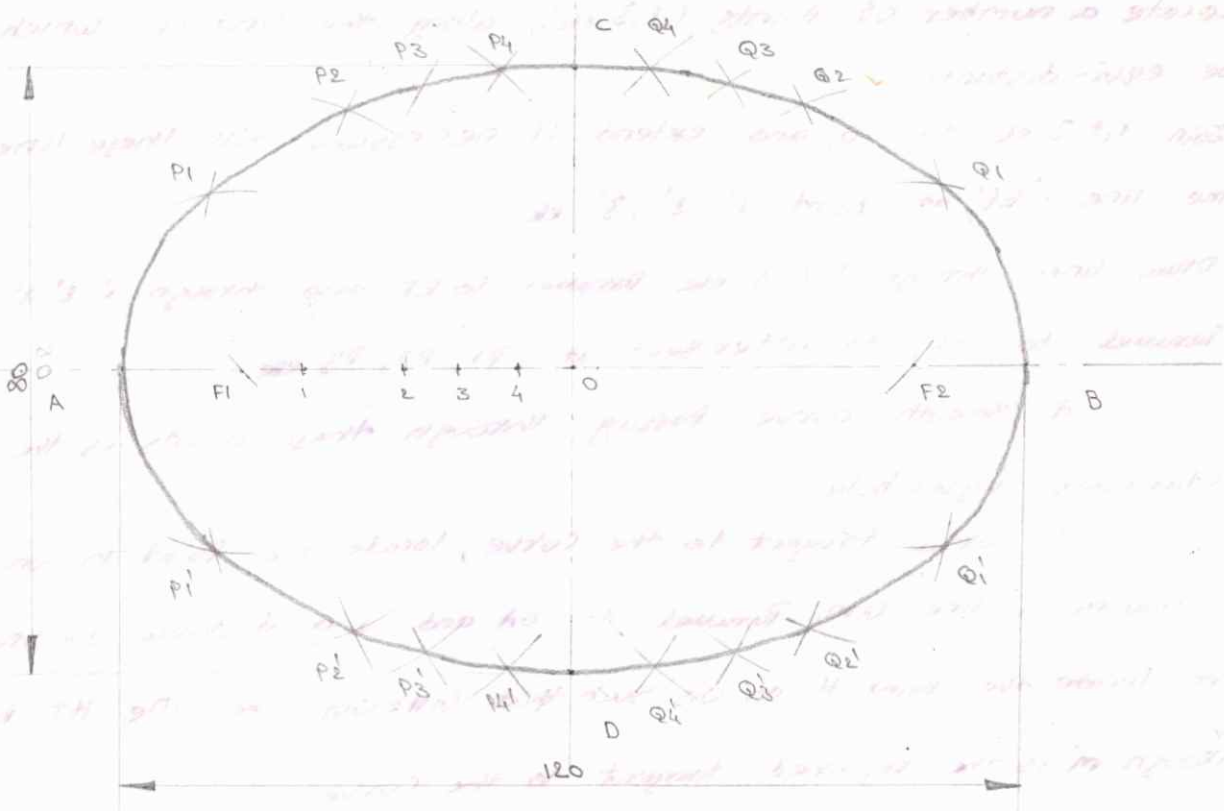
To draw tangent to the curve, locate the point m on the curve by drawing a line GM, parallel to OA and at a distance 20 from it. Then, locate the point H on OB such that GH = OG. The line HT passing through 'm' is the required tangent to the curve.

(5) The asymptotes of a hyperbola are inclined at 75° to each other. Construct the curve when a point 'P' on it is at a distance of 25 mm & 30 mm from the two asymptotes.

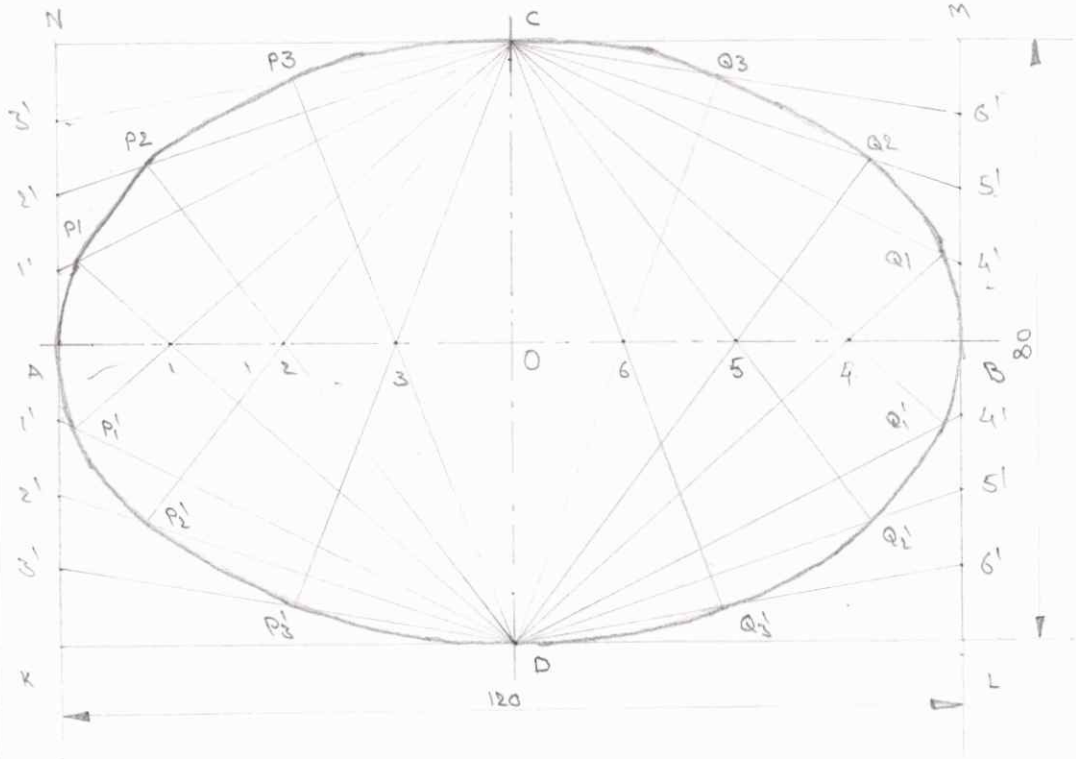


(6) The major and minor axes of an ellipse are 120 mm and 80 mm. Draw an ellipse by (i) Arcs of circles method
(ii) Oblong method (iii) Concentric circles method.
(iv) Parallelogram method

→ (i) Foci on arcs of circles method.



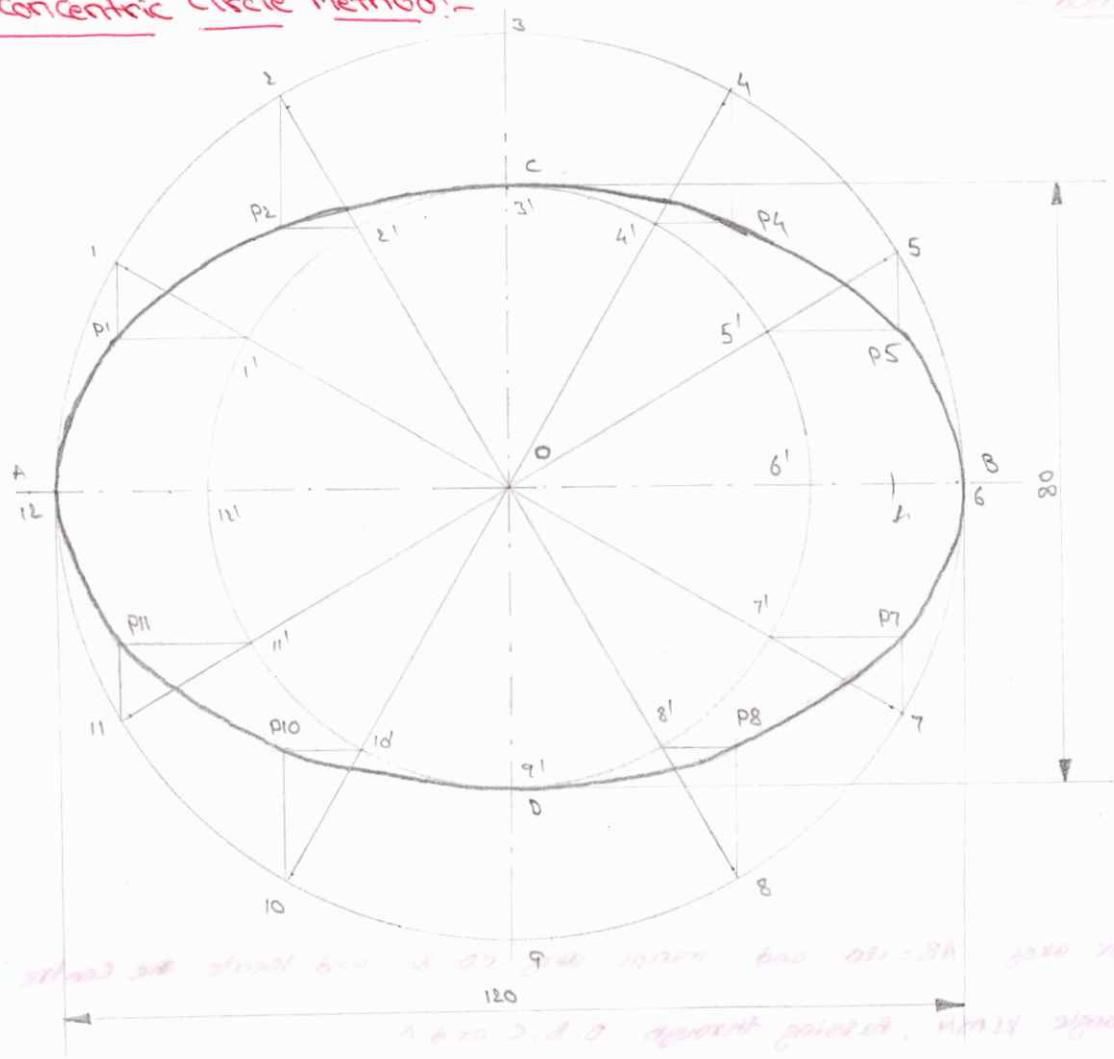
(ii) Oblong method :-



construction :-

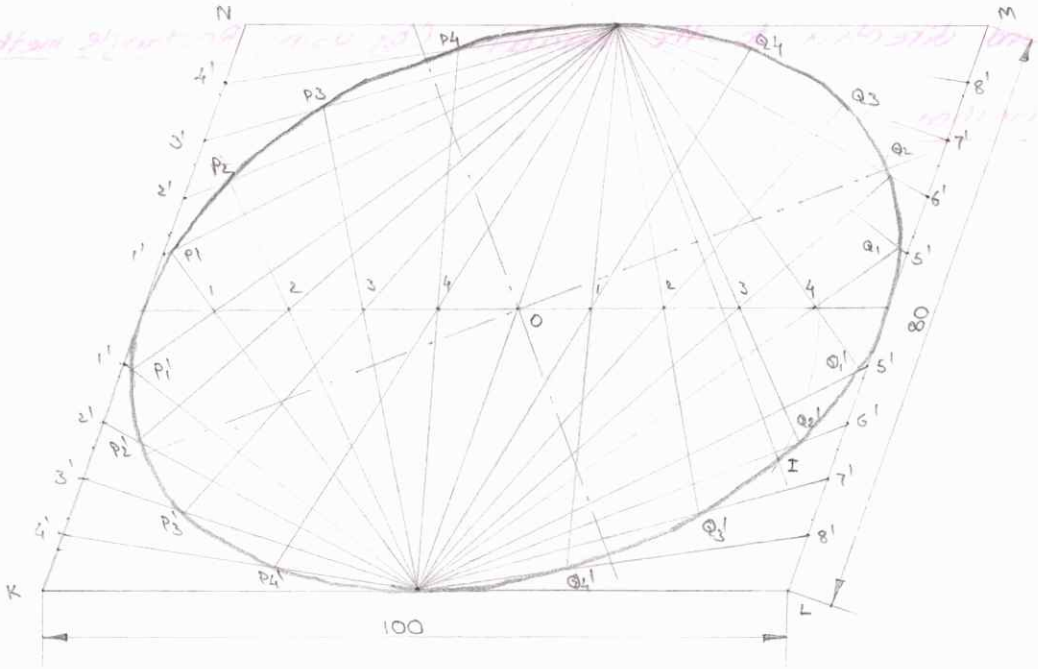
1. Draw the major axes AB = 120 and minor axes CD = 80 and locate the centre 'O'.
2. Draw the rectangle KLMN, passing through D, B, C and A.
3. Divide AO and AN, into the same number of equal parts and number the points.
4. Join C with points 1', 2' and 3'.
5. Join with 1, 2, 3 and extend till they meet the above lines i.e; C-1', C-2' and C-3' respectively at P1, P2 and P3.
6. Repeat steps 3 to 5 and obtain the points in the remaining quadrants.
7. Draw a smooth curve through all the points is the required ellipse.

III Concentric circle method:-



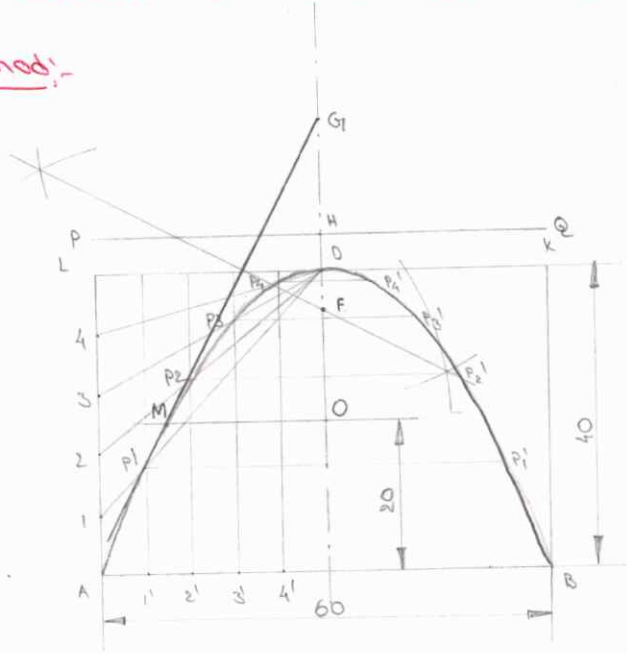
1. Draw the major (AB = 120) and minor (CD = 80) axes and locate the centre 'O'.
2. With centre 'O' and major and minor axes as diameters, draw two concentric circles.
3. Divide both circles into same number of equal parts, say 12 by radial lines.
4. Considering radial line O-1'-1, draw a horizontal line from 1' and a vertical line from 1, intersecting at P1.
5. Repeat the construction through all the points and obtain P2, P3 etc.
6. Draw a smooth curve through the points A, P1, P2 etc is the required ellipse.

(iv) Parallelogram method:-



7. Construct a parabola with base 60mm and length of the axis 40mm. Draw a tangent to curve at a point 20mm from the base. Also, locate the focus and directrix to the parabola. (By using Rectangle method)

At Rectangle method:-



1. Draw the base AB (=60) and axis CD (=40) such that CD is perpendicular bisector to AB.
2. Construct the rectangle ABKL, passing through D.
3. Divide AC and AL into the same number of equal parts and number the points as shown. Join 1,2 ~~and~~, 3, 4 to D.
4. Through 1', 2', ~~and~~, 3', 4' draw lines parallel to the axis; intersecting the lines 1-D, 2-D, 3-D and 4-D at P1, P2, P3 and P4.
5. Obtain the points P_1', P_2', P_3', P_4' which are symmetrically placed to P1, P2, P3 P4. with respect to the axis CD. Join the points by a smooth curve.

To draw a tangent to the curve

→ Locate the given point 'm' on the curve, which is at 20 from the base.

→ Draw a horizontal line through 'm', meeting the axis at 'o'.

→ Locate the point G1 on the axis such that GD = OD.

→ Join G1 m and extend, forming the required tangent.

To locate the focus and directrix:-

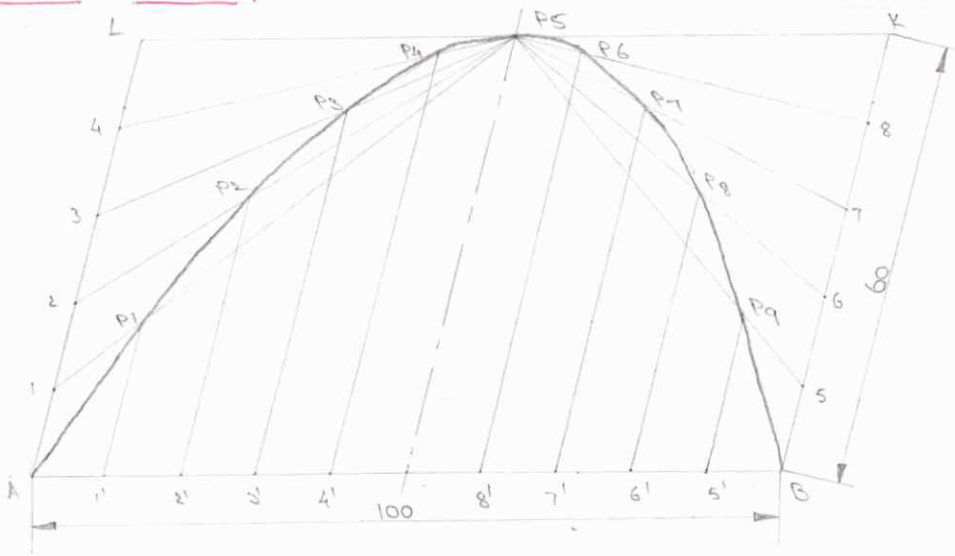
→ Draw a perpendicular bisector to the tangent G1m, intersecting the axis at F.

→ mark the point H on the axis such that HD = FD.

→ Draw a line PQ, perpendicular to the axis and passing through H.

F is the focus and PQ, the directrix of the given parabola.

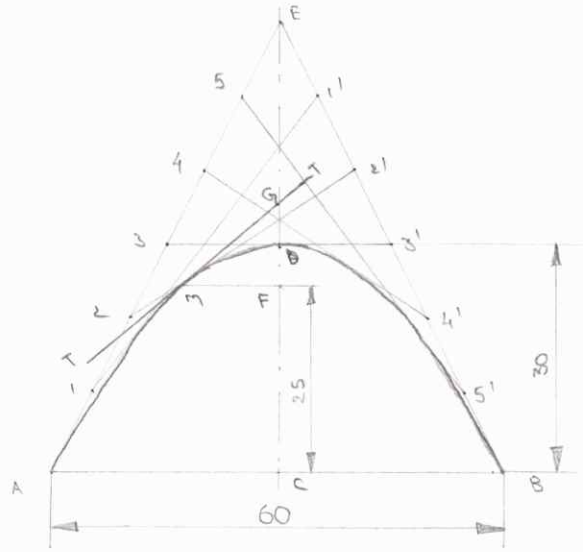
8. Construct a Parabola in a Parallelogram of sides 100 mm and 60 mm and with an include angle of 75°. (By using Parabola - Parallelogram method)



9. Construct a parabola with length of base of 60mm and axis 30mm long. Also, draw tangent to the curve at a point 25 mm from the base.

Tangent method:-

A-

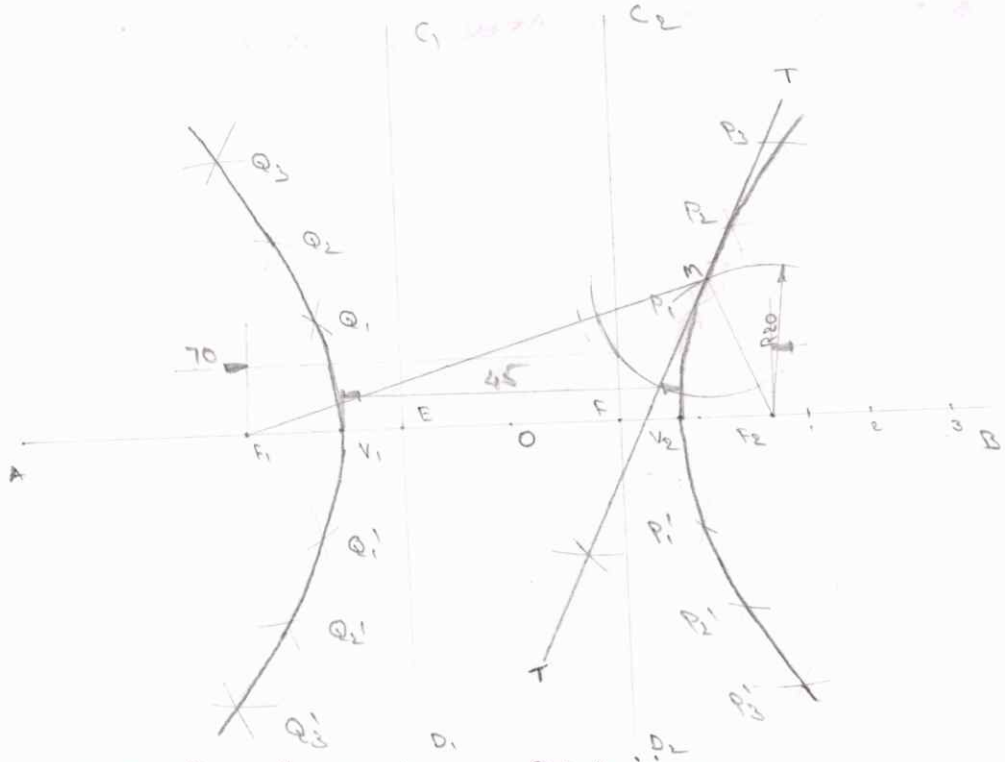


1. Draw the base AB(=60) and axis CD(=30) such that CD is a ⊥ bisector to AB.
2. Produce CD to E such that DE=CD.
3. Join E, A and E, B. These are the tangents to the parabola at A and B.
4. Divide AE and BE into the same number of equal parts and number the points as shown.
5. Join 1, 1' ; 2, 2' etc forming the tangents to the required parabola.

A smooth curve passing through A, D & B and tangential to the above lines is the required parabola.

To draw tangent to the parabola, locate the point M, which is 25 from the base. Then, draw a horizontal through M, meeting the axis at F. Mark G1 on the extension of the axis such that DG1 = FD. Join G1M and extend, forming the tangent to the curve at M.

Construct a hyperbola with it's foci, 70 mm apart and the major axis 45mm. Draw tangent to the curve at a point 20 mm from the focus 1. Also, determine the eccentricity of the curve. (by arcs of circles method).



1. Draw the Axis AB and locate a point 'O' on it.
2. Locate the foci F_1, F_2 ($F_1F_2 = 70$ mm) & vertices V_1, V_2 ($V_1V_2 = 45$) on AB which are symmentric about 'O'.
3. mark a numer of points 1, 2, 3 etc on AB, to the right of F_2. which need not be equi-distant.
4. with centre F_1 and radius V_1-1, with centre F_2 and radius V_2-1 draw arcs on either side of the transverse axis.
5. Repeat step 4 and obtain the points P_1, P_1' & Q_1, Q_1' etc.

To draw tangent to the hyperbola, locate the point m, which is at 20 from the foces, say F_2. Then, join m to foci F_1 and F_2. Draw a line TT, bisecting $\angle F_1MF_2$; forming the required tangent.

To locate the bisecting eqn:-

$$e = \frac{OF_1}{OV_1} = \frac{OF_2}{OV_2} = \frac{35}{22.5} = 1.56 \qquad (\because e = 1.56)$$

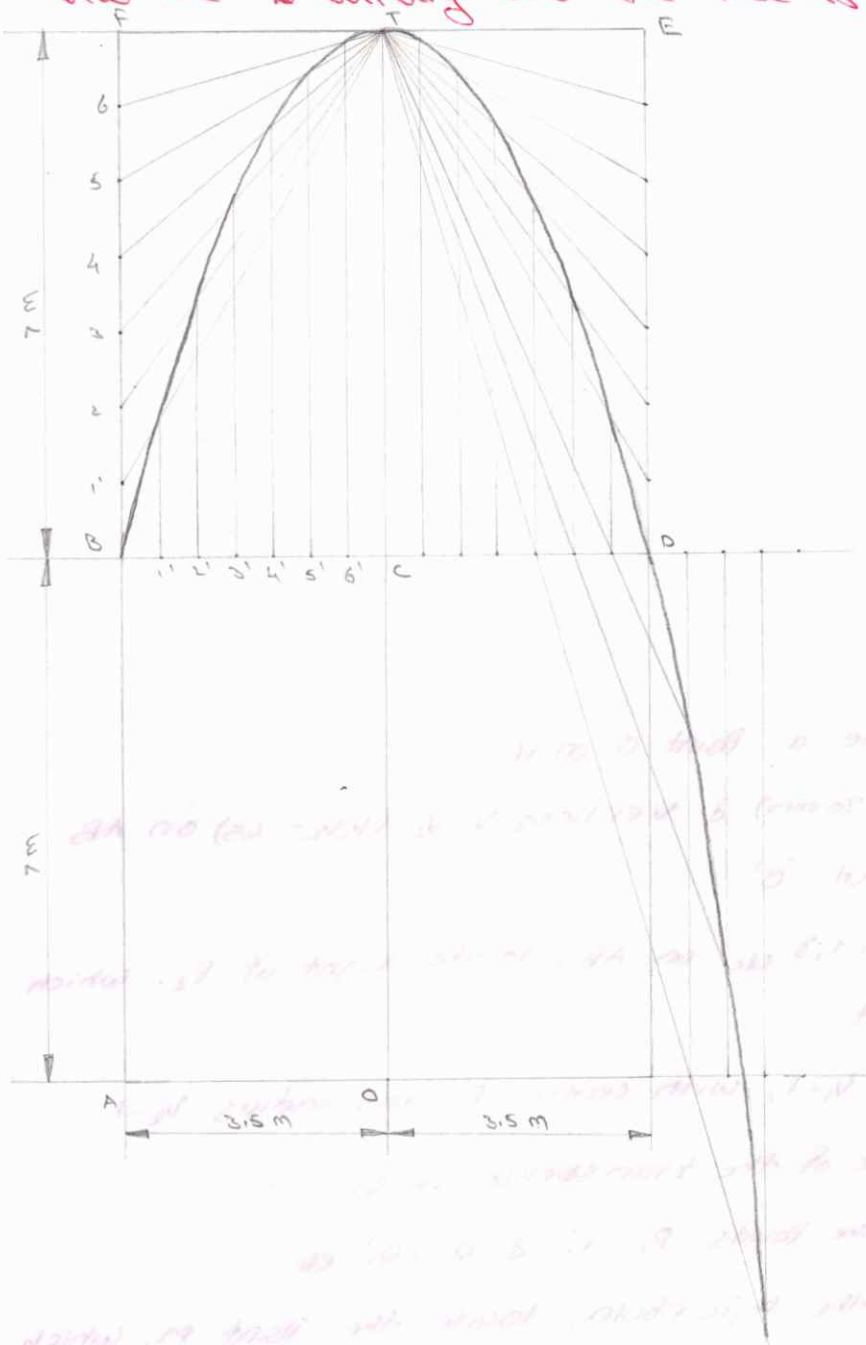
$$e = \frac{V_1F_1}{V_1E} \Rightarrow 1.56 = \frac{12.5}{V_1E}$$

$$V_1E \approx 8.0257$$

locate the points E and F on the transverse axis such that

$$\frac{OV_1}{OE} = \frac{OV_2}{OF} = e \qquad OE = \frac{OV_1}{e} = \frac{22.5}{1.56} \Rightarrow 14.4 = OF \quad \because OE \cong OF = 14.4$$

11. A stone is thrown from a building of 7m height and it's highest flight, the stone just crosses a ~~Bush~~ Palm tree of 4m height. Trace the path of the stone, if the distance b/w the ~~&~~ building and the tree is 3.5m?



CYCLOIDAL CURVES:-

Cycloidal curves are generated by a point lying on the circumference of a circle, when it rolls along a fixed straight (or) a curved path without slipping.

Generating circle - The circle which rolls is called the rolling circle (or) Rolling circle (or) the generating circle.

Directing line - The fixed straight line (or) the circle on which it rolls is called the directing line (or) the directing circle. (or) Directing circle

Cycloid:-

A cycloid is a curve traced by a point on the circumference of a circle which rolls without slipping along a fixed straight line.

Trochoid:-

Trochoid is a curve generated by a point fixed to a circle, within (or) outside it's circumference, as the circle rolls along a straight line.

→ Inferior trochoid → Superior trochoid.

Epicycloid:-

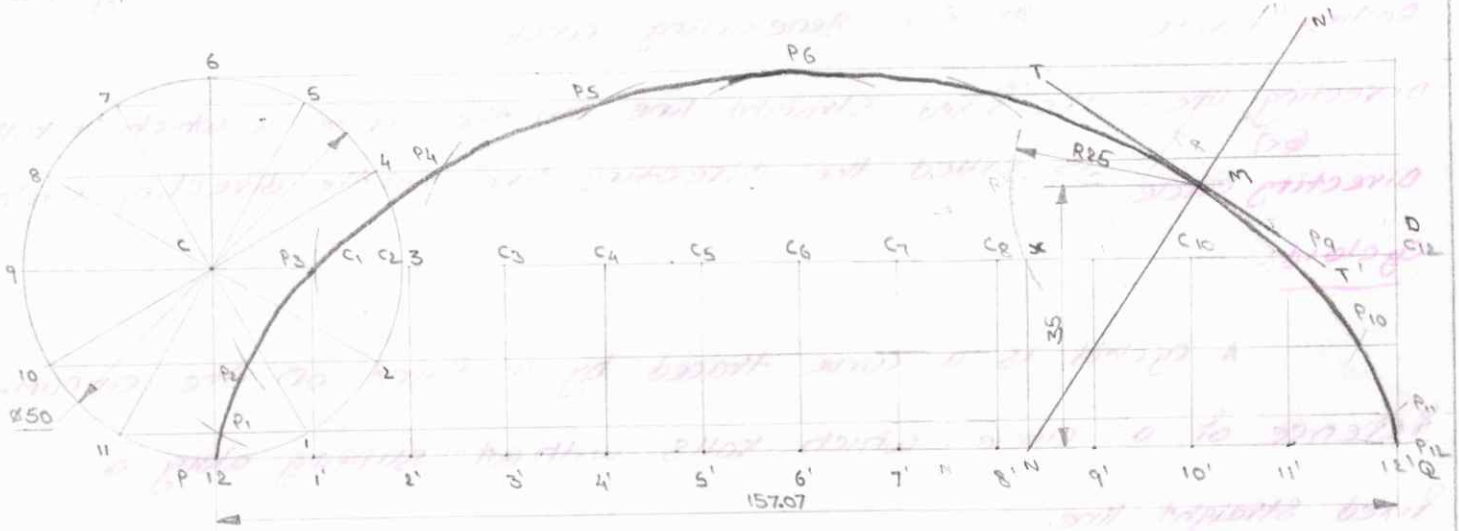
An Epicycloid is a curve traced by a point on the circumference of a circle which rolls along another circle outside it, without slipping.

Hypocycloid:-

A hypocycloid is a curve traced by a point on the circumference of a circle which rolls along another circle and inside it, without slipping.

Cycloids:-

① Construct a cycloid having a rolling (generating) circle diameter of 50 mm. Draw a normal and a tangent to a curve at a point 35 mm above the base line. D = 50 ⇒ πD = 157.07

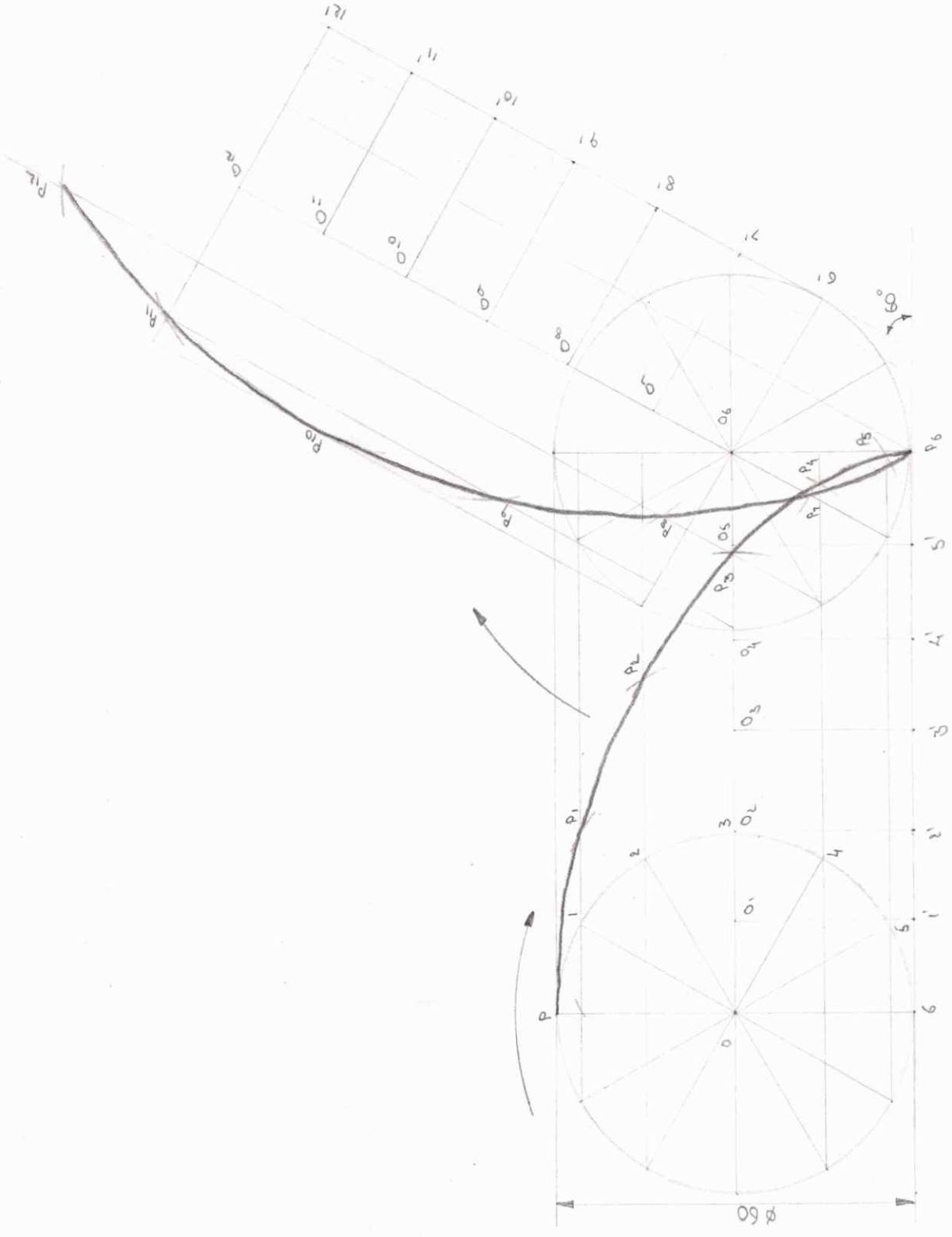


1. Draw the generating circle with a 50mm diameter.
2. Draw the directing line PQ = πD = 157.07 mm, tangential to the circle.
3. Divide the rolling circle into 12 equal parts and mark 1, 2, 3 etc., . Draw lines through points 1, 2, 3 etc parallel to PQ.
4. Divide PQ into 12 equal parts and mark 1', 2', 3' etc on it. Draw perpendicular lines through these points to meet the centre line CD at points C_1, C_2, C_3 etc.
5. Assume that the circle rolls to the right through $\frac{1}{12}$ rotation.
6. Draw arcs with centres C_1, C_2, C_3 etc with 25 mm radius, to meet the locus lines through points 1, 2, 3 etc., at points P_1, P_2, P_3 etc respectively.
7. Draw smooth curve passing through all the points P_1, P_2, P_3 etc. The curve obtained is the required cycloid.

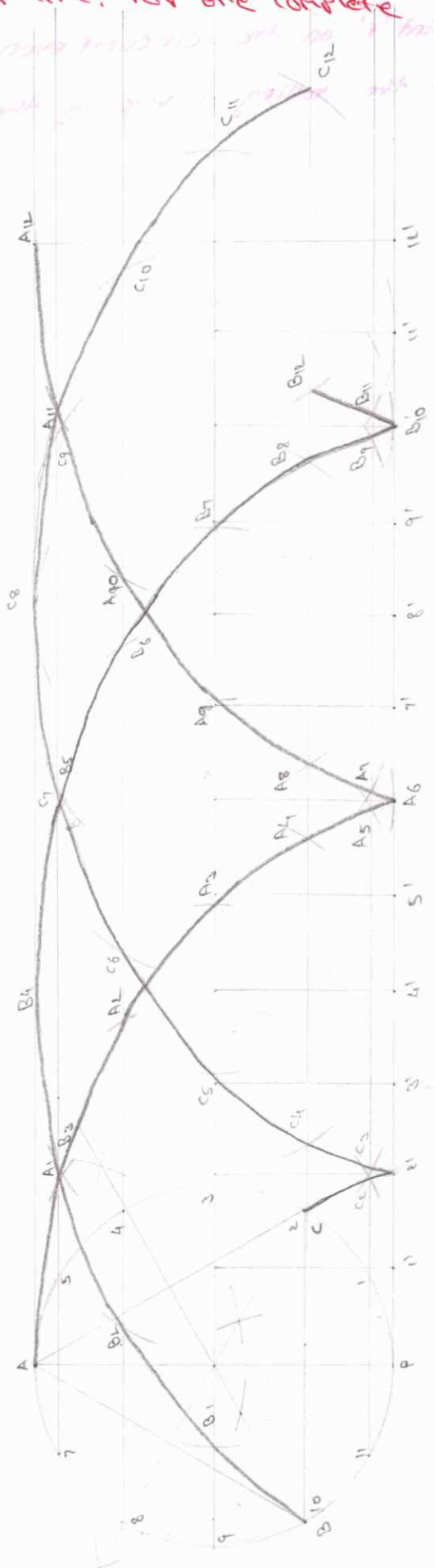
Tangent and normal to the curve:-

8. Mark a point m on the cycloid at 35 mm from the directing line.
9. With m as the centre and radius 25 mm, cut the centre line at point 'x'.
10. Through point x, draw a line perpendicular to PQ, which meets PQ at point 'N'.
11. Join mN and extend it to N'. The line NN' is the required normal.
12. Through point 'm', draw a line TT' perpendicular to NN'. The line TT' is the required tangent.

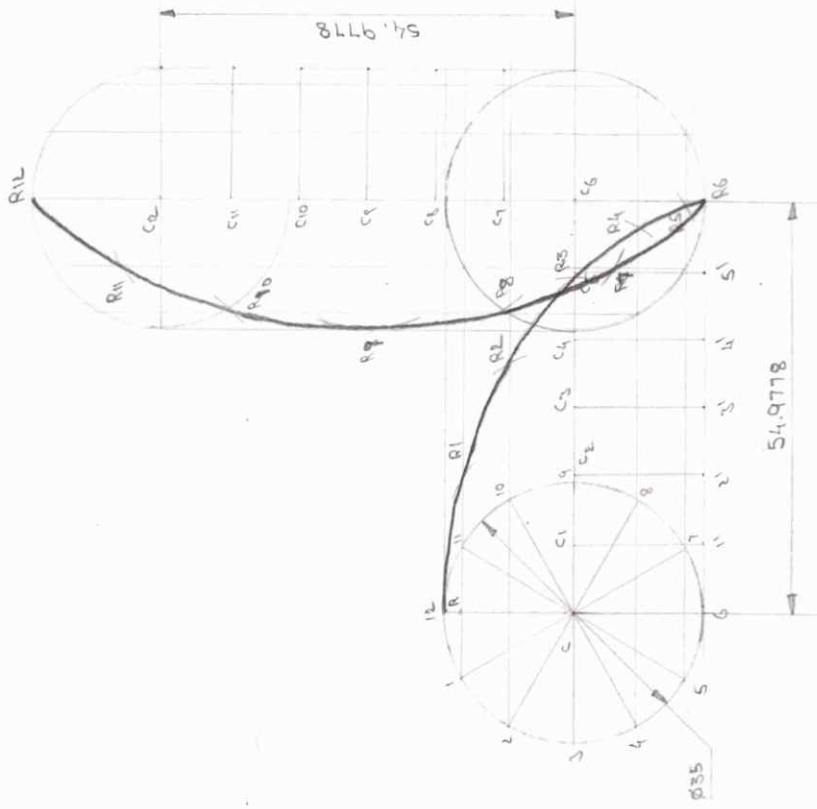
2 A circles of 60 mm diameter rolls on a horizontal line for half a revolution clock wise and then on a line inclined at 60° to the horizontal for another half clock wise. Draw the curve traced by the point 'P' on the circumference of the circle, taking the top most point on the rolling circle of the initial position of the generating point.



3. ABC is an equilateral triangle of side 70 mm. Trace the loci of vertices A, B & C, when the circle circum-scribing ABC, rolls with out slipping, along a fixed straight line. For one complete re volution.

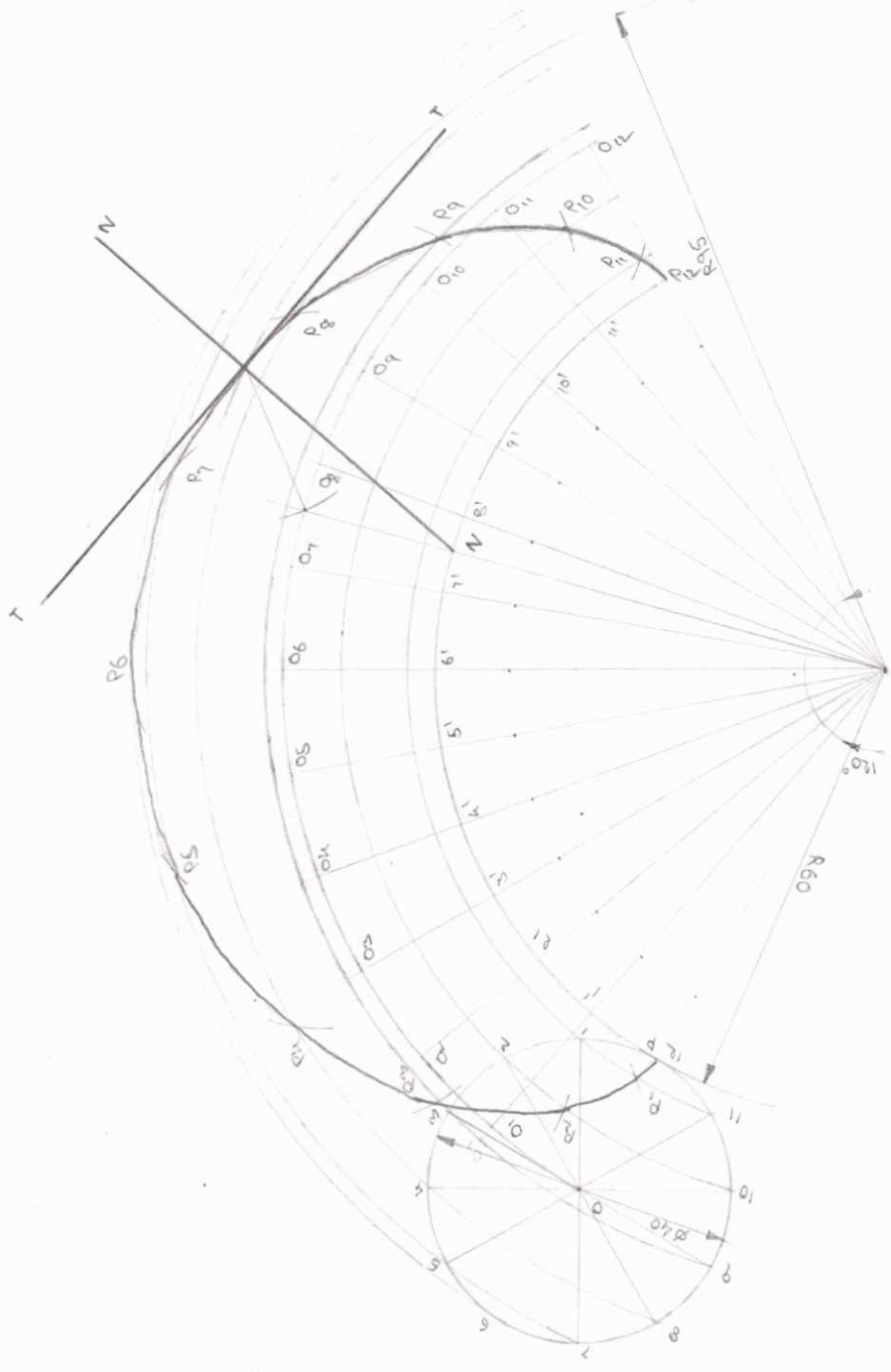


4 A circle of 35mm diameter rolls on a horizontal line. Draw the curve traced out by a point R on the circumference for one half revolution, the circle rolls on the vertical line. the point R vertically above the centre of the circle in the starting position?

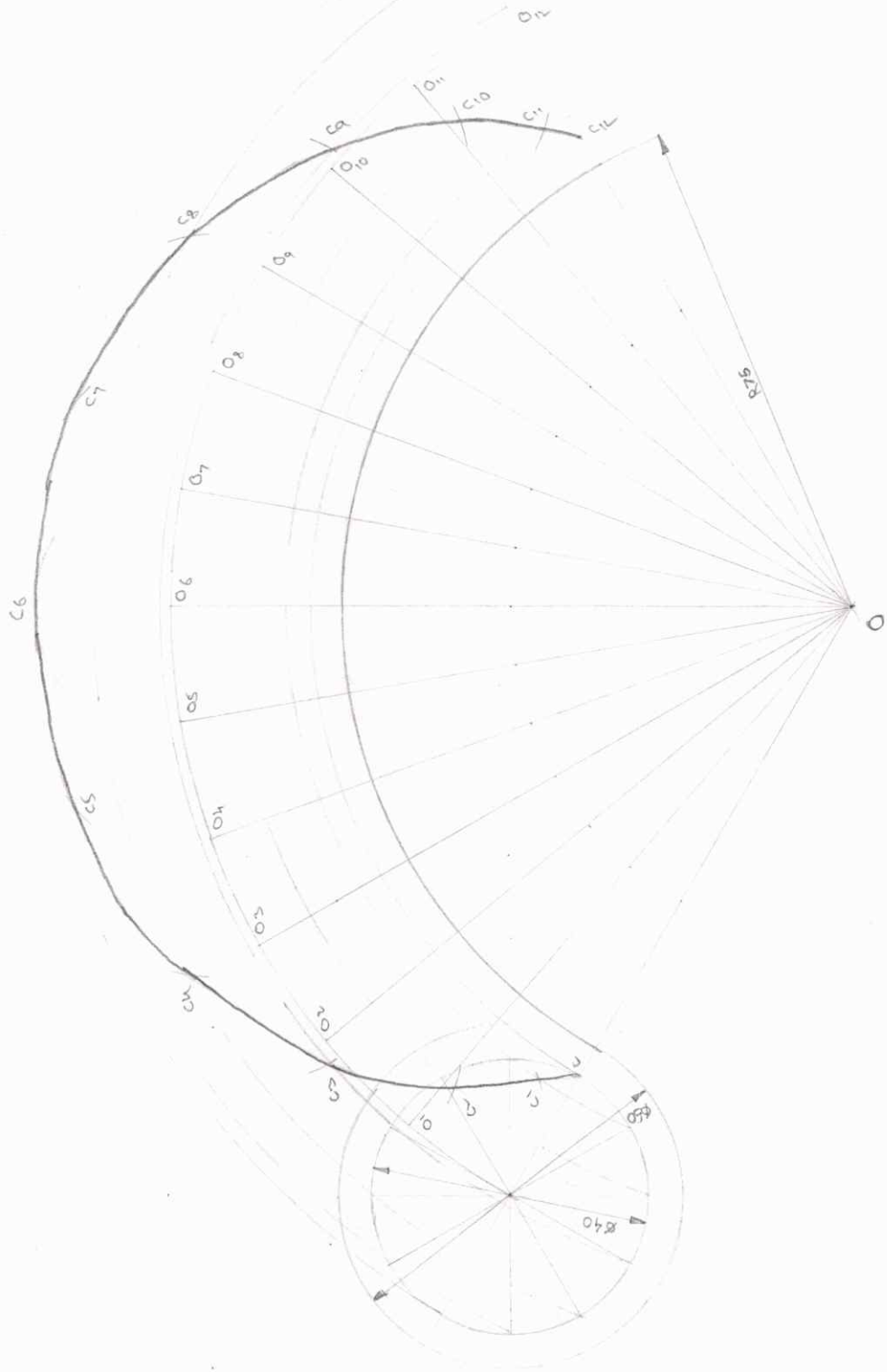


Epicycloids:-

5. Draw epicycloids of a circle of 40 mm diameter, which rolls outside on another circle of 120mm diameter for one revolution clockwise. Draw a tangent and a normal to it at a point 95 mm from the centre of the directing circle?



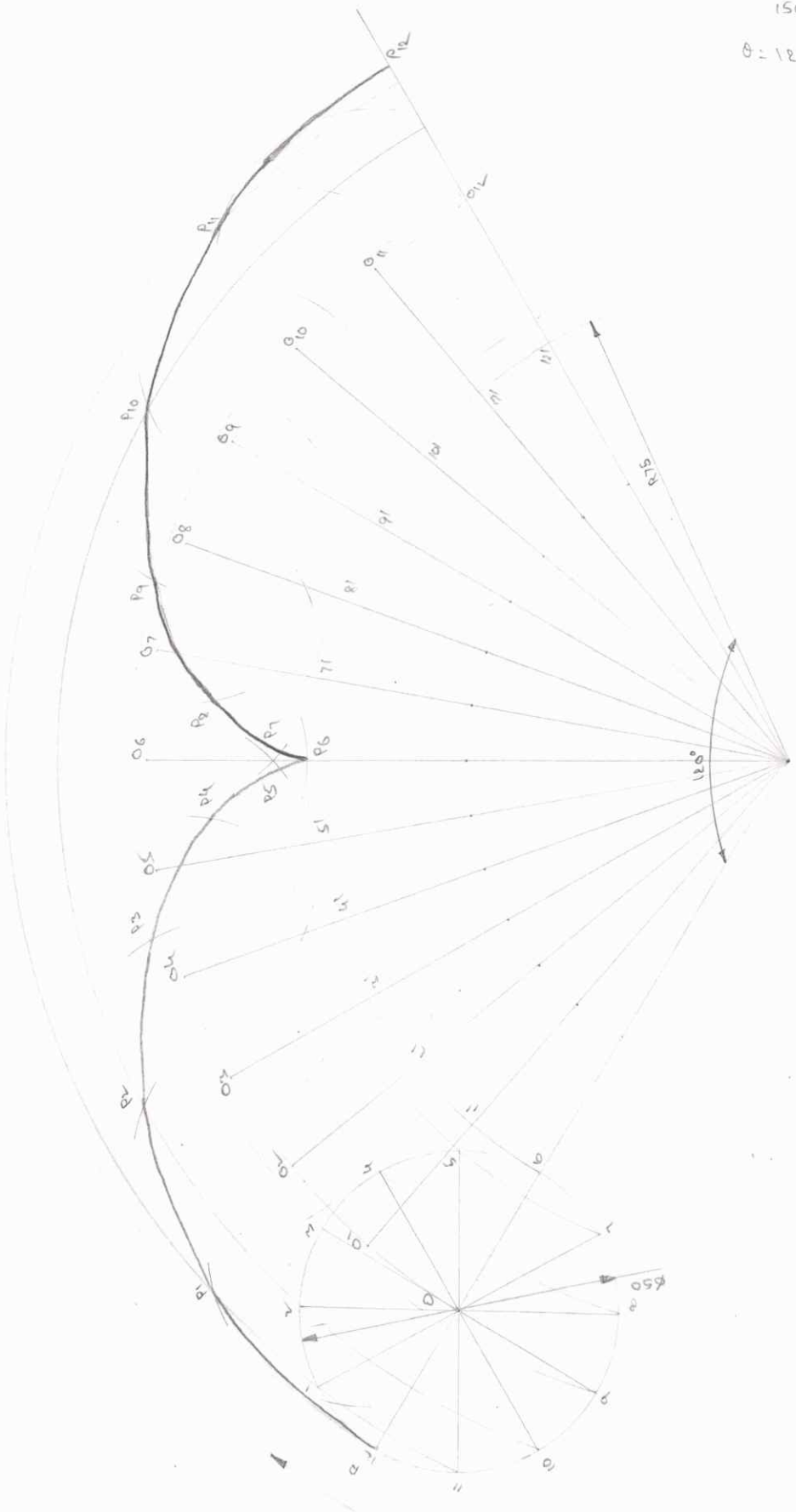
6 Draw an inferior epitrochoid of base circle 150mm diameter and rolling circle 50 mm diameters. The tracing point P is 20mm from the center of the rolling circle.



7. A circle of 50mm diameter, rolls without slipping on the outside of another circle of diameter 150mm. Show the path of a point on the periphery of the generating (rolling) circle, diametrically opposite to the initial point of contact between the circles?

$$\theta = \frac{50}{150} \times 360^\circ$$

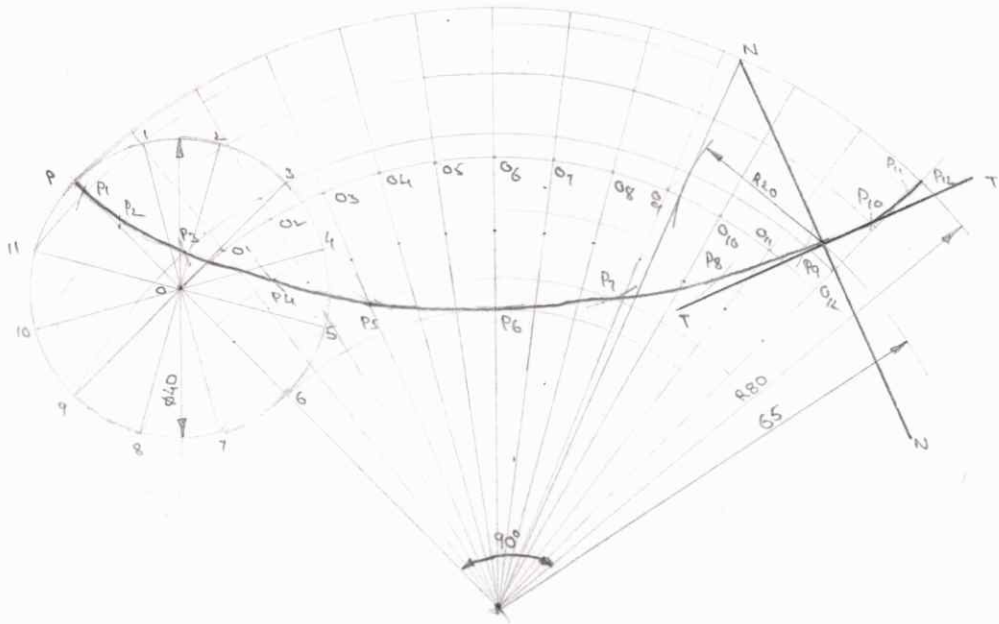
$$\theta = 120^\circ$$



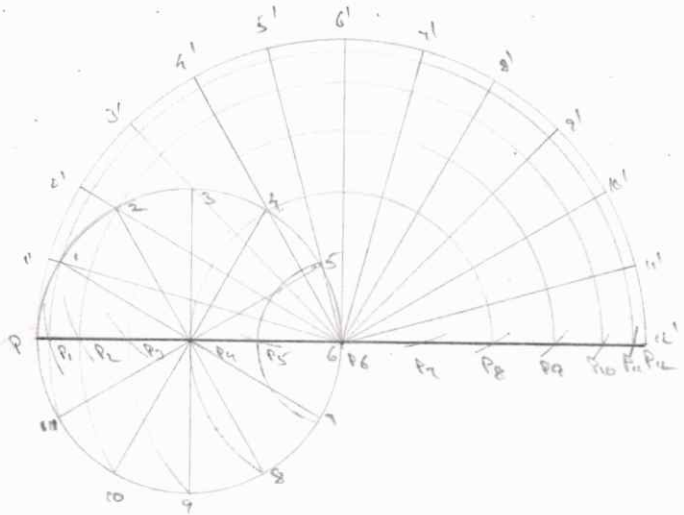
8. Draw a hypocycloid of a circle of 40 mm diameter, which rolls inside another circle of 160 mm diameter, for one revolution counter clockwise. Draw a tangent & a normal to it at a point 65 mm from the centre of the directing circle.

$$\theta = \frac{40}{160} \times 360^\circ$$

$$\theta = 90^\circ$$



9. A circle of 40mm diameter rolls on the concave side of another circle of 40mm radius. Draw the Path traced by a point on the generating circle for one complete revolution.

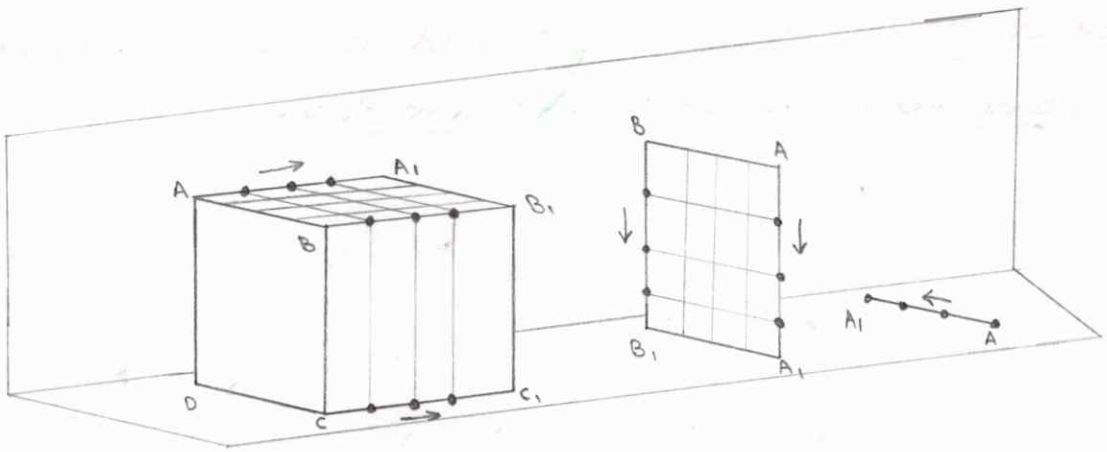


HYPO - cycloid - straight line

PROJECTIONS OF POINTS

Projections of points, lines, and planes must be studied in order to understand the projections of solids, because it could be said that a solid consists of a number of planes, a plane consists of a number of lines and a line consists of a number of points.

A solid may be generated by a plane moving in space, a plane may be generated by a straight line moving in space and a straight line in turn, may be generated by a point moving in space.



BIS CONVENTIONS:-

BIS recommends the following conventional representations in orthographic projections, similar to that of a language. These conventions are obeyed internationally and a variation will be treated as a spelling or grammar mistake in the graphics language.

1. The actual points are denoted by capital letters A, B, C etc.; in the pictorial view.
2. In the Front view, the points are denoted by the corresponding lower-case letters with dash a', b', c' etc.
3. In the TOP view, the points are denoted by the corresponding lower-case letters a, b, c. etc.

4. In the side view, the points are denoted by the corresponding lower case letters with double dashes a'', b'', c'' etc.

5. The intersection line of HP and VP is shown as the reference line XY.

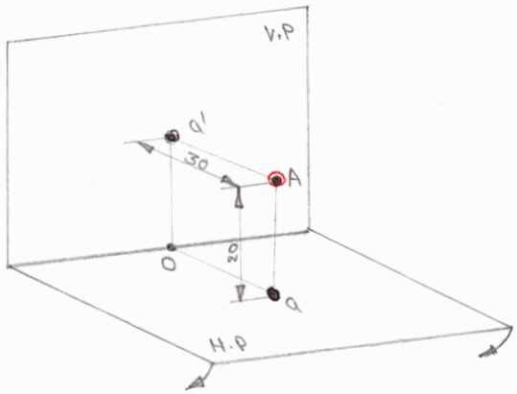
6. Projectors are to be necessarily shown in the orthographic views in thin lines (2H Pencil).

7. The distance of a point from the H.P is shown by the length of the projector from its front view to XY, eg. a'o, b'o etc.

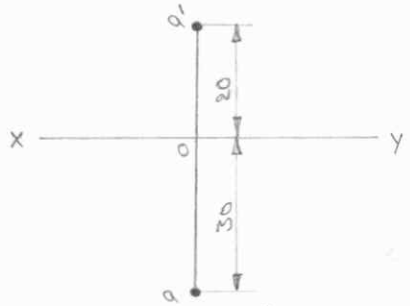
8. The distance of a point from the V.P is shown by the length of the projector from its front view to XY, etc ao, bo etc.

Projections of a point situated in first quadrant:-

→ A, 20mm above H.P and 30mm infront of V.P



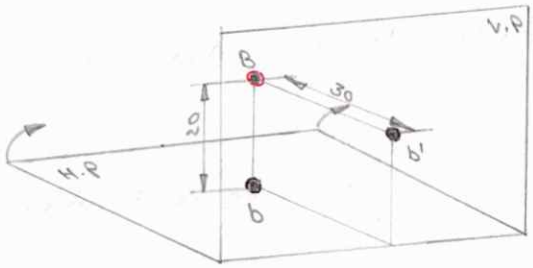
Pictorial view



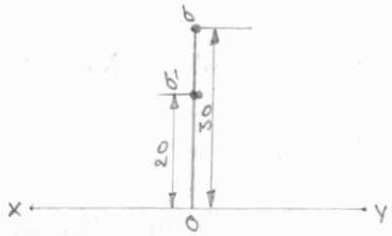
Projection of a point in I- Quadrant

Projections of a point situated in second quadrant:-

→ B, 20mm above H.P and 30mm behind V.P



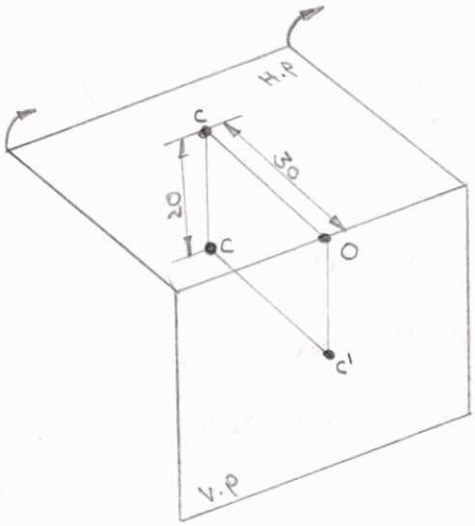
Pictorial view



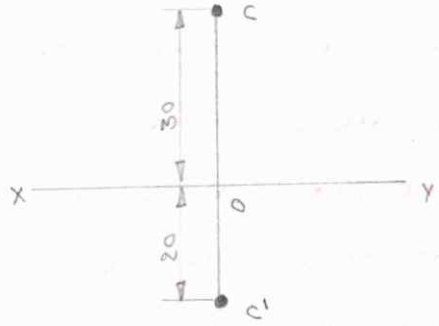
Projection of a point in II- Quadrant

Projections of a Point situated in third quadrant:-

→ C, 20 mm Below H.P and 30 mm behind V.P



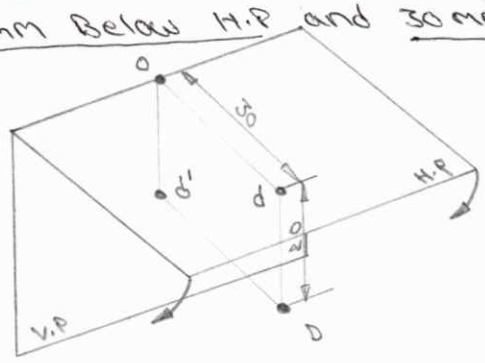
Pictorial view



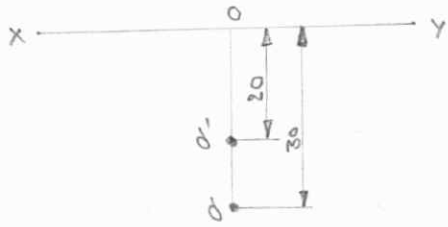
Projection of a Point in III - quadrant

Projections of a Point situated in fourth quadrant:-

→ D, 20 mm Below H.P and 30 mm infront of V.P



Pictorial view



Projection of a Point in IV - quadrant

Locations of a Point:-

When a Point lies in the First quadrant, it will be above HP and infront of VP

When the Point lies in the Second quadrant, it will be above HP and behind VP

When the Point lies in the Third quadrant, it will be below HP and behind VP

When the Pint lies in the Fourth quadrant, it will be below HP and infront of VP

20/3 Absentees (01)

C4, C9, D0, D3, D7, E6, E9, F3, F5, F7, G1, H9, I3, I5, I6,

① Draw the Projections of the following points on the same ground line, keeping the Projections 25 mm apart.

(i) A, in the HP & 20 mm, behind the V.P

(ii) B, 40 mm above the H.P and 25 mm in front of the V.P.

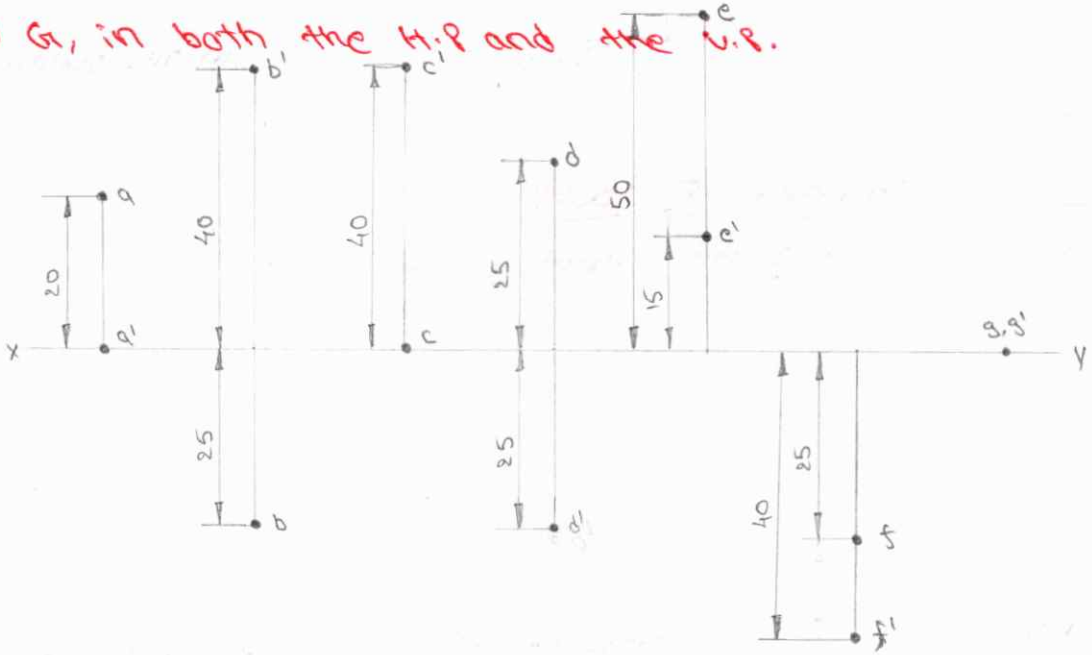
(iii) C, in the V.P and 40 mm above the H.P.

(iv) D, 25 mm below the H.P and 25 mm behind the VP.

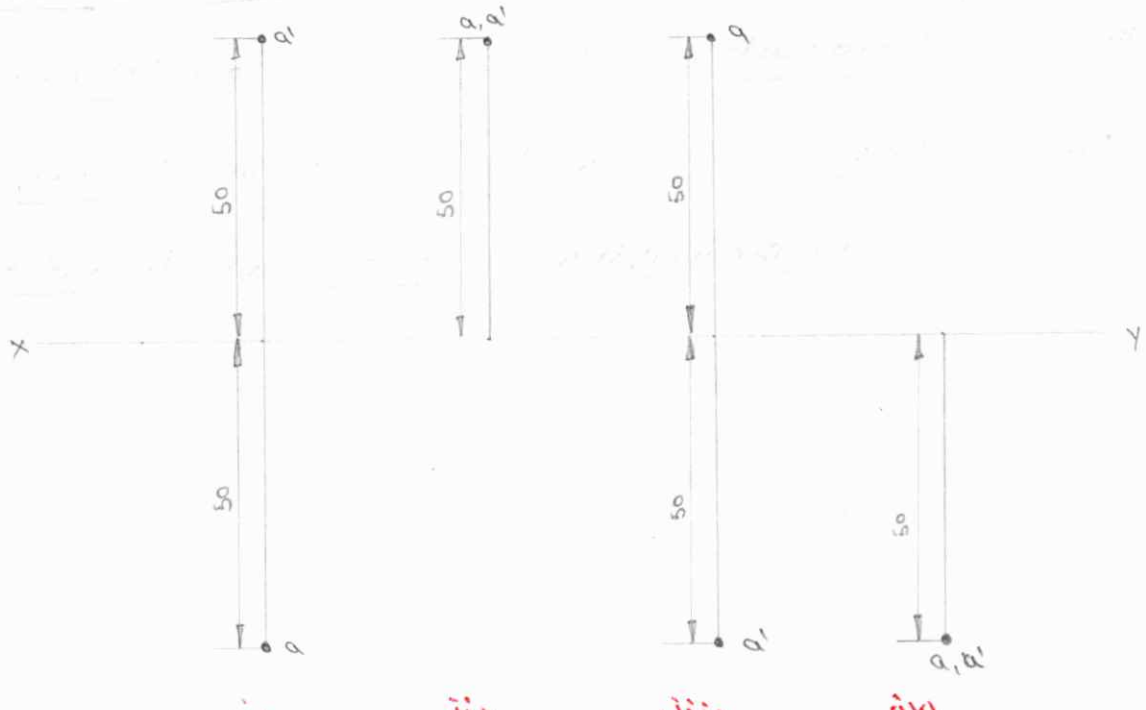
(v) E, 15 mm above the H.P and 50mm behind the VP

(vi) F, 40 mm below the H.P and 25 mm in front of the V.P

(vii) G, in both the H.P and the V.P.

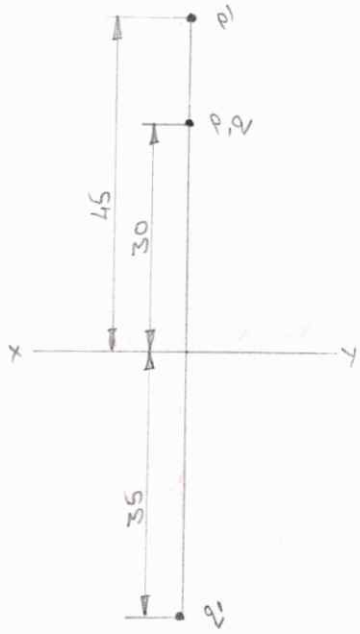


② A Point is 50 mm from both the reference Planes. Draw it's Projections in all Possible Positions



3. A Point A is 25mm above the H.P and 35mm infront of the V.P. Another Point is 40mm behind the V.P and 30mm below the H.P.

4. A Point 30mm above xy line is the Plane view of two Points P and Q the elevation of P is 45mm above the H.P. while that of the Point Q is 35mm below the H.P. Draw the projections of the Points and State their Positions with reference to the Principal Planes on the Quadrant in which they lie.

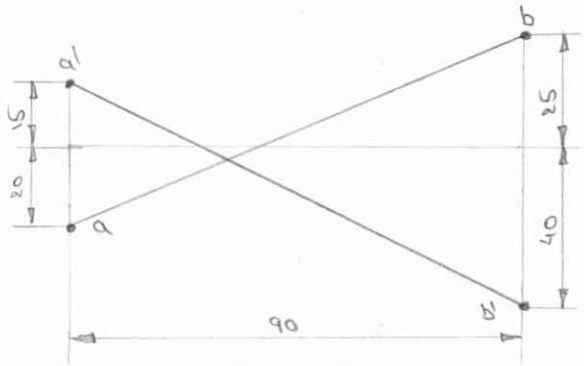


Conclusion :-

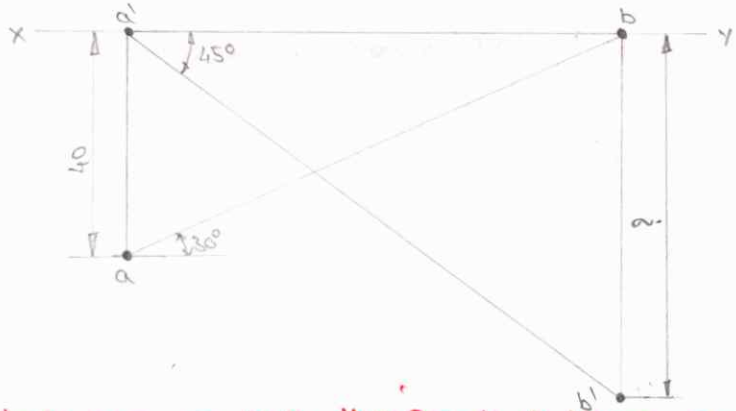
→ The Point P lies 45 mm above H.P and 30mm behind V.P - II Quadrant

→ The Point Q lies 35mm below H.P and 30mm behind V.P - III quadrant

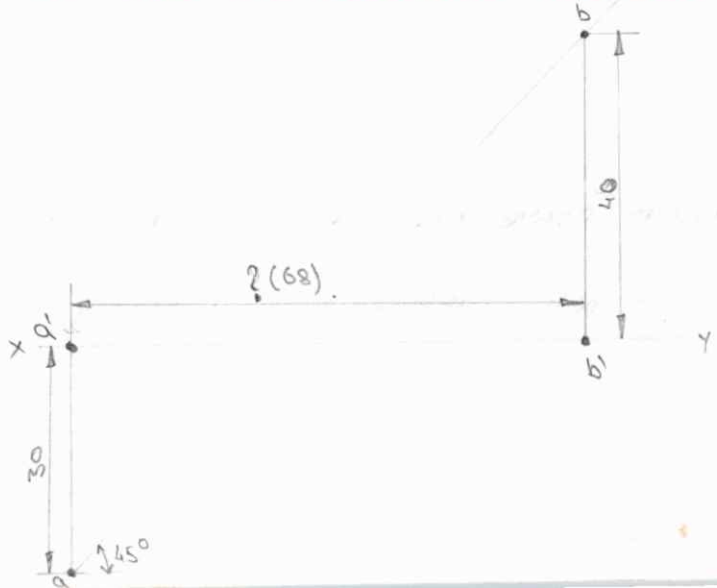
⑤ A Point A is ~~above~~ is above H.P and 20 infront of V.P. Another Point B is 25 behind V.P and 40 below H.P. Draw the Projections of A and B, keeping the distance between the Projectors equal to 90. Draw straight lines, joining (i) the top views and (ii) the front views



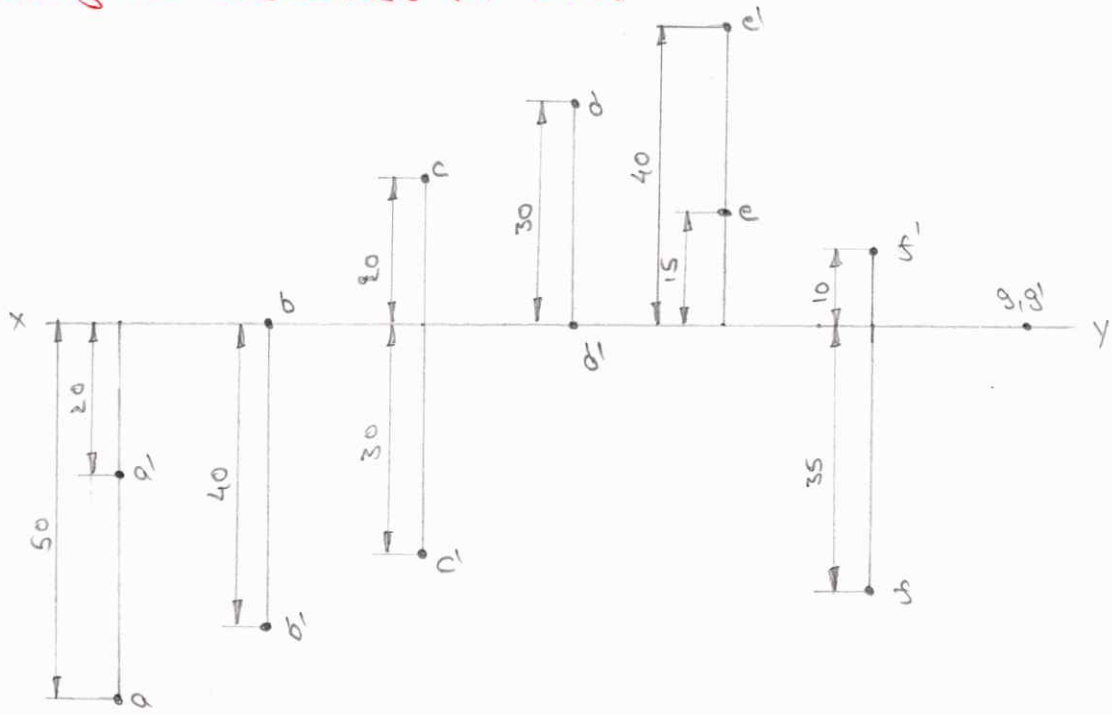
⑥ A Point A is on H.P and 40 infront of V.P. Another Point B is on V.P and below H.P. The line joining their front views makes an angle of 45°, with xy, while the line joining their top views makes an angle of 30°. Find the distance of the Point B from H.P.



⑦ Two Points A and B are on H.P; the Point A being 30 infront of V.P, while B is 40 behind V.P. The line joining their top views makes an angle of 45° with XY. Find the horizontal distance between two Points.



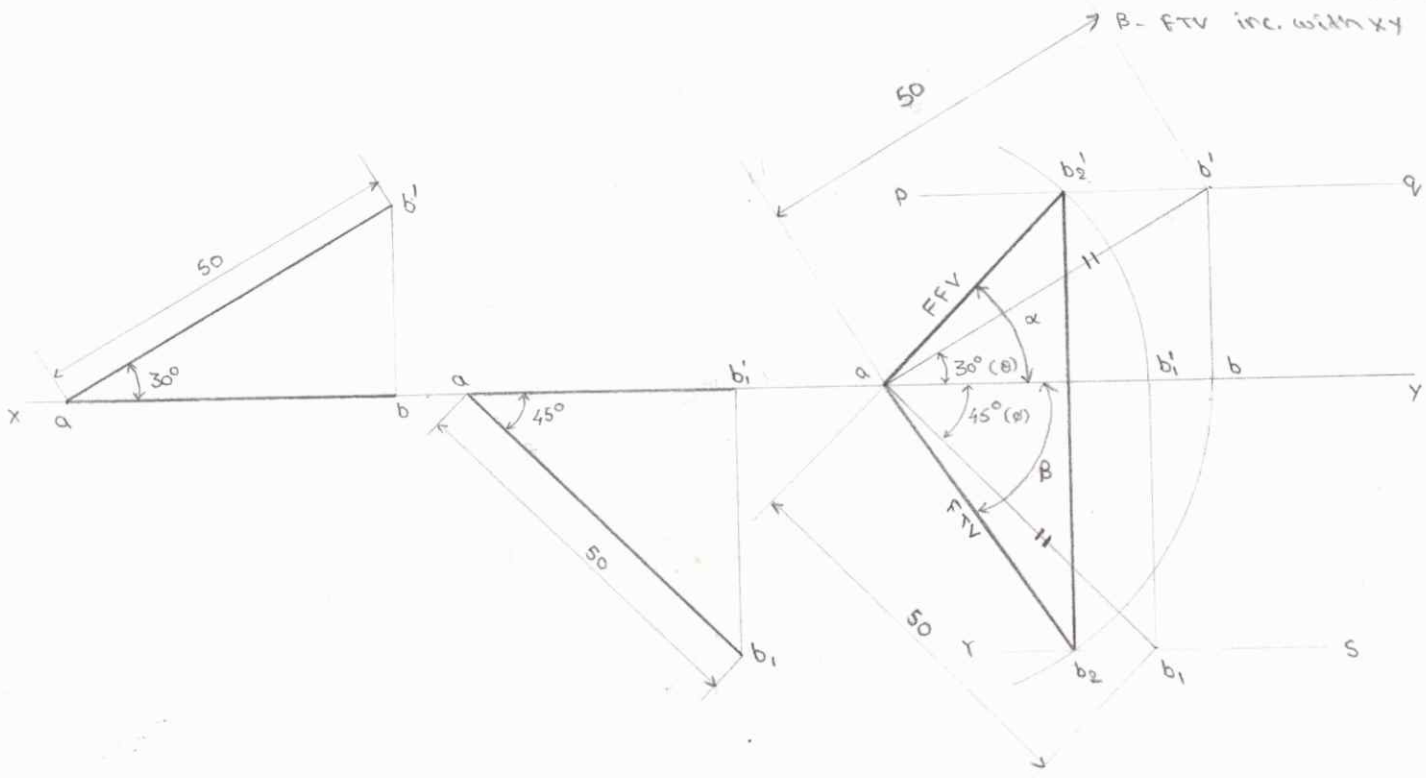
8. Projections of various points are given below figure. State the positions of each point with respect to the planes of projection, giving the distances in mm.



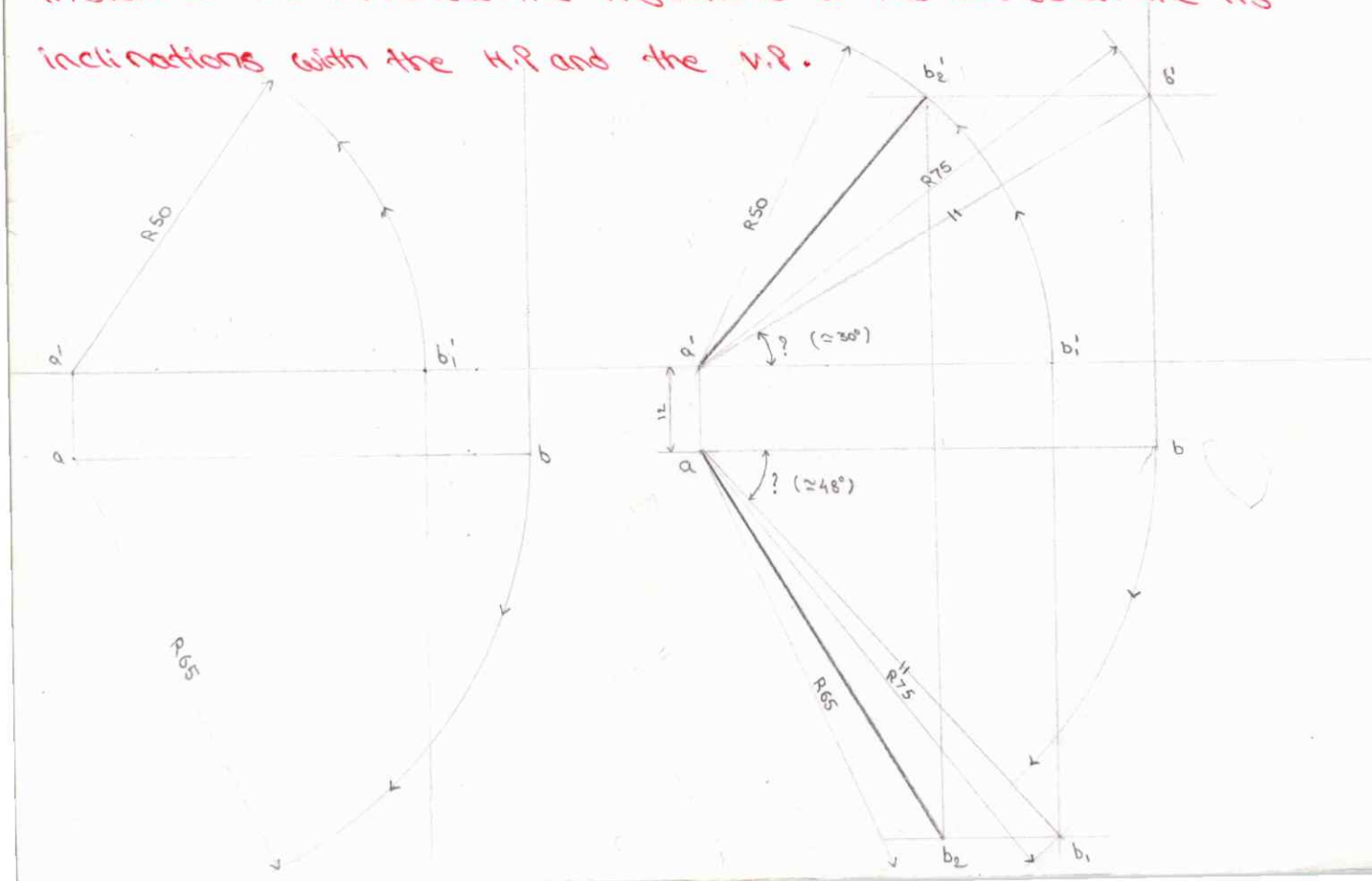
Line inclined to both the planes:-

① A line AB, 50mm long, has it's ends A in both the H.P and the V.P. It is inclined at 30° to the H.P and at 45° to the V.P. Draw the Projections.

θ - Inclination with H.P
ϕ - " " V.P
α - FFV inc. with XY
β - FTV inc. with XY

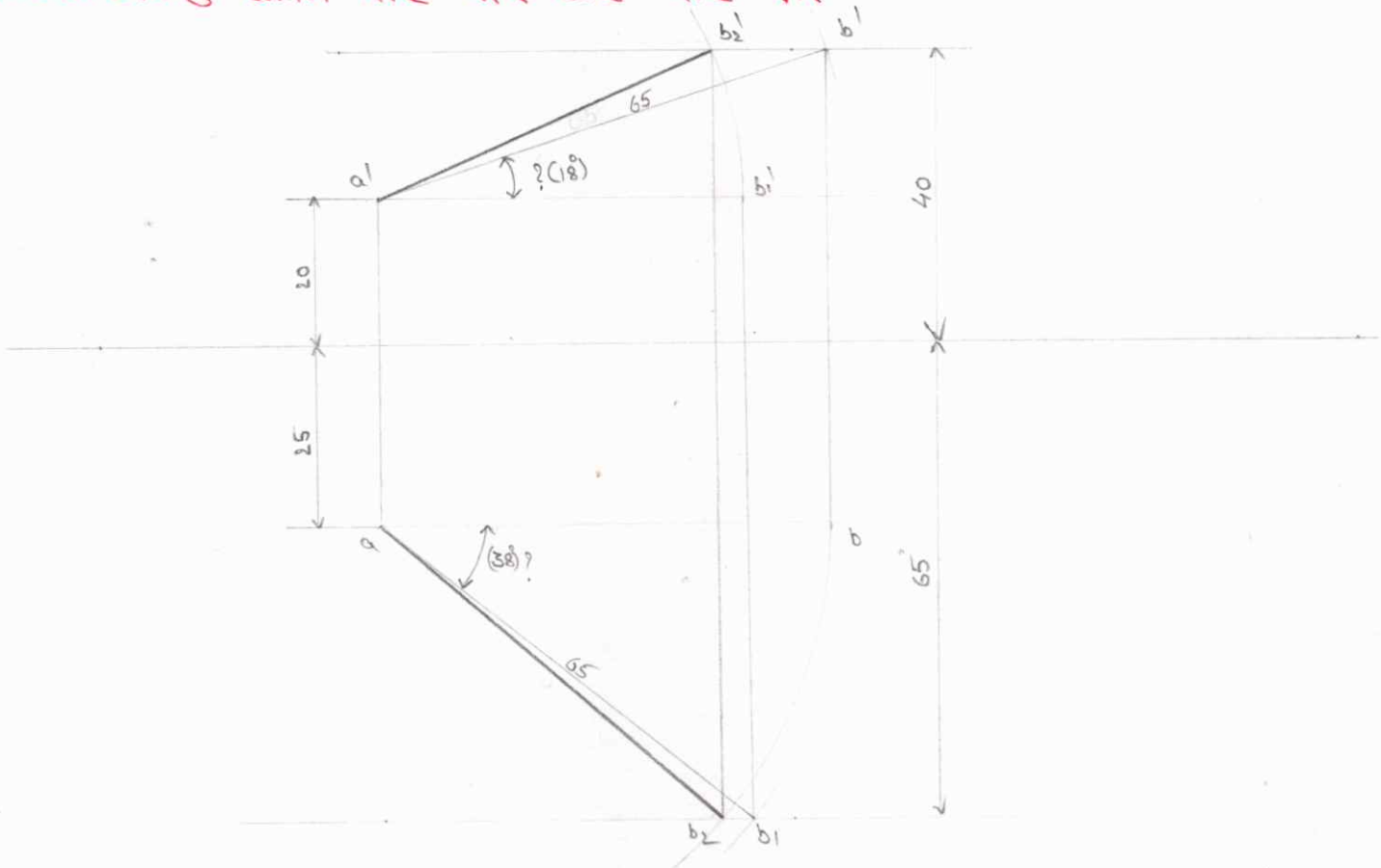


② The top view of a 75mm long line AB measures 65 mm, while the length of its front view is 50 mm. It's one end A is in H.P and 12 mm in front of the V.P. Draw the projections of AB and determine its inclinations with the H.P and the V.P.



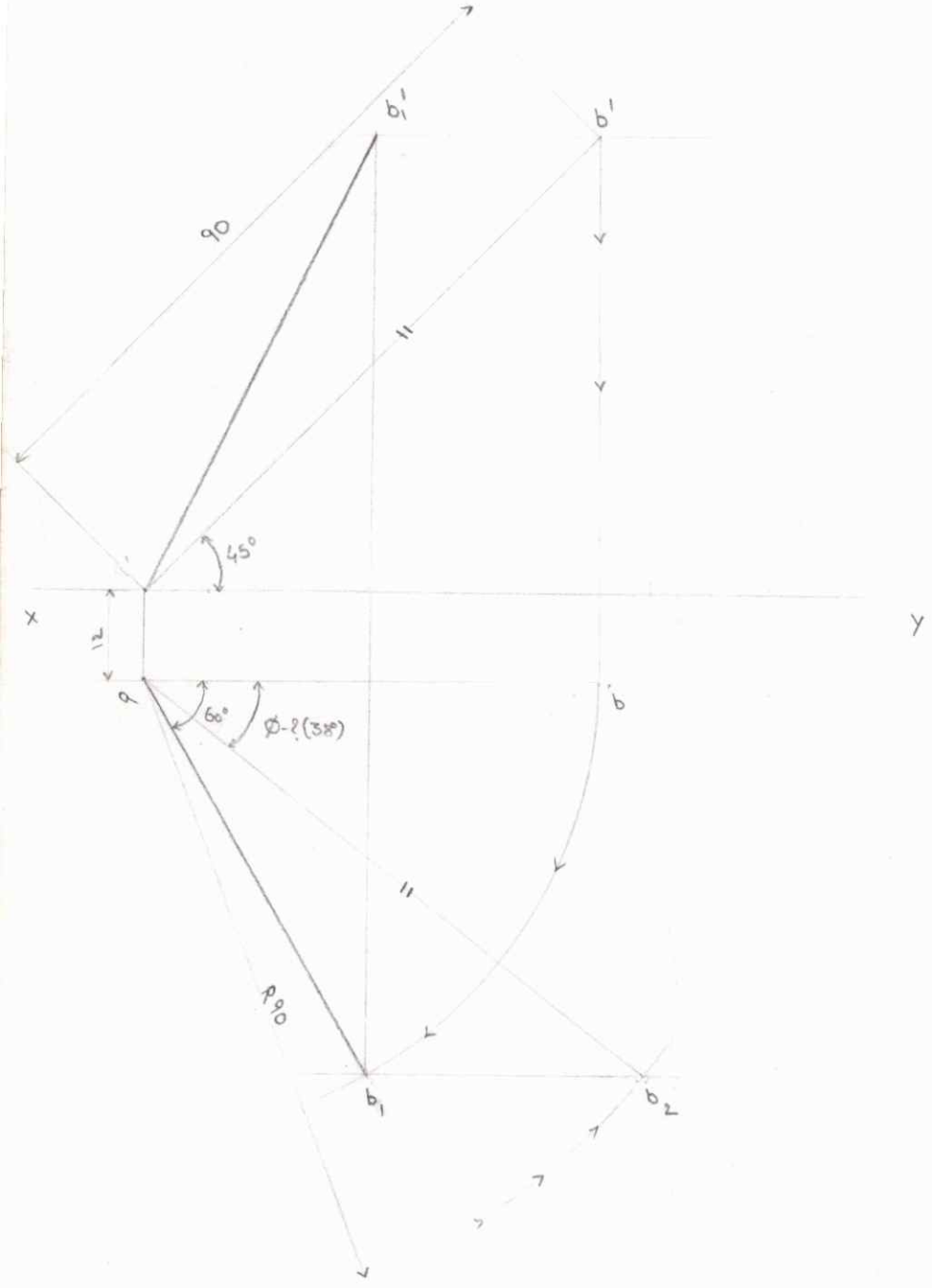
~~(2) A line AB, 90 mm long is inclined at 45~~

3. A line AB, 65 mm long has it's end A 20 mm above the H.P and 25mm infront of the V.P. The end B is 40 mm above the H.P and 65 mm infront of the V.P. Draw the projections of AB and show it's inclinations with the H.P and the V.P



④ A line AB, 90mm long is inclined at 45° to the H.P. and its top view makes an angle of 60° with the V.P. The end A is in the H.P and 12 mm infront of the VP. Draw its projections and find its true inclination with the VP.

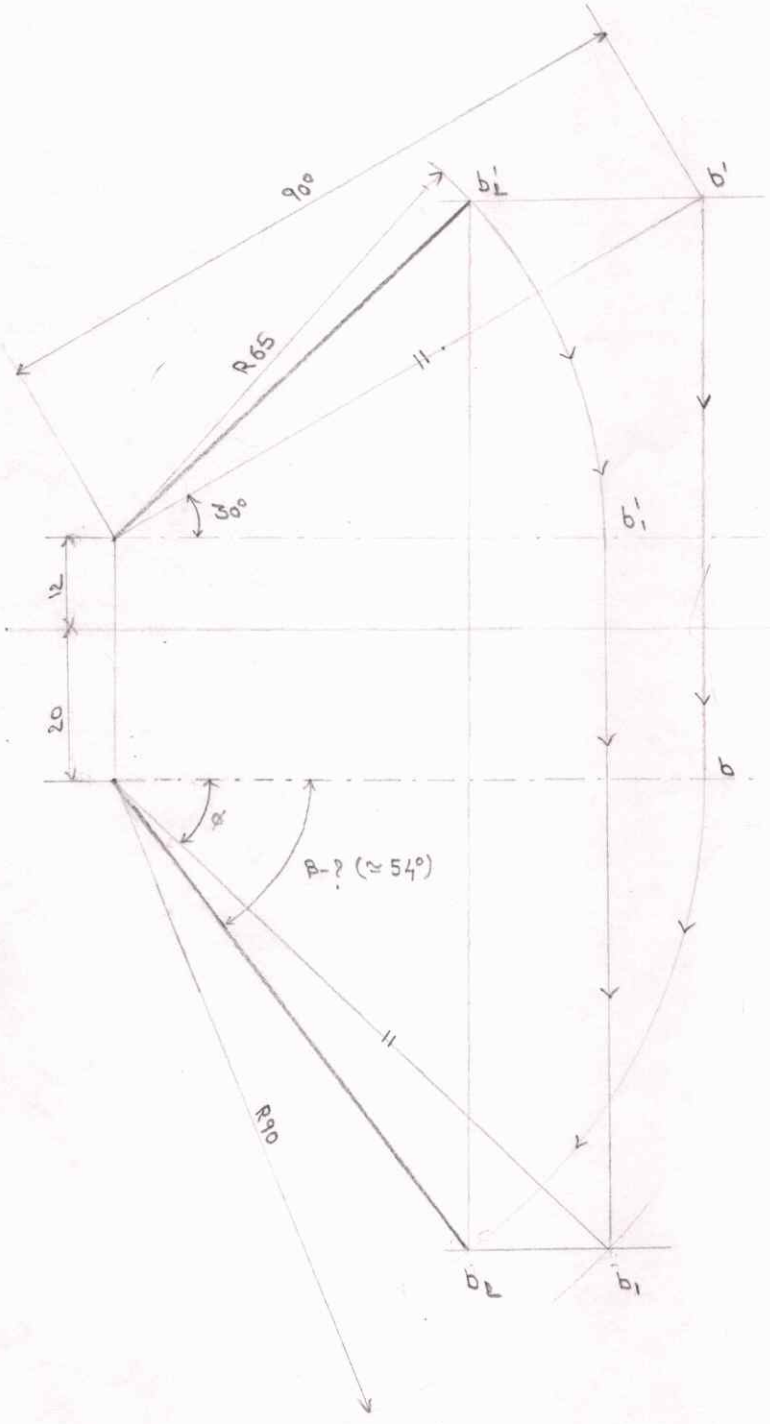
AB = 90 mm $\theta = 45°$ $\phi = ?$ $\alpha = -$ $\beta = 60°$ A { H.P, V.P - 12



5. A line AB, 90 mm long is inclined at 30° to the H.P. Its end A is 12 mm above the H.P. and 20 mm infront of the V.P. Its front view measures 65mm. Draw the top view of AB and determine its inclination with the V.P.

AB = 90 mm θ = 30° ϕ = - α = - β = ?

A { H.P- 12, V.P- 20 FFV = 65 mm



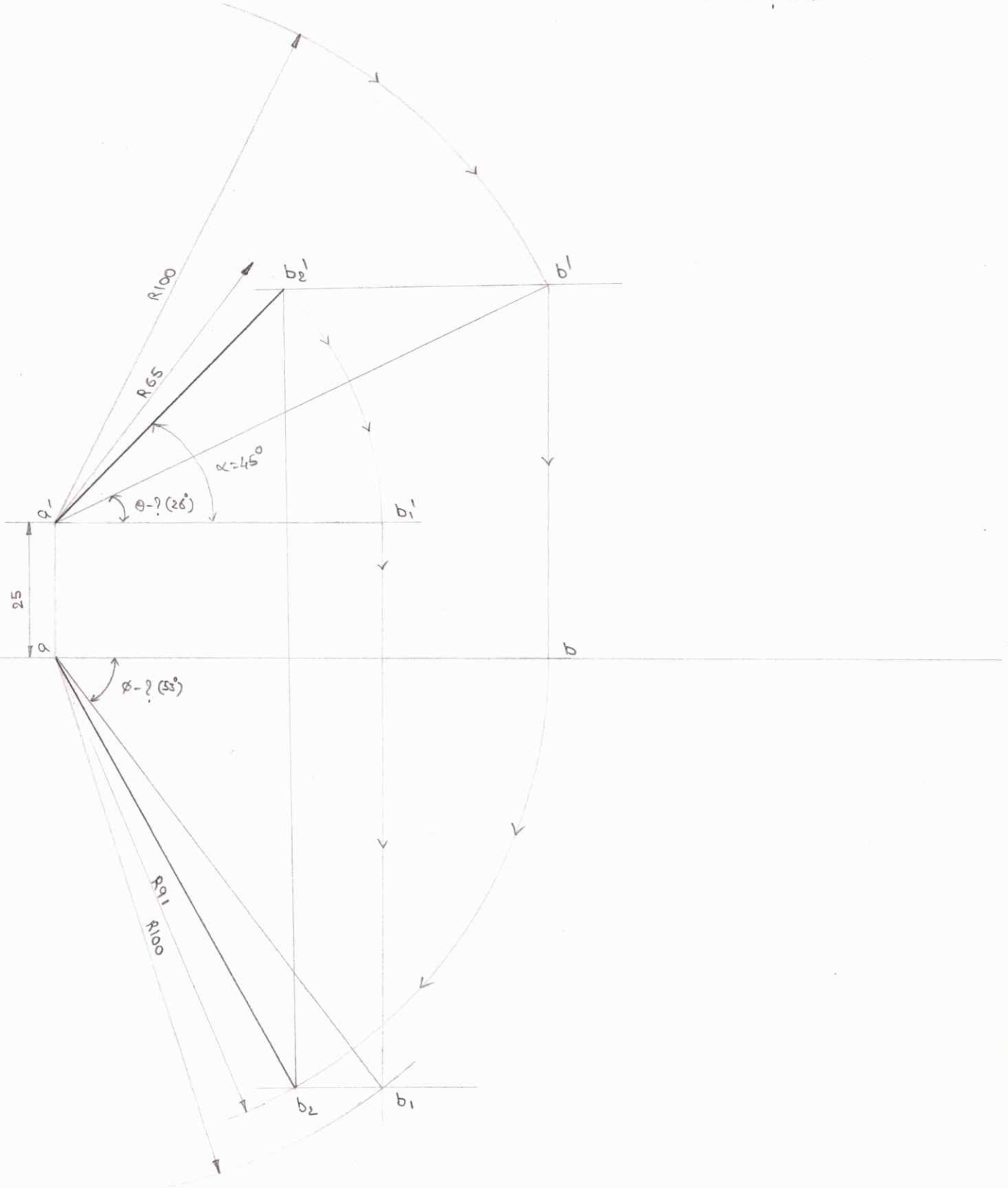
6. One end A of a line AB, 75mm long is 20mm above the H.P and 25 mm infront of the V.P. The line is inclined at 30° to the H.P and the top view makes 45° with the V.P. Draw the Projections of the line and find the true inclination with the vertical Plane.

AB = 75 mm $\theta = 30°$ $\phi = ?$ $\alpha = -$ $\beta = 45°$

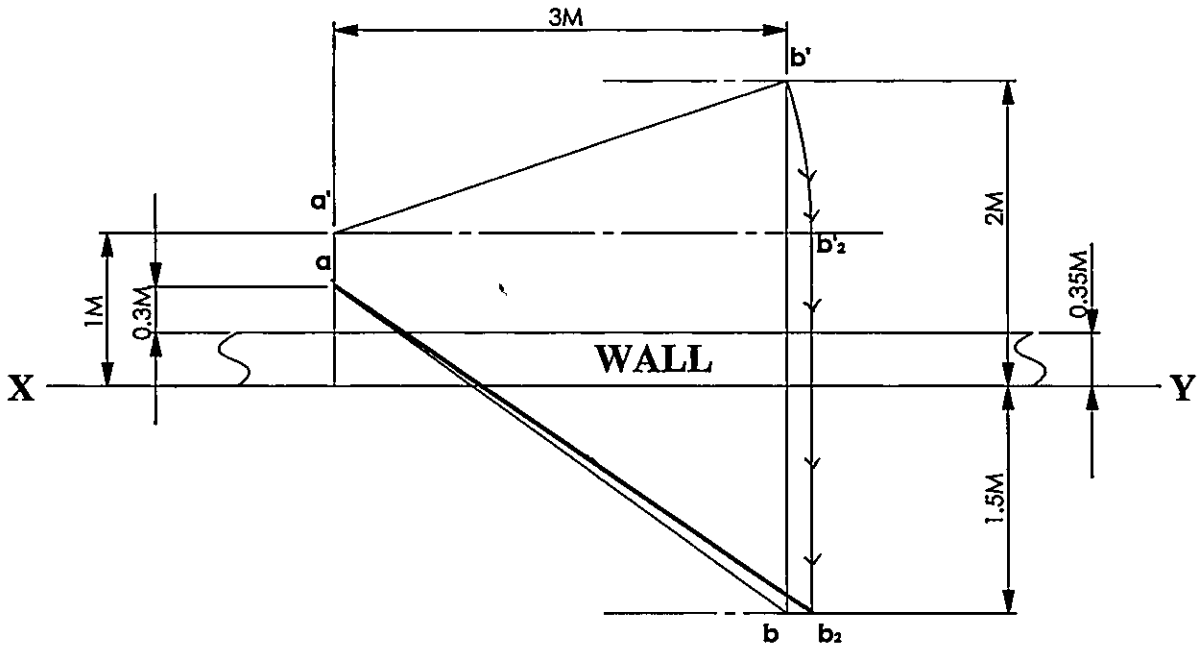
A { H.P = 20 mm, V.P - 25mm

7. A line 100mm long has its front view inclined at 45° to x'y'. The Point A is in the V.P and 25mm above the H.P. The length of the front view is 60mm. Draw the top view of the line and measure it's length. Also find the inclination of the line AB to H.P and V.P.

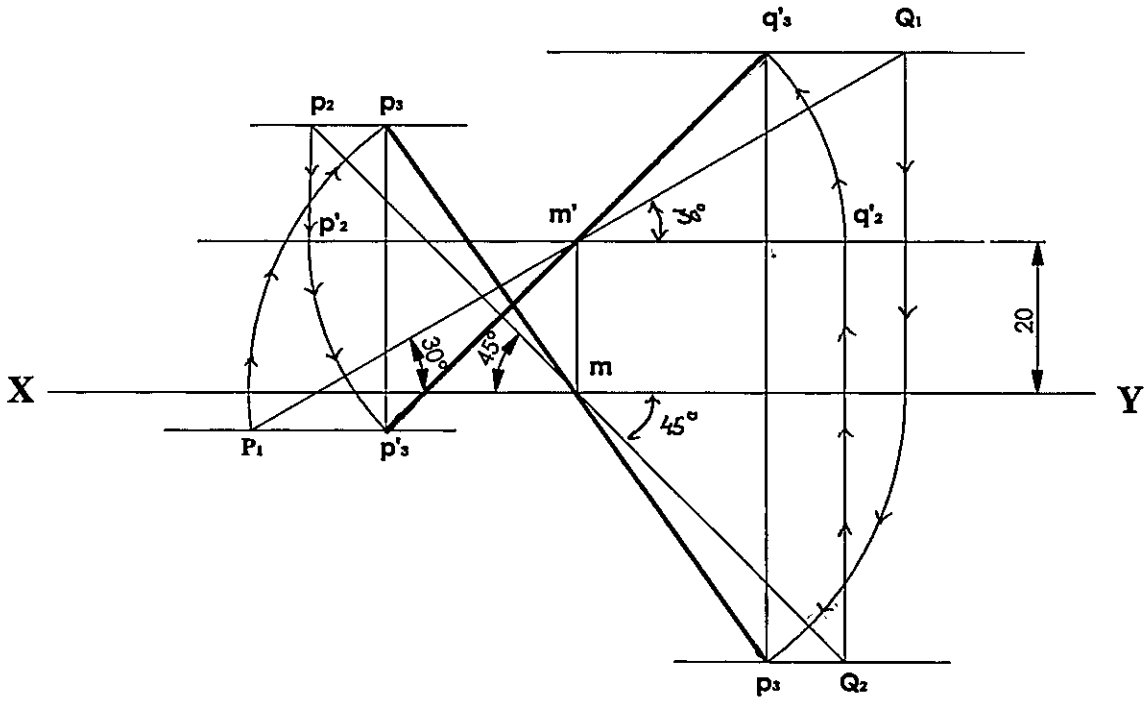
AB = 100mm θ = ? ϕ = ? α = 45° A { H.P - 25, V.P - in } FFL = 60 mm FTL = ? (91)



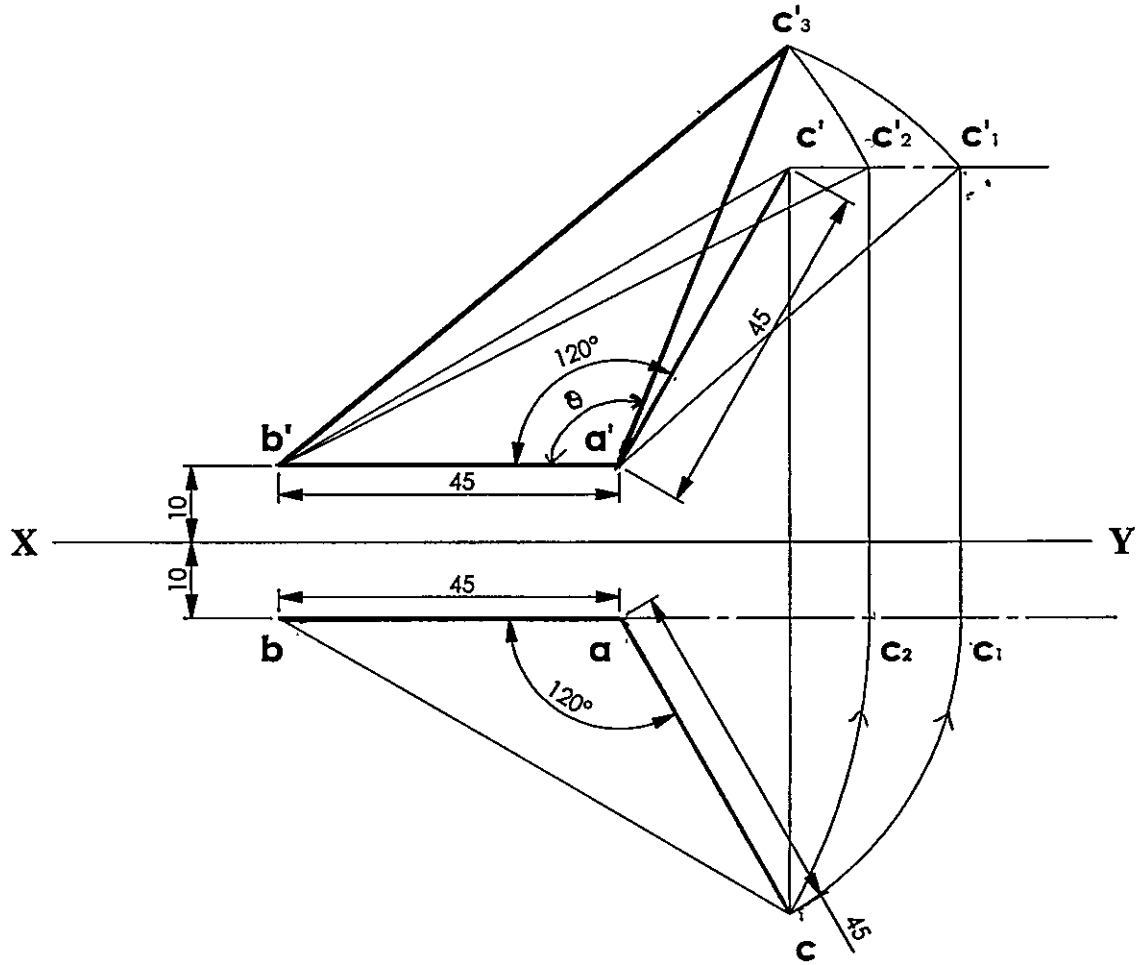
1. Two oranges A and B on a tree are respectively at 1m and 2m above the ground and 0.3m and 1.5m from a 0.35m thick wall but on opposite sides of the wall. The distance between the oranges measured along the ground and parallel to the wall is 3m. Determine the true distance between the oranges.



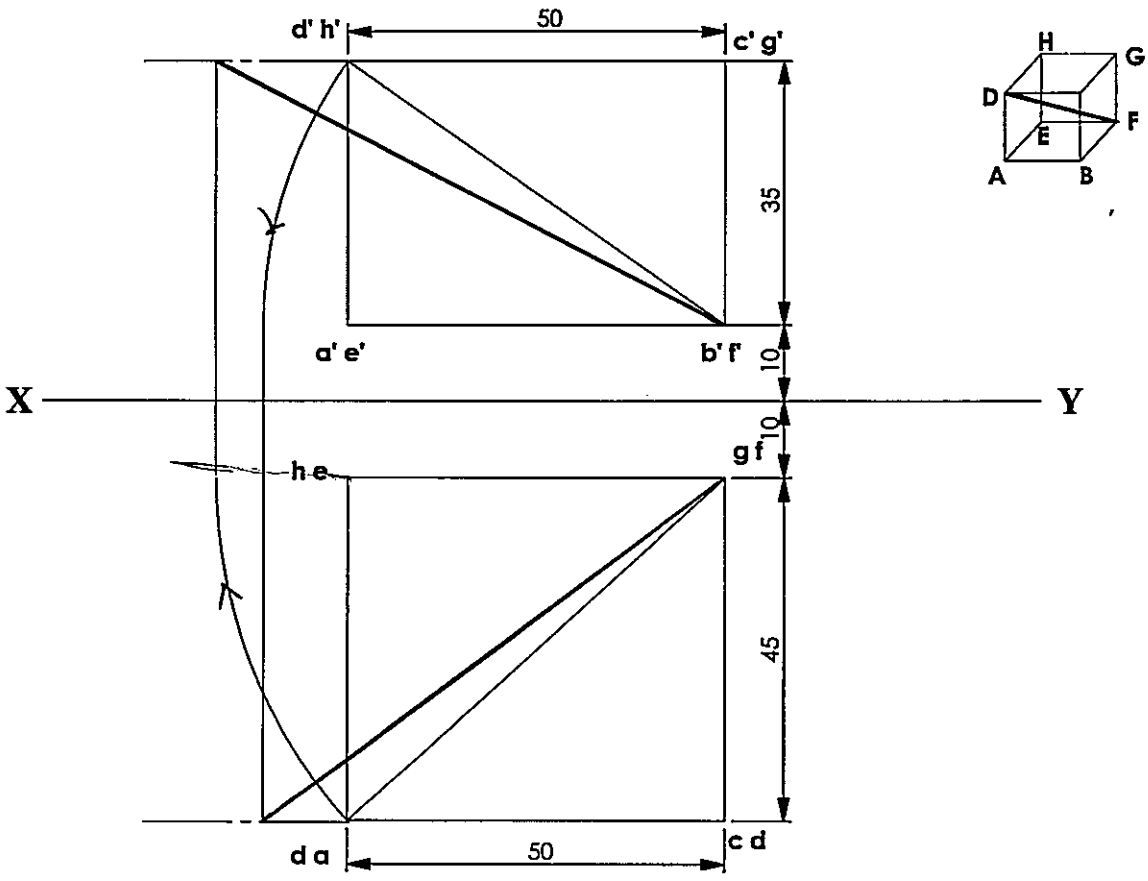
2. A line PQ 100mm long, is inclined at 30°to the H.P. and 45° to the V.P. Its midpoint is in theV.P. and 20mm above the H.P. Draw its projections, if its end P is in the third quadrant and Qis in first quadrant



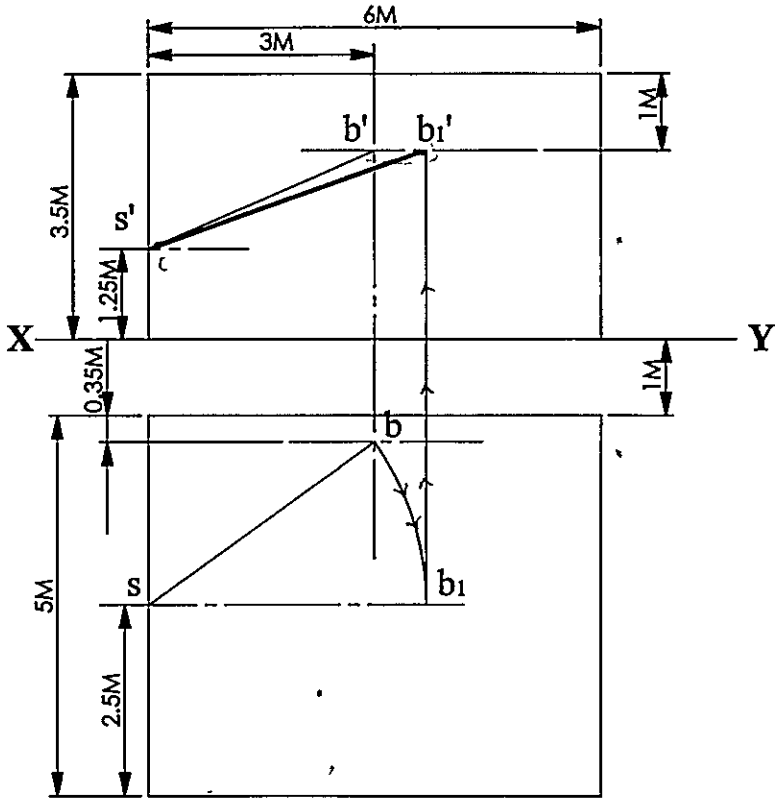
3. Two lines AB and AC makes an angle of 120° between them in their front view and top view. AB is parallel to both the H.P and the V.P. Determine the real angle between AB and AC.



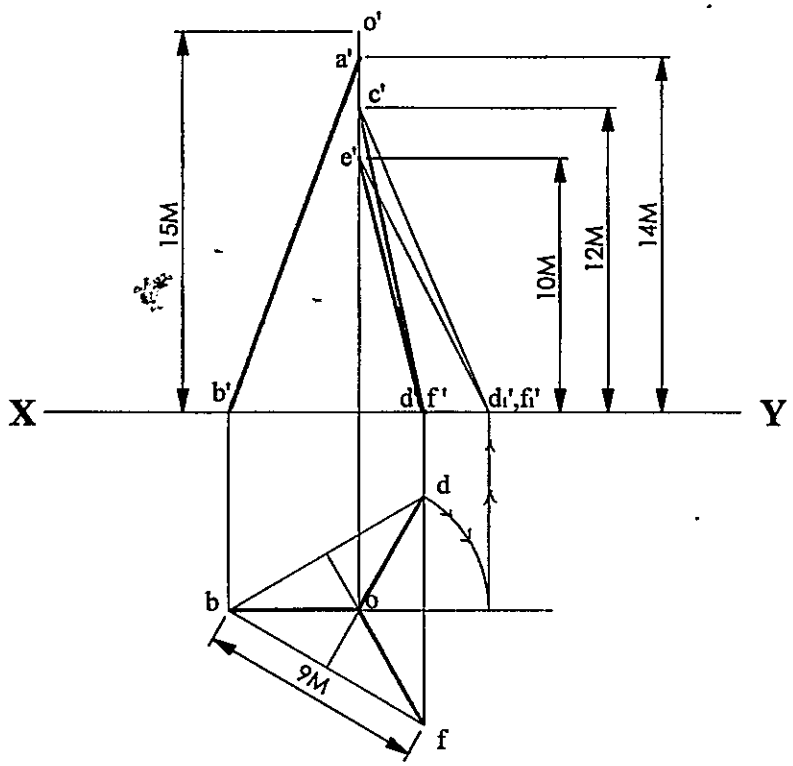
4. A room is 5m x 4.5m x 3.5m high. Determine the distance between the top corner and the bottom corner, diagonally opposite to it, by drawing the projections of the line joining the two corners.



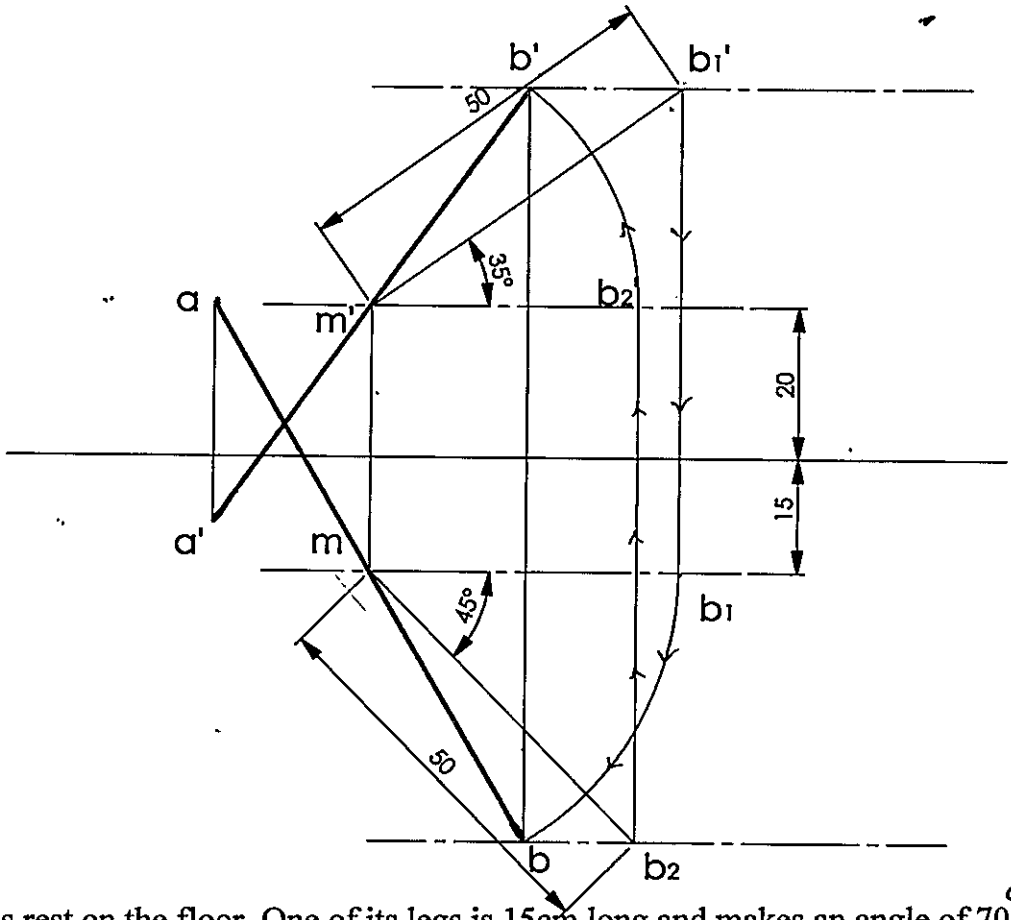
5. A room is 6m x 5m x 3.5m high. An electric bulb is above the centre of the larger wall and 1m below the ceiling and 0.35m away from the wall. The switch for the light is 1.25m above the floor, on the centre of an adjacent wall. Determine graphically, the shortest distance between the bulb and switch.



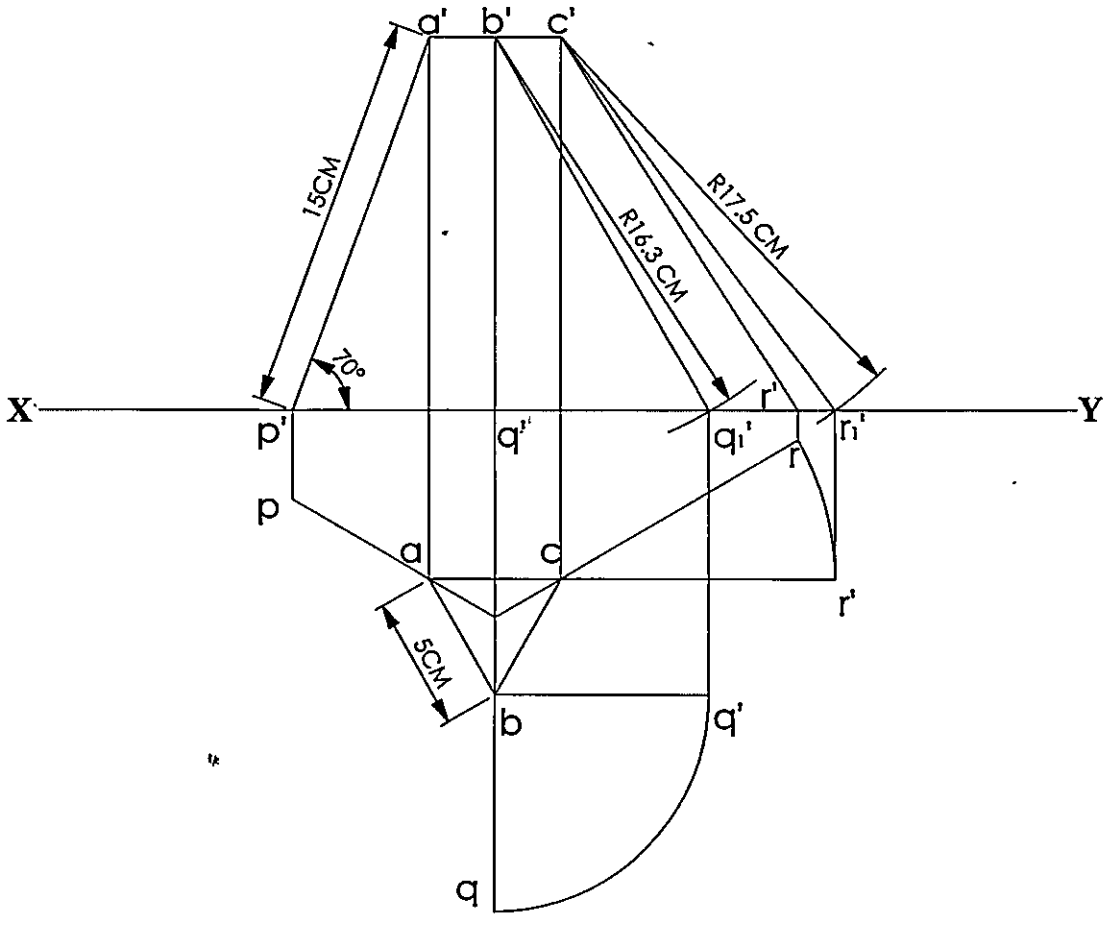
6. Three wires AB, CD & EF are tied at A, C & E on a 15m long vertical post at heights of 14m, 12m &10m respectively from the ground. The lower ends of the wires are tied to hooks at points B, D & F at the ground level. If the points B, D & F lie at the corners of an equilateral triangle of 9m side, and if the post is situated at the centre of the triangle, determine the length of each rope and its inclination with the ground. Assume thickness of the post and the wires to be equal to that of a line.



√7. A line of 100mm long makes an angle of 35° with the H.P. and 45° with the V.P. Its mid point is 20mm above H.P. and 15 mm in front of V.P. Draw the projections of the line.



8. A tripod stands rest on the floor. One of its legs is 15cm long and makes an angle of 70° with the floor. The other two legs are 16.3cm and 17.5cm long respectively. The upper ends of the legs are attached to the corners of a horizontal equilateral triangular frame of 5cm side, one side of which is parallel to the V.P. In the top view, the legs appear as lines 1200 apart, which it produced, would meet in a point. Draw the projections of the tripod and determine the angle which each of the other two legs makes with the floor. Assume the thickness of the frame and of the legs to be equal to that of the line.



Projections of Planes

Plane surfaces (or) Planes:-

Any machine (or) structure is considered to be made up of a number of components which are formed by geometrical surfaces known as planes. A plane (or) plane surface (also known as lamina), has only two dimensions viz., length and breadth with negligible thickness.

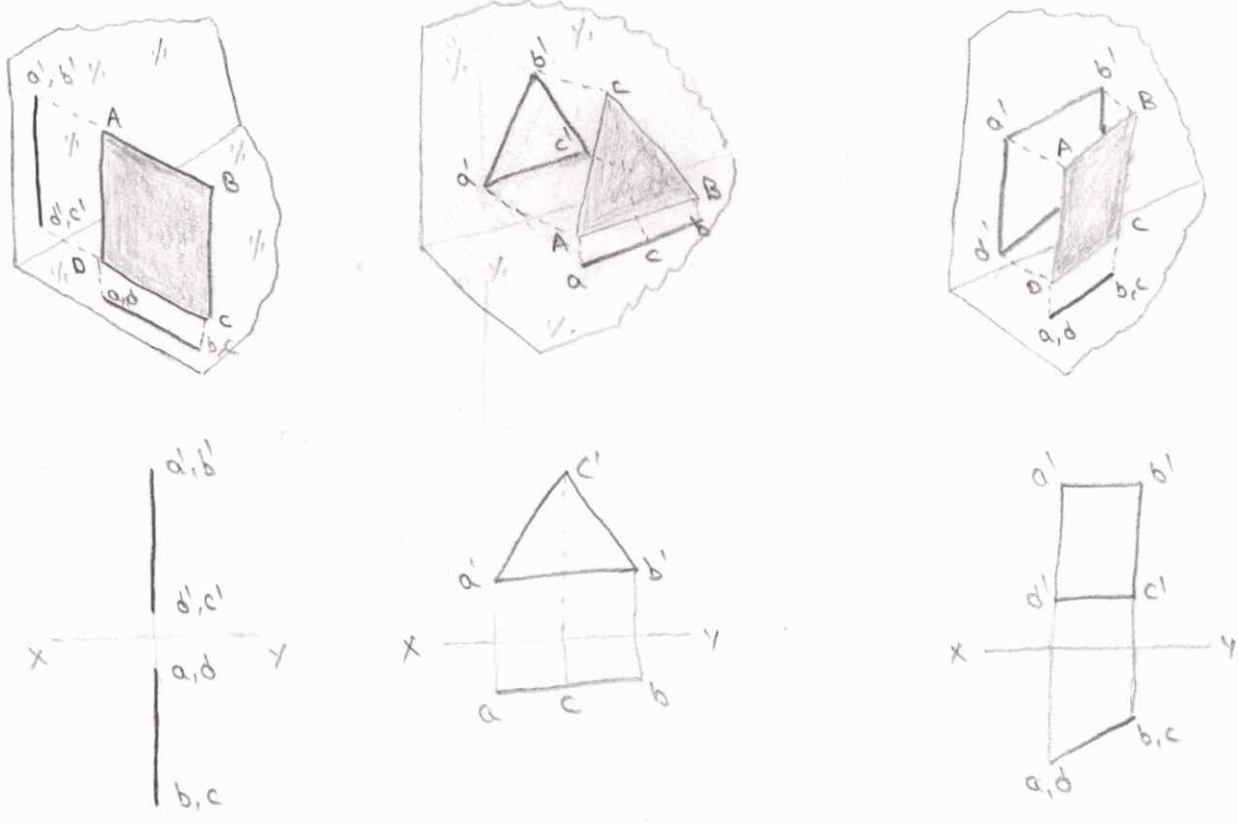
Types of planes:-

Planes may be divided into two main types:-

1. Perpendicular planes 2. oblique planes.

1. Perpendicular planes:-

(a) Perpendicular to both the reference planes.
(b) Perpendicular to one plane and Parallel to the other.
(c) Perpendicular to one plane and inclined to the other.



(a) (b) (c)

2. Oblique Planes:-

Planes which are inclined to both the reference planes are called oblique planes.

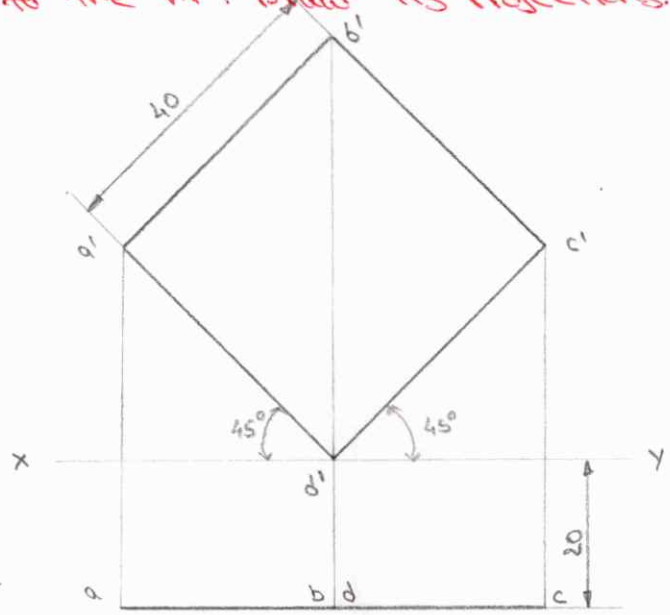
General Conclusions:-

(a) When a plane is perpendicular to a reference plane, its projection on that plane is a straight line.

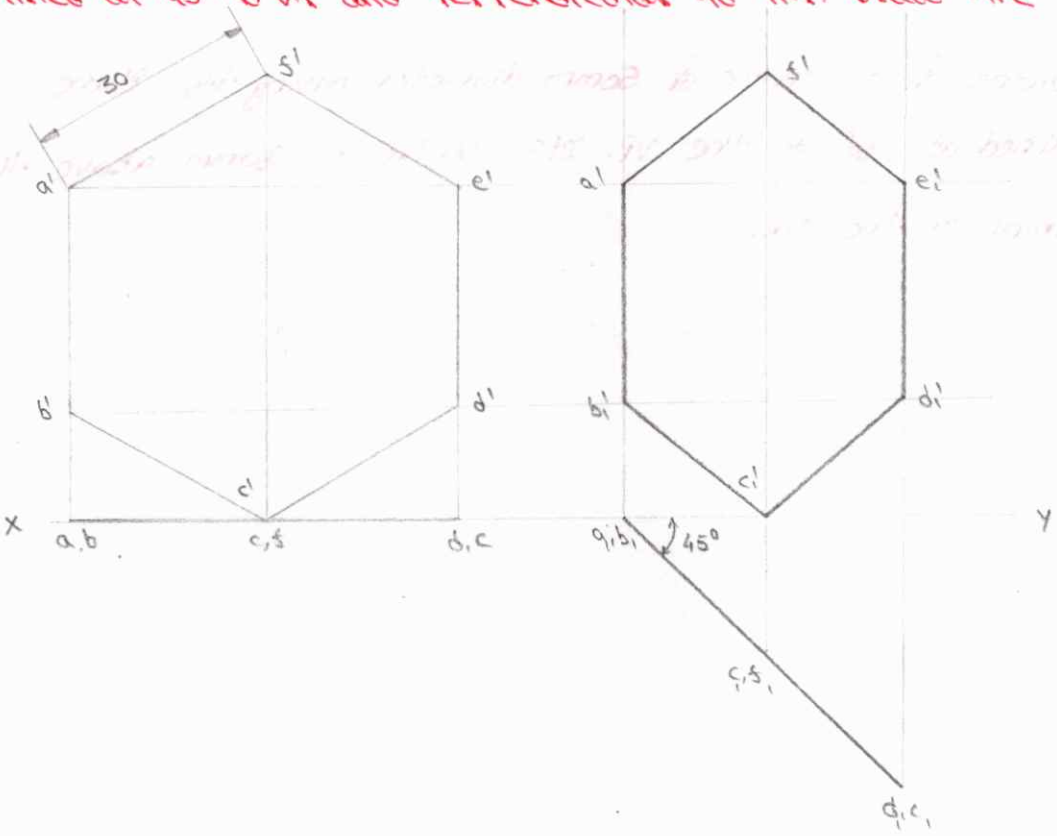
(b) When a plane is parallel to a reference plane, its projection on that plane shows its true shape and size.

(c) When a plane is perpendicular to one of the reference plane and inclined to the other, its inclination is shown by the angle which its projection on the plane to which it is perpendicular, makes with XY. Its projection on the plane to which it is inclined, is smaller than the plane itself.

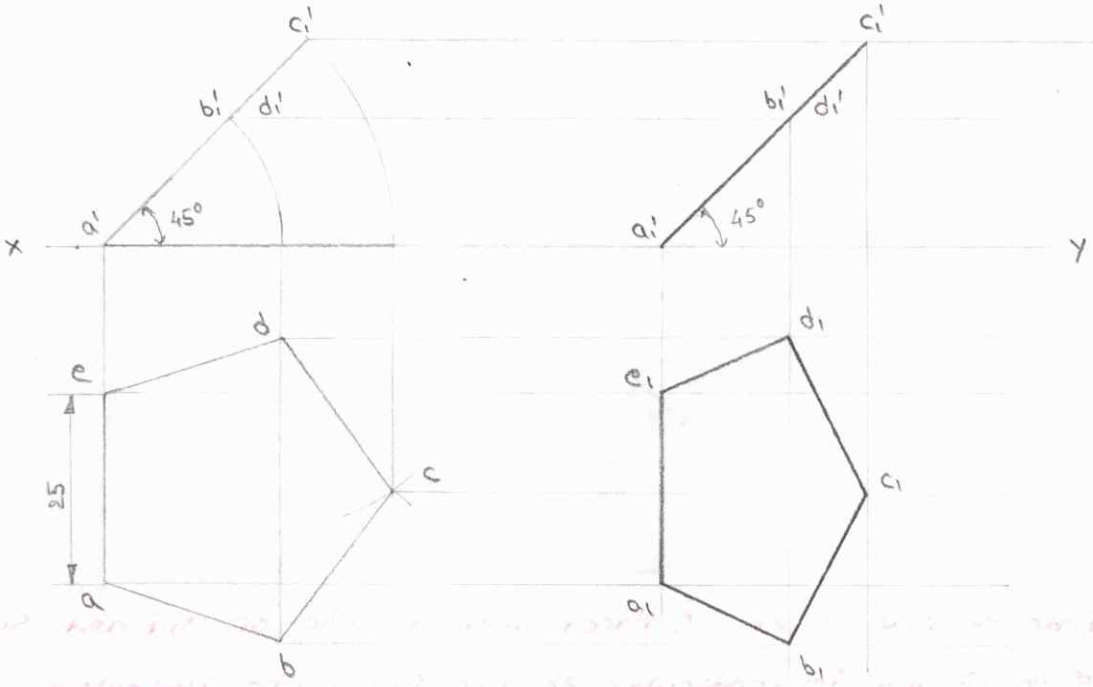
(1) A square ABCD of 40mm side has a corner on the H.P and 20mm infront of the V.P. All the sides of the squares are equally inclined to the H.P and parallel to the V.P. Draw its projections.



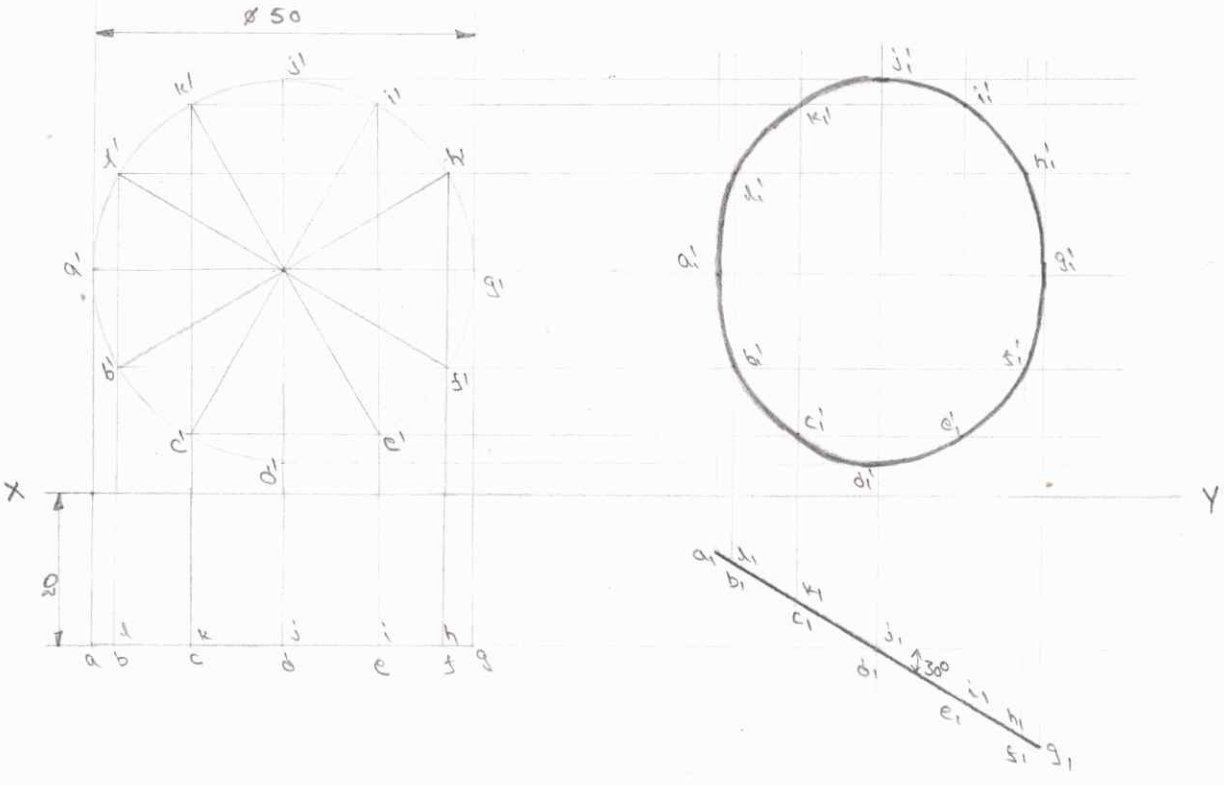
(2) A hexagonal Plate of side 30mm is placed with a side on V.P and Surface inclined at 45° to V.P and perpendicular to H.P. Draw the projection.



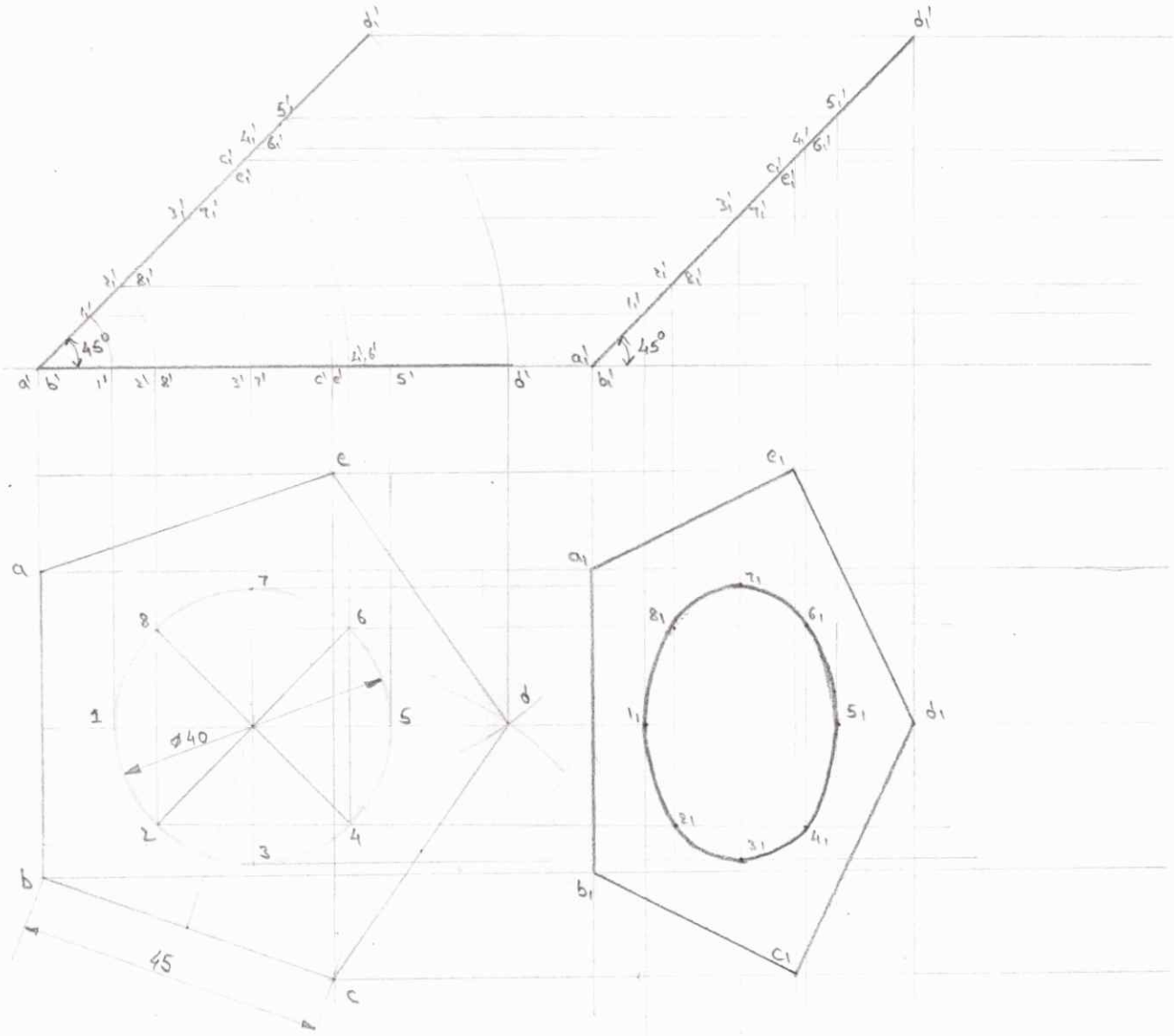
③ A regular Pentagon of 25 mm side has one side on the ground. Its plane is inclined at 45° to the H.P and perpendicular to the V.P. Draw its projections.



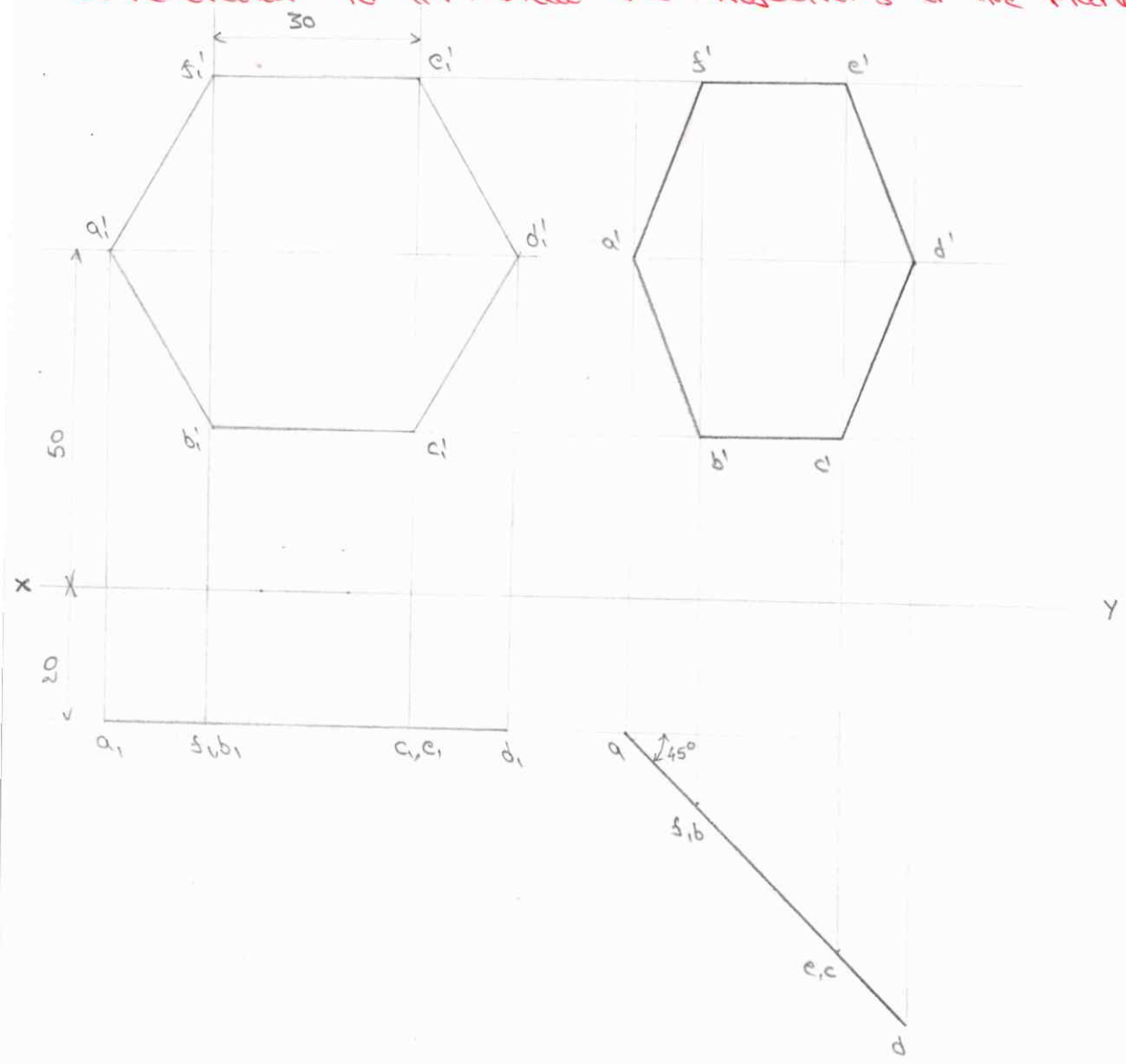
④ Draw the projections of a circle of 50mm diameter, having its plane vertical and inclined at 30° to the VP. Its centre is 30mm above the HP and 20mm infront of the VP.



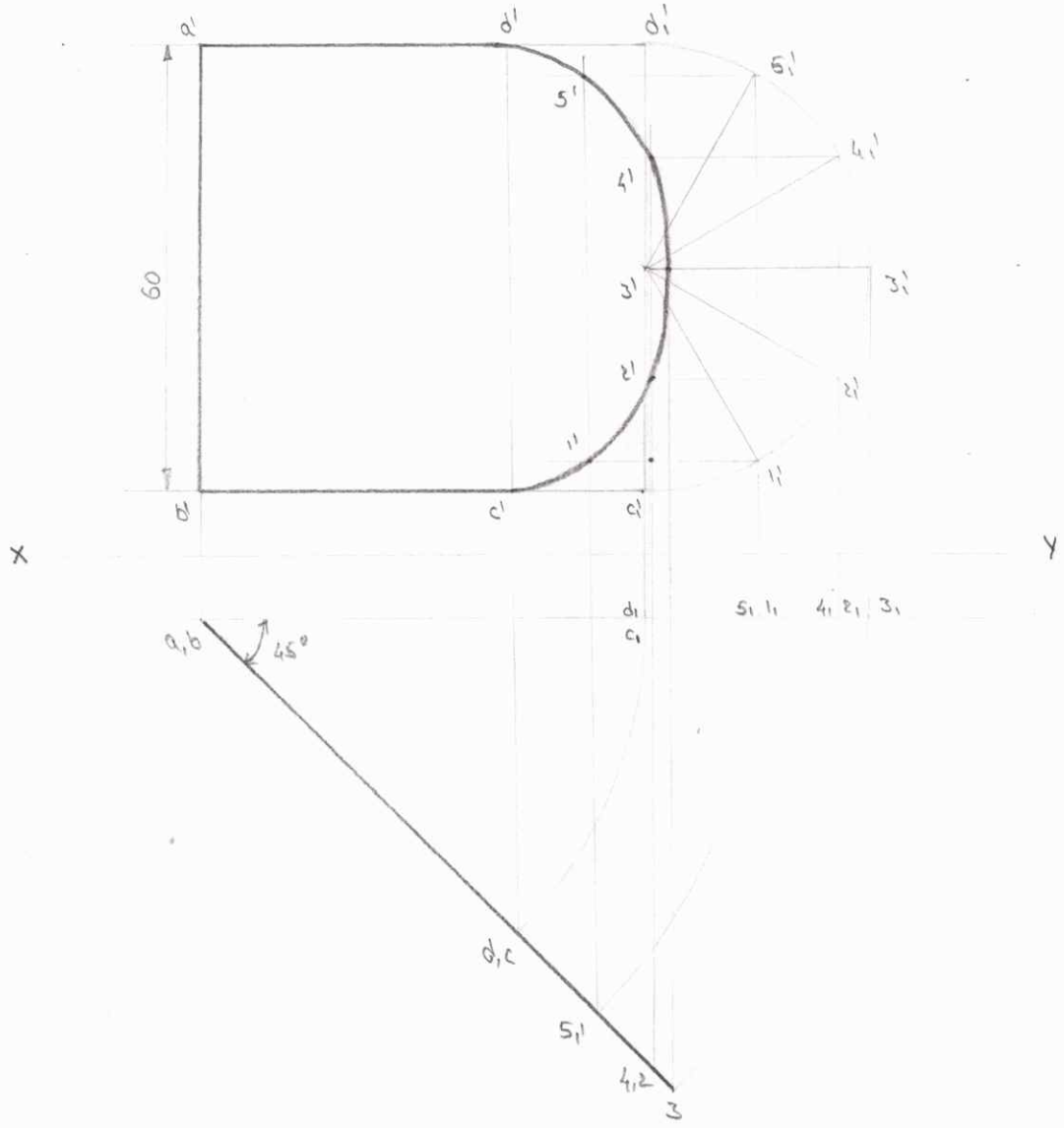
(5) A pentagonal plate of 45mm side has a circular hole of 40mm diameter in its centre. The plane stands on one of its sides on the HP with its plane perpendicular to VP and 45° inclined to the H.P. Draw the projections.



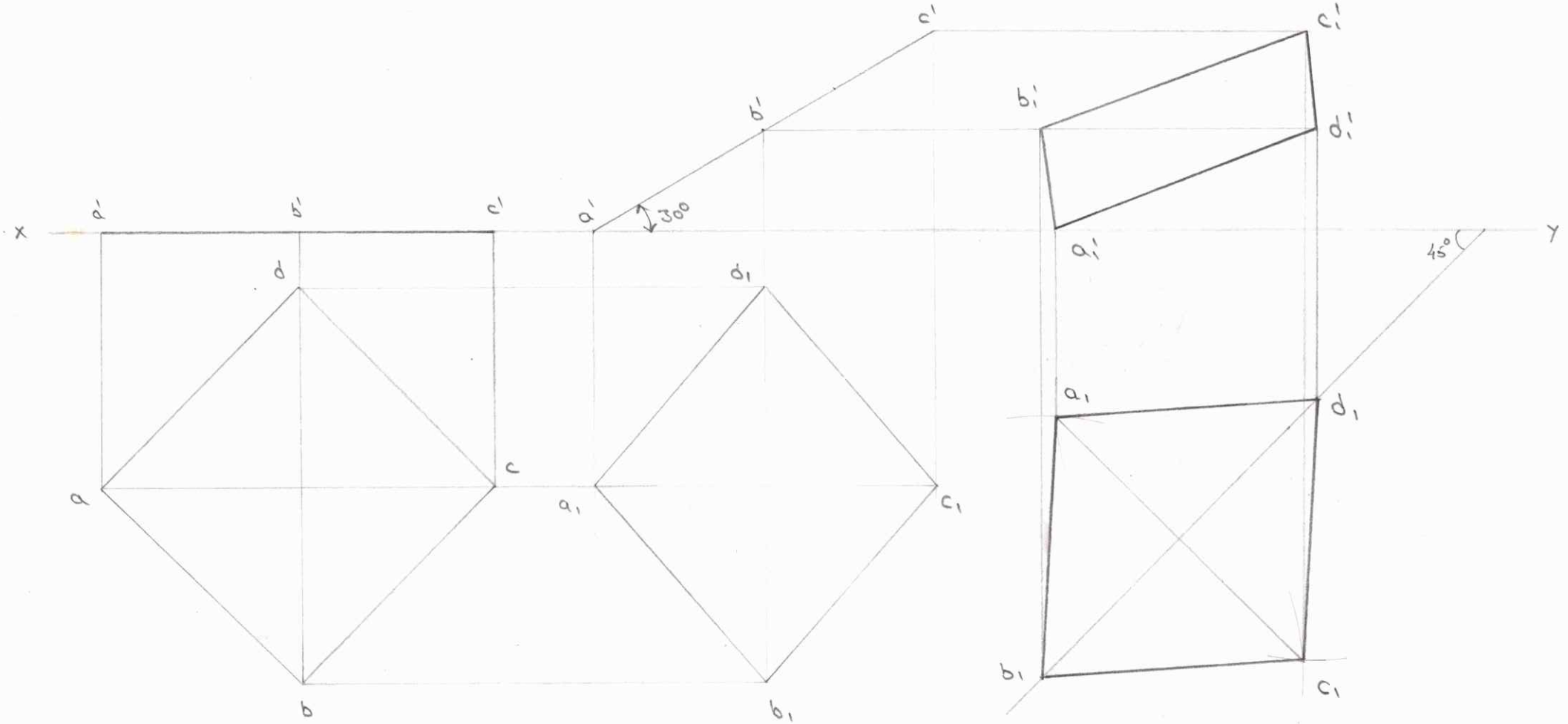
⑥ A regular hexagonal Plane of 30mm side, has a corner at 20mm from VP and 50mm from H.P. Its surface is inclined at 45° to V.P and Perpendicular to H.P. Draw the Projections of the Plane.



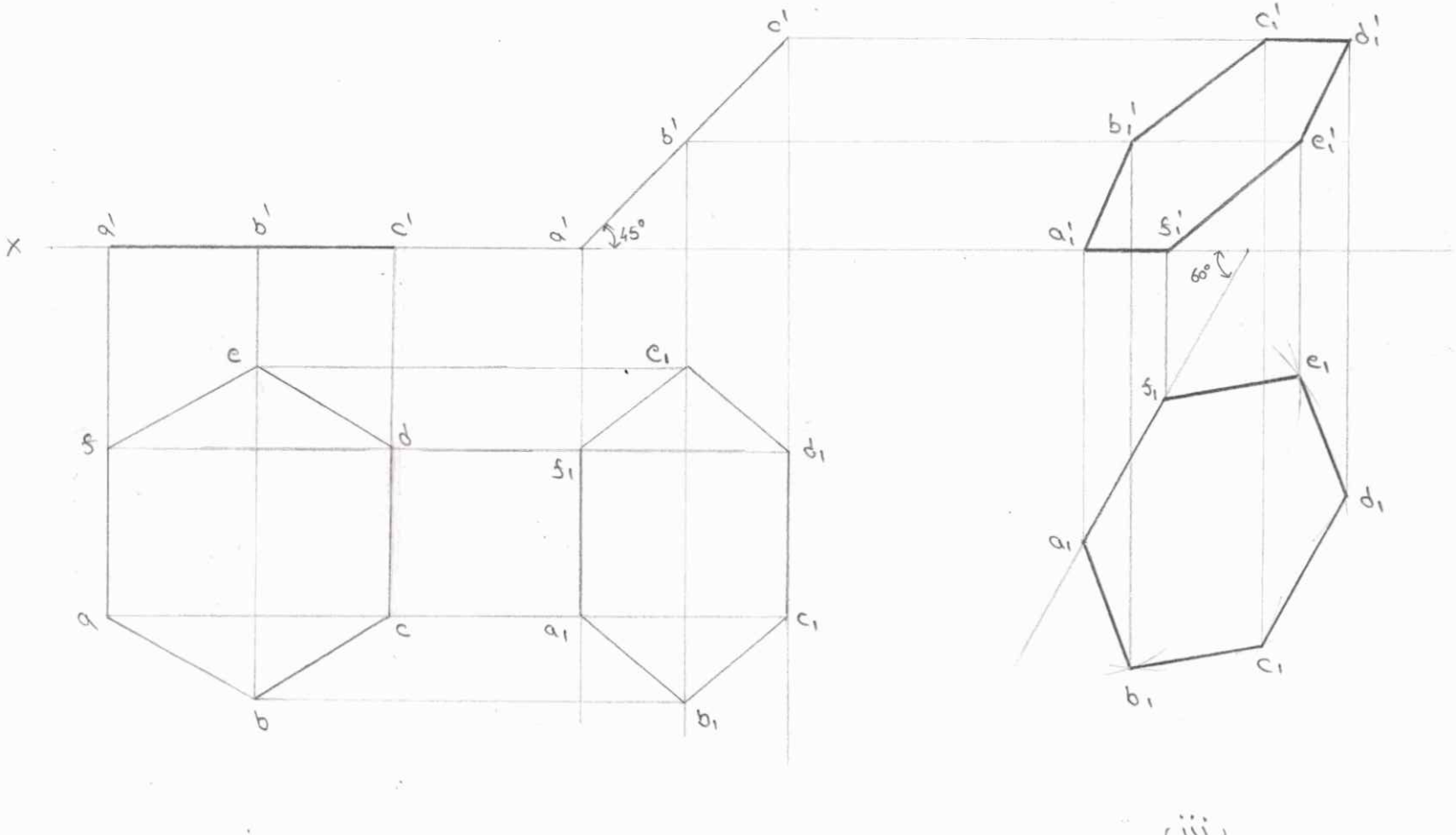
(7) A composite plane ABCD, consists of a square of 60mm side, with an additional semi-circle constructed on CD as diameter. Draw the projections of the plane when the side AB is vertical and the plane makes an angle of 45° with ~~H.P~~ V.P



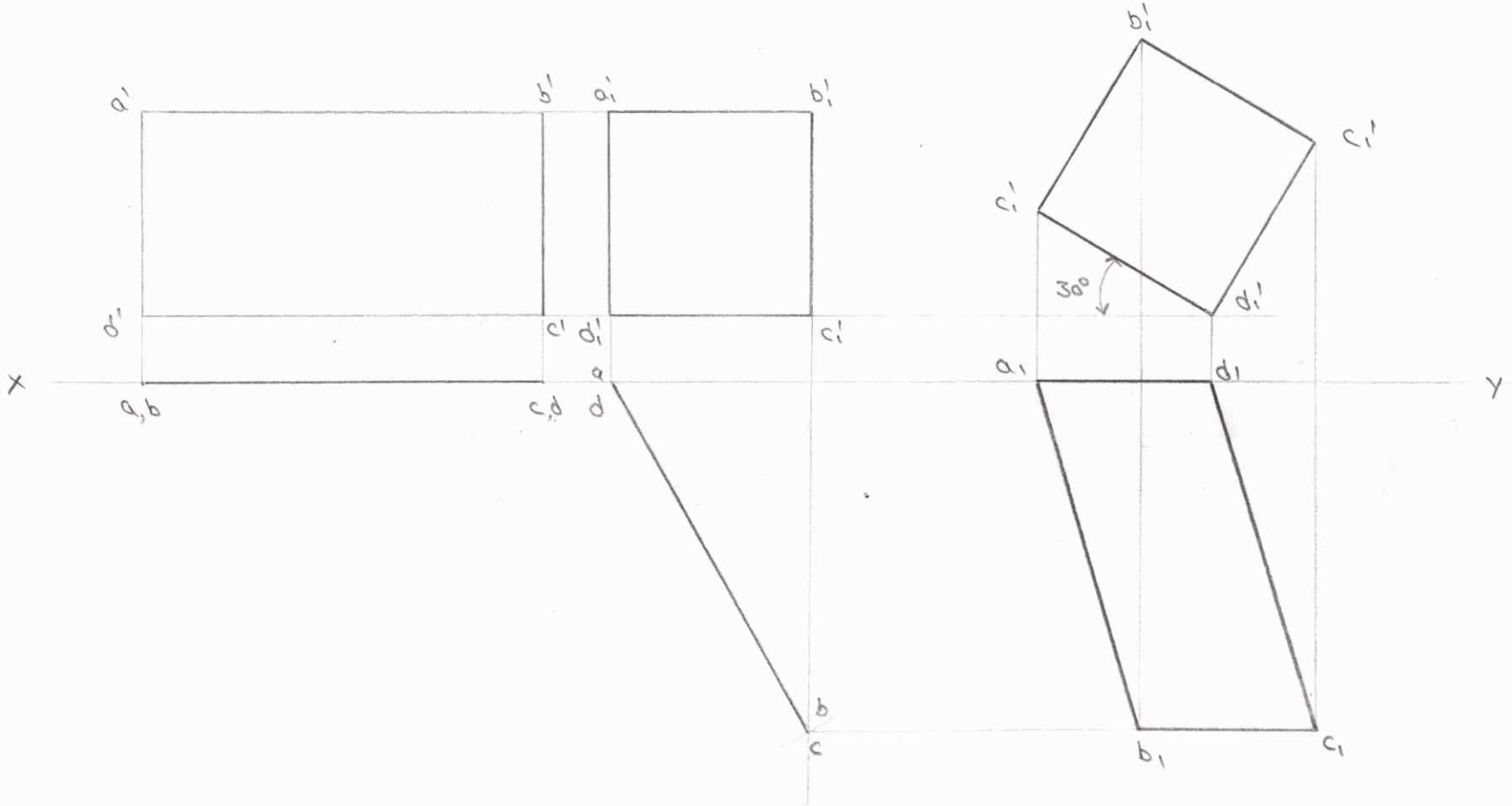
1. A square ABCD of 50mm side has its corner A in the H.P., its diagonal AC inclined at 30° to the H.P and the diagonal BD inclined at 45° to the V.P and Parallel to the H.P. Draw its Projection



② Draw the Projections of a Regular hexagon of 25mm side, having one of its sides in the H.P. and inclined at 60° to the V.P., and its surface making an angle of 45° with the H.P.

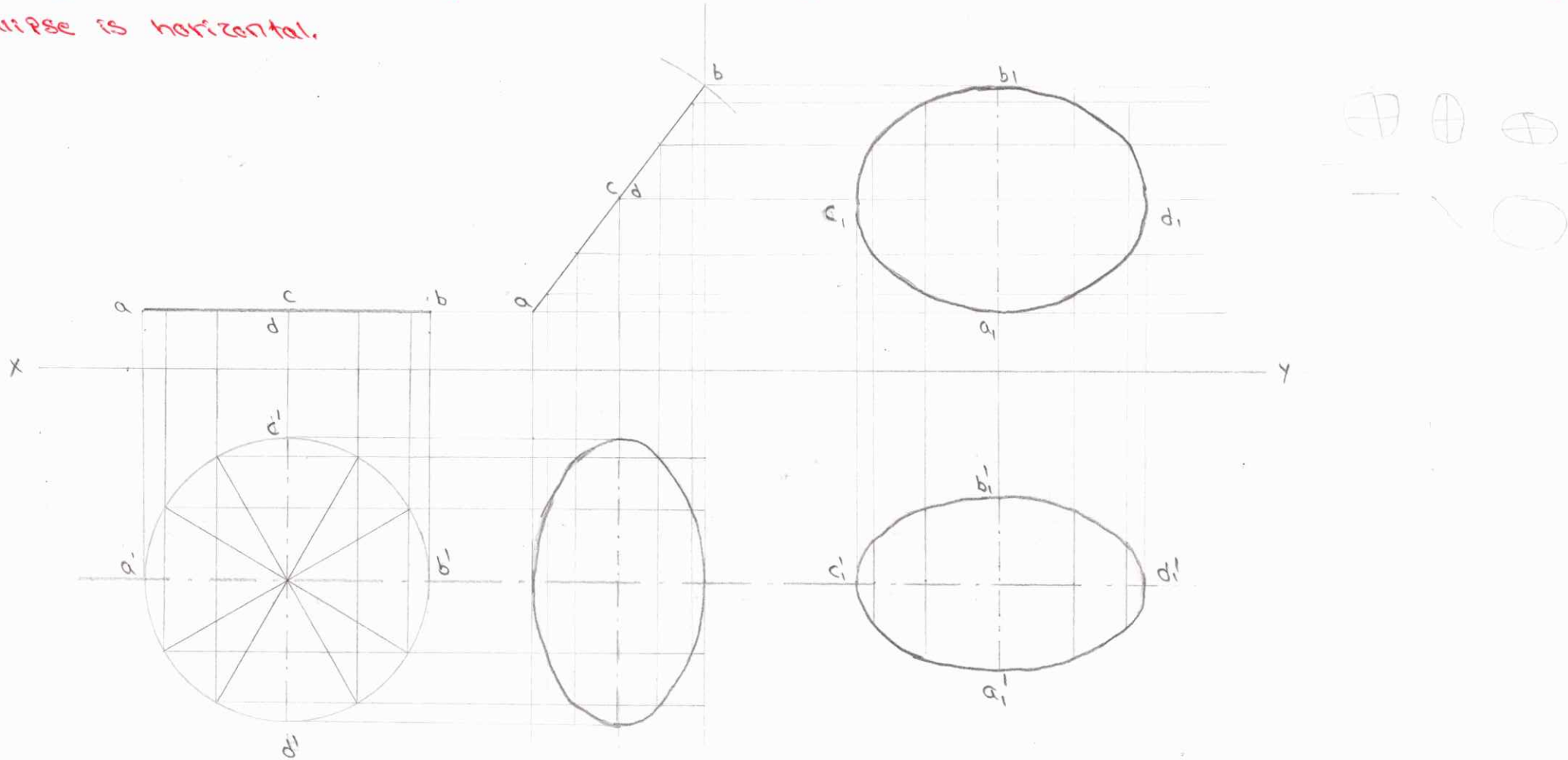


3. A thin rectangular Plate of sides 60mm x 30mm has it's shorter side in the V.P and inclined at 30° to the H.P. Project it's top view if it's front view is a square of 30 mm long sides.



(i) (ii) (iii)

4. A circular plate of negligible thickness and 50mm diameter appears as an ellipse in the 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.

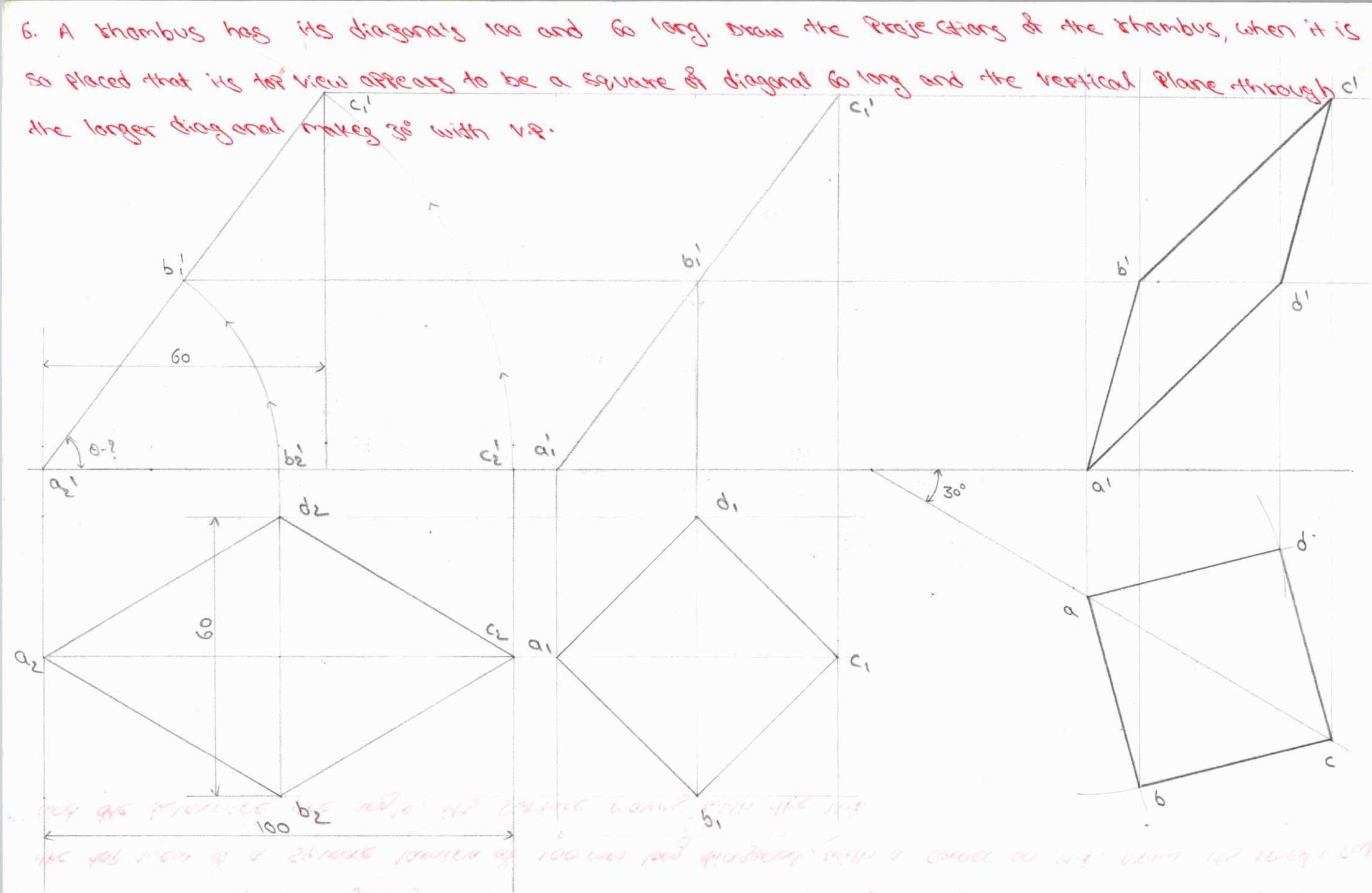


(i) (ii) (iii)

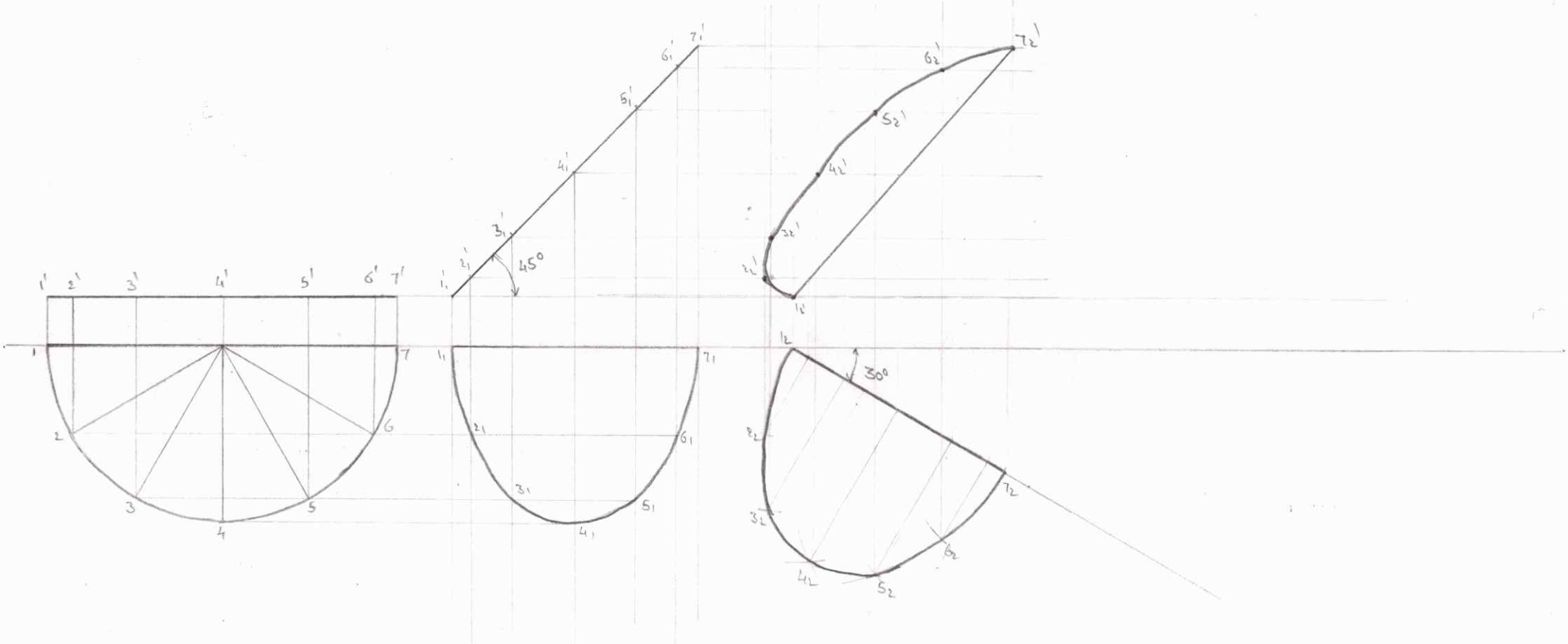
3rd. Angle Projection

5. Draw a rhombus of diagonals 100 mm and 60 mm with the longer diagonal horizontal. The figure is the top view of a square lamina of 100 mm long diagonal, with a corner on H.P. Draw its front view and determine the angle, its surface makes with the H.P.

6. A rhombus has its diagonals 100 and 60 long. Draw the Projections of the rhombus, when it is so placed that its top view appears to be a square of diagonal 60 long and the vertical plane through the longer diagonal makes 30° with V.P.



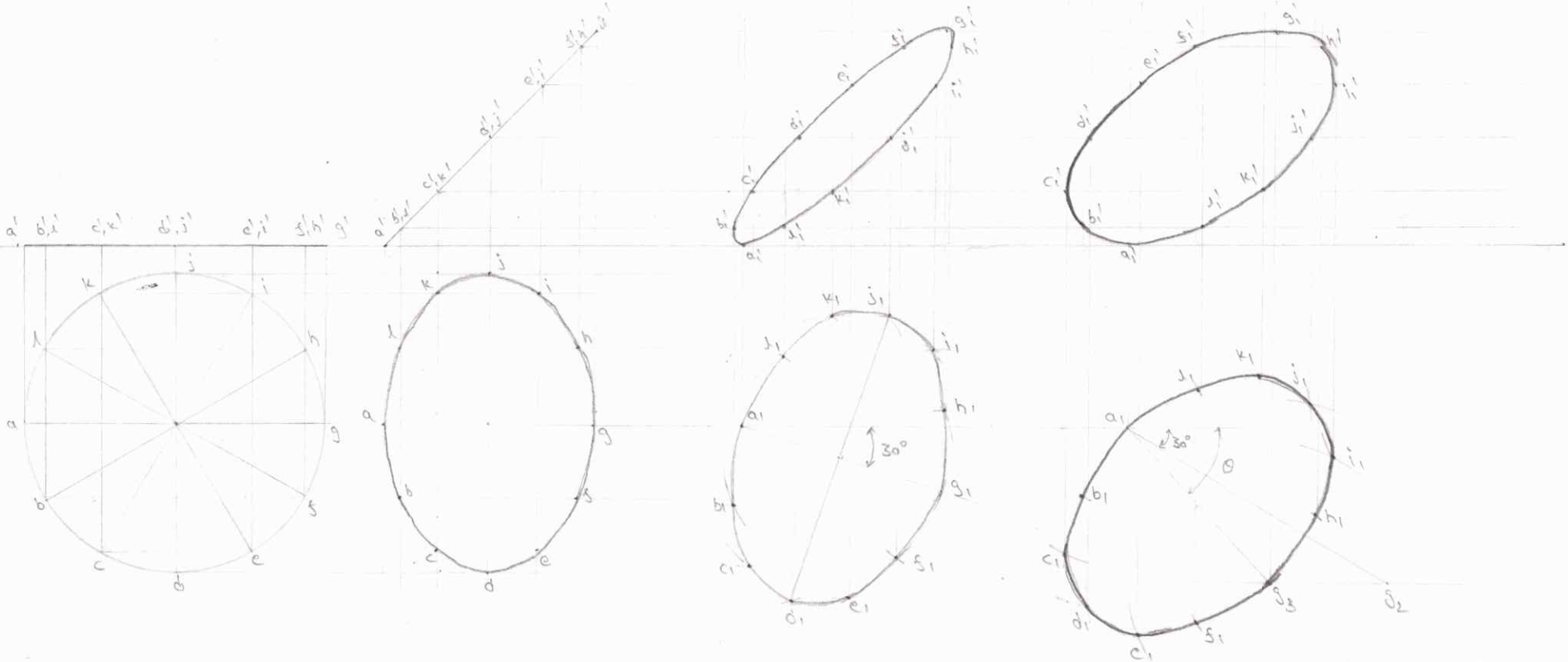
7. A semi-circular lamina of 64mm diameter has its straight edge in V.P and inclined at an angle of 45° to H.P. The surface of the lamina makes an angle of 30° with V.P. Draw the projections.



8 Draw the Projections of a circle of 50mm diameter resting in the H.P on a Point A on the circumference, its plane inclined at 45° to the H.P and

(a) the top view of the diameter AB making 30° angle with the V.P (b) the dia. AB making 30° angle with the V.P.

Draw the Projections of the circle with A in the H.P and its plane inclined at 45° to the H.P and Perpendicular to the V.P.



PROJECTIONS OF SOLIDS

A solid has three dimensions viz. length, breadth and thickness. To represent a solid in orthographic projections, the number and types of views necessary will depend upon the type of solid and its orientation with respect to the Principal Planes of projection.

Types of solids:-

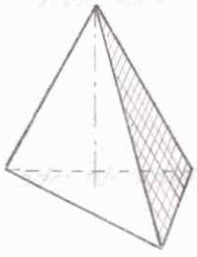
Solids are mainly divided into two main groups

(i) Polyhedra
(ii) Solids of revolution

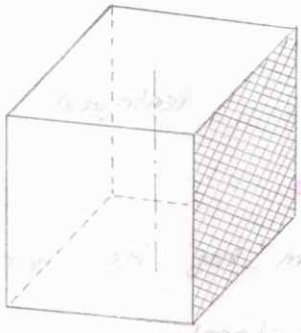
(i) Polyhedra:-

A Polyhedron is defined as a solid bounded by Planes called faces. When all faces are equal and Regular, the Polyhedron is said to be regular.

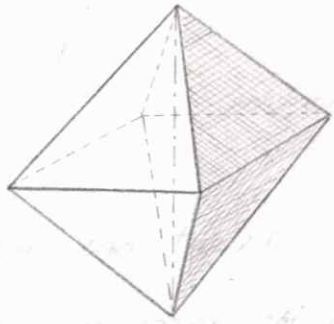
There are seven regular polyhedra which may be defined as stated below:



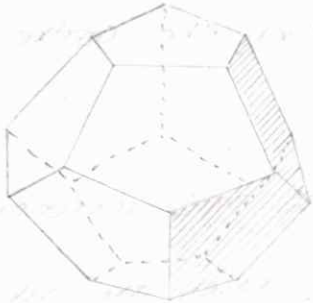
(a) Tetrahedron



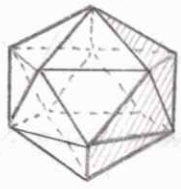
(b) Cube



(c) Octahedron



(d) Dodecahedron



(e) Icosahedron

(a) Tetrahedron - It has four equal faces, each an equilateral triangle.

(b) Cube (or) hexahedron - It has six faces, all equal squares.

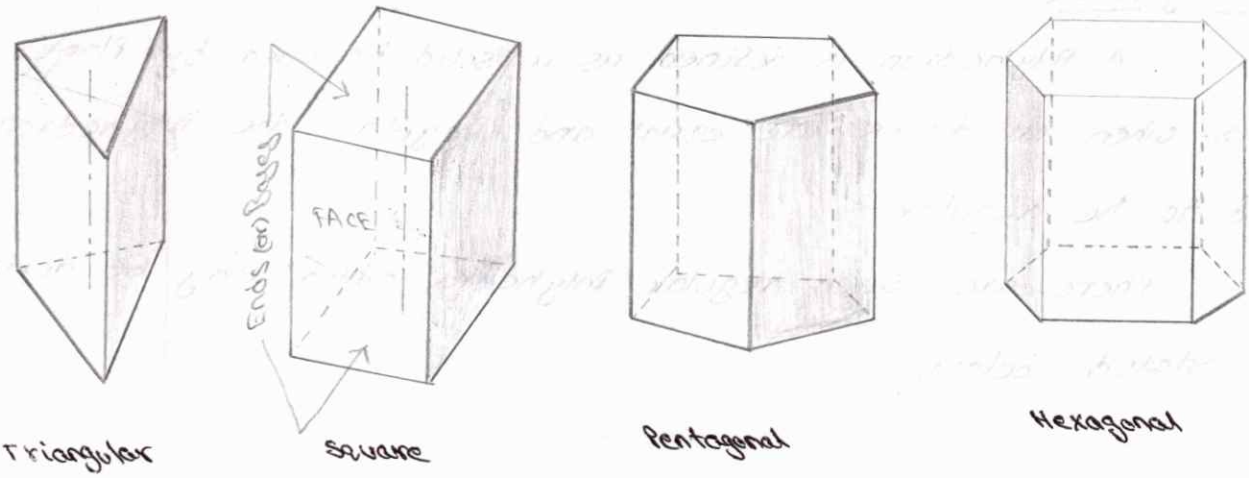
(c) Octahedron - It has eight equilateral triangles as faces.

(d) Dodecahedron - It has twelve equal and regular pentagons as faces.

(e) Icosahedron - It has twenty faces, all equal equilateral triangles.

(f) Prism:-

This is a Polyhedron having two equal and similar faces called its ends (or) bases, Parallel to each other and joined by other faces which are parallelograms. The imaginary line joining the centres of the bases is called the axis.



Triangular Square Pentagonal Hexagonal

Prisms

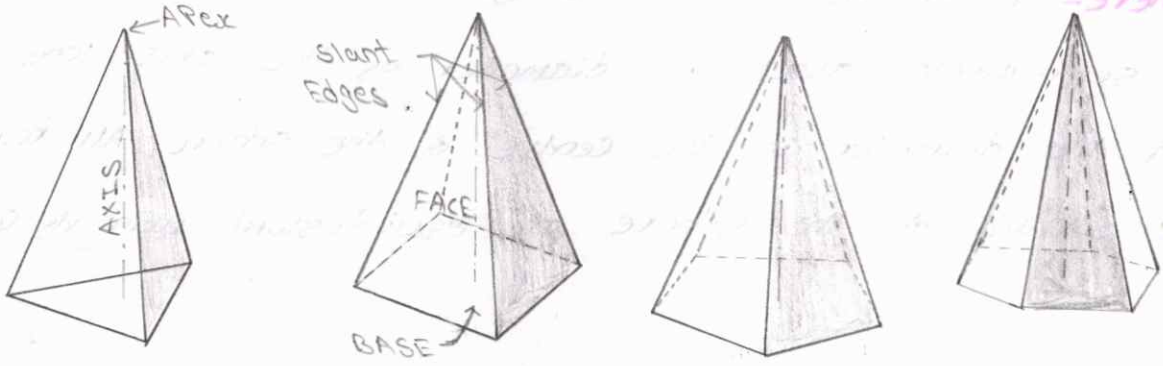
A right and regular Prism has its axis perpendicular to the bases. All its faces are equal rectangles.

(g) Pyramid:- This is a Polyhedron having a plane figure as a base and a number of triangular faces meeting at a point called the vertex (or) apex. The imaginary line joining the apex with the centre of the base is its axis.

A right and regular Pyramid has its axis perpendicular to the base which is a regular plane figure. its faces are all equal isosceles triangles.

Oblique Prisms and Pyramids have their axes inclined to their bases

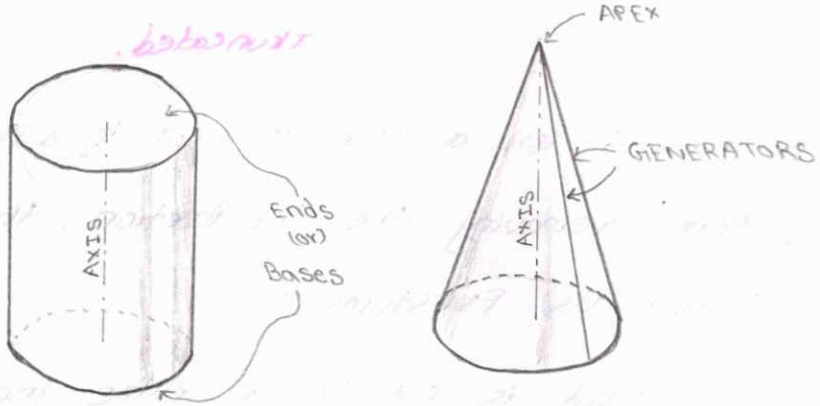
Prisms and Pyramids are named according to the shape of their bases, as triangular, square, pentagonal, hexagonal etc.



Triangular Square Pentagonal Hexagonal

Pyramids

(ii) Solids of revolution:—



Cylinder Cone Sphere

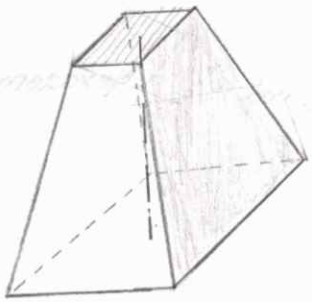
(a) Cylinder - A right circular cylinder is a solid generated by the revolution of a rectangle about one of its sides which remains fixed. It has two equal circular bases. the line joining the centres of the bases is the axis. It is perpendicular to the bases.

(b) Cone - A right circular cone is a solid generated by the revolution of a right-angled triangle about one of its perpendicular sides which is fixed.

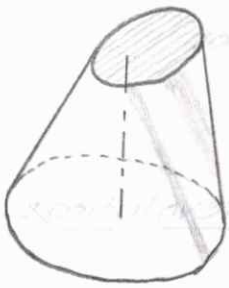
It has one circular base. Its axis joins the apex with the centre of the base to which it is perpendicular. Straight line drawn from ~~one~~ ~~called~~ ~~generaters~~ ~~of~~ ~~the~~ the apex to the circumference of the base circle are equal and are called

generators of the cone. The length of the generator is the slant height of the cone.

(c) Sphere- A sphere is a solid generated by the revolution of a semi-circle about its diameter as the axis. The mid-point of the diameter is the centre of the sphere. All points on the surface of the sphere are equidistant from its centre.



Frustums

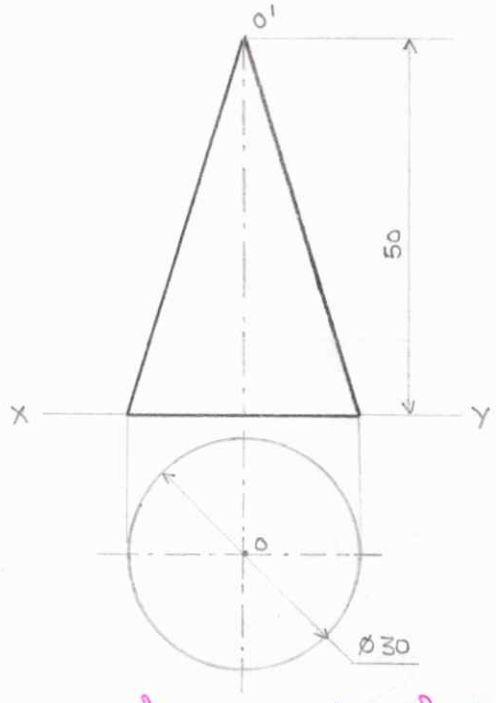


Truncated.

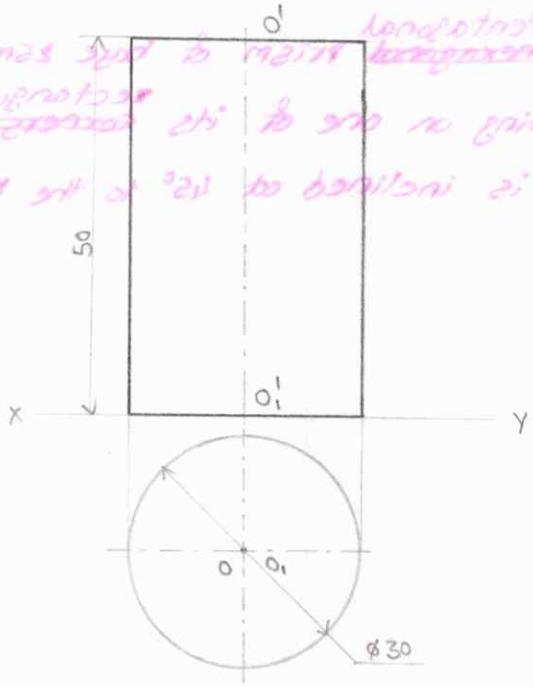
(d) Frustums- when a Pyramid (or) a cone is cut by a plane parallel to it's base, thus removing the top portion, the remaining portion is called its Frustums.

(e) Truncated- when a solid is cut by a plane inclined to the base it is said to be truncated.

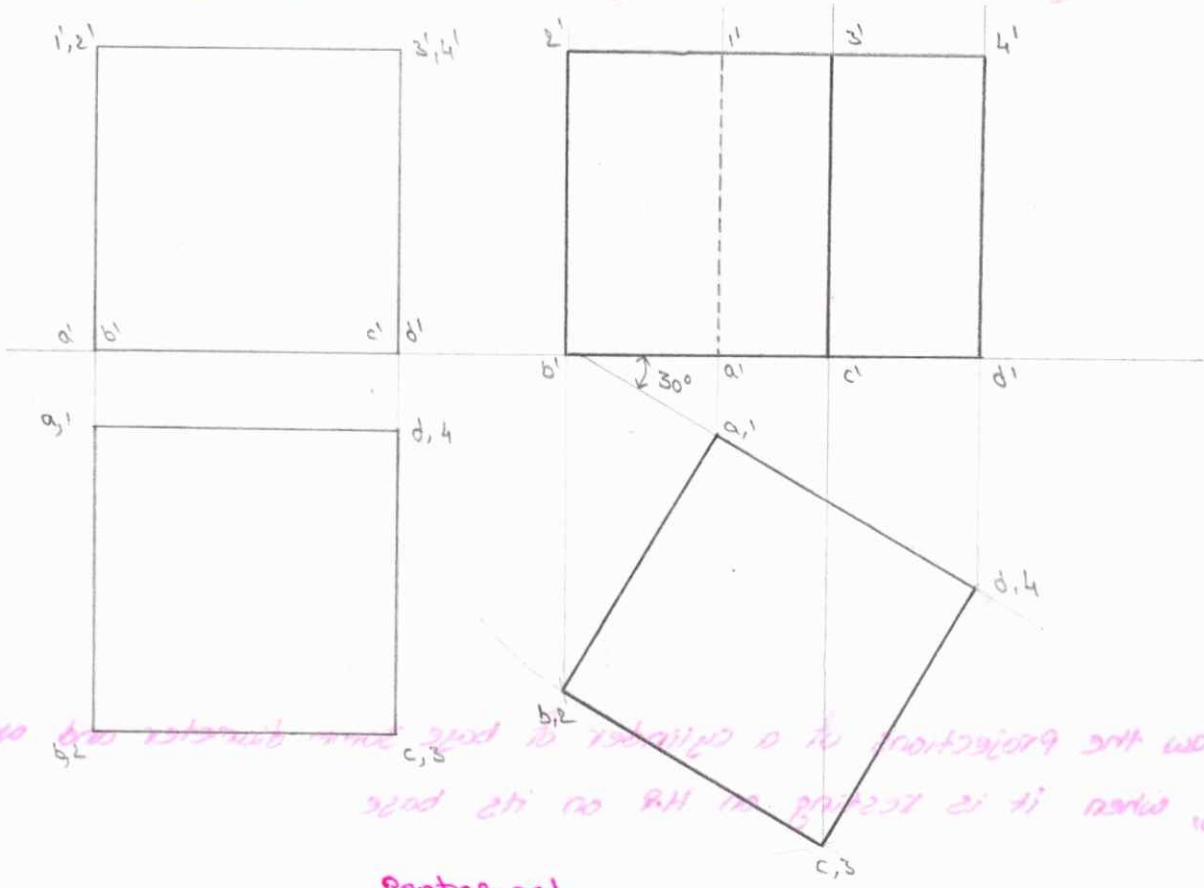
① a) Draw the Projections of a cone of base 30mm diameter and axis 50mm long, when it is resting on H.P on its base.



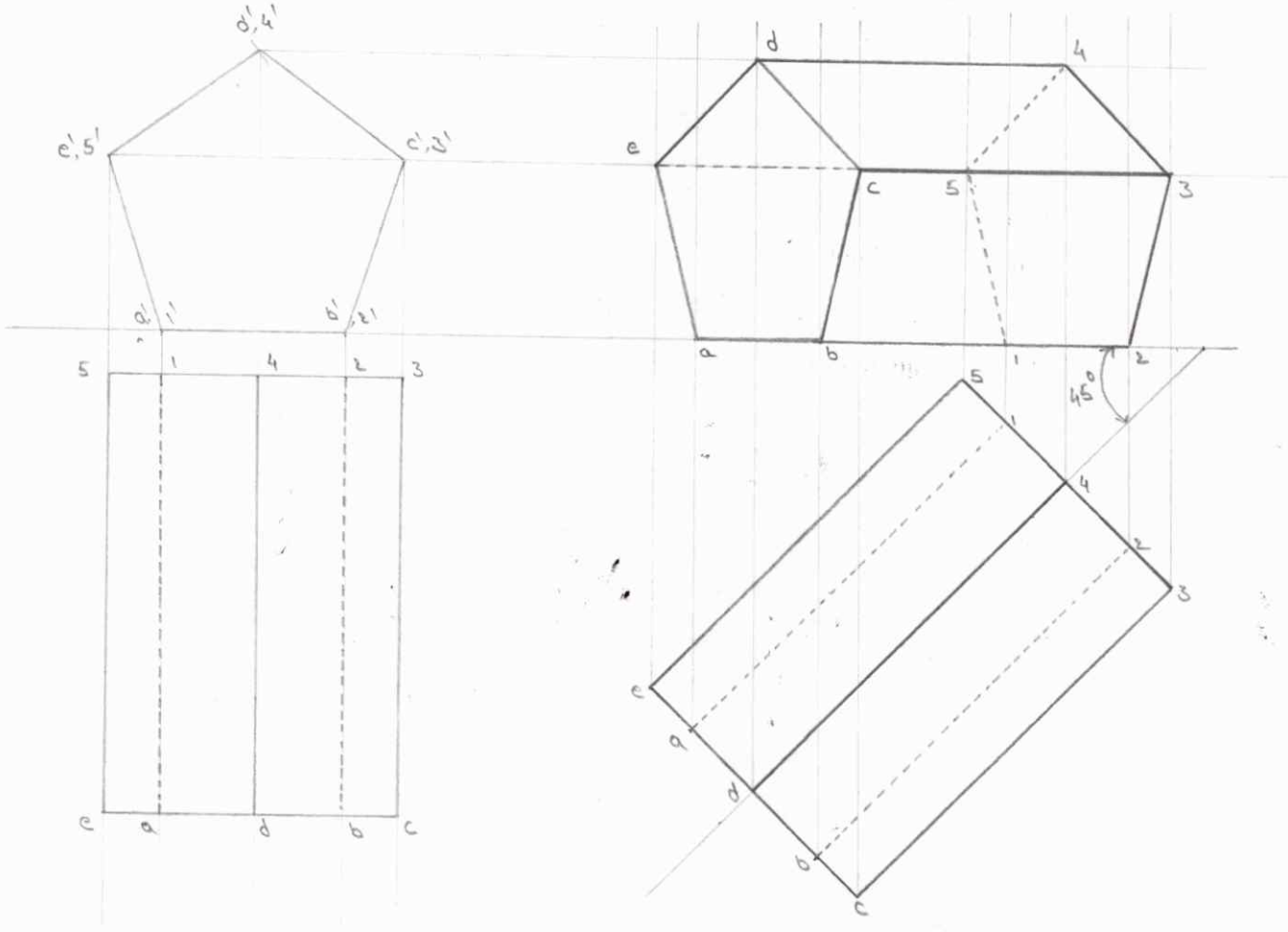
b) Draw the projections of a cylinder of base 30mm diameter and axis 50mm long, when it is resting on H.P on its base.



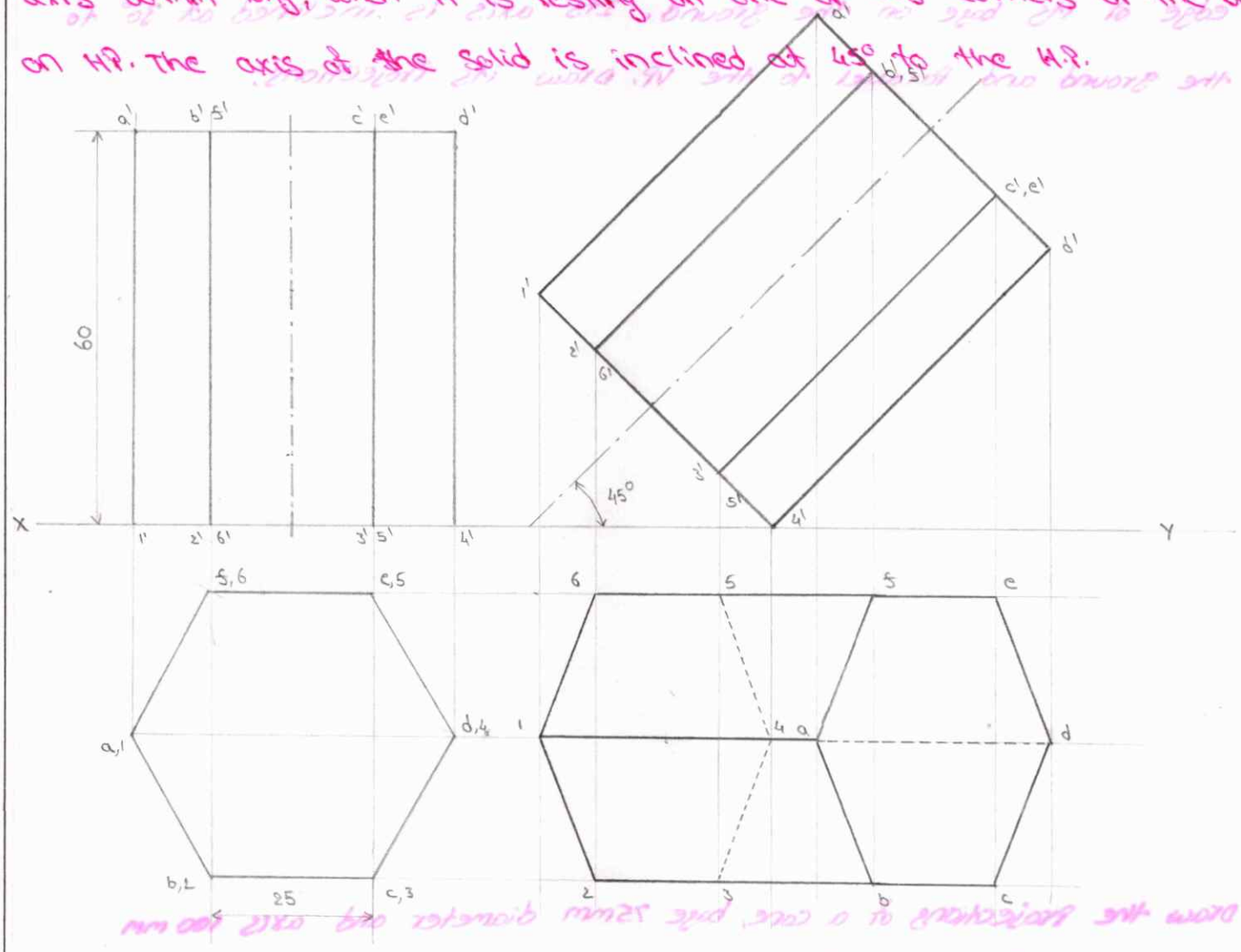
2) A cube of 40mm ~~diameter~~ side, is resting with a face on HP such that when on of its vertical faces is inclined at 30° at V.P.



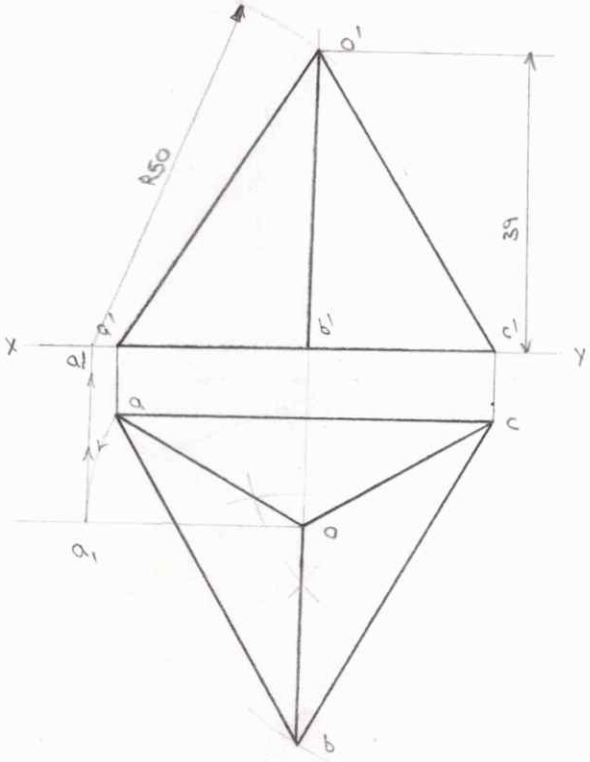
3) Draw the projections of a ~~hexagonal~~ Pentagonal prism of base 25mm side and axis ~~60mm~~ long, when it is resting on one of its ~~corners of the base on~~ rectangular faces on the H.P ~~H.P~~. The axis of the solid is inclined at 45° to the ~~H.P~~ V.P.



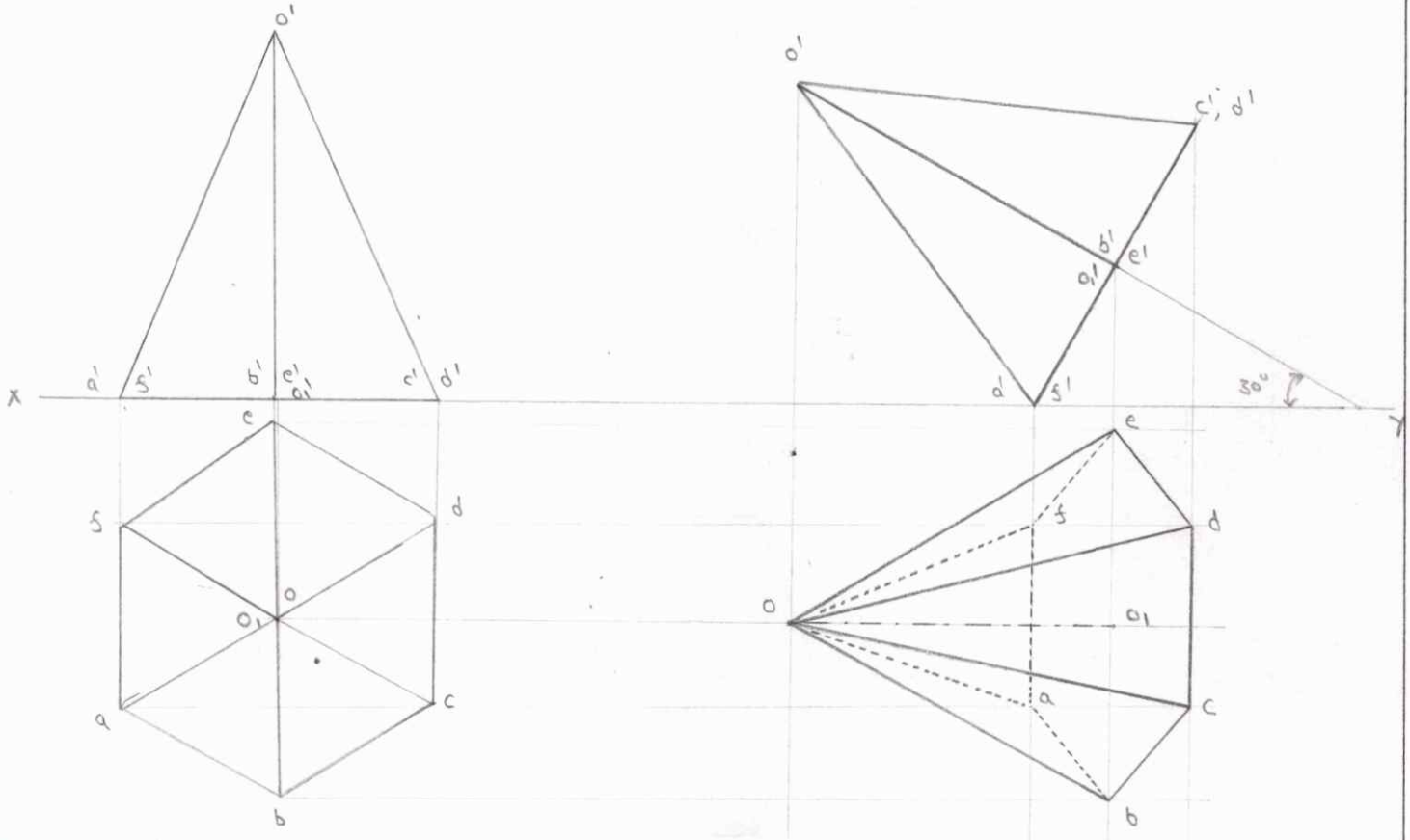
4. Draw the projections of a hexagonal prism of base 25mm side and axis 60 mm long, when it is resting on one of its corners of the base on H.P. The axis of the solid is inclined at 45° to the V.P.



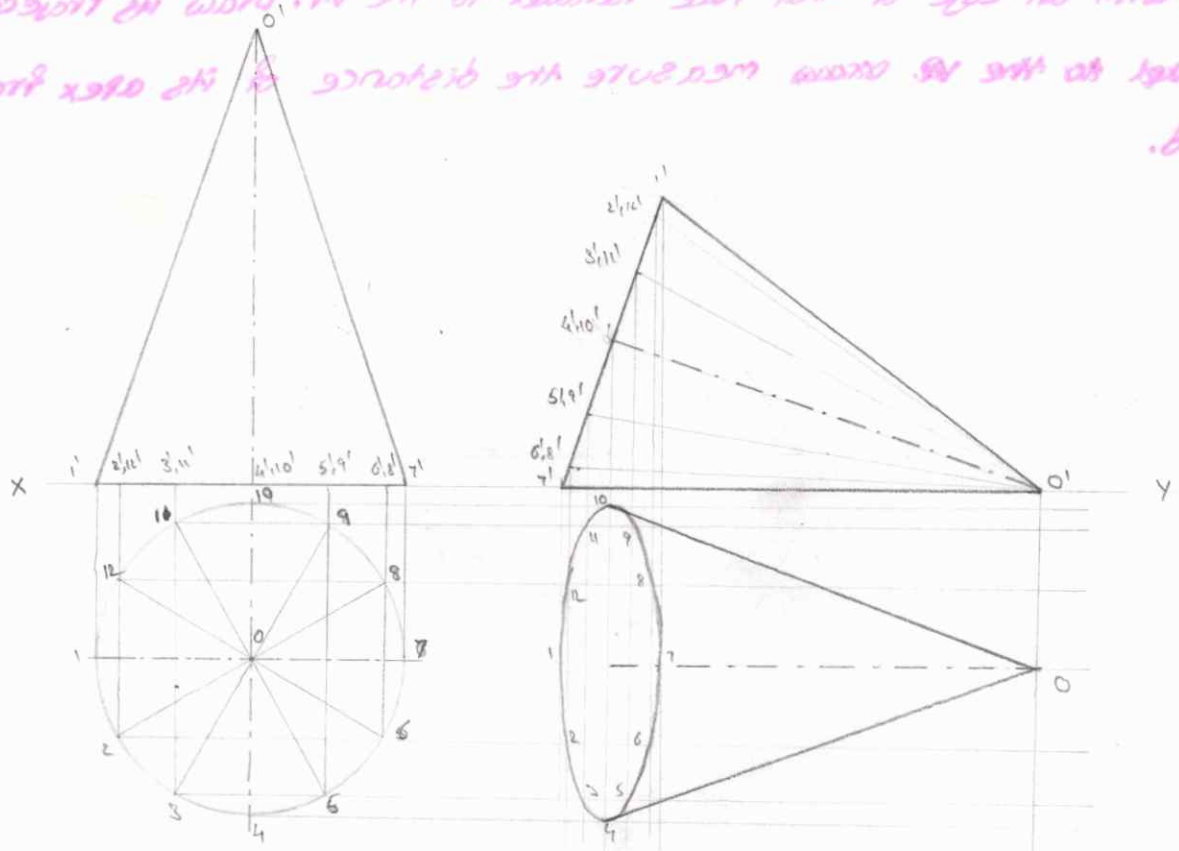
5. A tetrahedron of 50mm long edges is resting on the H.P on one of its faces, with an edge of that face parallel to the V.P. Draw its projections and measure the distance of its apex from the ground.



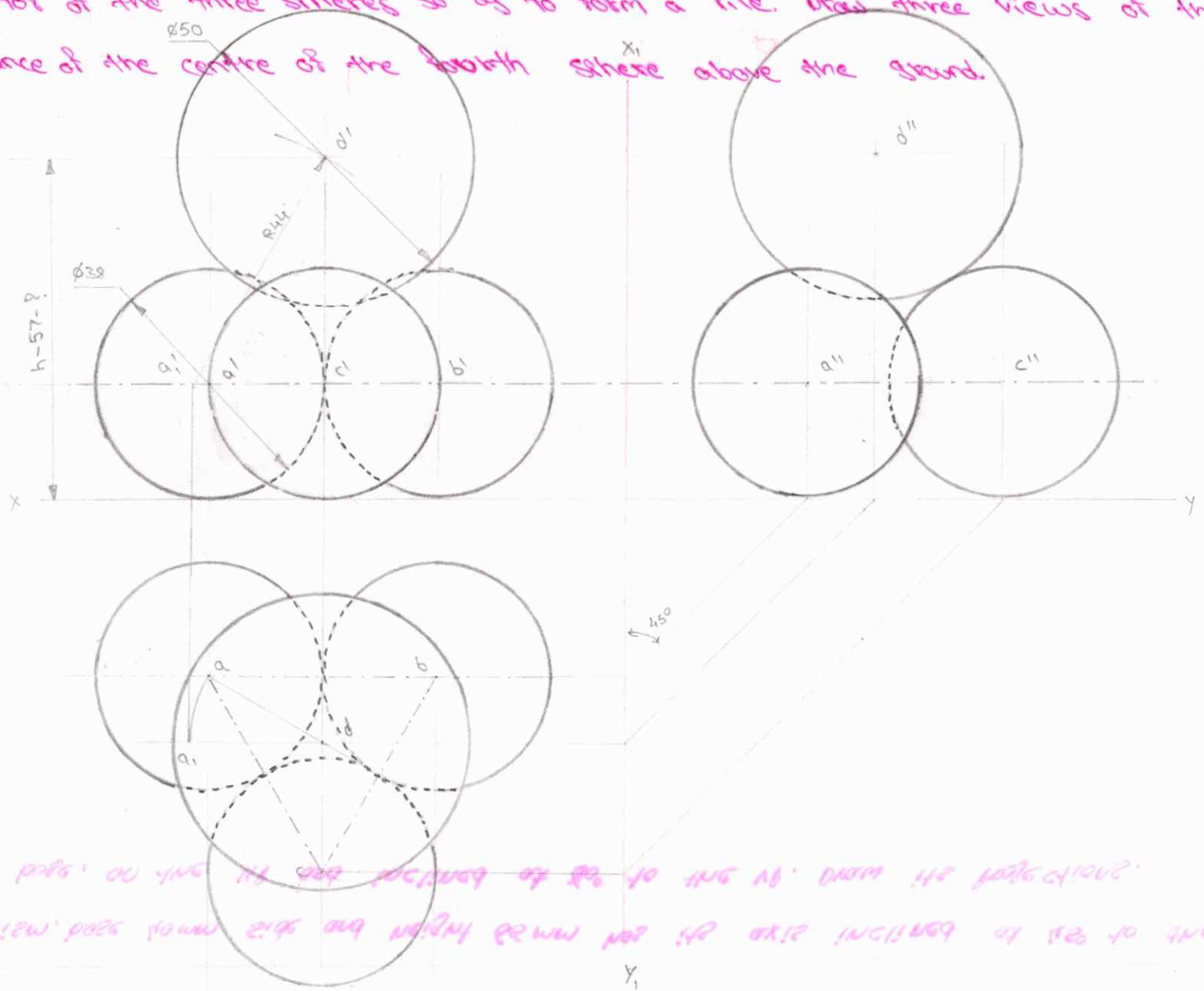
6. A hexagonal pyramid, base 25 mm side and axis 50 mm long, has an edge of its base on the ground. Its axis is inclined at 30° to the ground and parallel to the VP. Draw its projections.



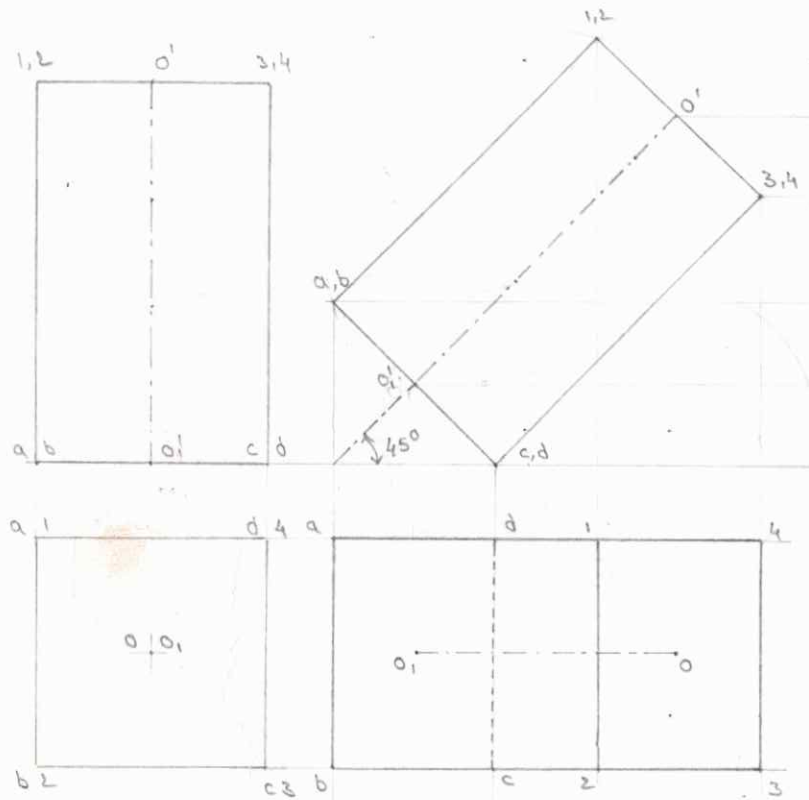
7. Draw the projections of a cone, base 75mm diameter and axis 100 mm lying on the HP on one of its generators with the axis parallel to the VP.



2. Three equal spheres of 38mm diameter are resting on the ground so that each touches the other two and the line joining the centres of two of them is parallel to the VP. A fourth sphere of 50mm diameter is placed on top of the three spheres so as to form a pile. Draw three views of the arrangement and find the distance of the centre of the fourth sphere above the ground.

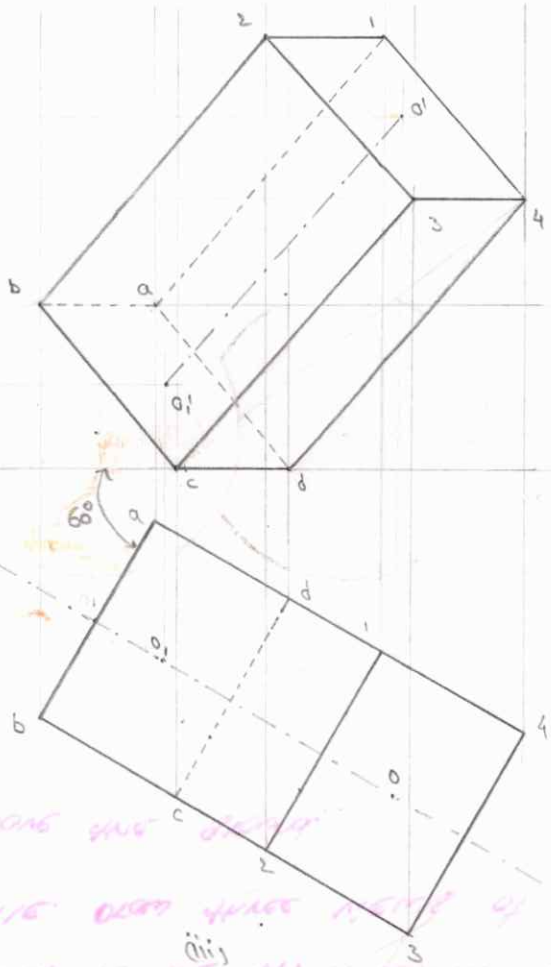


1. A square prism, base 40mm side and height 65mm has its axis inclined at 45° to the HP and has an edge of its base, on the HP and inclined at 60° to the VP. Draw its projections.



(i)

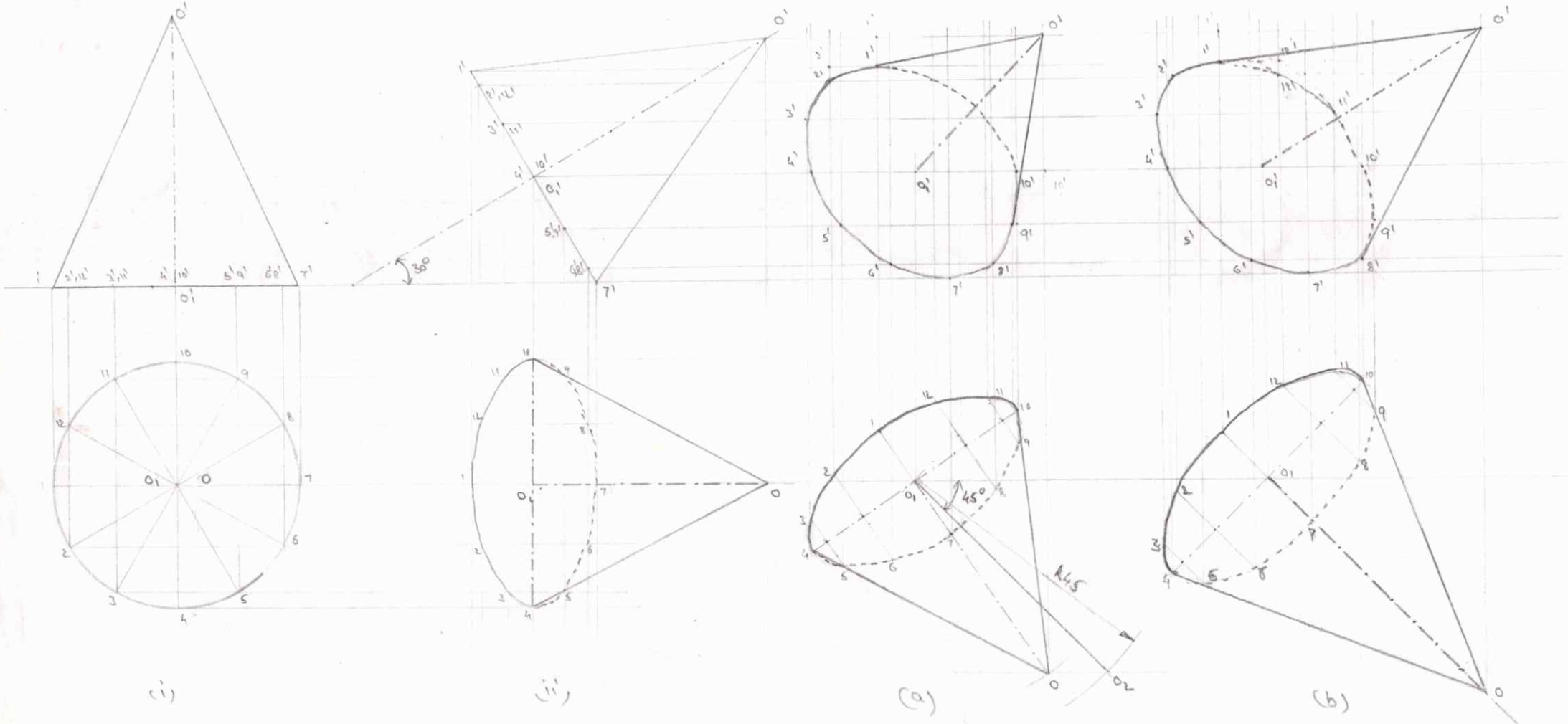
(ii)



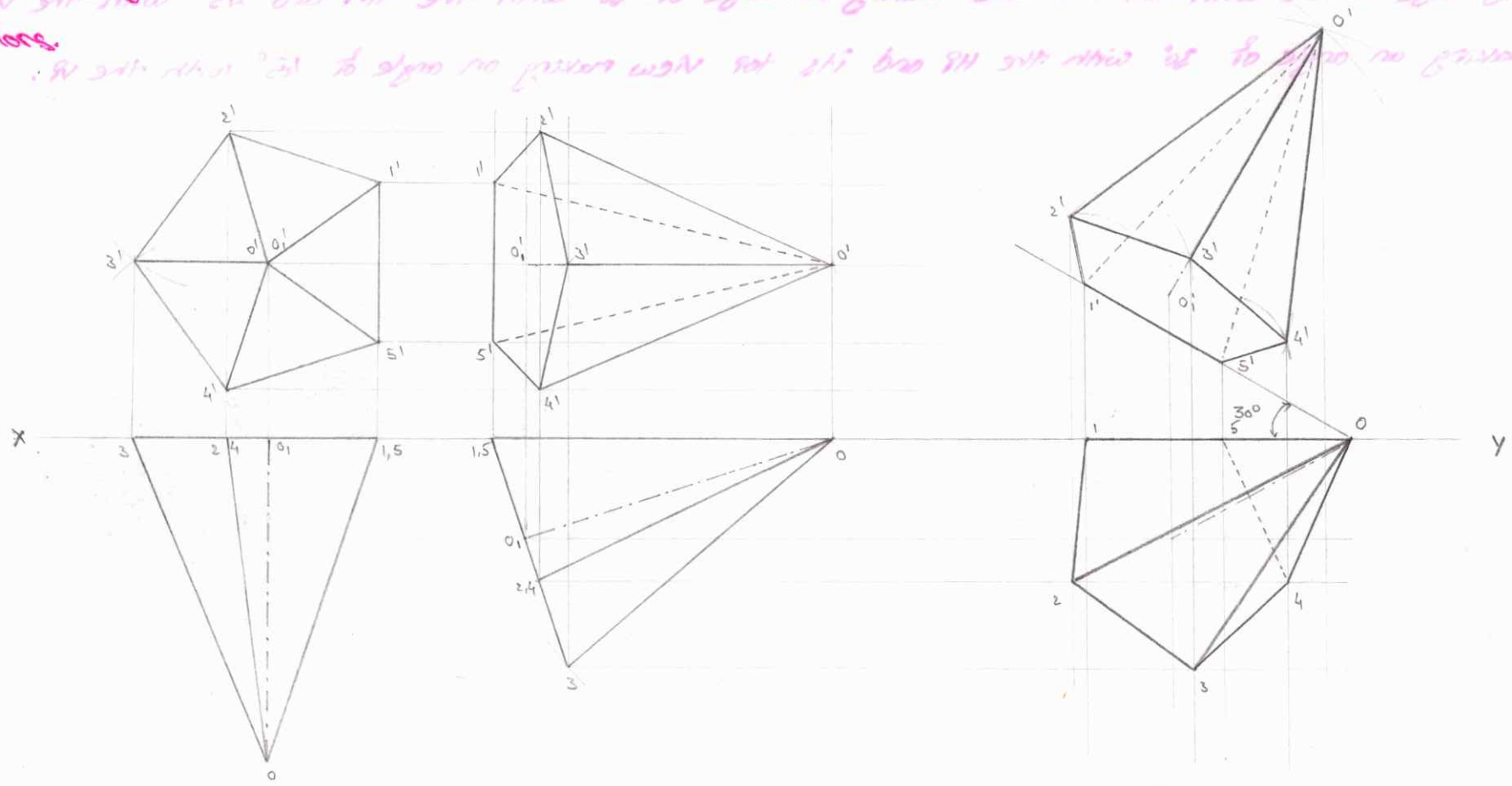
(iii)

3. Draw the projection of cone, base 45mm diameter and axis 50 mm long, when it is resting on the ground on a point on its base circle with (a) the axis making an angle of 30° with the H.P and 45° with the V.P

(b) the axis making an angle of 30° with the HP and its top view making an angle of 45° with the V.P.



4. A Pentagonal Pyramid, base 25mm side and axis 50mm long has one of its triangular faces in the V.P and the edge of the base contained by that face makes an angle of 30° with the H.P. Draw its projections.



(i) (ii) (iii)

ISOMETRIC PROJECTIONS

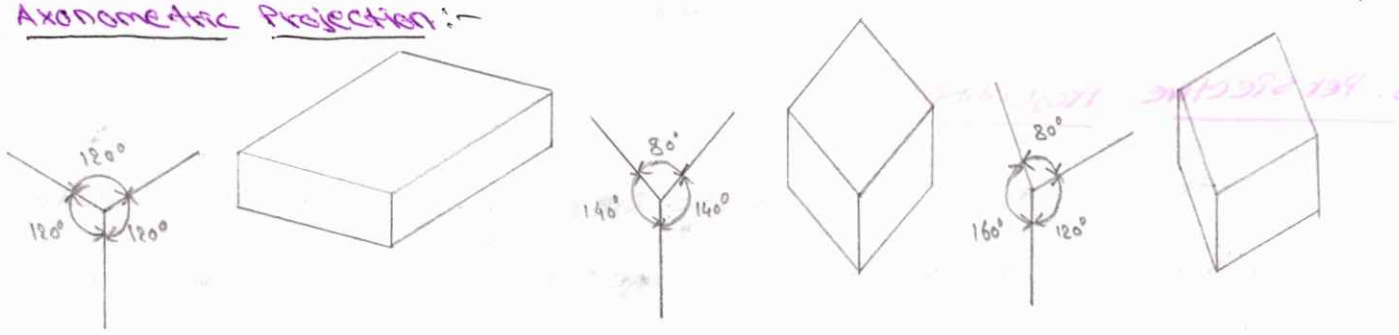
Interpretation of the shape of an object from a multi-view drawing is difficult, without the knowledge of the principles of orthographic projections. Pictorial drawings are used to convey specific information to persons who cannot visualize an object from it's views. Pictorial drawings are mainly used to show complicated structures such as aircraft, rocket cell etc. Pictorial drawings in the form of exploded views are used in the maintenance catalogues and manuals. These are also used for Patent drawings, furniture designs and structural details, which would be difficult to visualize.

These drawings suffer from the limitations such as, distorted appearance, execution times being unduly long, difficult to dimension etc.

Classification of Pictorial Projections:-

There are three types of Pictorial Projections: Axonometric, oblique and Perspective projections.

1. Axonometric Projection:-



(a) - Isometric Projection (b) - Diametric Projection (c) Trimetric Projection

An axonometric projection of an object is one, in which all the three faces of an object are inclined to the plane of Projection. Axonometric projections are further classified into three types: Isometric, dimetric, and trimetric projections.

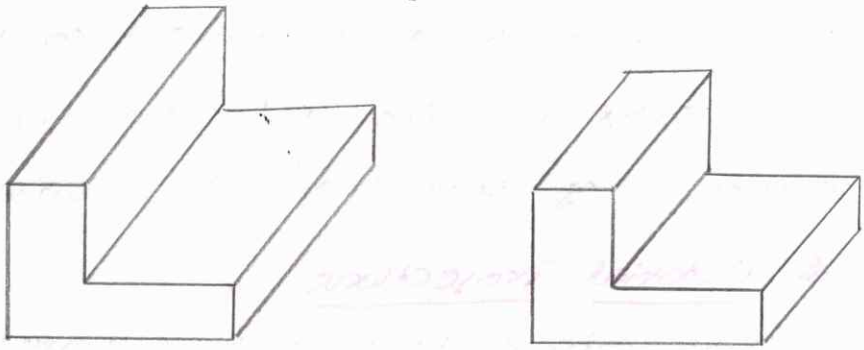
→ In Isometric projection, the three principal faces and axes of an object are equally inclined to the plane of projection.

→ In Dimetric projection, two of the principal faces and axes of the object are equally inclined to the plane of projection.

→ In trimetric projection, all the three faces and axes of the object, make different angles with the plane of projection.

2. Oblique Projection:-

This is also a 3-Dimensional Projection, obtained on plane of projection. In this, the projectors are parallel to each other, but are oblique to the plane of projection. Any surface of the object, parallel to the plane of projection, will appear in its true size and shape. Below figure shows the two types of oblique projections; cavalier and cabinet, based on the width of the object used on the drawing, in terms of its true width.

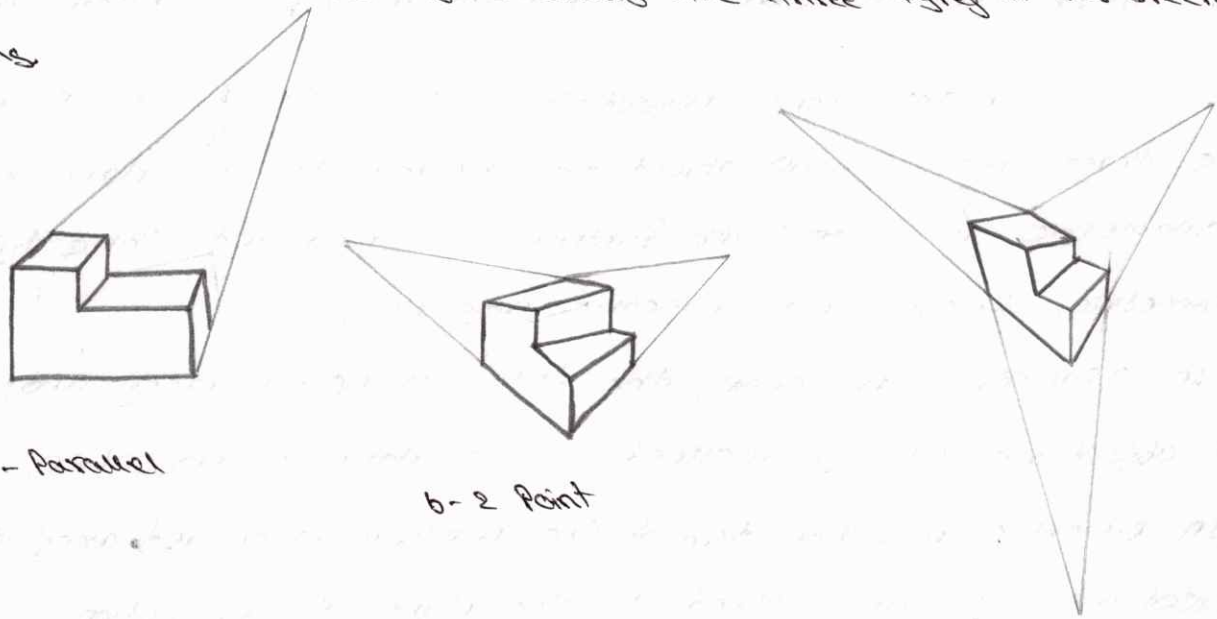


(a) Cavalier (b) Cabinet

Oblique Projections

3. Perspective Projection:-

This is the most realistic projection. In this, the projections will converge towards the viewer's eye: making different angles with the picture plane. Below figure shows the three types of perspective projections.



a - Parallel b - 2 Point c - 3 Point

Perspective Projections

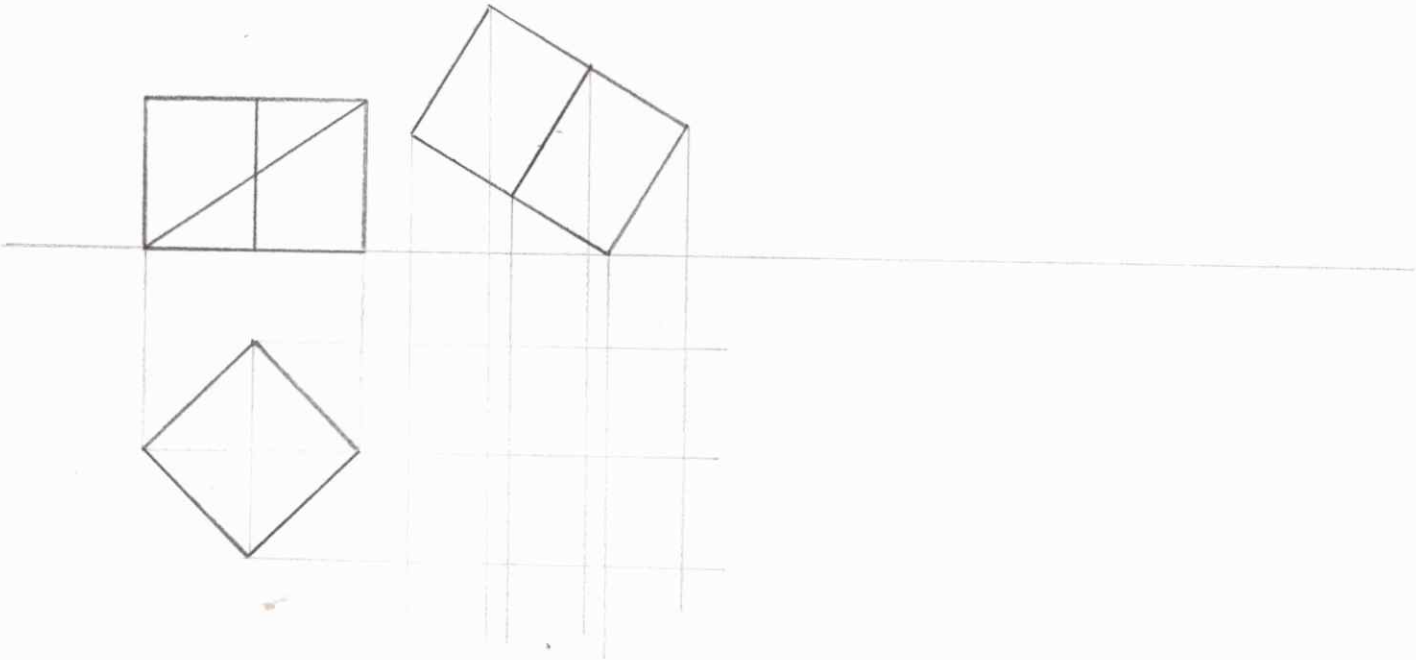
ISOMETRIC PROJECTION:-

Isometric Projection is a Pictorial Projection of an object and it is a single view, in which all the three dimensions of an object are revealed. Isometric Projection gives a clear picture of an object and hence it is helpful even to a layman, for proper understanding of an object. Isometric Projection is used by engineers for the preparation of rough sketches on the site, to convey ideas. These projections are also used by the design engineers, in the design and development of new (or) complicated parts, the shape of which is difficult to understand from the multi-view drawings.

Principles of isometric Projection:-

Iso → equal metric → measure

Isometric Projection → a system of Projection of equality of measure



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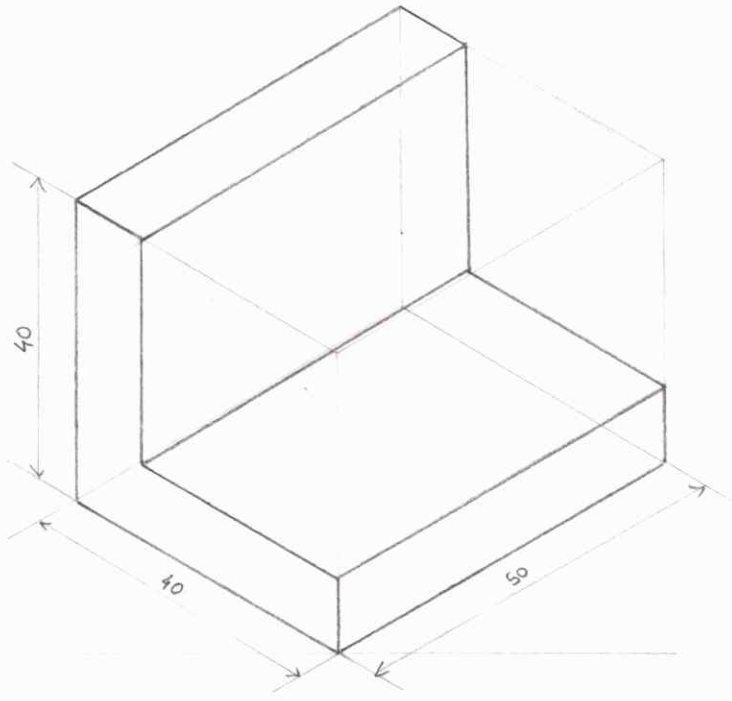

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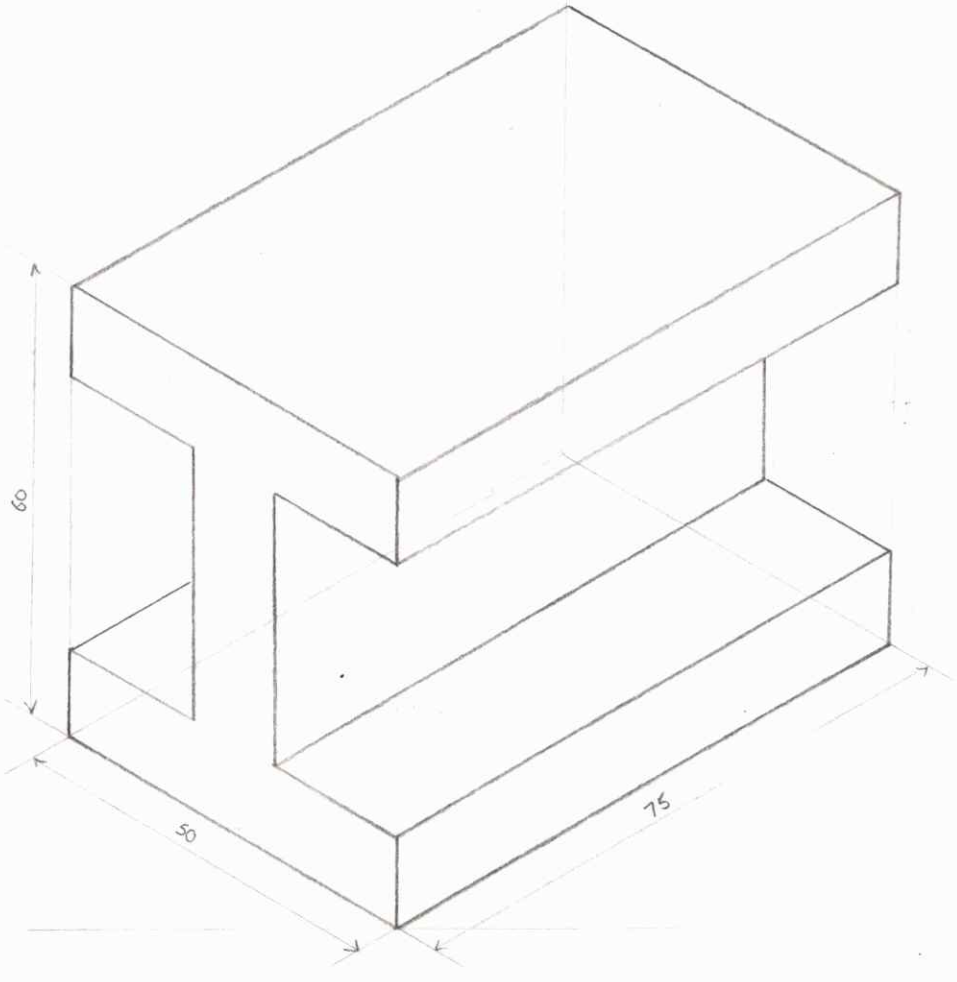

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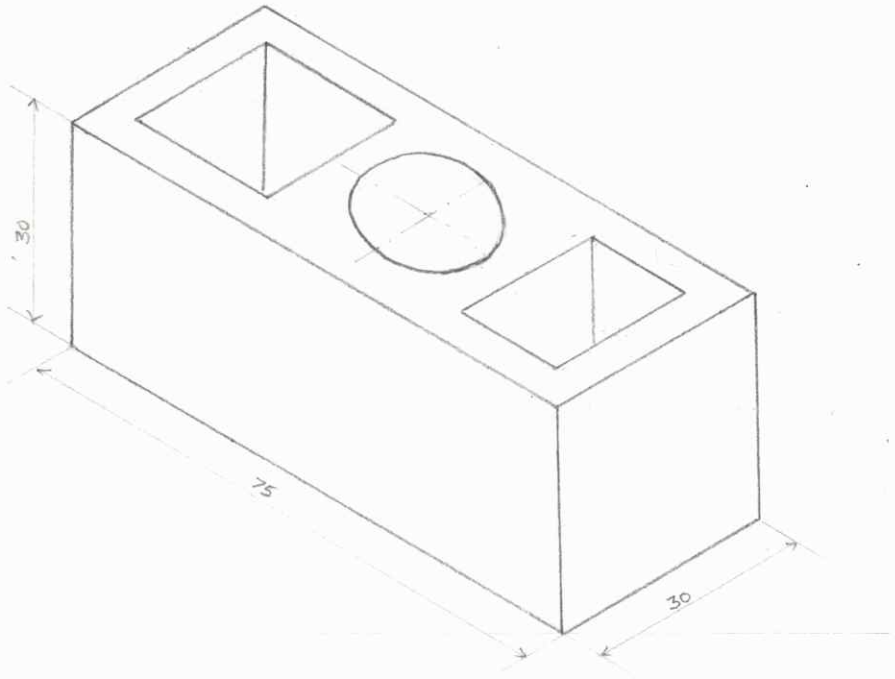

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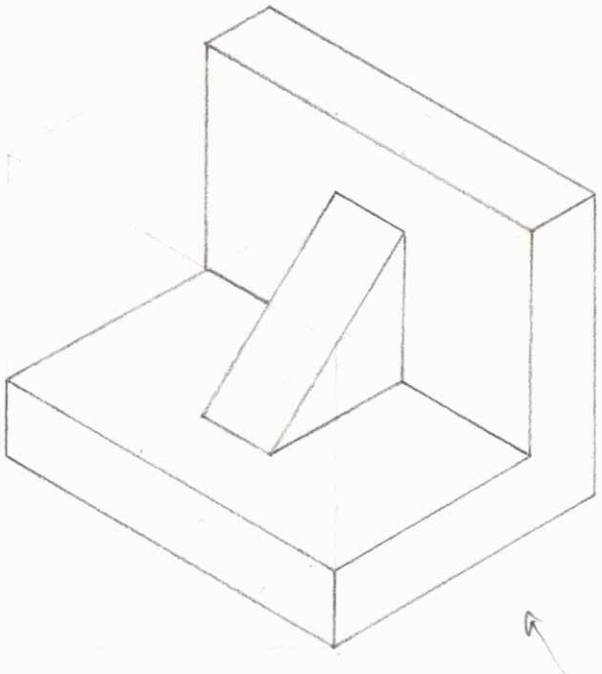

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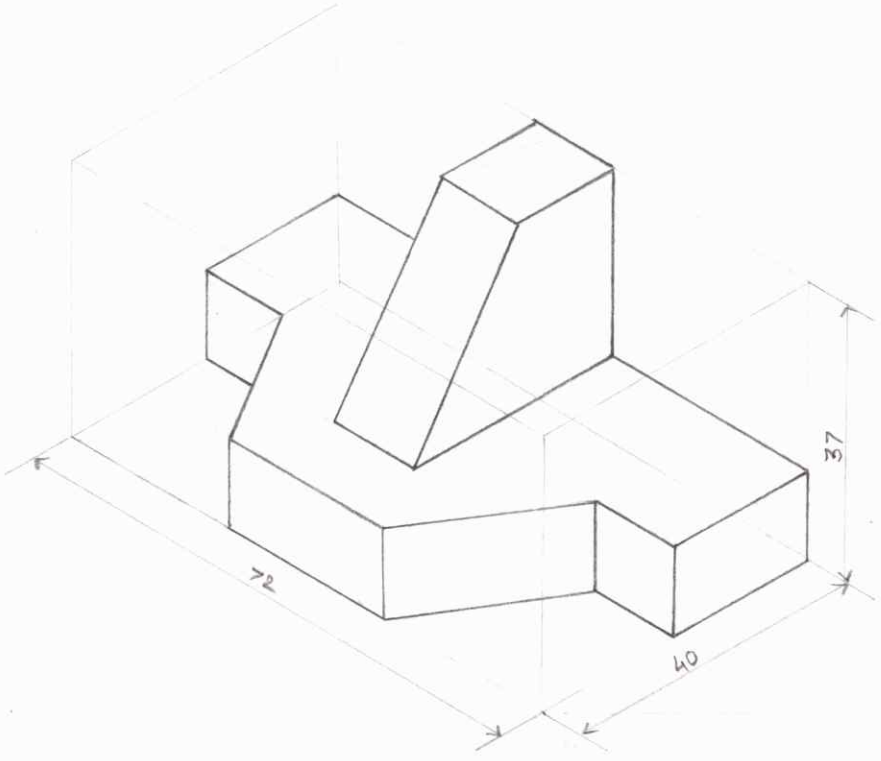

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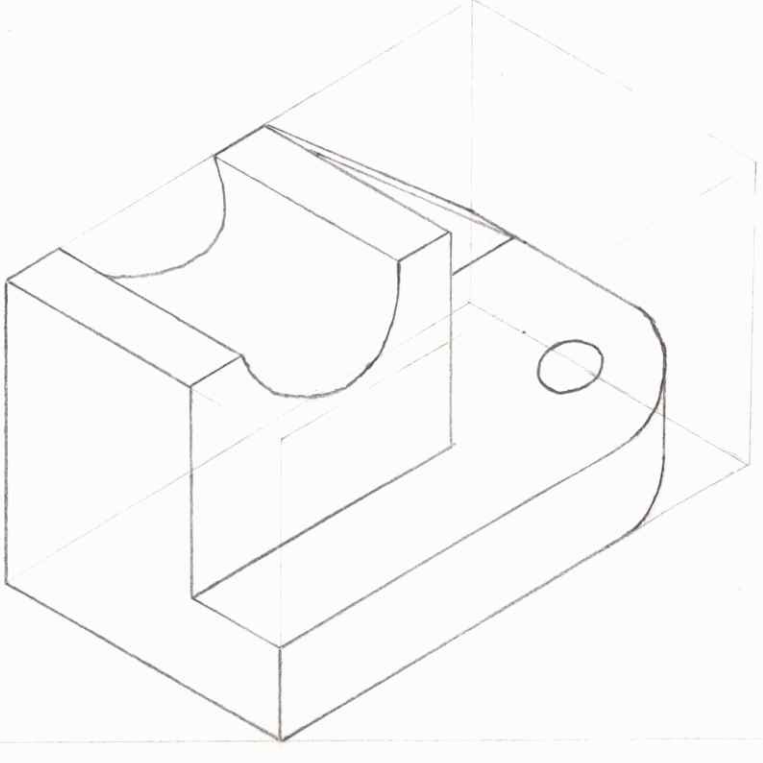

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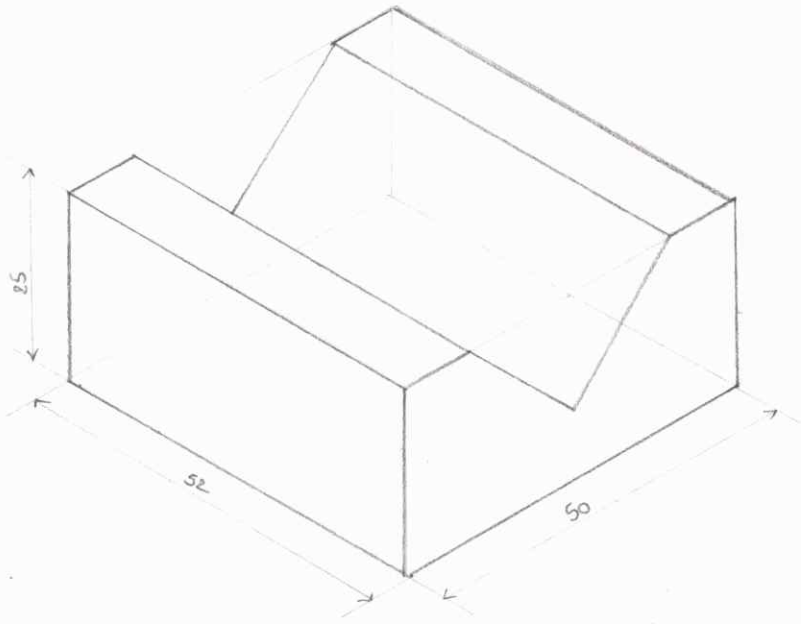

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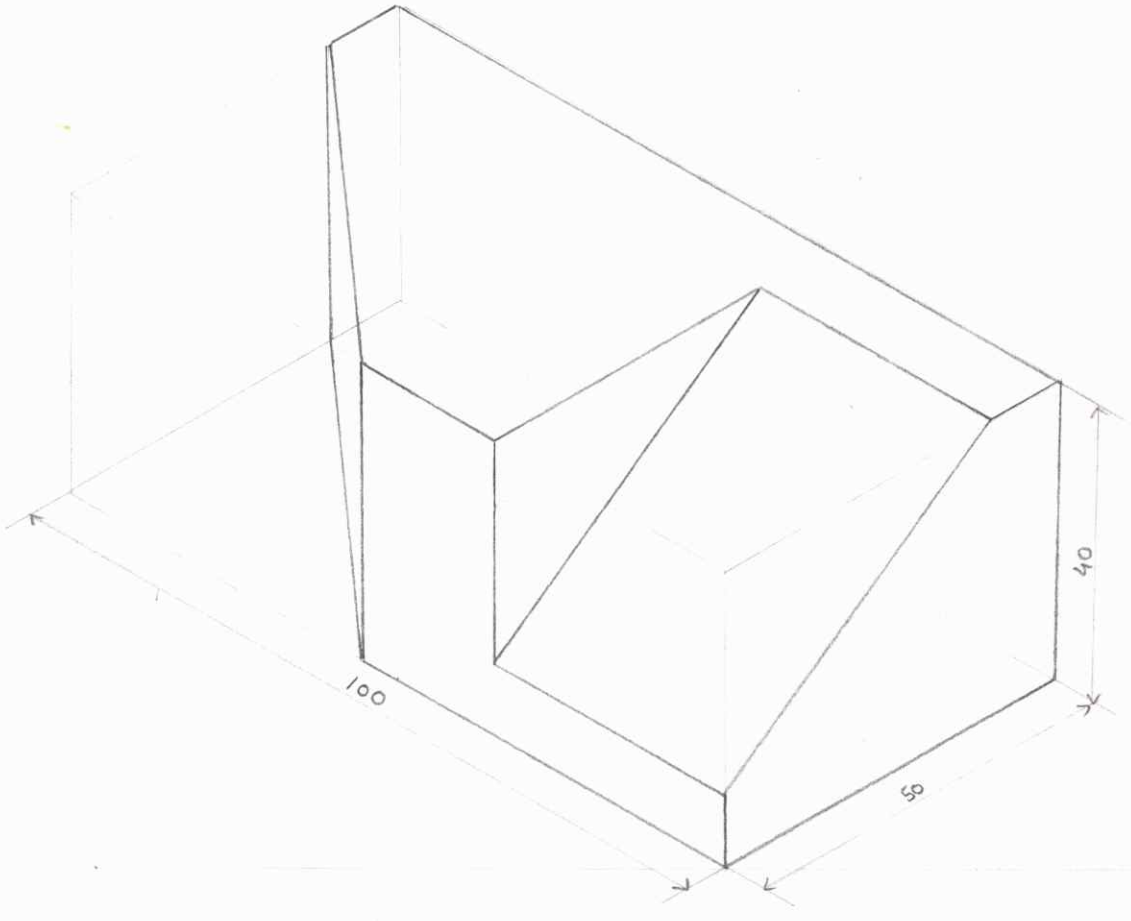

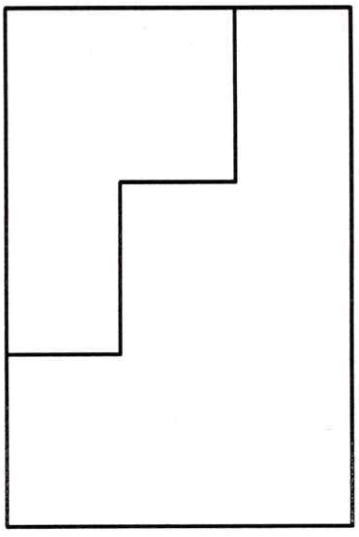

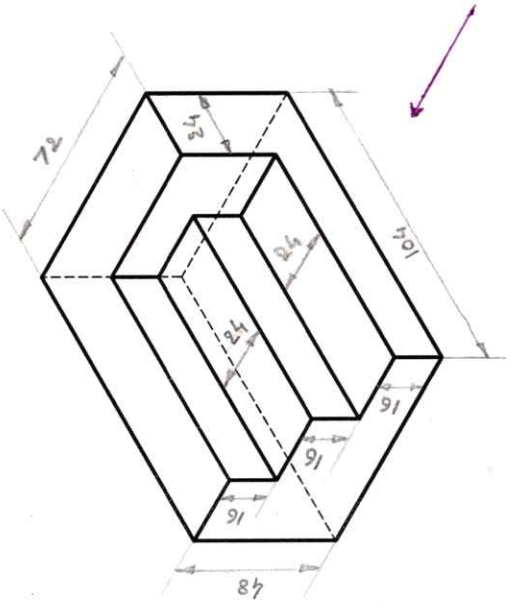
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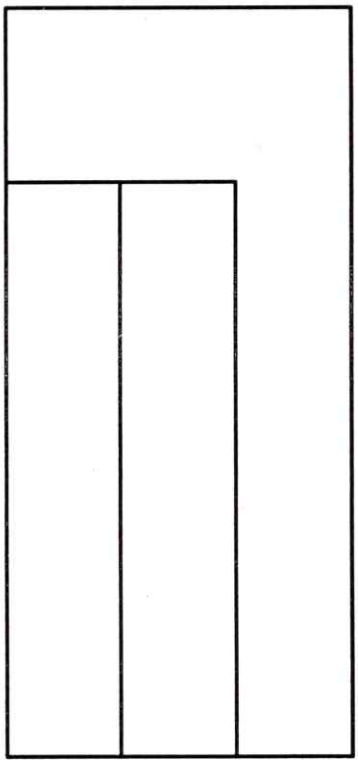

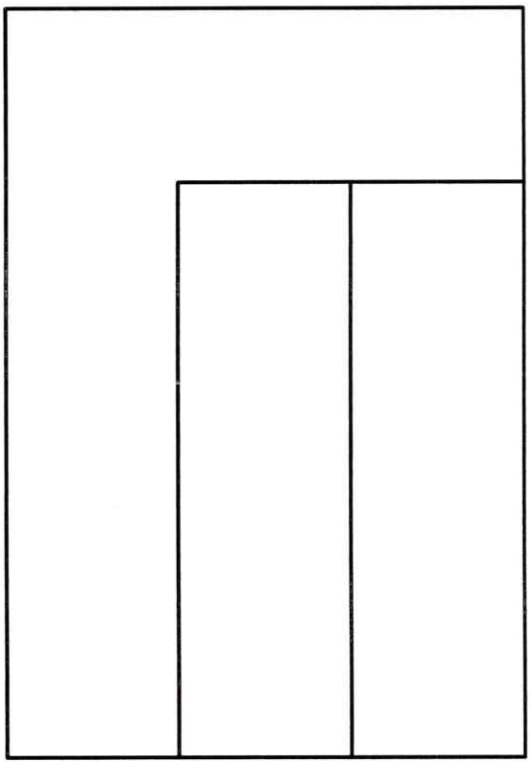

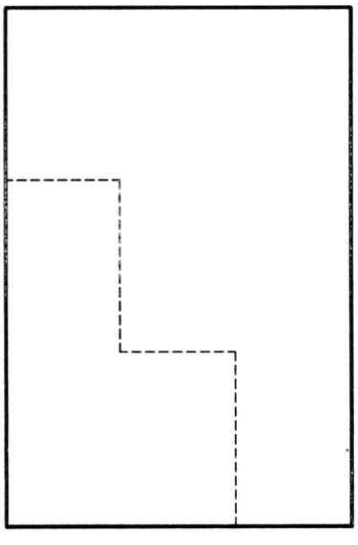

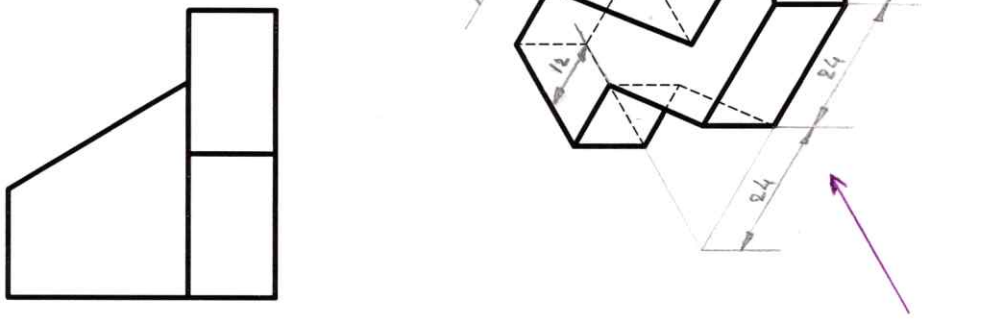

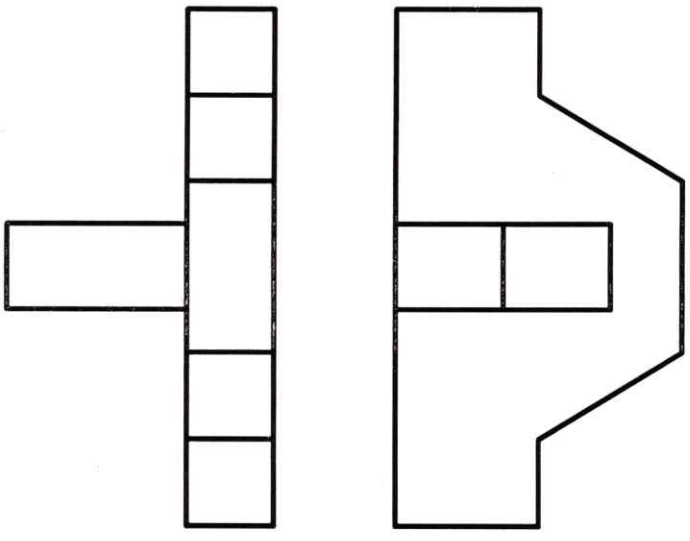

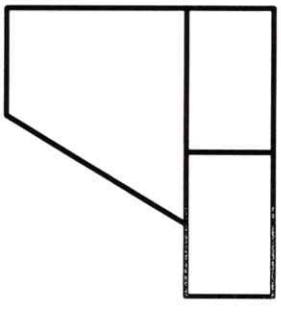

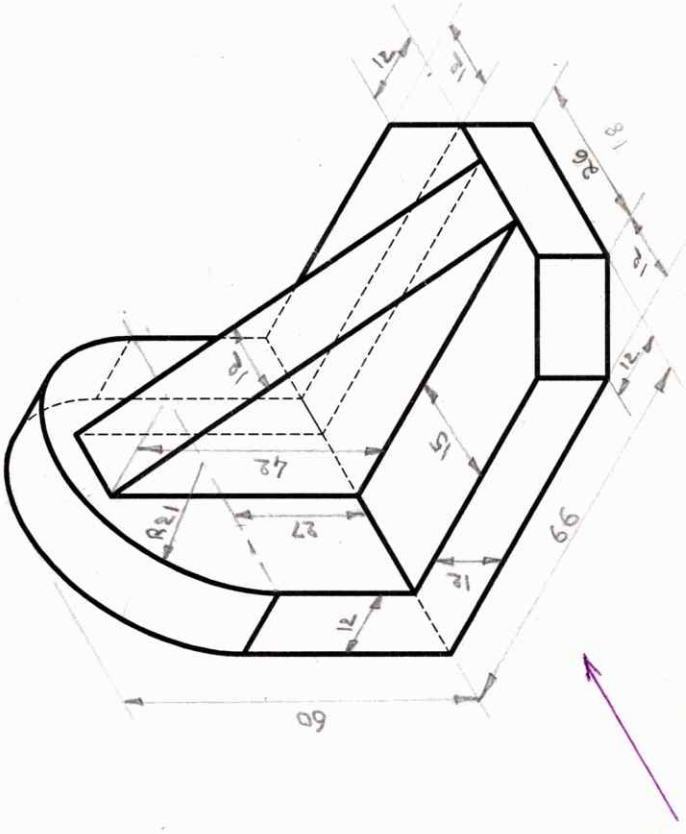
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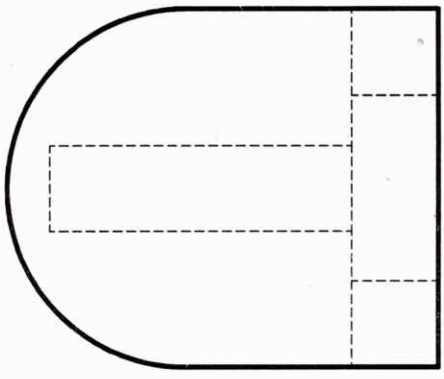

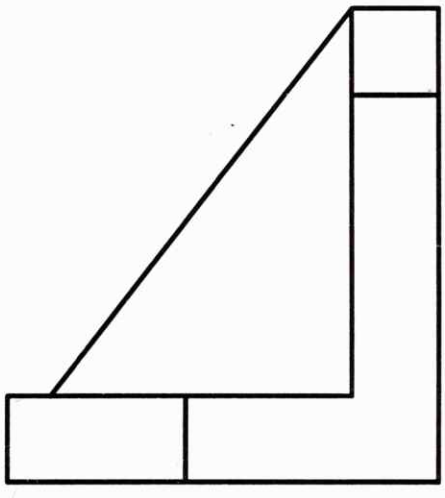

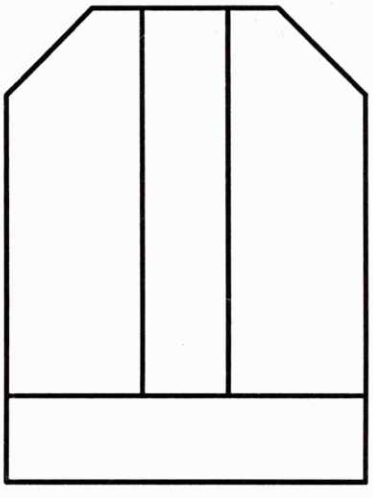

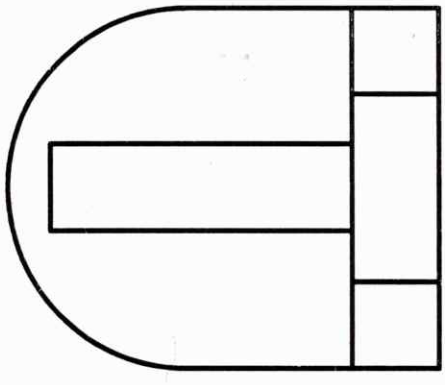

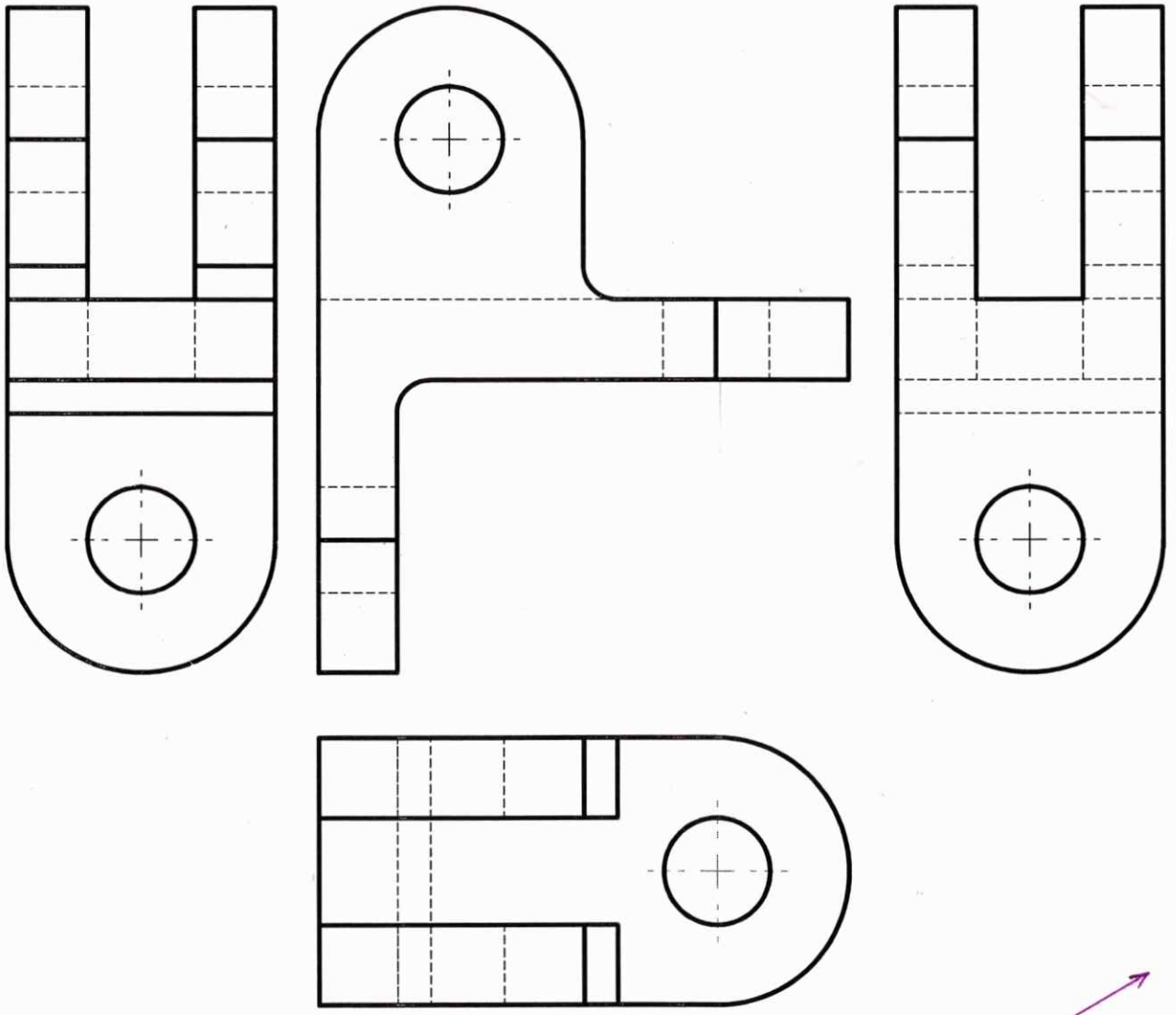

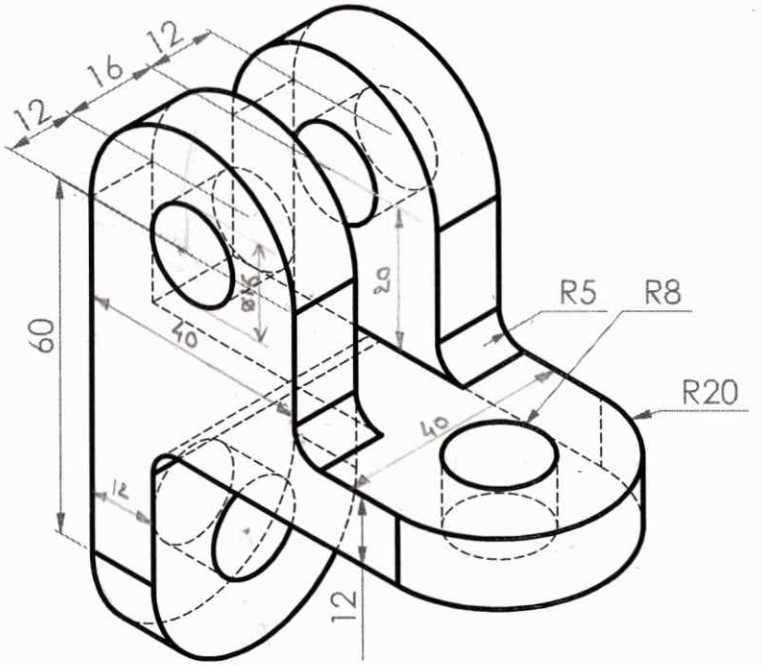
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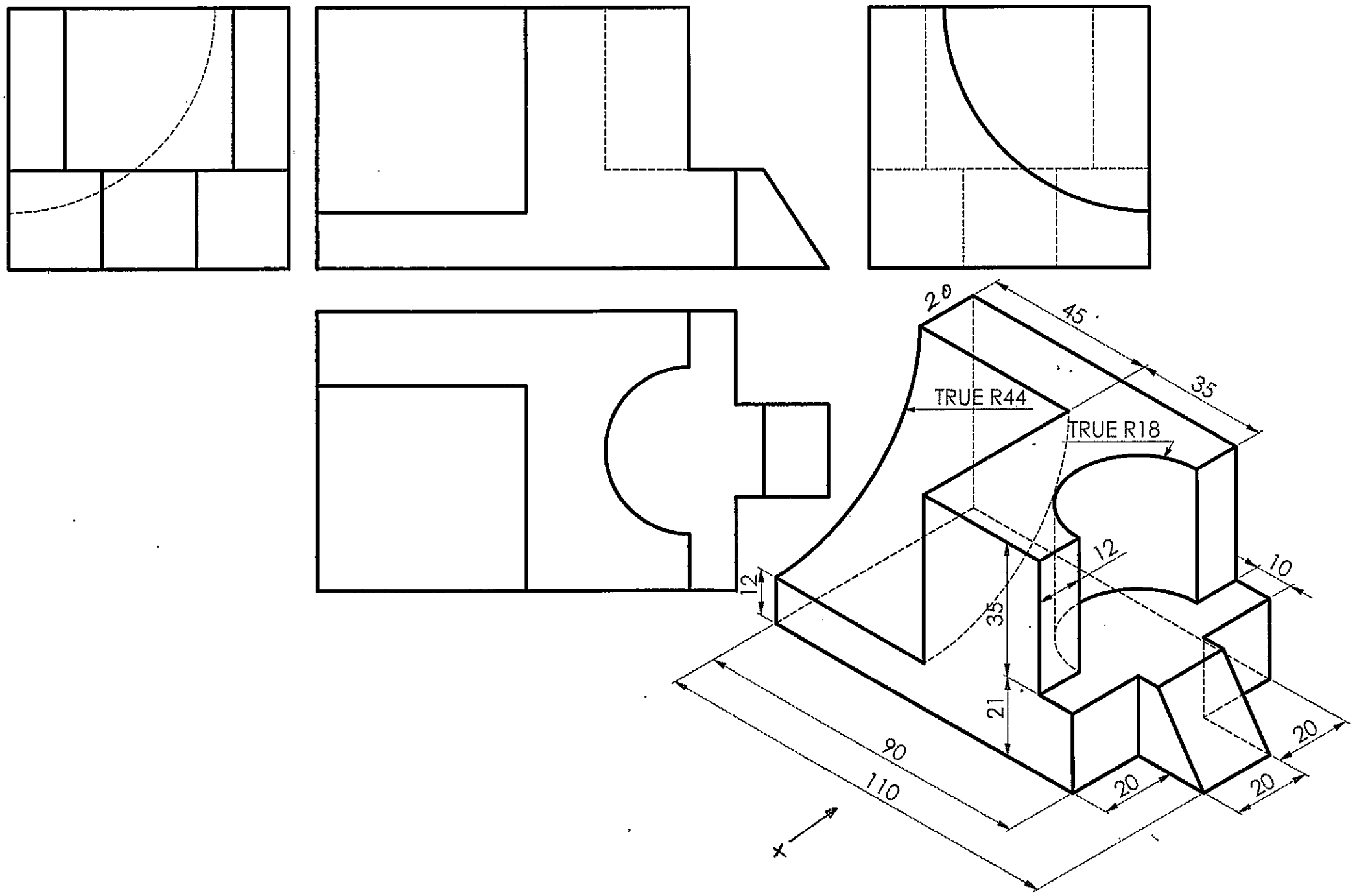

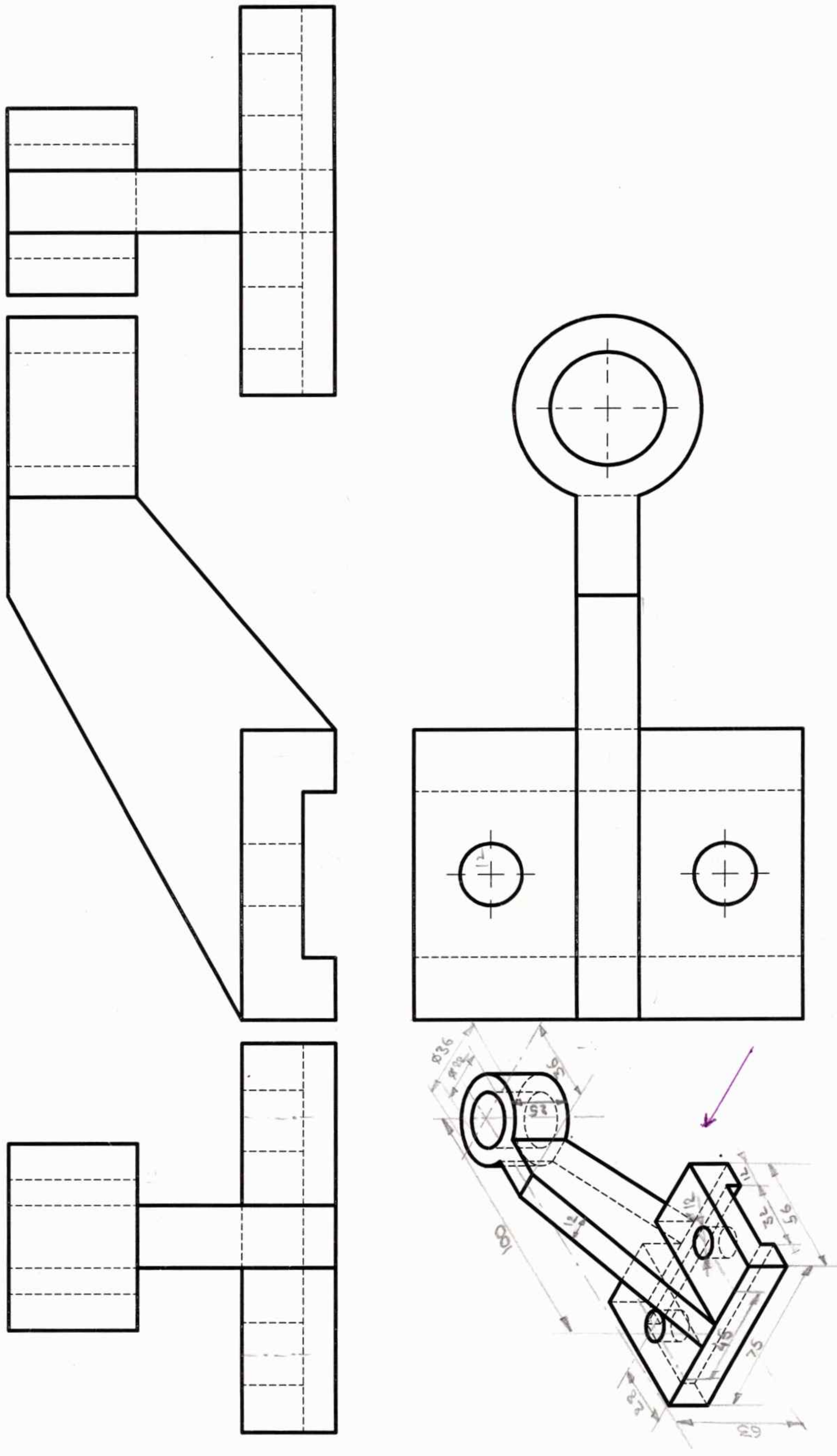

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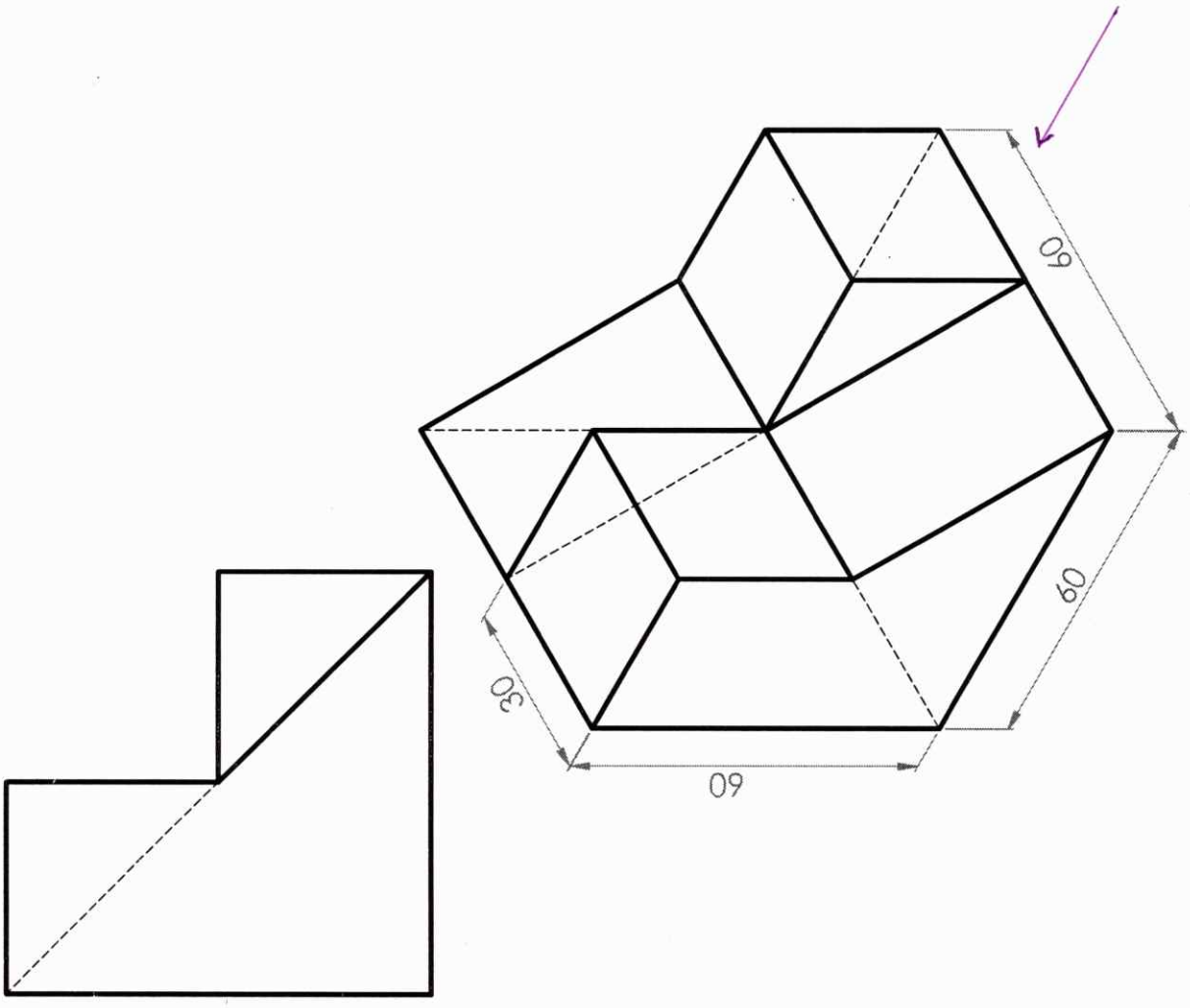
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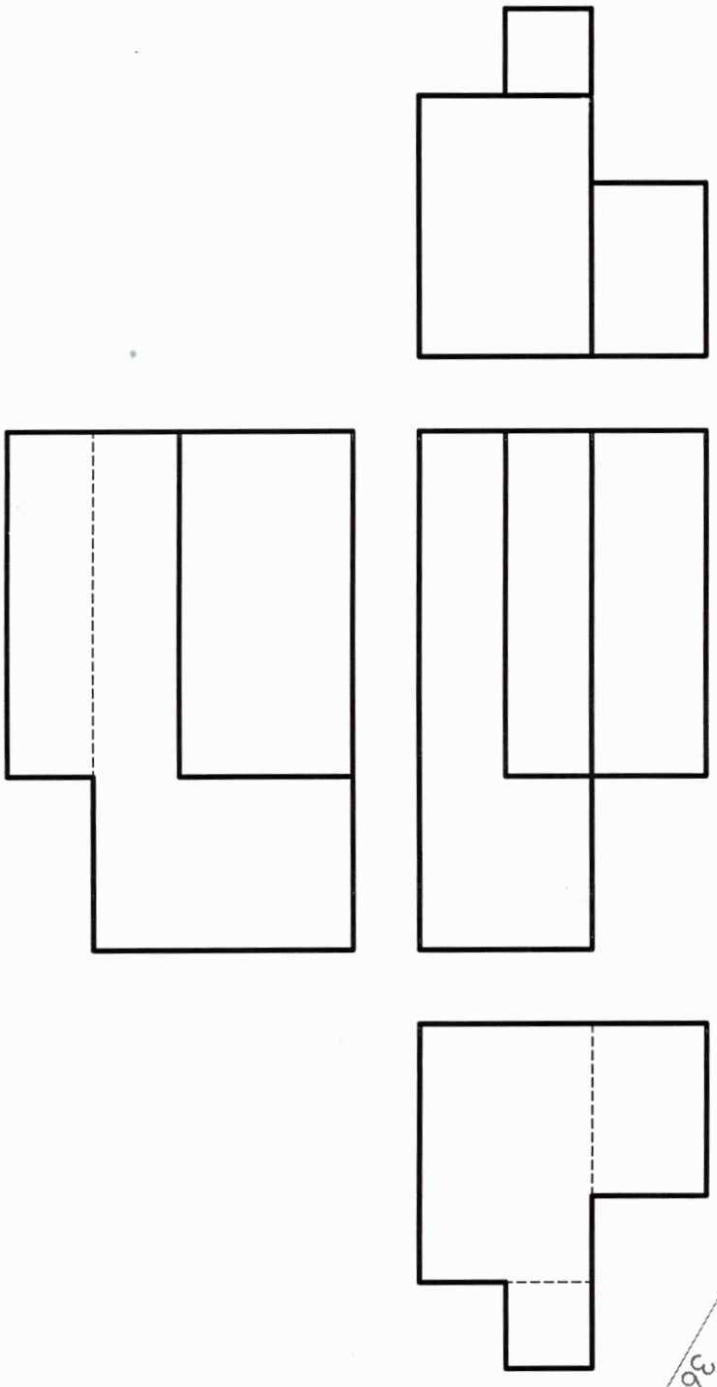

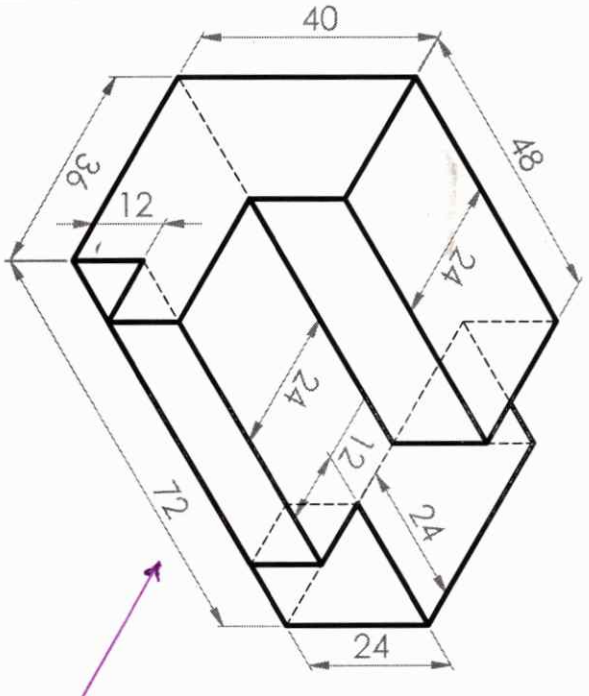
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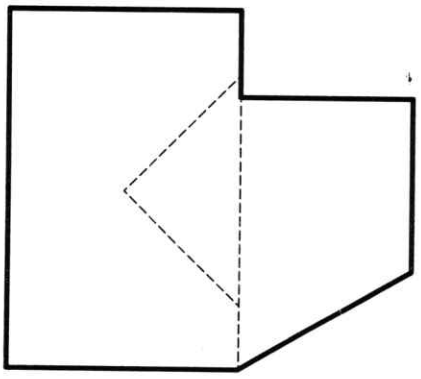

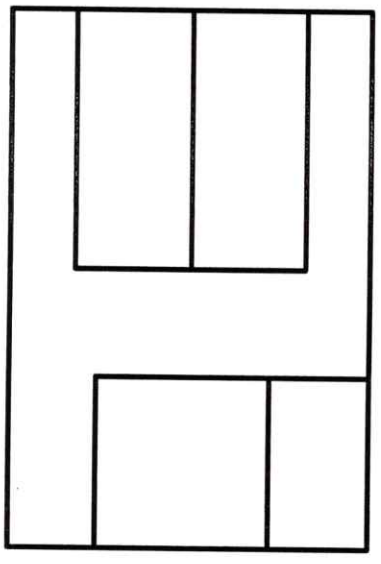

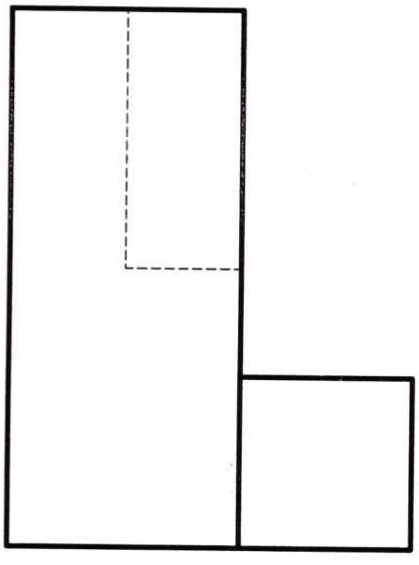

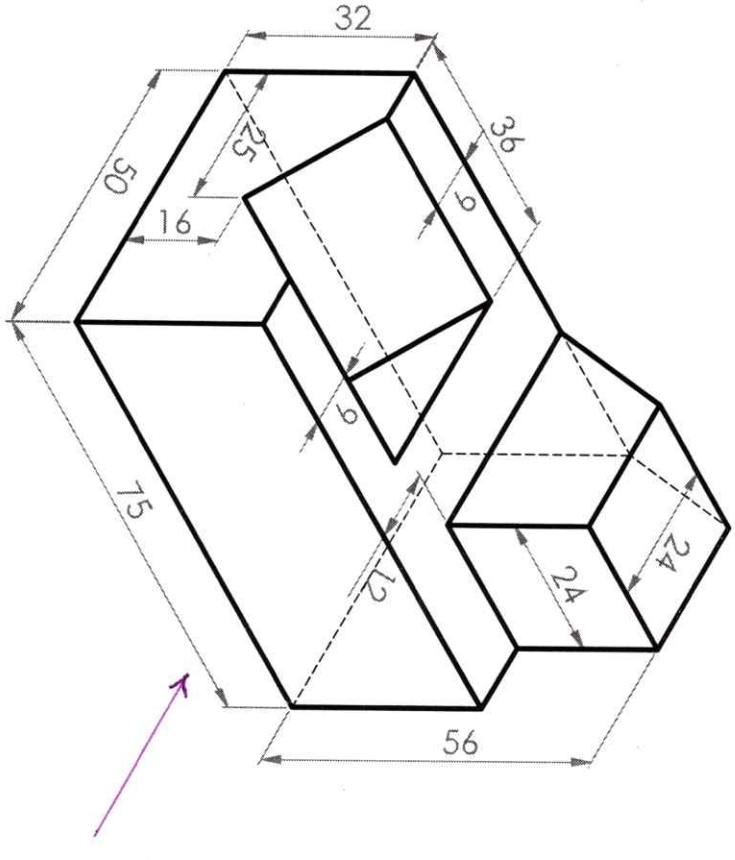
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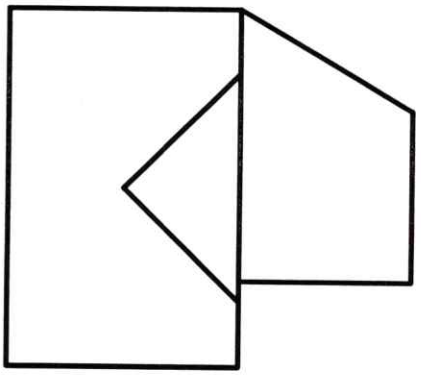

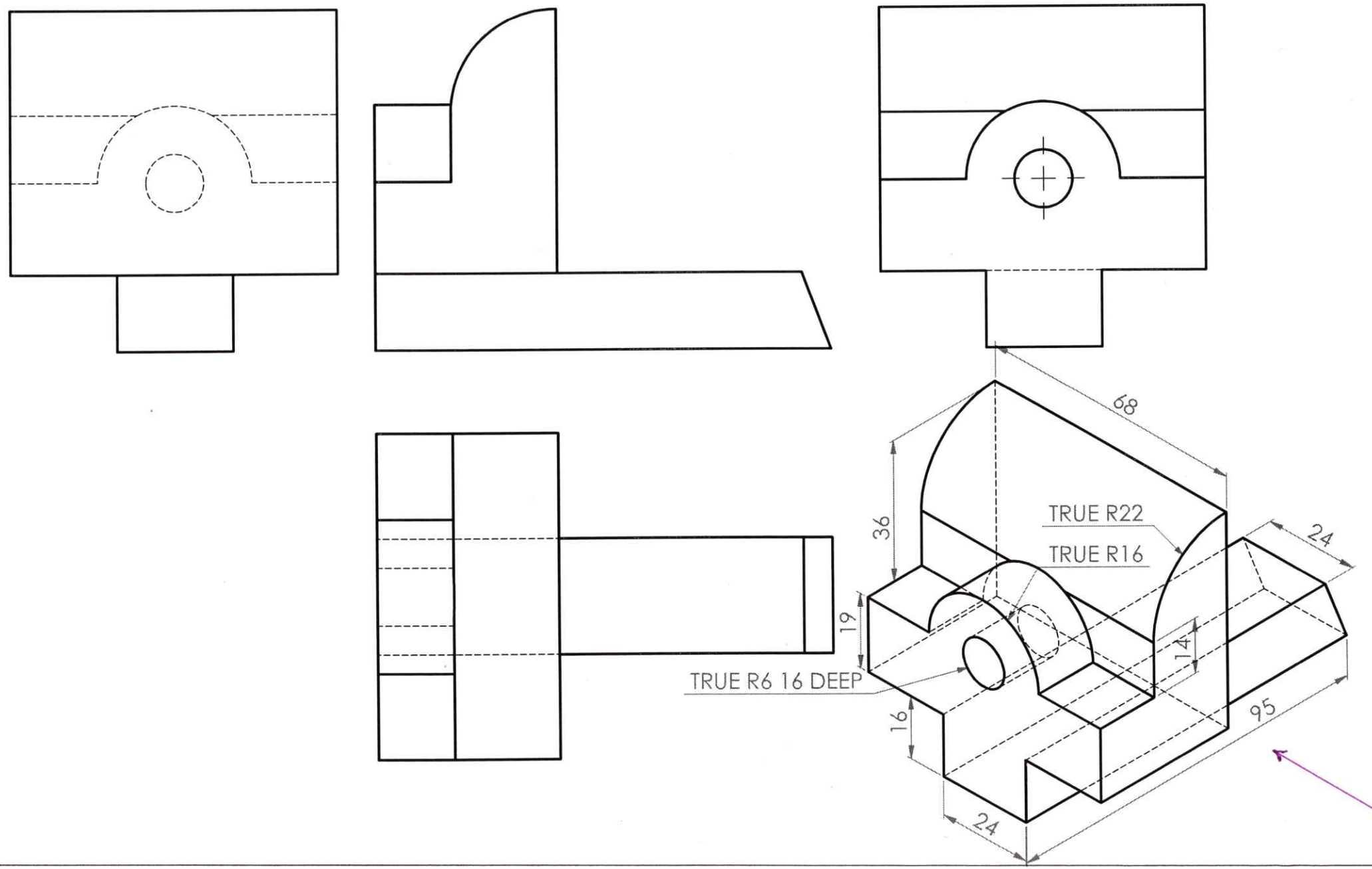
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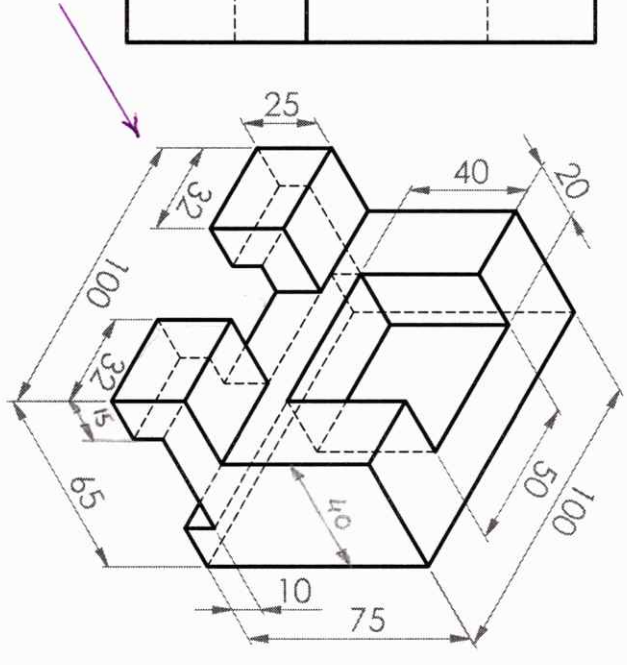
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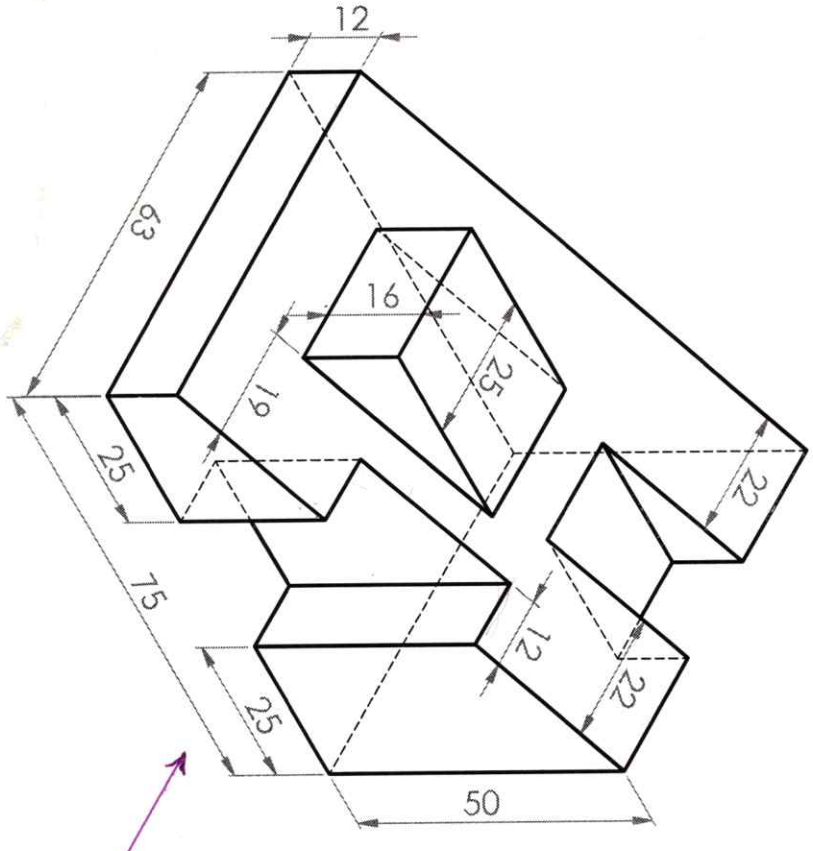
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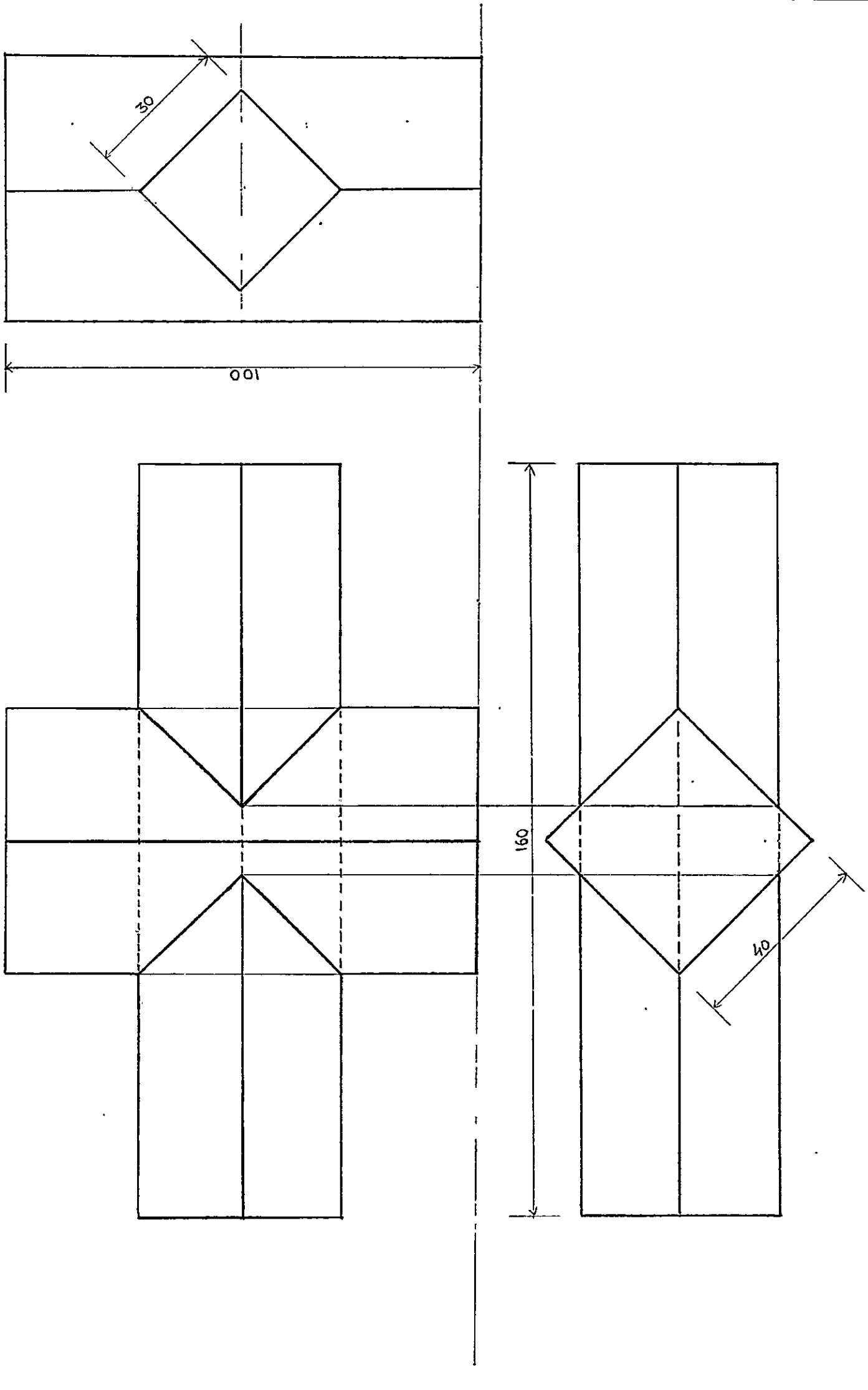
25
19
25
75
22
12
22
25
50

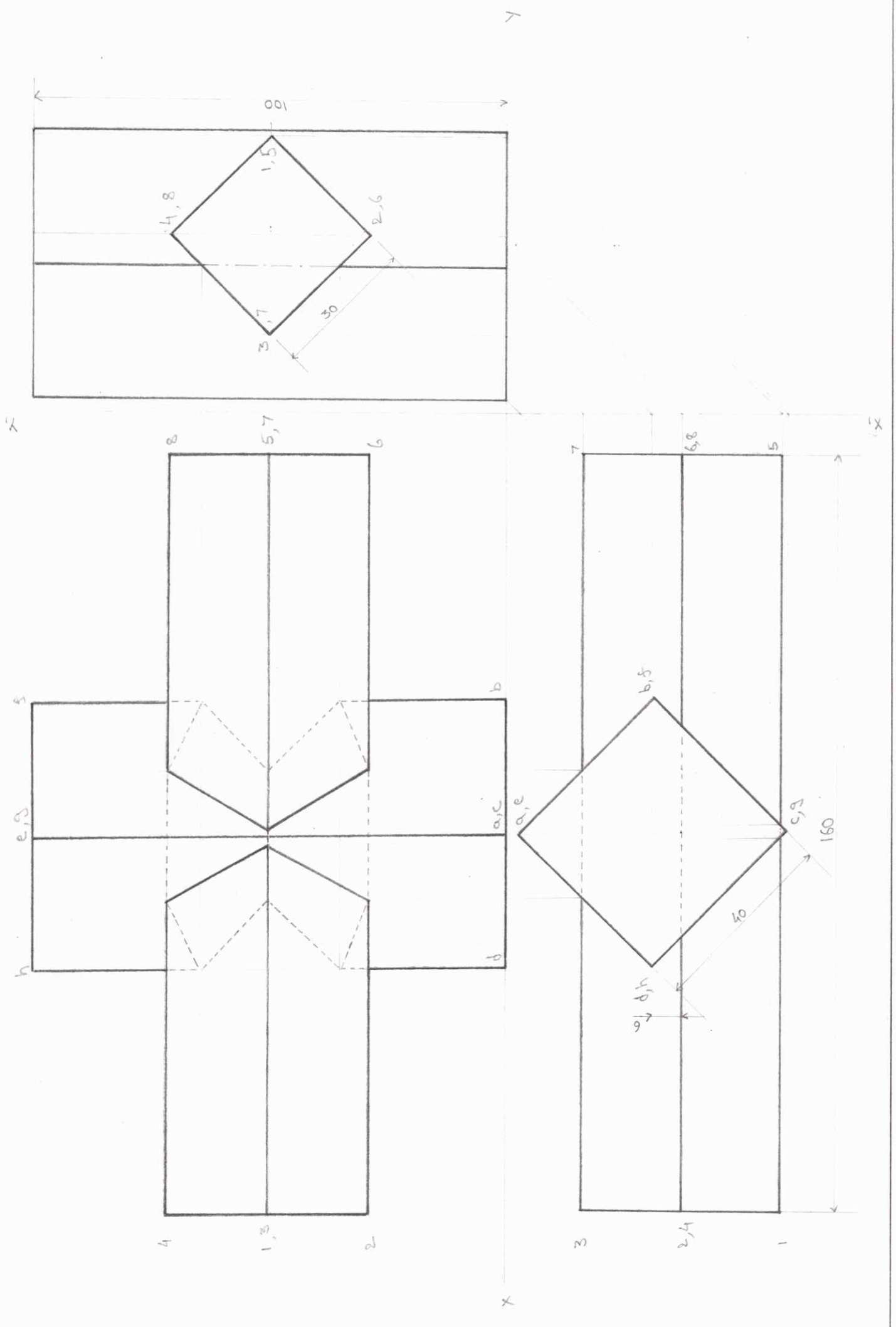
① A vertical square prism base 40 mm side, is completely penetrated by a horizontal square prism, base 30 mm side, so that their axes intersect. The axis of the horizontal square prism is parallel to V.P. while the faces of the two prisms are equally inclined to V.P. Draw the projections of solids showing the lines of intersection. (Assume suitable lengths for the solids)

② A vertical square prism base 40 mm side is completely penetrated by a horizontal square prism, base 30 mm side so that their axes are 6 mm apart. The axis of the horizontal prism is parallel to V.P. while the faces of both the prisms are equally inclined to V.P. Draw the projections of the prisms showing the lines of intersection.

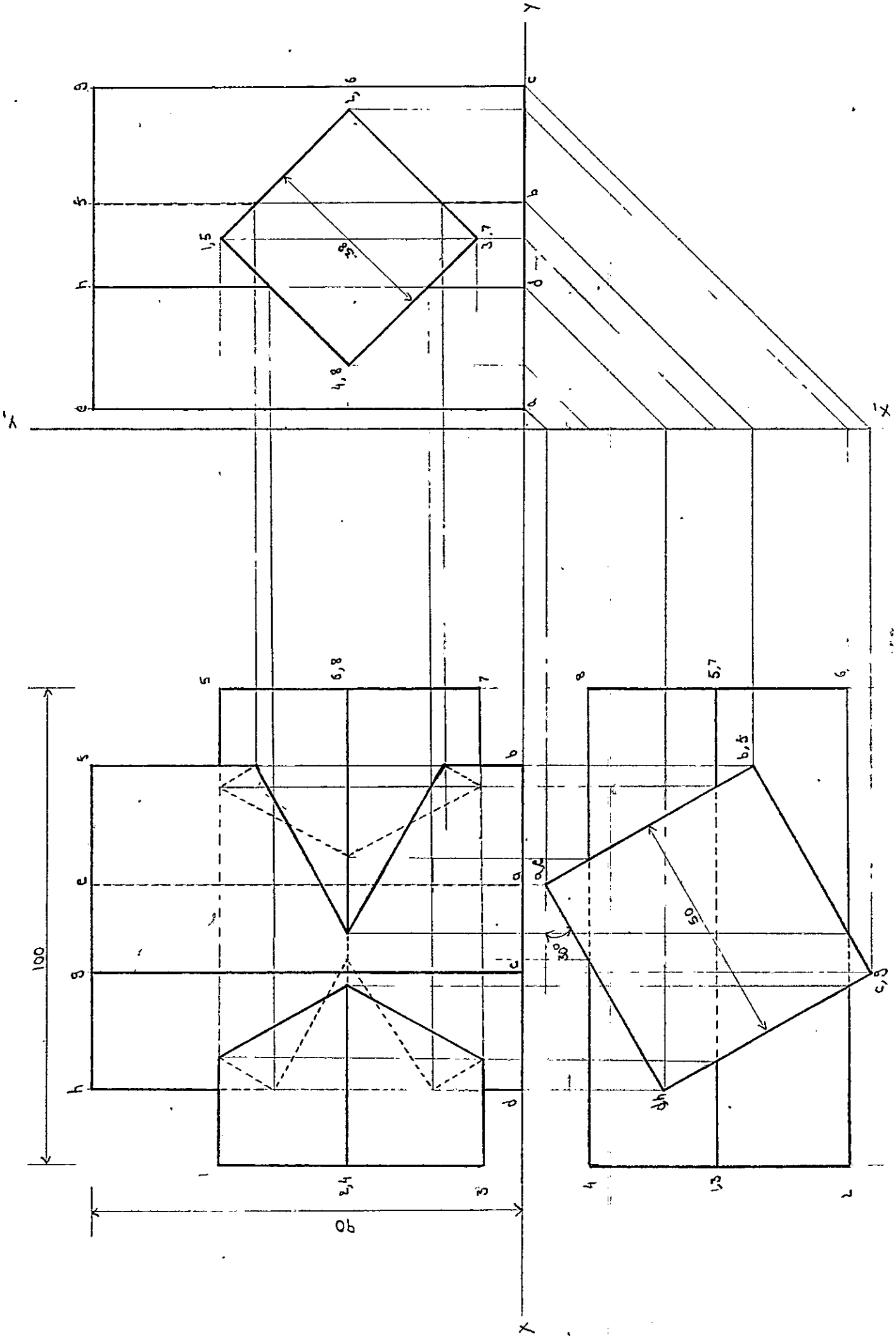
③ A vertical square prism, base 50 mm side and height 90 mm has a face inclined at ~~30°~~ 30° to V.P. It is completely penetrated by a horizontal square prism, base 35 mm and axis 100 mm long faces of which are equally inclined to V.P. ~~The axes of two points bisect~~ e. Draw the projections showing lines of intersection.

④ A vertical square prism base 60 mm side is joined by a square prism 35 mm side. The vertical square prism has a rectangular face inclined at 30° to V.P. The 35 mm square prism has its axis intersecting the axis of vertical square prism at 60° angle, and all its rectangular surfaces are equally inclined to V.P. Draw the projections of the combination of solids along with the lines of intersection.

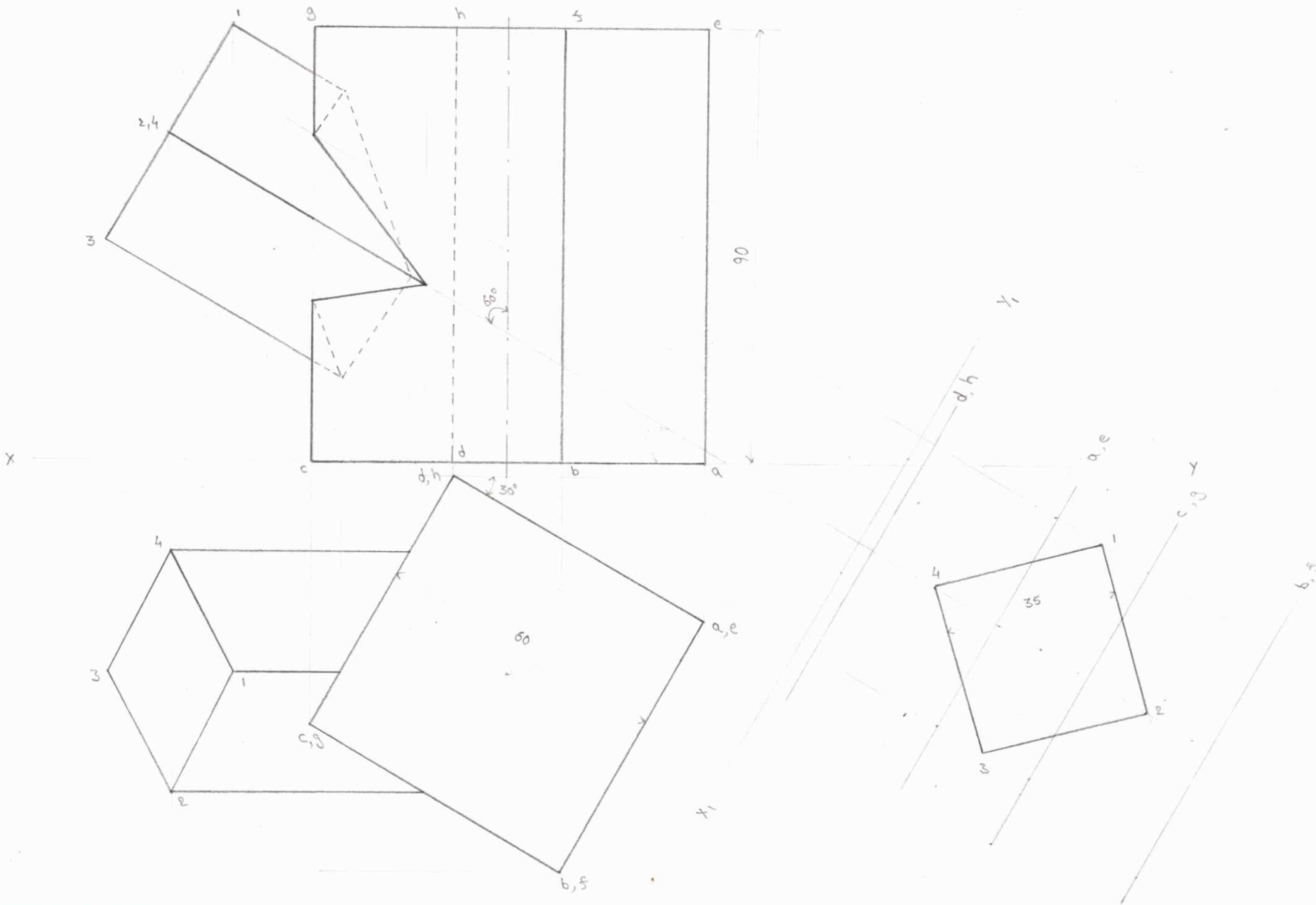

30
100
160
40



a!


Y
X
Y1
X1
g
f
h
e
c
b
d
a
6
7
1,5
3,7
8,5
4,8
5
6,8
7
8
5,7
6
100
90
2,4
3
4
1,3
2
b,5
0,2
30°
5,5
c,5
dh

4



(1) A vertical cylinder of 80 mm dia. is completely penetrated by another cylinder of 60mm dia, their axes bisecting each other at rt. angles. Draw the projections showing the lines of intersection assuming the axis of horizontal cylinder to be ||el to V.P.

(2) A Horizontal circular cylinder of 70 mm dia Penetrates another of 100 dia, their axes being at rt. angles but 10 mm apart. Draw the projections of the solids along with the curves of intersection assuming the axes of the cylinders to be ||el to V.P.

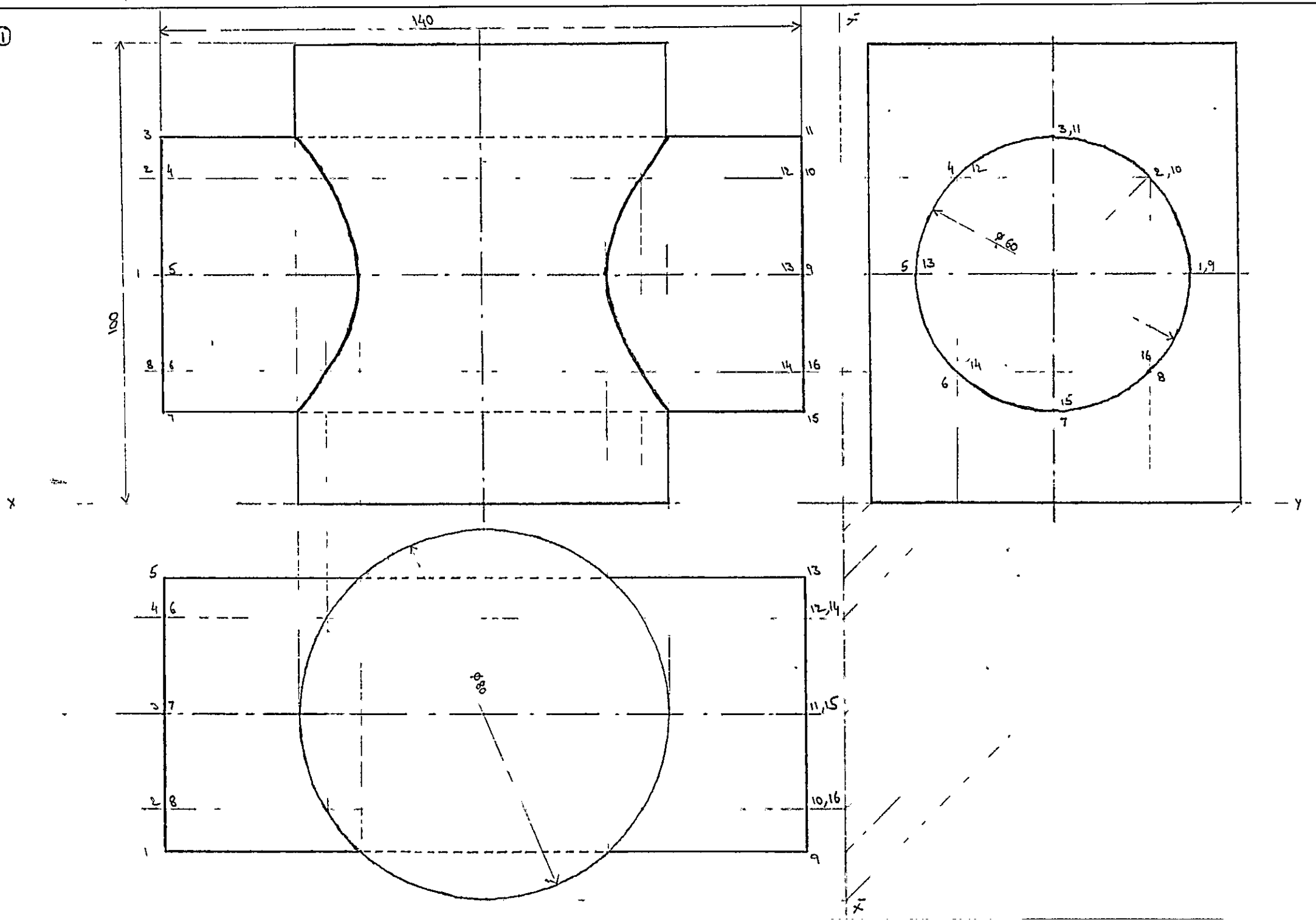
(3) A vertical cylinder of 80 ⌀ is Penetrated by a horizontal cylinder of same size with its axis parallel to V.P but at 10 mm distance from axis of vertical cylinder. Draw the projections showing curves of inter section.

(4) A cylindrical boiler is 2 m in dia and has a cylindrical dome of 0.8m dia and 0.6m hight. The axis of the dome intersects the Axis of the boiler, Draw three views of the arrangement Develop the surface of the dome.

(5) A horizontal square hole of 40mm side is cut in a vertical cylindrical shaft of 80mm dia, the axes of the two intersecting at rt. angles. All faces of the hole are equally inclined to H.P. Draw the 3views of the solid, when the axes of the two are ||el to V.P.

(6) A vertical cylinder of 60⌀ is Penetrated by another cylinder of 40⌀. The axis of the Penetrating cylinder is ||el to V.P and intersects the axis of vertical cylinder at 60° angle. Draw the projections showing lines of intersection.

①


140
180
3
2
4
1
5
8
6
7
11
12
10
13
9
14
16
15
x
3,11
4
12
2,10
ø60
5
13
1,9
14
16
6
8
15
7
y
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4
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3
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2
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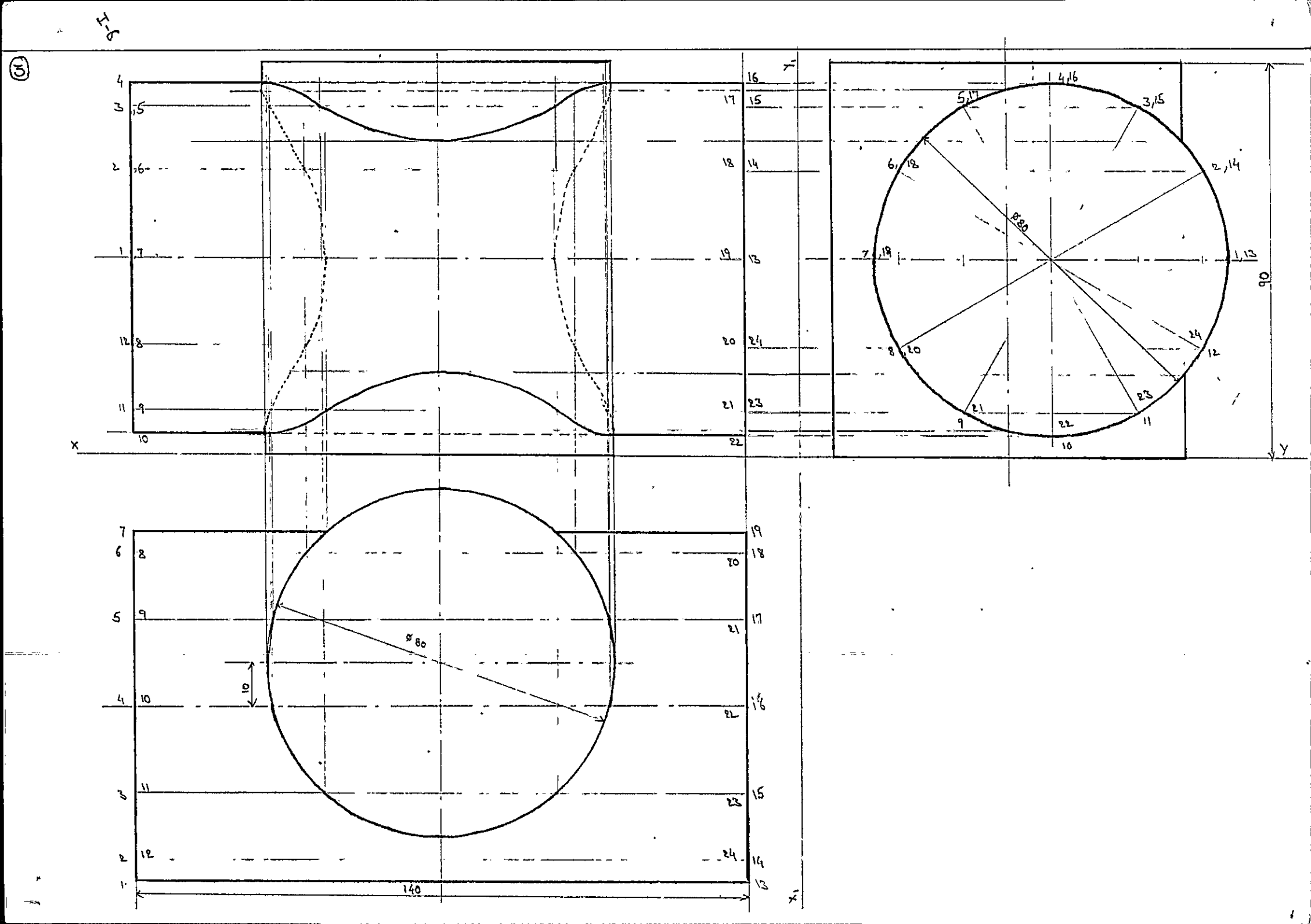
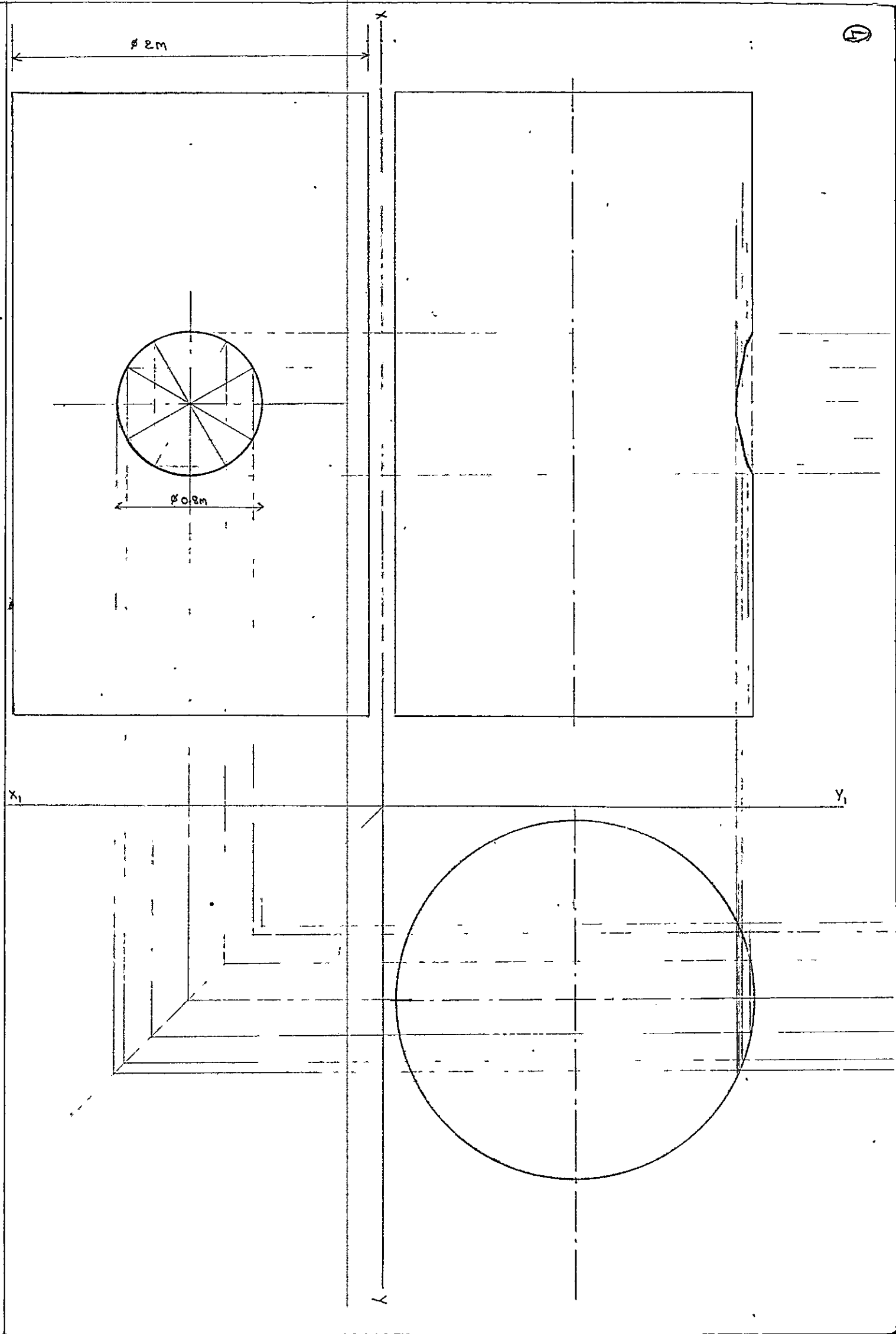
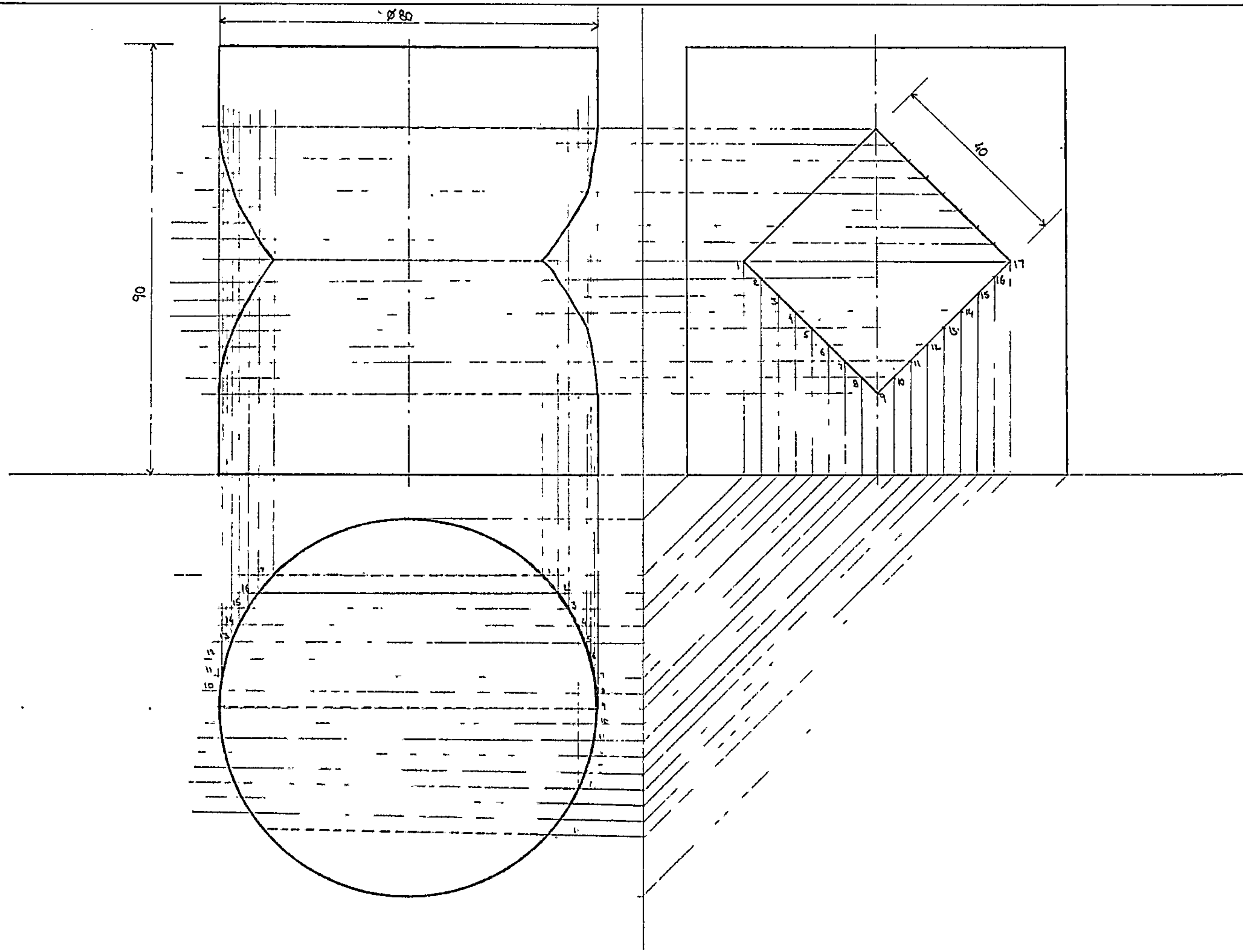
1
13
12,14
11,15
10,16
9
ø80
x

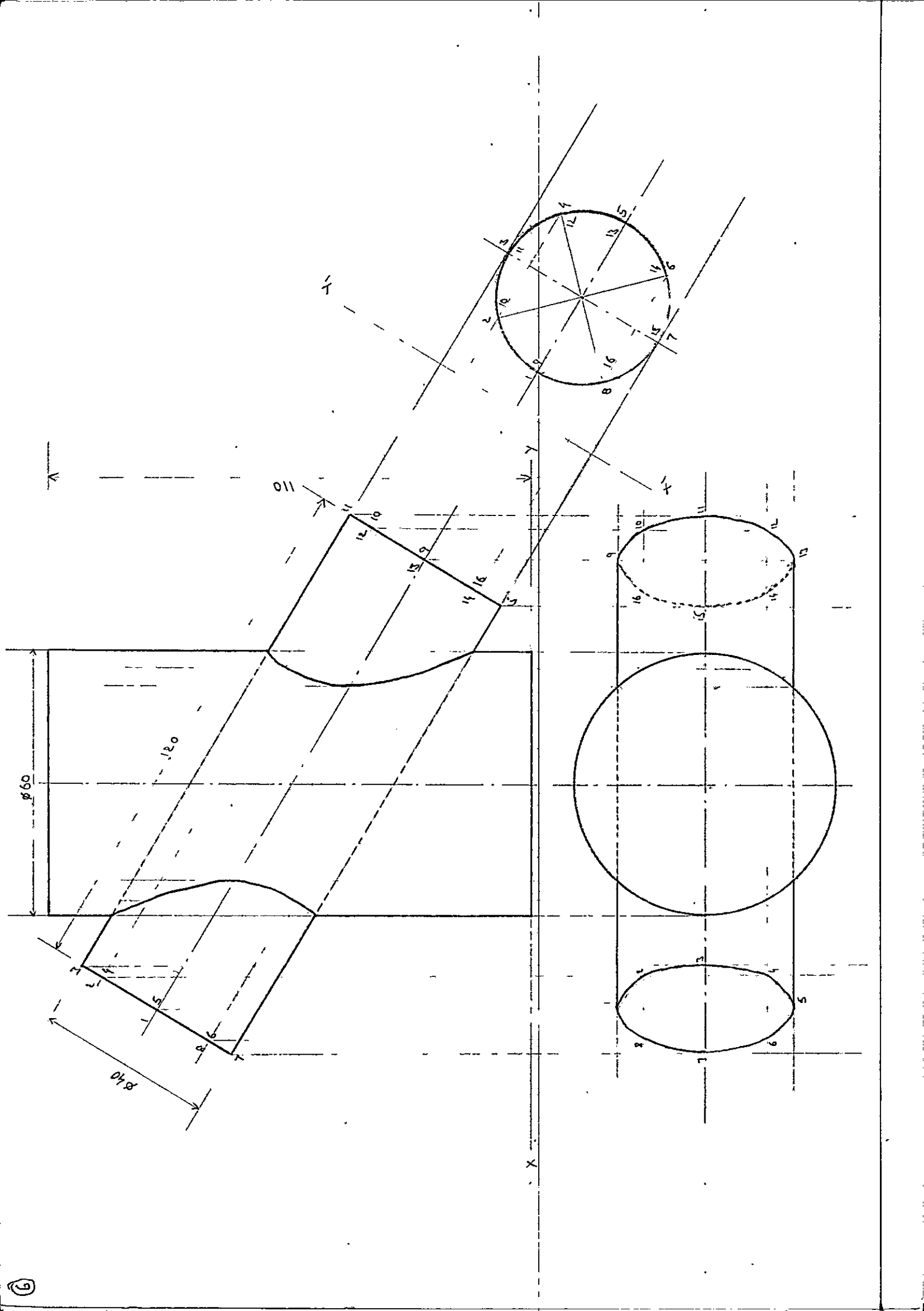

X
X1
Y
Y1
90
140
10
Ø80
Ø80

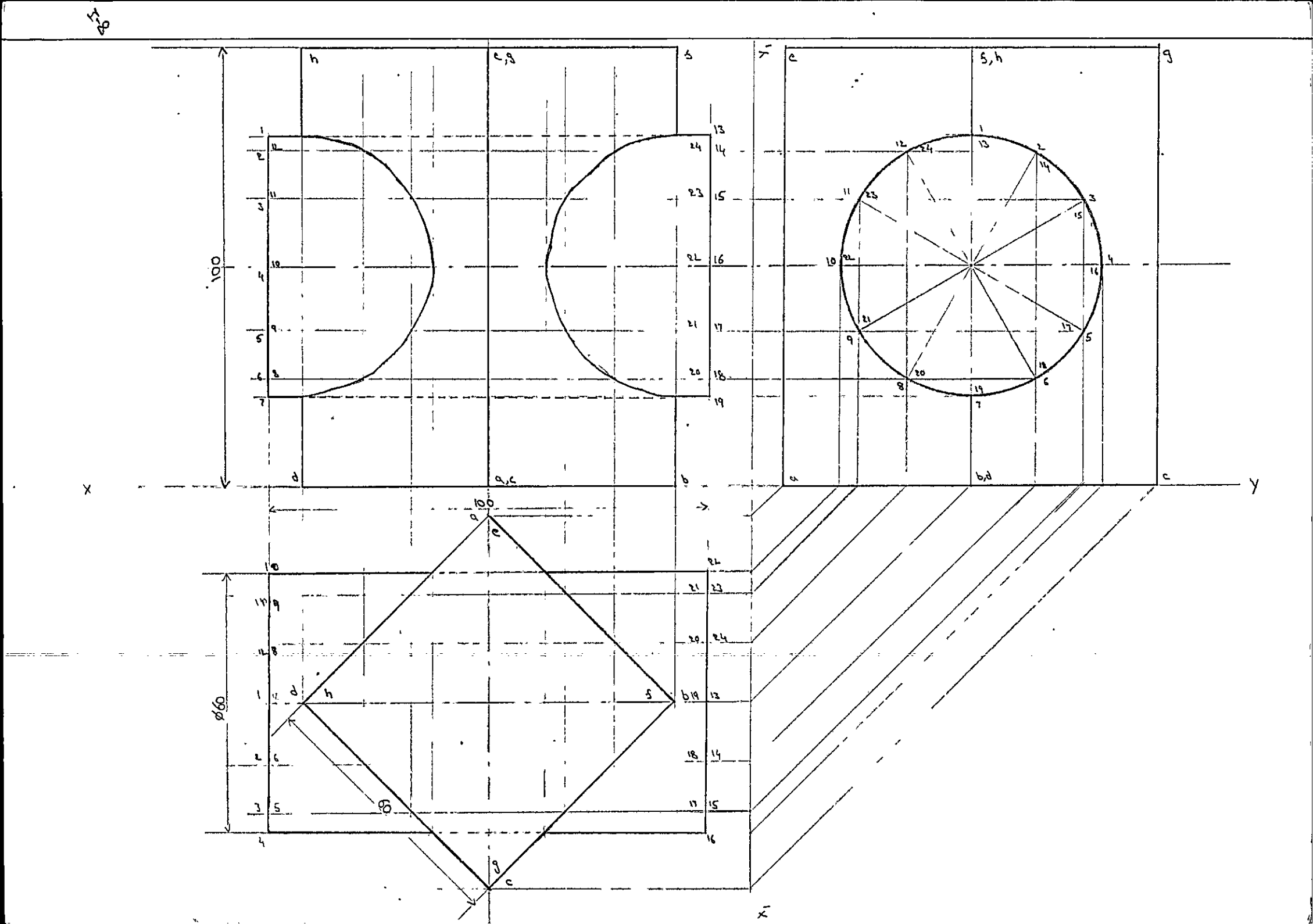

ø 2m
X
ø 0.8m
X1
Y1
Y

I-7

5




Y
X
120
ø60
ø40


h
c,g
s
e
s,h
g
100
x
y
z
d
a,c
b
a,d
c
100
ø60
60
60

① A square Prism of side of base 40 and axis 80mm long, is resting on its base on H.P such that, a rectangular face of it is Parallel to V.P. Draw the development of the Prism.

② A cube of 45 50 mm edge, is resting on a face on H.P such that, a vertical face is inclined at 30° to V.P. It is cut by a section Plane Perpendicular to V.P and inclined to H.P at 30° and Passing through a Point at 12 mm from the top end of the axis. Devel0p the development of lateral the Surface of the cube.

③ A hexagonal Prism of side of base 30mm and axis 65 mm long, is resting on its base on H.P such that, a rectangular face is Parallel to V.P. It is cut by a section Plane, Perpendicular to V.P and inclined at 30° to H.P. The section Plane is Passing through the top end of an extreme lateral edge of the Prism. Draw the development of the lateral Surface of the cut Prism.

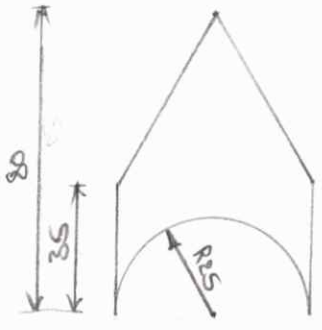
④ A hexagonal Prism of side of base 30mm and 75mm is resting on H.P. with one of its base edge Parallel to V.P. Right half of the Solid is cut by an upward Plane inclined at 60° to the ground and starting from the axis and 30mm below the top end. The left half of the Solid is cut by a Plane inclined at 30° to the H.P downwards from the axis. The two section Plans are continuous. Draw the development of the lower Portion of the hexagonal Prism.

DS-1

⑤ A cube of 45 mm edge, stands on one of its faces on H.P, with the vertical faces equally inclined to V.P. A hole of ~~35 mm~~ 20 mm diameter is drilled through the Prism such that, the axis of the hole bisects the cube and is perpendicular to V.P. Draw the development of the cube when the hole axis is ~~25 mm~~ 15 mm away from the left edge of the cube.

⑥ A cylinder of diameter of base 50 mm and axis 75mm long is resting on its base on H.P. It is cut by a section plane, perpendicular to V.P and inclined at 45° to H.P. The section plane is passing through the top end of an extreme generator of the cylinder. Draw the Development of the lateral surface of the cut cylinder.

⑦ Draw the development of the lateral surface of the cylinder cut as shown in below figure.



⑧ A square Pyramid, with side of base 45mm and axis 80mm long is resting on its base on H.P, with an edge of the base parallel to V.P. It is cut by a section plane, perpendicular to V.P and inclined at 45° to H.P. The section plane is passing through the mid-point of the axis. Draw the development of the cut Pyramid.

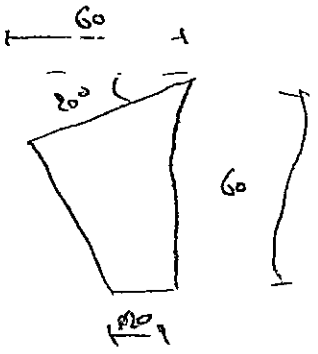
⑨ Draw the development of cut Pentagonal Pyramid, shown in below figure.

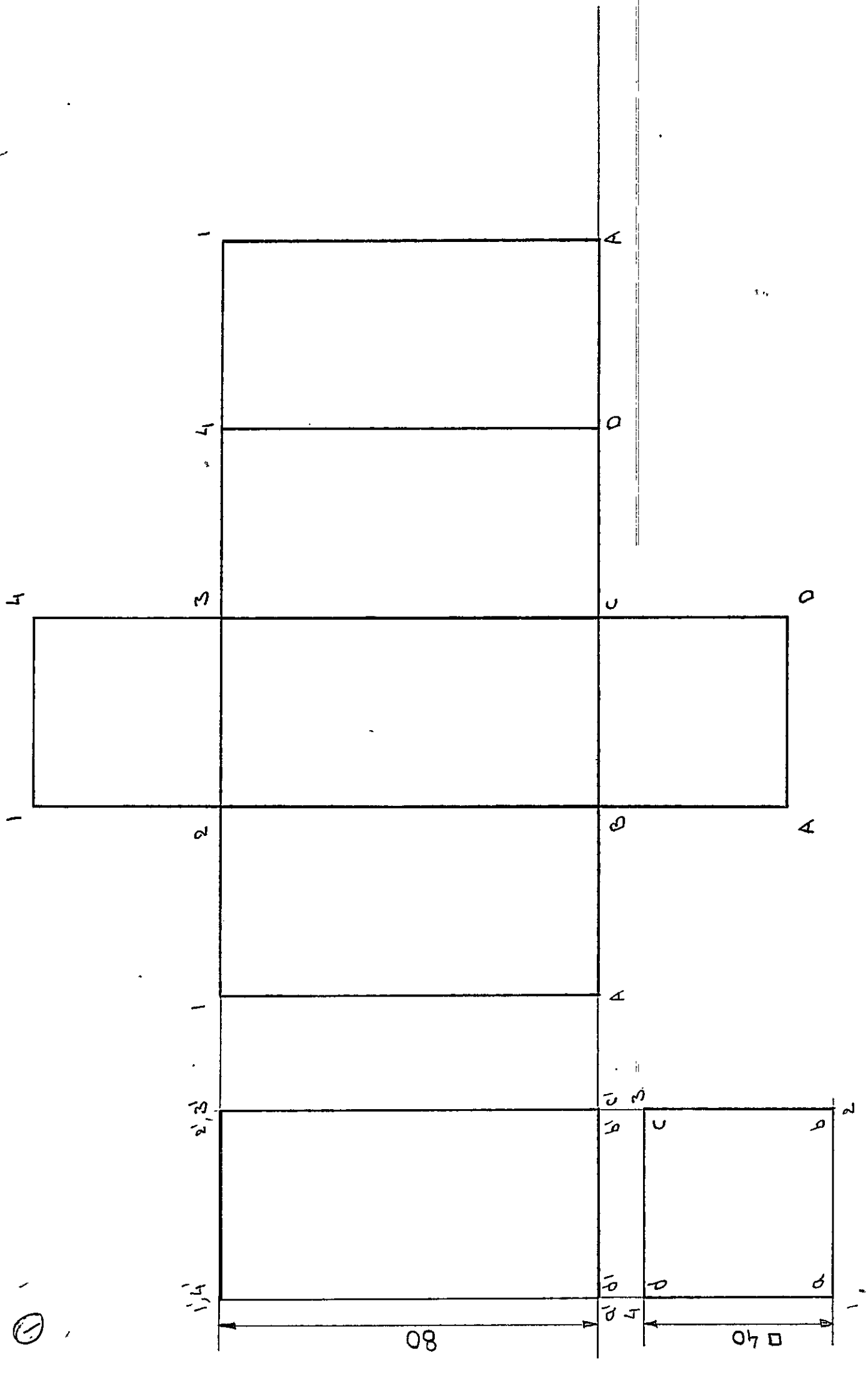
⑩ A cone of diameter of base 50 mm and axis 80 mm long, is resting on its base on H.P. Draw the projections of the cone and show on it, the shortest path traced by a point, starting from a point on the circumference of the base of the cone moves around it and reaching the same point.

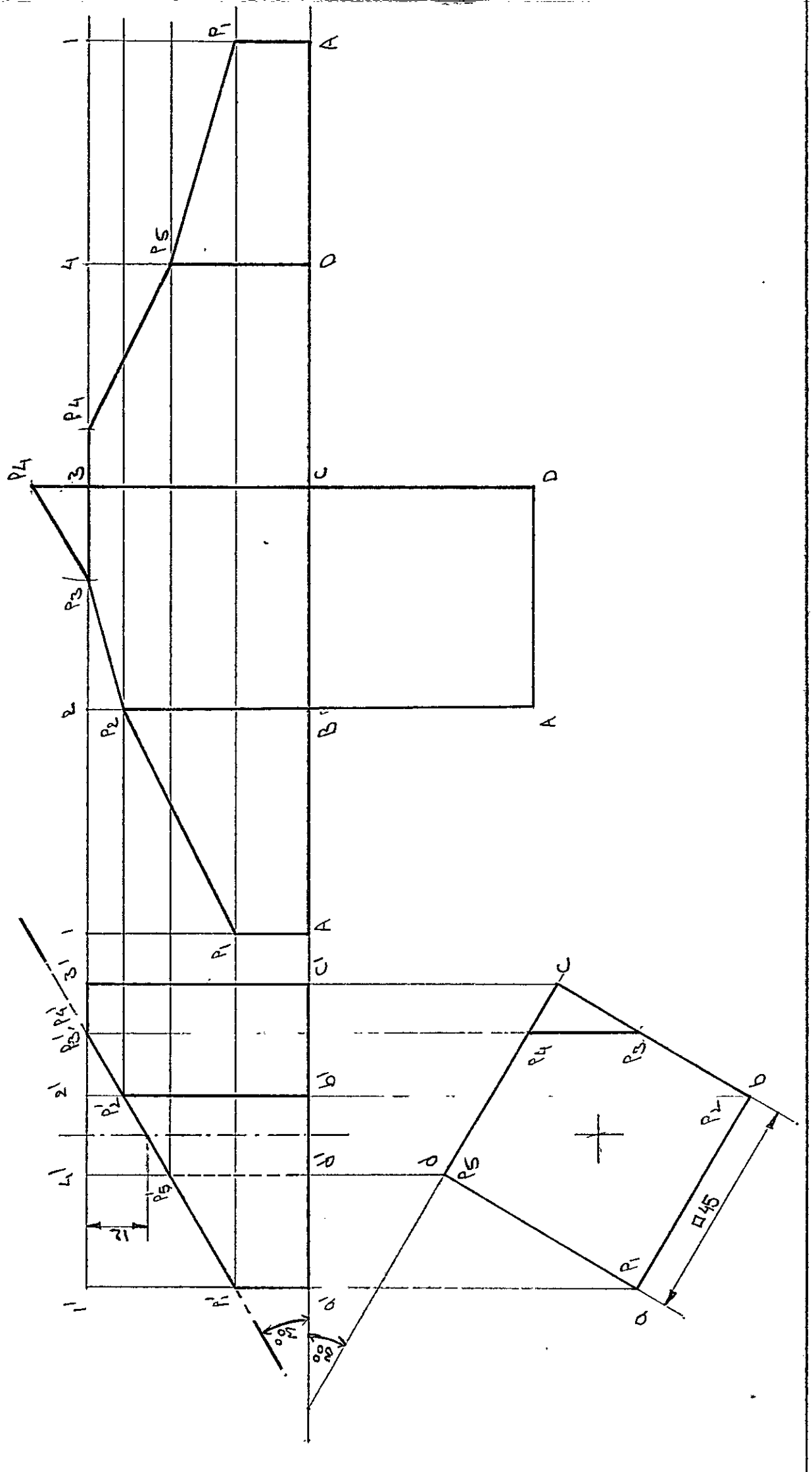
⑪ A vertical cone of 40mm diameter of base and height 70mm is cut by a cutting plane perpendicular to V.P and inclined at 30° to the H.P so as to bisect the axis of the cone. Draw the development of the lateral surface of the truncated position of the cone.

DS-2

(12) Draw the development of the lateral surface of the part of the cone shown in below figure

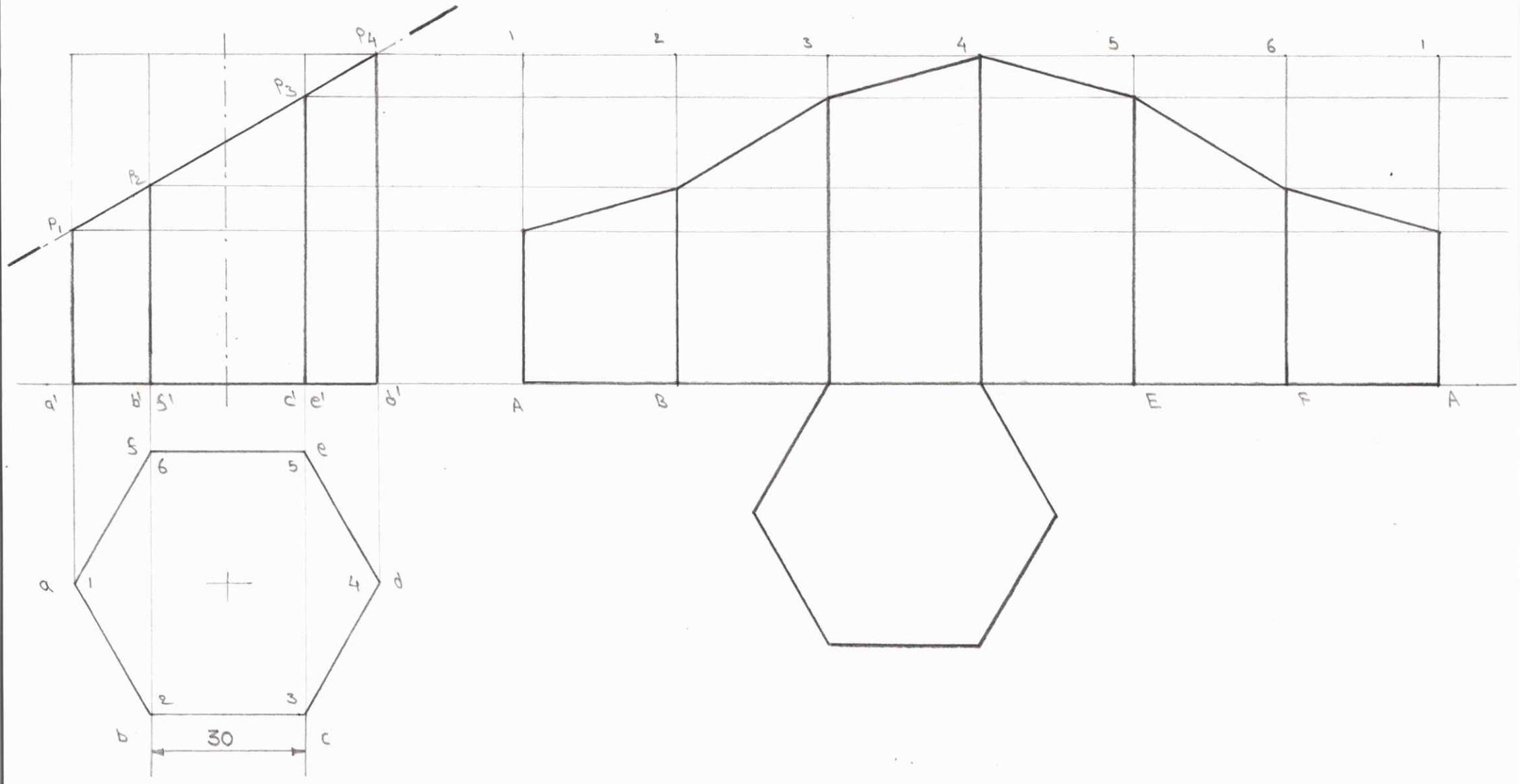


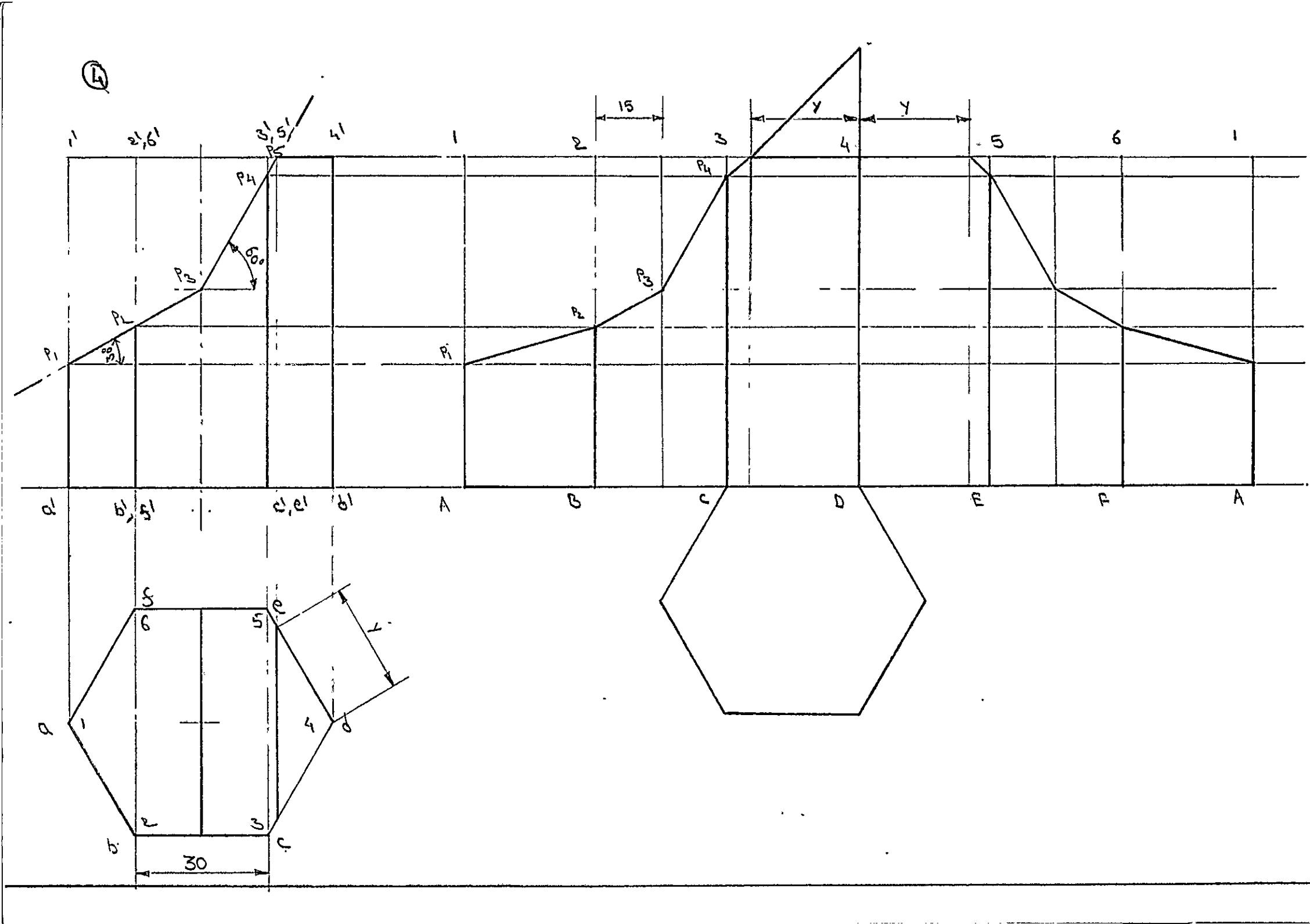

1
A
4
D
4
3
C
D
1
2
B
A
1
A
2',3'
1',4'
80
40

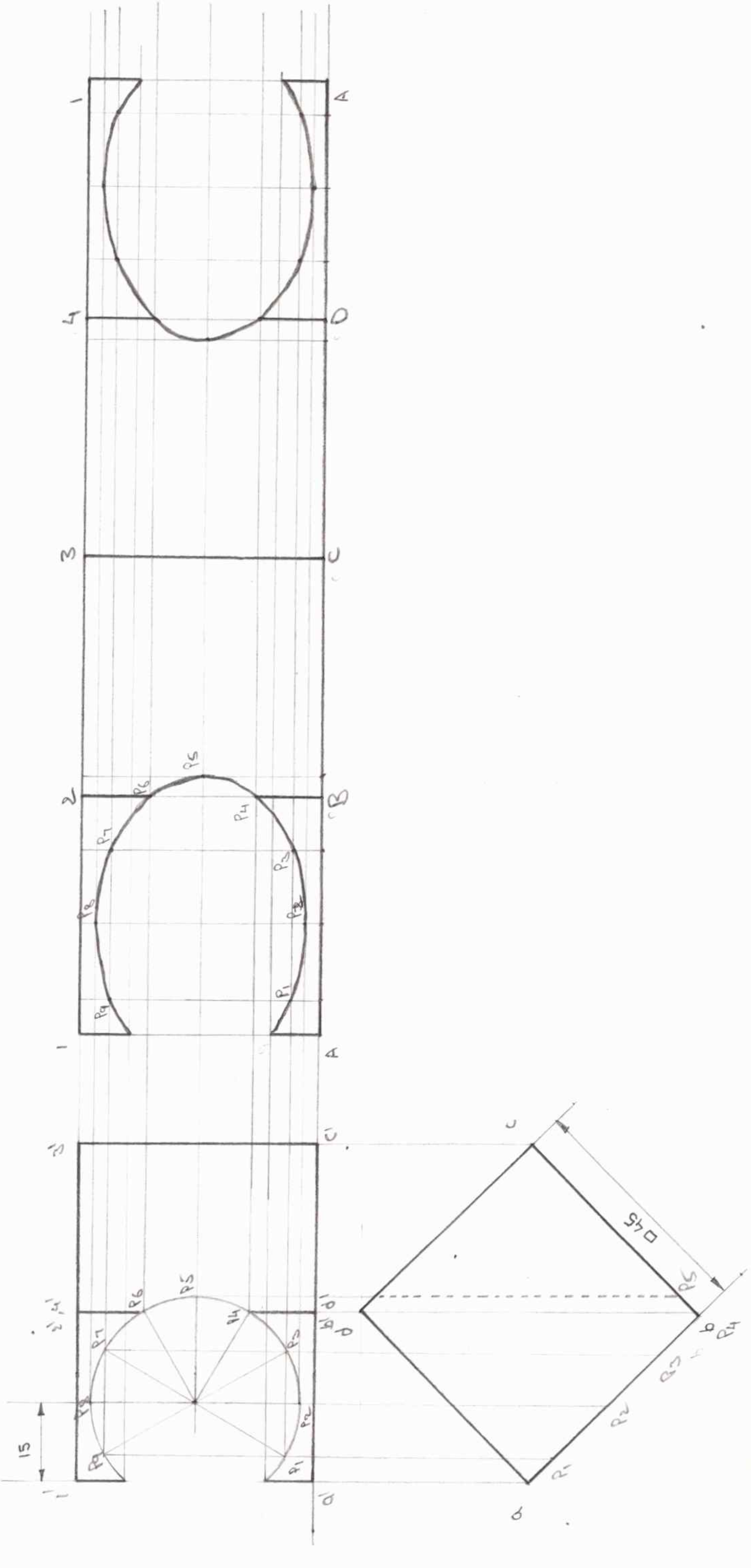

P1
A
P5
4
D
P4
3
C
D
P4
P3
2
B
A
P2
P1
A
1'
3'
C'
P3', P4'
2'
D'
P2'
4'
P5'
21
1'
P1'
D'
01
02
C
P4
P3
D
P2
P5
P1
D
45

(2)

3

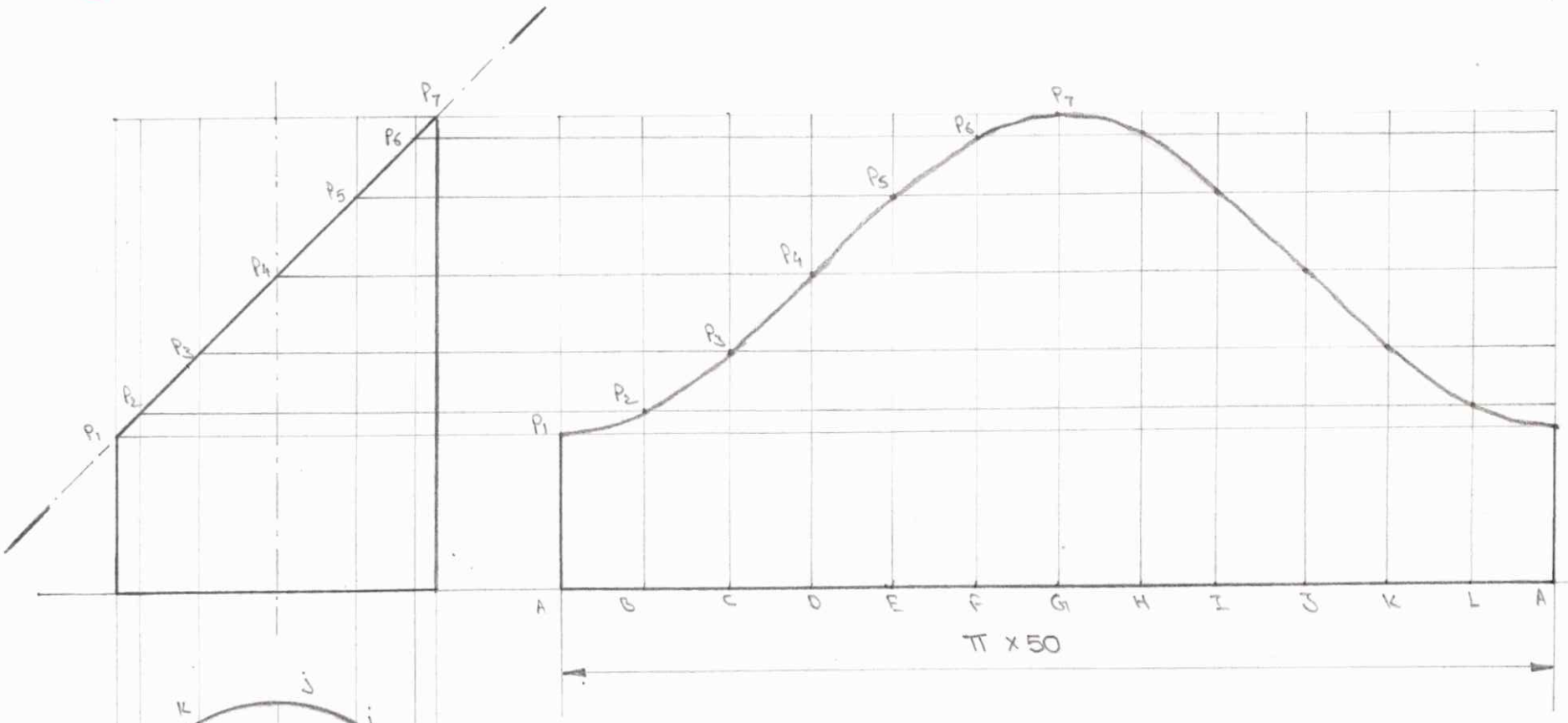


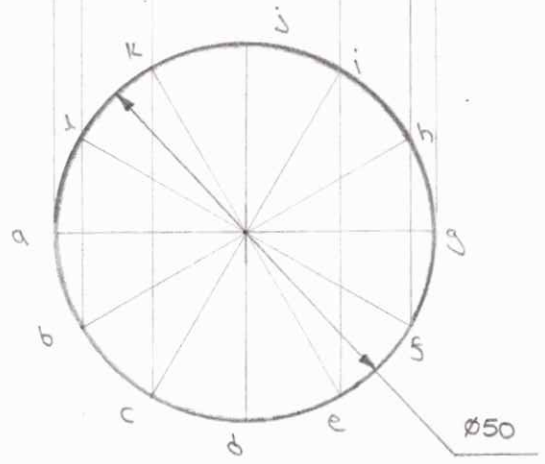

4
1'
2',6'
3',5'
4'
P5
P4
P3
P2
P1
60°
30°
15
Y
Y
1
2
3
4
5
6
1
P4
P3
P2
P1
a'
b',f'
e',e
d'
A
B
C
D
E
F
A
f
e
6
5
1
4
a
d
2
3
b
c
30
L



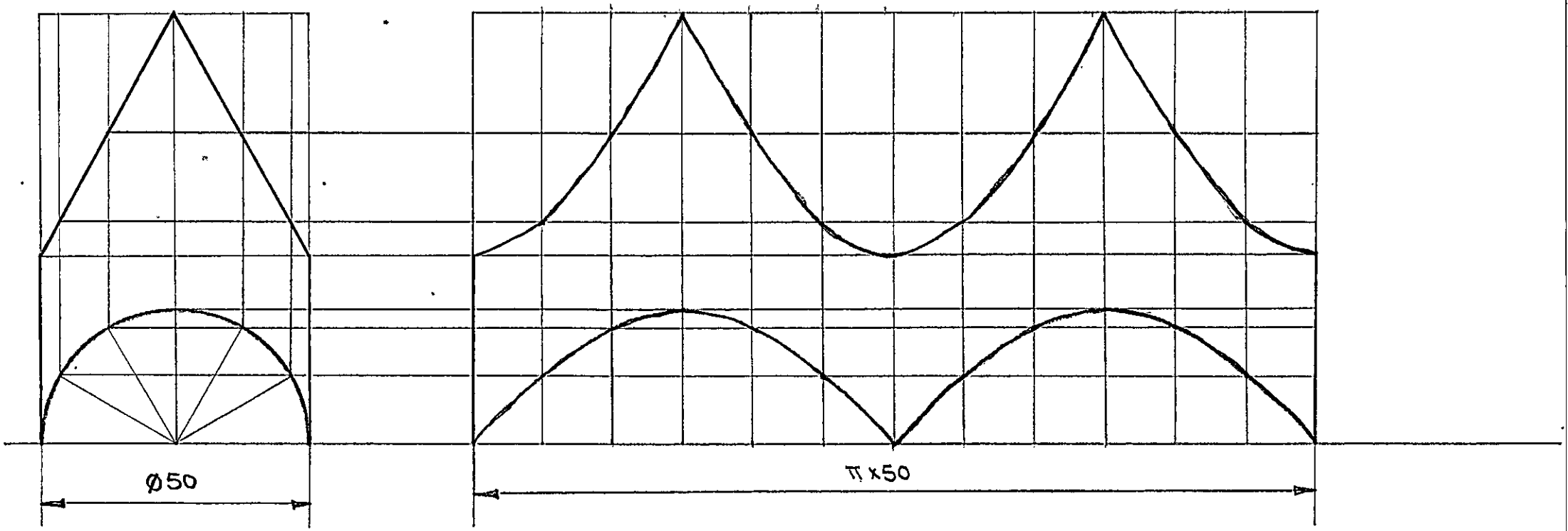
6

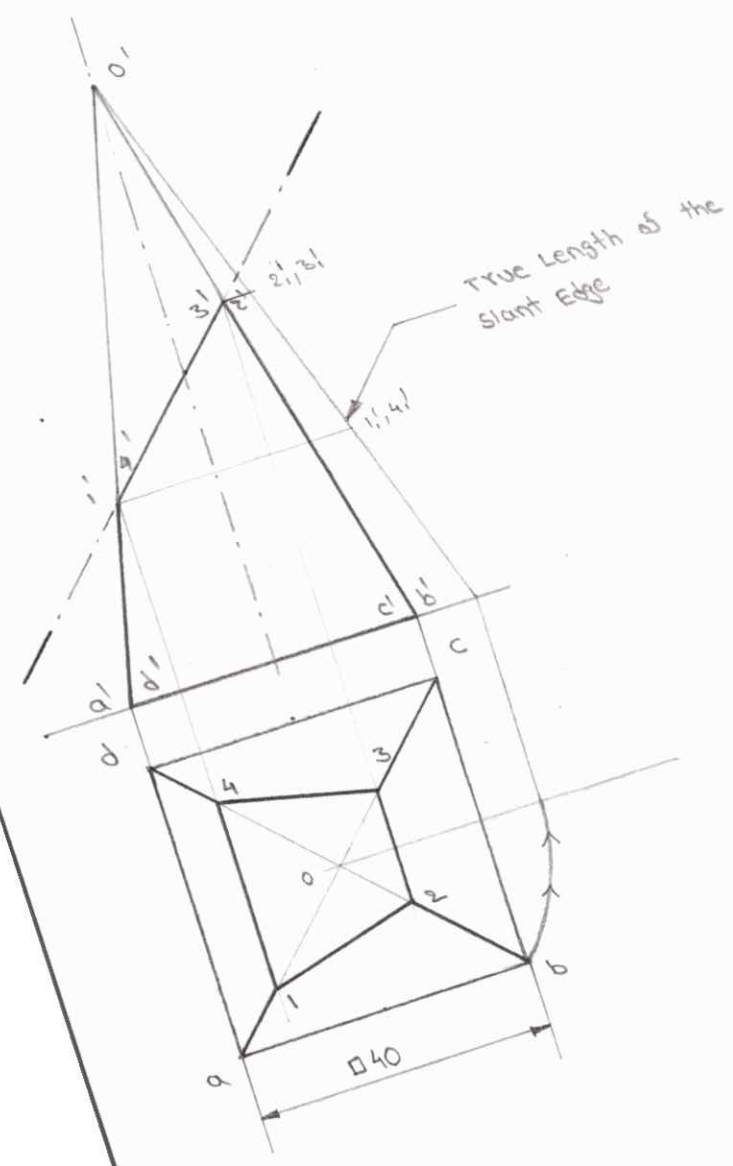
6

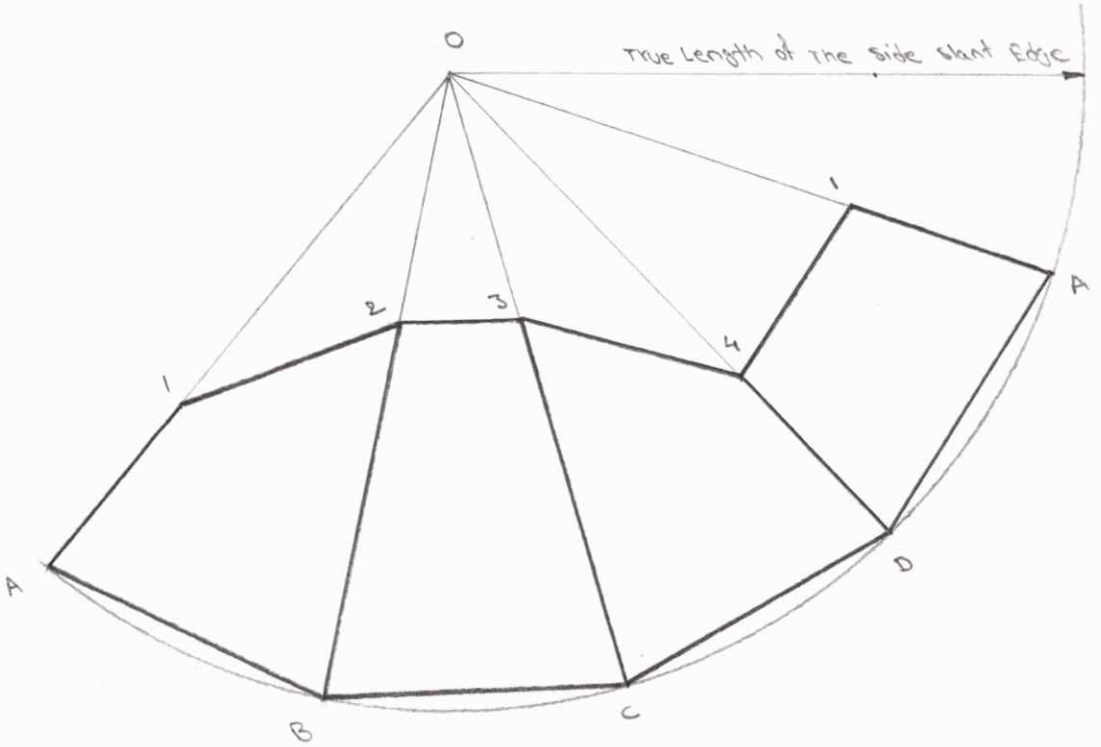


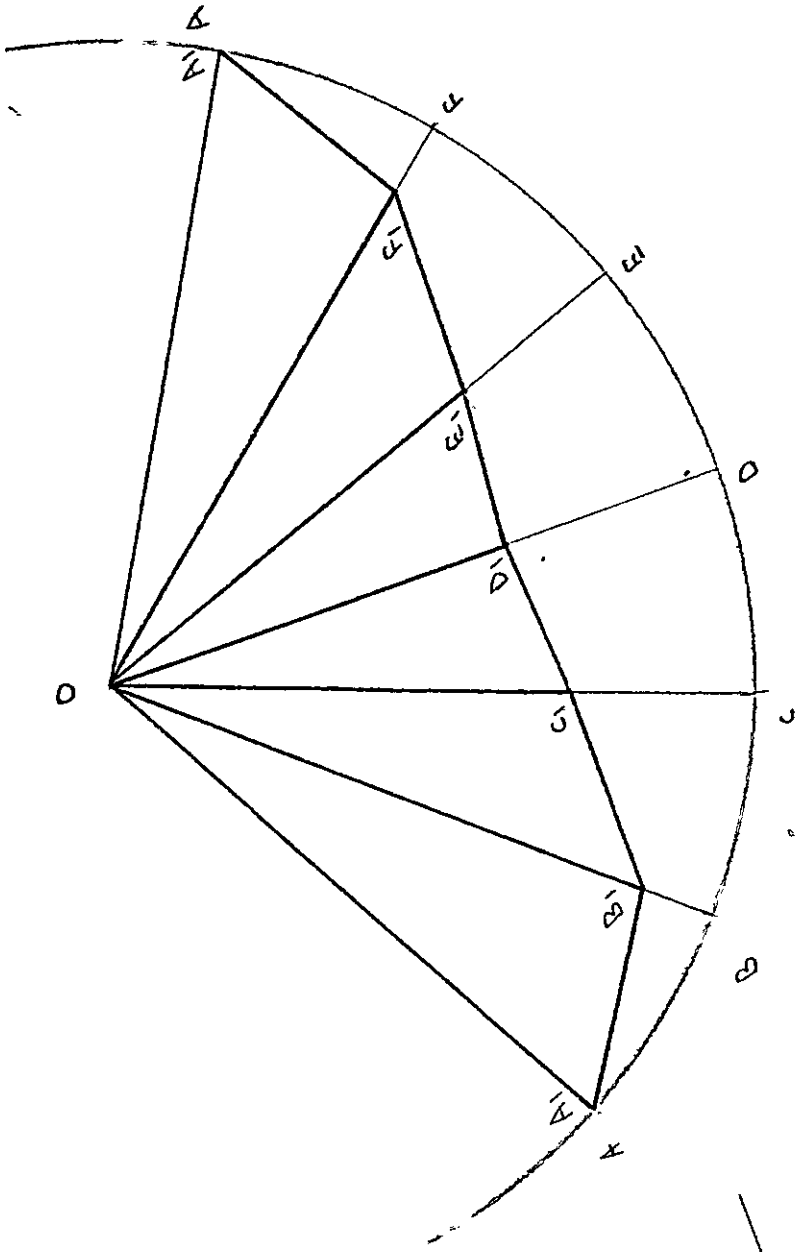


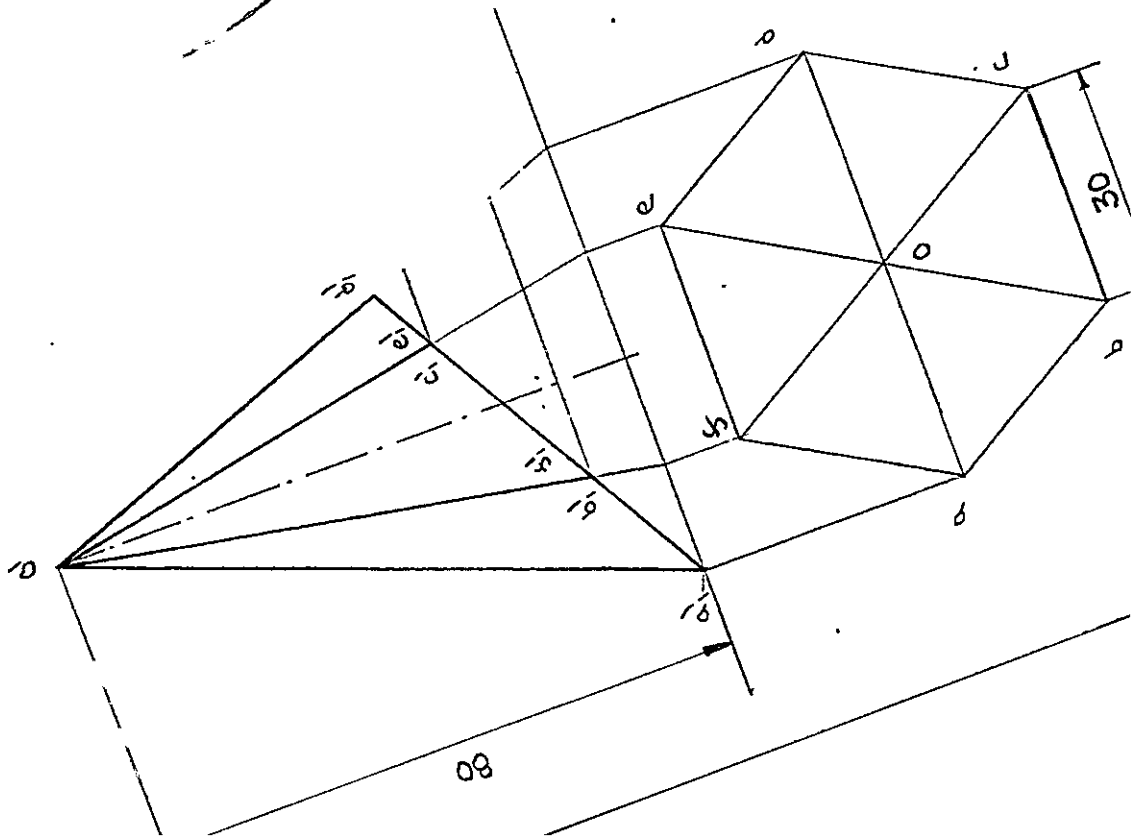
⑦

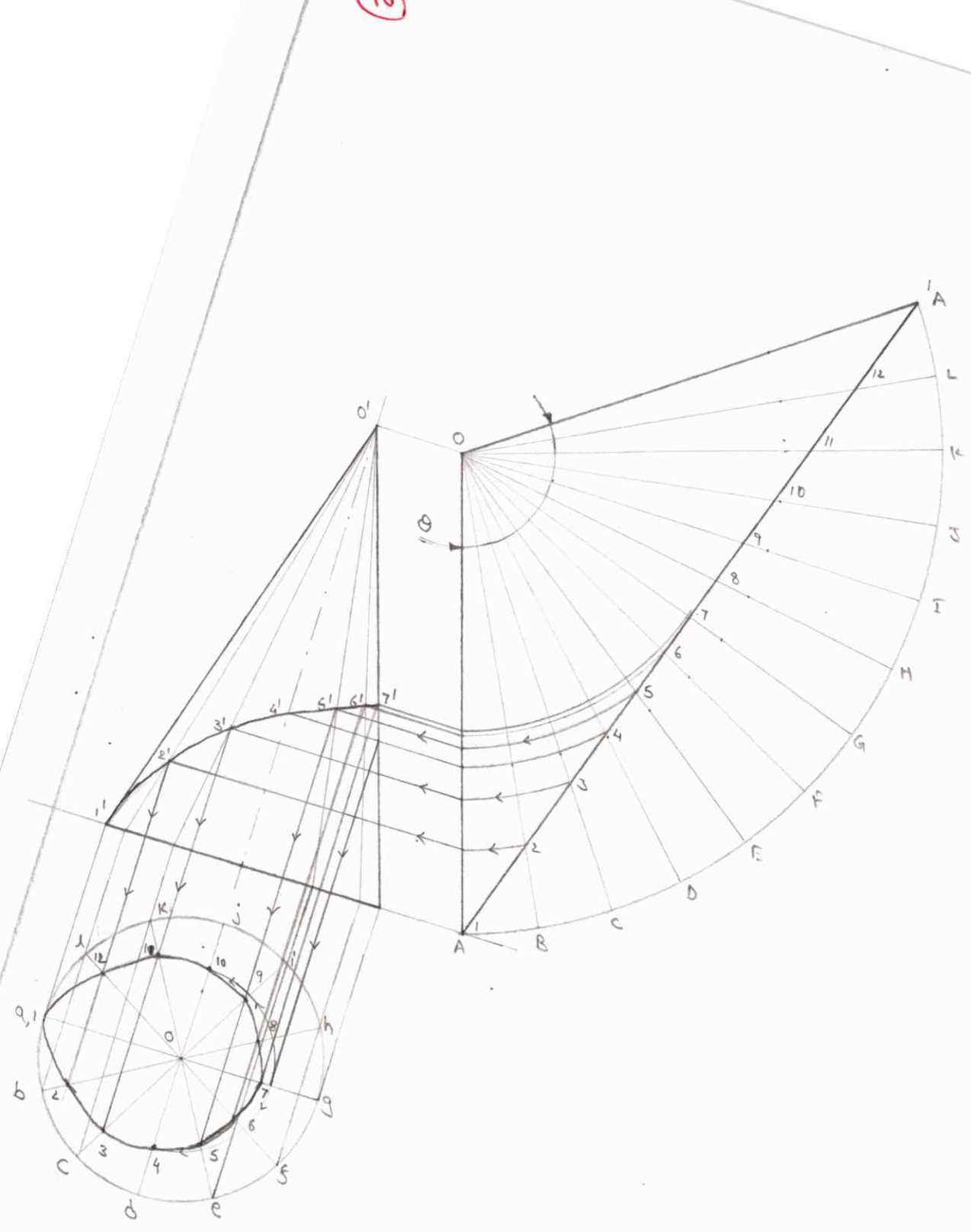



o'
1',4'
2',3'
3'
2'
1'
4'
True Length of the
slant Edge
a'
d'
d
c
b'
b
a
4
3
o
2
1
□40


o
True Length of the Side slant Edge
1
2
3
4
A
A
B
C
D




30
80


O'
O
θ
A
B
C
D
E
F
G
H
I
J
K
L
1'
2'
3'
4'
5'
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7'
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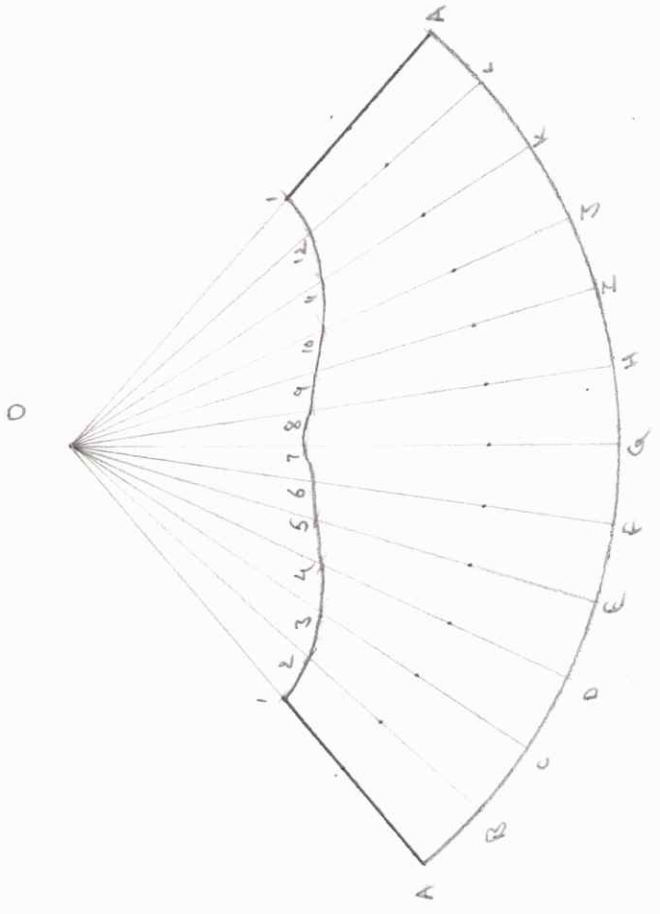
O


A
B
C
D
E
F
G
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I
J
K
L
M
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1
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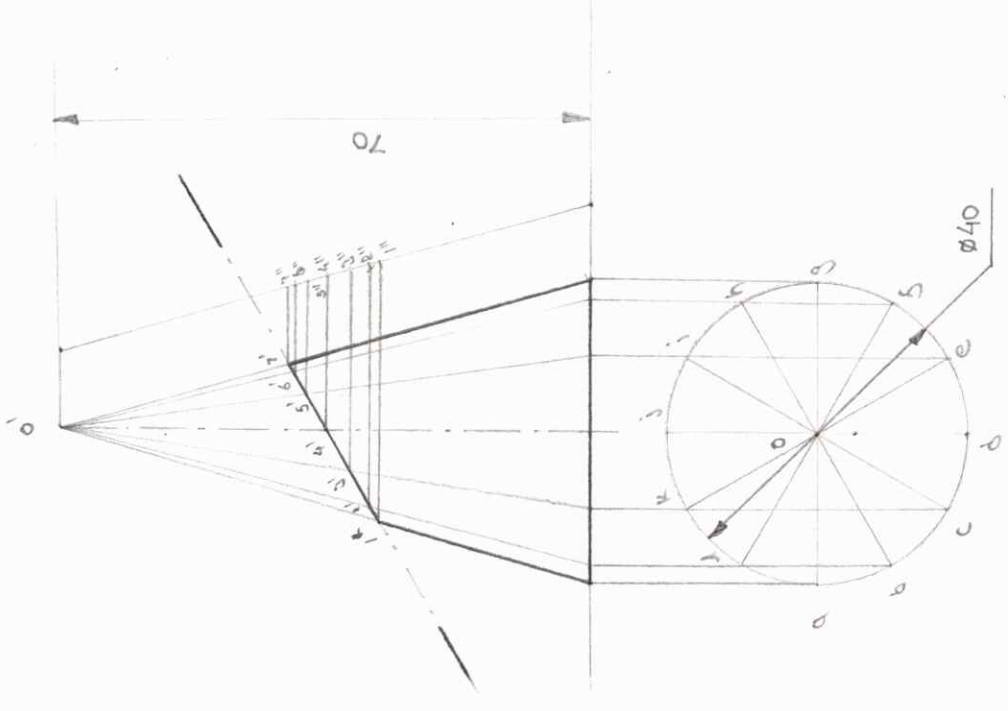
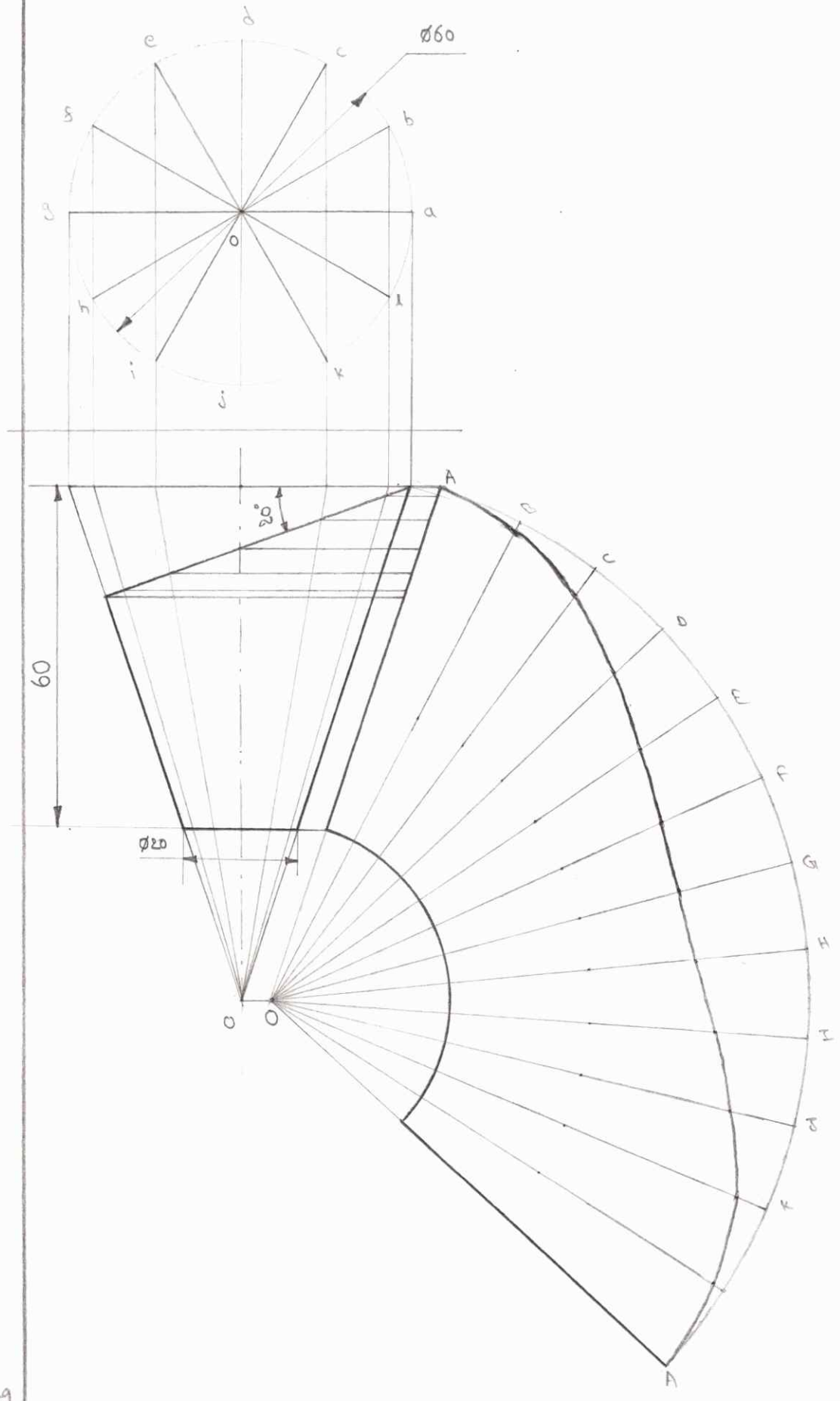
3
4
5
6
7
8
9
10
11
12


70
Ø40
O
O'

12



DS-9

METHODS OF PERSPECTIVE PROJECTION :-

To draw Perspective Projection, we need the TV and FV (or SV) of the object. As the PP lies b/w the observer and the object, it is customary to use the third-angle method of projection.

→ The second thing that we should know is the orientation and location of the object with respect to the PP.

→ The location of S with respect to the PP and the GL is the third important requirement

As a standard Practice, for big immovable objects like buildings, S is located at the normal eye level of human beings. For small objects, S is located at such a height that all the three dimensions of the object are appropriately visible. The distance of S from the PP is usually taken twice of the greatest dimension of the object.

There are two common methods of drawing perspective views of an object.

1. Visual ray method
2. Vanishing Point method.

1. Visual ray method :-

The visual ray method is a general method applicable to an object having any kind of orientation. Usually two views i.e TV and FV (or SV) of the object are given. Visual rays are then obtained by joining each point in TV with S and each point in FV (or SV) with S' (S"). The points at which these rays intersect the PP (i.e., piercing points) are projected vertically and horizontally to meet each other. The required points are located at the corresponding intersections.

2. Vanishing Point method:-

It is an imaginary point infinite distance away from the station point. The point at which the visual ray from the eye to that infinitely distant vanishing point pierces the picture plane is termed as the 'vanishing point'.

Depending on the object's orientation with respect to the PP, one (or) two (or) three the VPs may exist. All the corners of the object are joined with 'S' by drawing visual rays. The points at which the visual rays cut the PP. i.e., the piercing points, are then located. The piercing points when joined in a sequence give the perspective view of the object.

→ Single Point (or) Parallel Perspective

The object is placed such that one of its Principal faces is parallel to the PP. The face shows the true shape. If the face is on the PP, it will show the true size. It is seen reduced (or) enlarged if it lies behind (or) in front of the PP. The edges perpendicular to this face will be seen converging to a VP on HL.

→ Two Point (or) Angular Perspective

The object is so placed that one of its three mutually perpendicular edges is parallel to the PP. The two faces sharing that edges are inclined to the PP. The edges perpendicular to the edge parallel to the PP will converge to two VPs on HL on either sides of the observer.

Angular perspectives are more realistic than Parallel perspectives.

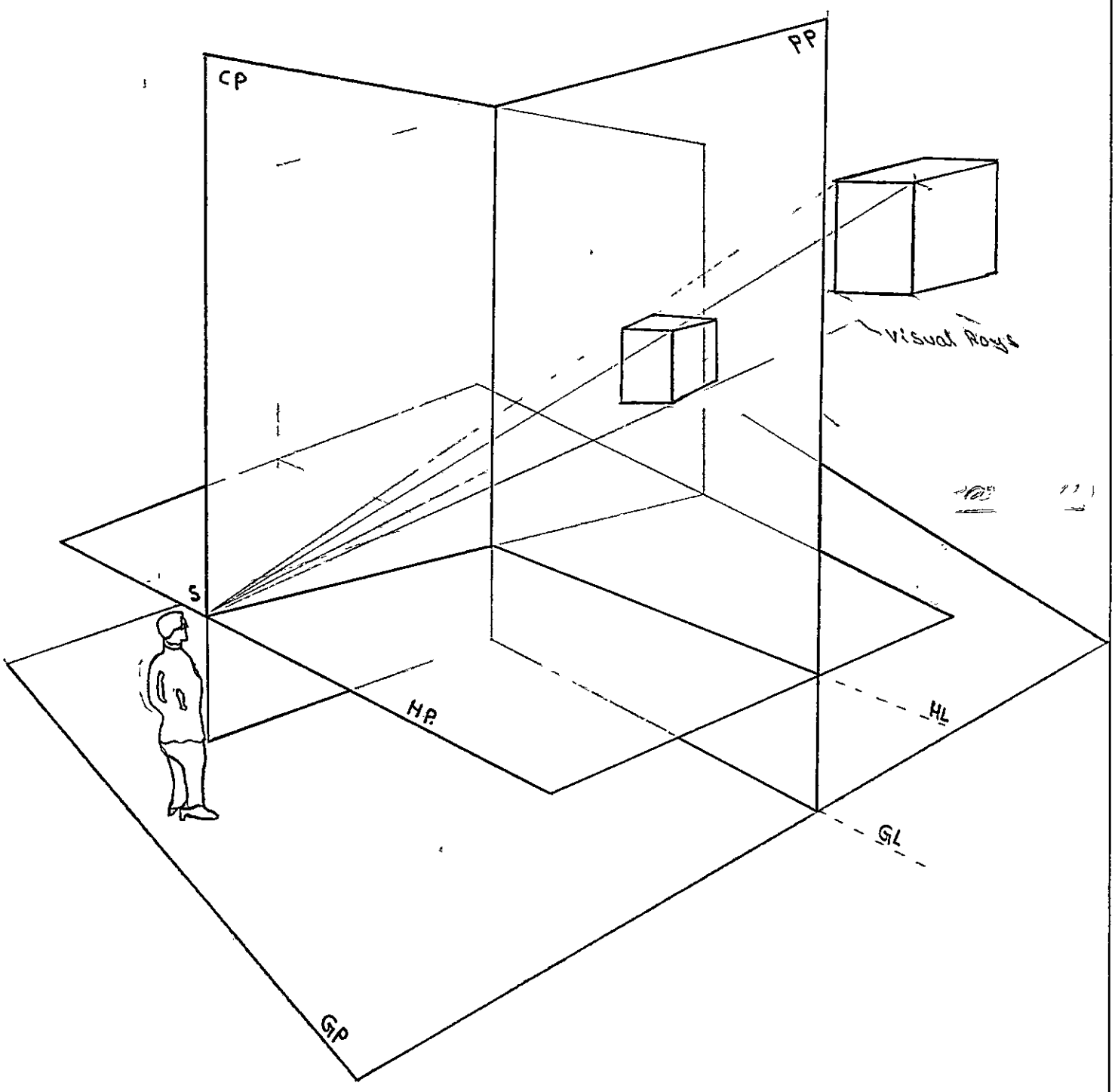
Perspective Projection

An object appears differently each time when viewed from different directions. Such a view of an object which changes with respect to the observer's location is called "Perspective Projection". The Perspective views are much similar to images seen by human eyes (or) photographed by a camera.

→ Perspective views are not used in manufacturing drawings

Applications:-

1. Architectural and civil engineering drawings to show the appearance of proposed buildings, roads, railroad tracks and interior designs.


CP
PP
visual Rays
S
HP
HL
GL
GP

Terminology in Perspective Projection

Station Point (S)- It is a point at which the eyes of the observer are located. S and S' indicate TV and FV of S respectively.

Picture Plane (PP)- It is a vertical transparent plane on which the perspective view of the object is projected. It is placed in b/w the object and observer.

Horizontal Plane (HP)- It is an imaginary horizontal plane at the level of the observer's eye on S. It is above and parallel to the GP and perpendicular to the PP.

Ground Plane (GP)- It is the real ground or an imaginary plane parallel to the ground on which the object is assumed to be resting.

Central Plane (CP)- It is vertical plane passing through S and perpendicular to the PP.

Vanishing Points (V)- These are the points at which the edges of the object are seen to be converging.

Ground Line (GL)- It is the line of intersection of the GP with the PP

Horizon Line (HL)- It is the line of intersection of H.P with PP. ∥el to GL

Auxiliary Ground Plane (AGP)- It is a horizontal plane parallel to GP. The view of the object and of the perspective elements is projected on this plane.

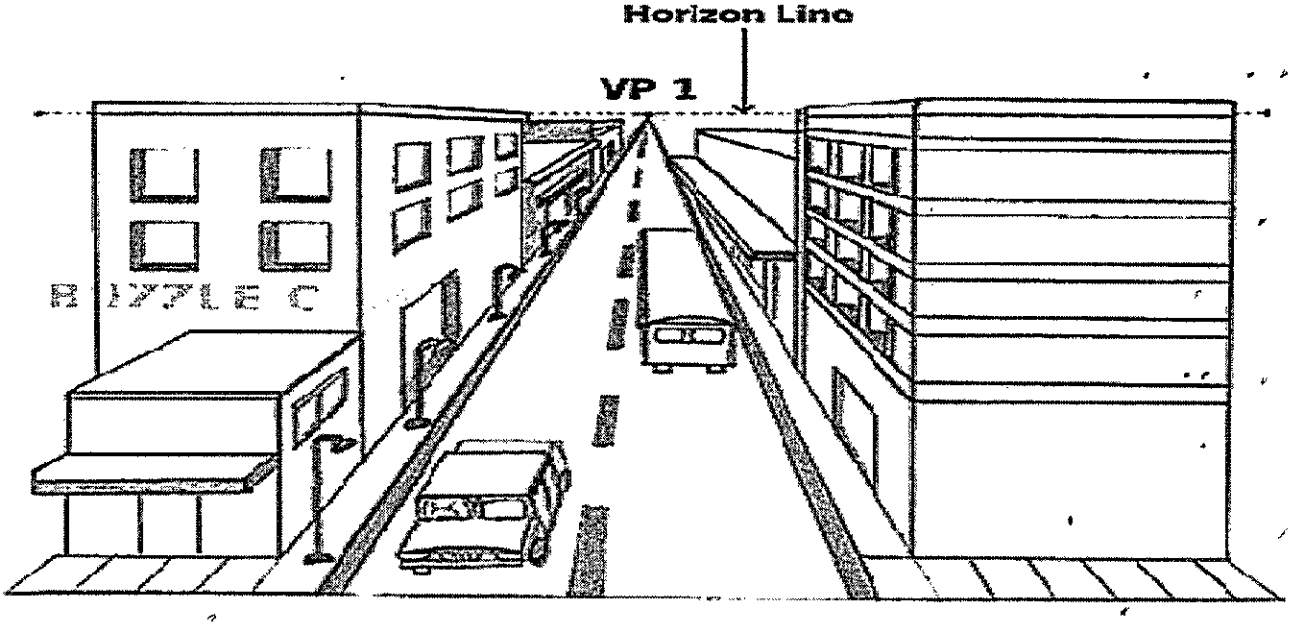
Visual rays- These are the rays of sight emerging from S and ending at the object's corners. The intersections of the visual rays with the PP are called the "piercing points."

TYPES OF PERSPECTIVE PROJECTIONS:-

Linear perspective drawing is the art of depicting a three-dimensional (3D) image onto a two-dimensional (2D) flat surface. In simpler terms, it means, creating the illusion of depth on a flat 2D sketch. In perspective, all the contents in the sketch seem to gradually decrease in size as they recede, and all the parallel lines coming out from the objects in the sketch appear to meet at one particular point

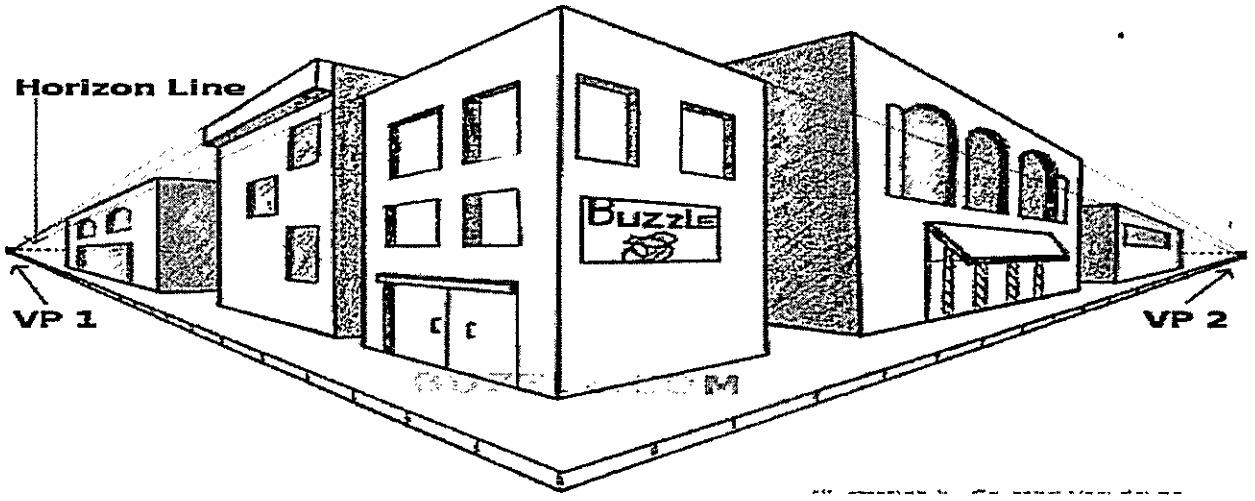
1. One-point perspective or Parallel perspective
2. Two-point perspective or Angular perspective
3. Three-point perspective or Oblique perspective
4. Four-point perspective
5. Five-point perspective
6. Six-point perspective
7. Zero-point perspective
8. Infinite-point perspective
9. Aerial perspective or Atmospheric perspective

1. One-point perspective or Parallel perspective:-



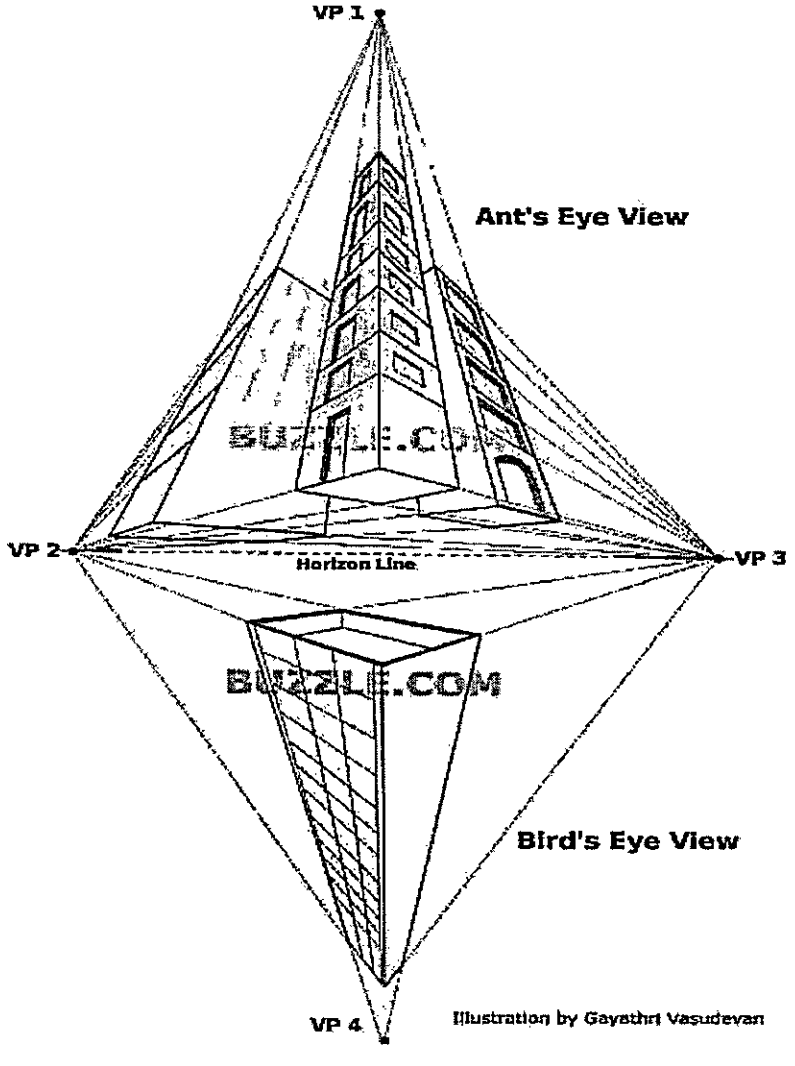
Object made up of lines, either parallel or perpendicular with the view's line of sight, can be represented with one-point perspective. All elements which are parallel to the plane of projection are drawn as parallel lines, whereas those which are perpendicular to the plane of projection converge at a single point. Such a point, where the lines of sight converge, is commonly known as a vanishing point and the plane of projection is known as picture plane. One point perspective is also called parallel perspective because one face if the object is parallel to the plane of projection. It is generally used for roads, railroad tracks or such buildings which are viewed directly from the front.

2. Two-point perspective or Angular perspective:-



Two-point perspective as shown in Figure is used when the object is positioned with all horizontal edges at an angle with the plane of projection and with all vertical edges parallel to it. When a house is viewed from the corner, one wall would converge at one point, the other wall would converge at another point opposite to it. Two-point perspective is also called angular perspective because the object is positioned at an angle with the plane of projection. It is generally used for building viewed from vertical edge though a corner.

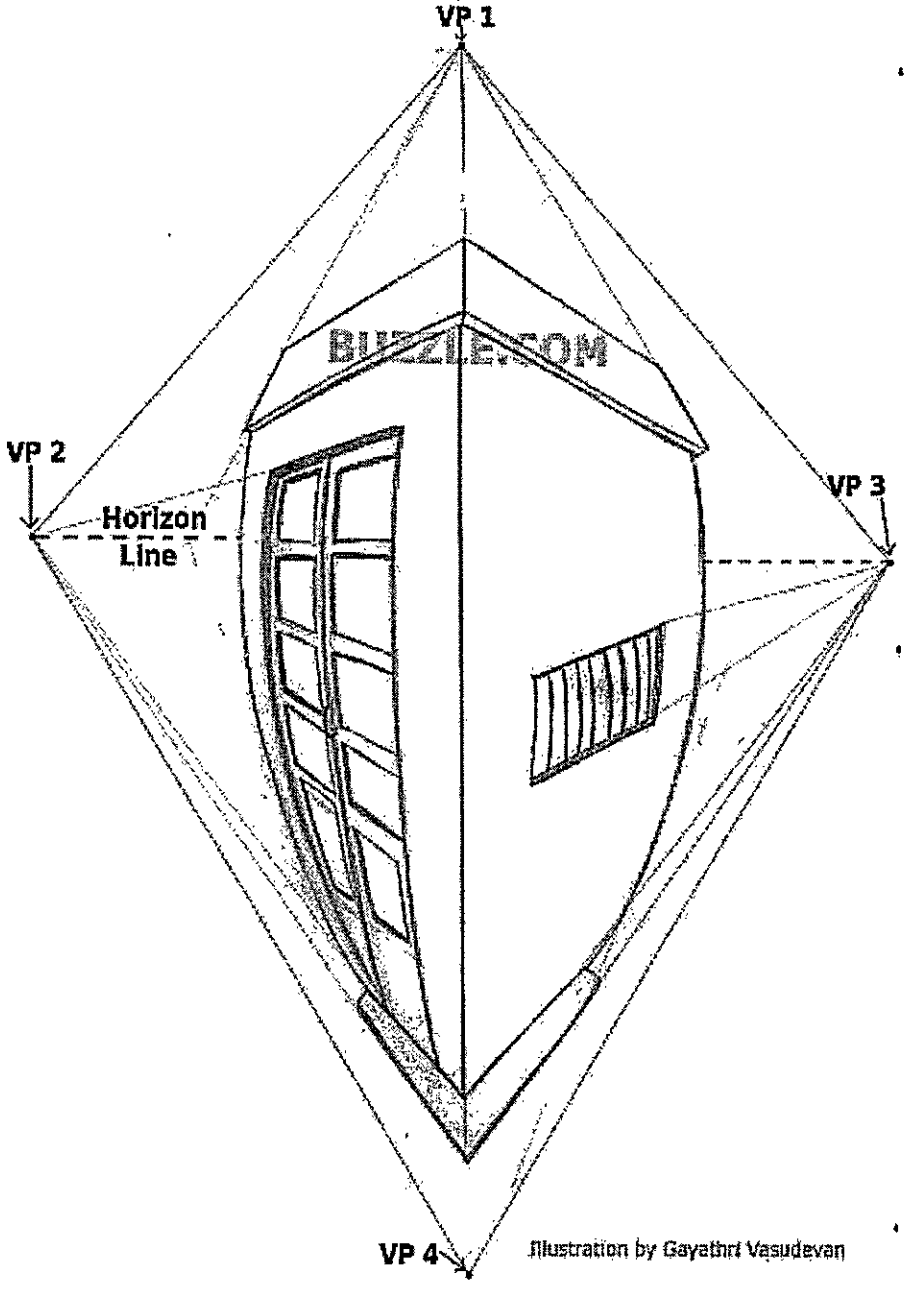
3. Three-point perspective or Oblique perspective:-



P.P-4

A three-point perspective drawing is usually an exaggerated form of illustration, and is usually drawn with the spectator either below the horizon (ant's-eye view) or above the horizon (bird's-eye view). This perspective drawing has three vanishing points, two on the horizon line and one either above or below the horizon. In the above example, we see that the right and left parallel lines of the buildings are extended and projected to the right, and the left vanishing points on the horizon line and the vertical parallel lines are projected to the third VP in the sky or the ground. If you are looking at the building from an ant's-eye view, the topmost point is known as the zenith (highest point), and when you look at the building from a bird's-eye view, the lowermost point, is known as the nadir (lowest point). A 3-point perspective is used mainly for skyscrapers, and it is slightly difficult to understand as compared to the previous two types of perspectives. This is because of the third VP that is added here, and it rules out all the parallel lines.

4. Four-point perspective:-



This is a curvilinear version of a two-point perspective, and can give a panoramic or a 360° view, as the number of vanishing points surpass the least needed amount. In simpler terms, the vertical lines emerging from a two-point perspective sketch which meet at the vanishing points would now get curved at the VPs. This type of projection can be viewed both vertically as well as horizontally, and when viewed vertically, it describes a bird's-eye view, and at the same time an ant's eye-view too. In this projection, four vanishing points are equally spaced, two on the horizon line, and one above and below, to define four vertically-drawn lines in a 90° angle related to the horizon line

5. Five-point perspective:-

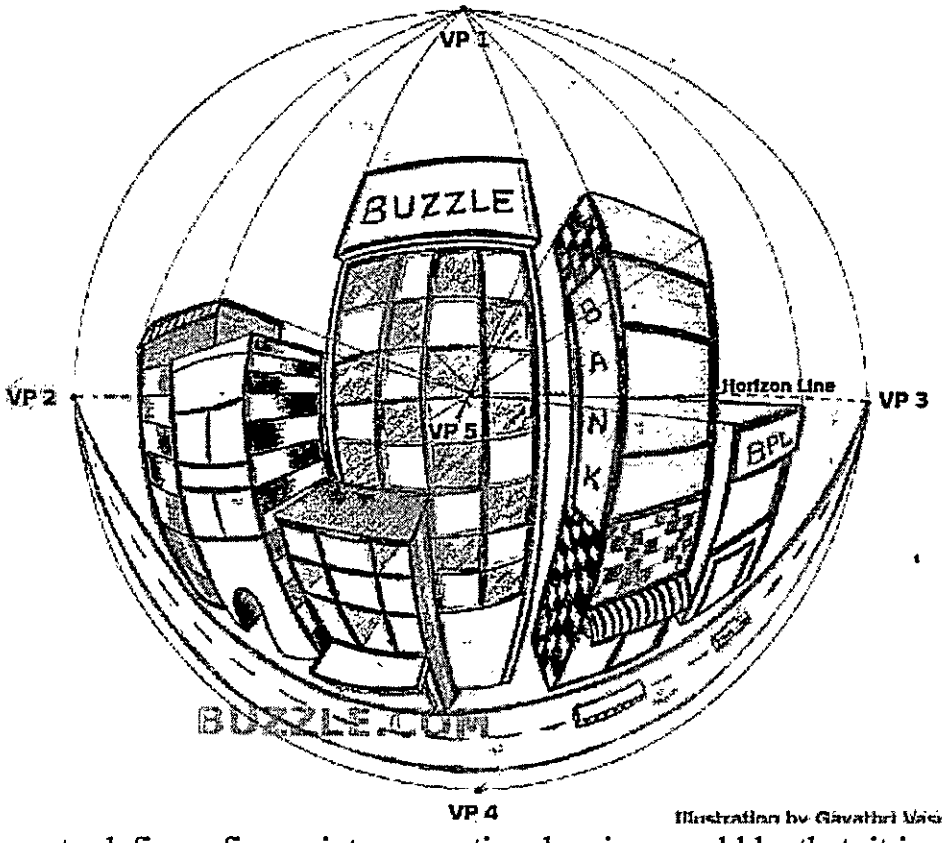
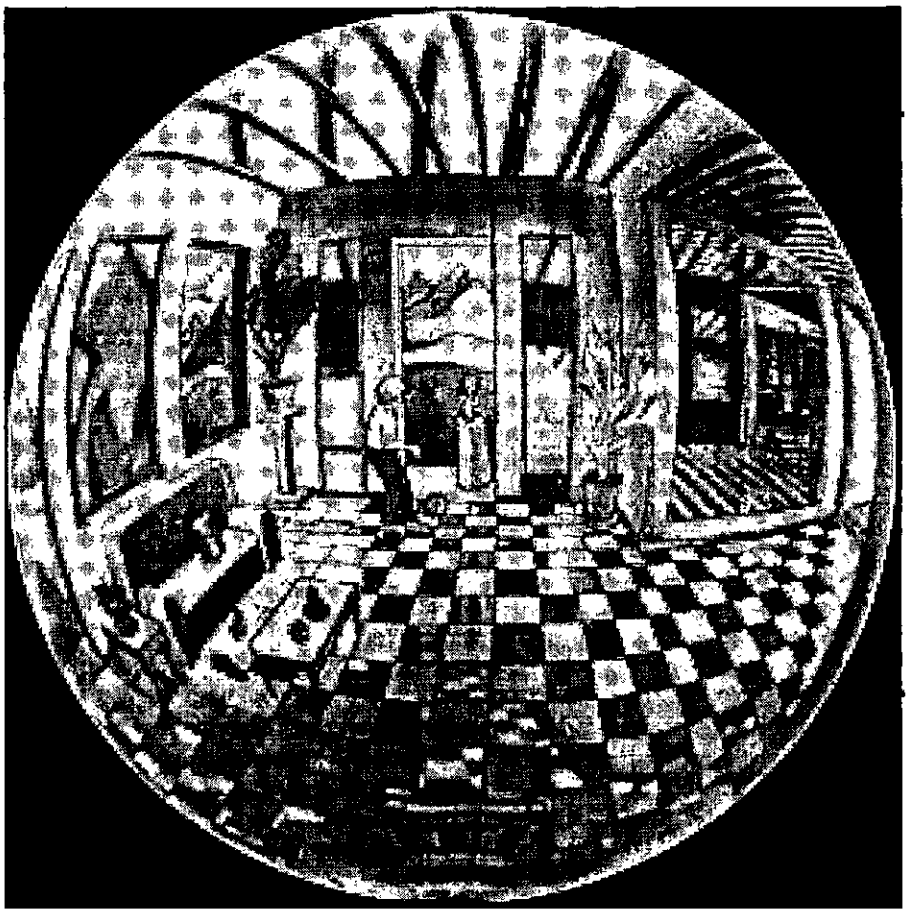


Illustration by Gayathri Vaid

An easy way to define a five-point perspective drawing would be that, it is a collection of 5 one-point perspective drawings, the difference being, it has curved lines instead of horizontal or vertical ones. The entire visual field is put together into the shape of a circle, and the lines are distorted, giving a wide-angled or a fish-eye lens effect to the image. For example, imagine yourself at the center of a globe, a five-point view allows you to see the entire half of the globe that is in front of you. The two differences between a 5- and 4-point perspective drawing are, a five-point drawing has curved, vertical and horizontal lines, and it has a fifth point at the center (central vanishing point), both of which are not depicted in a four-point sketch.

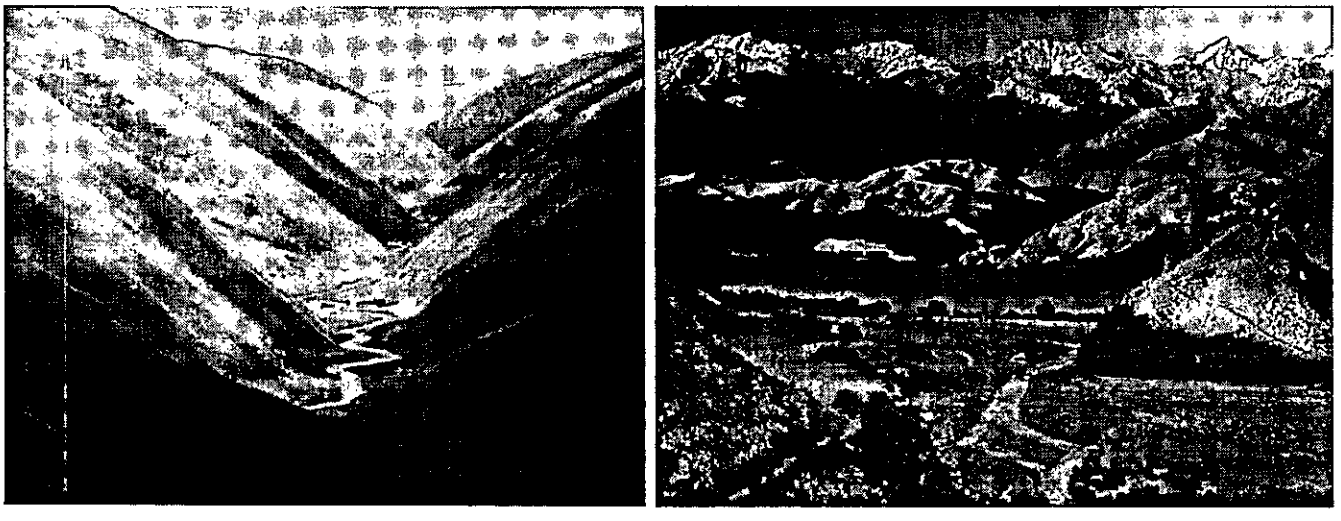
PP-5

6. Six-point perspective



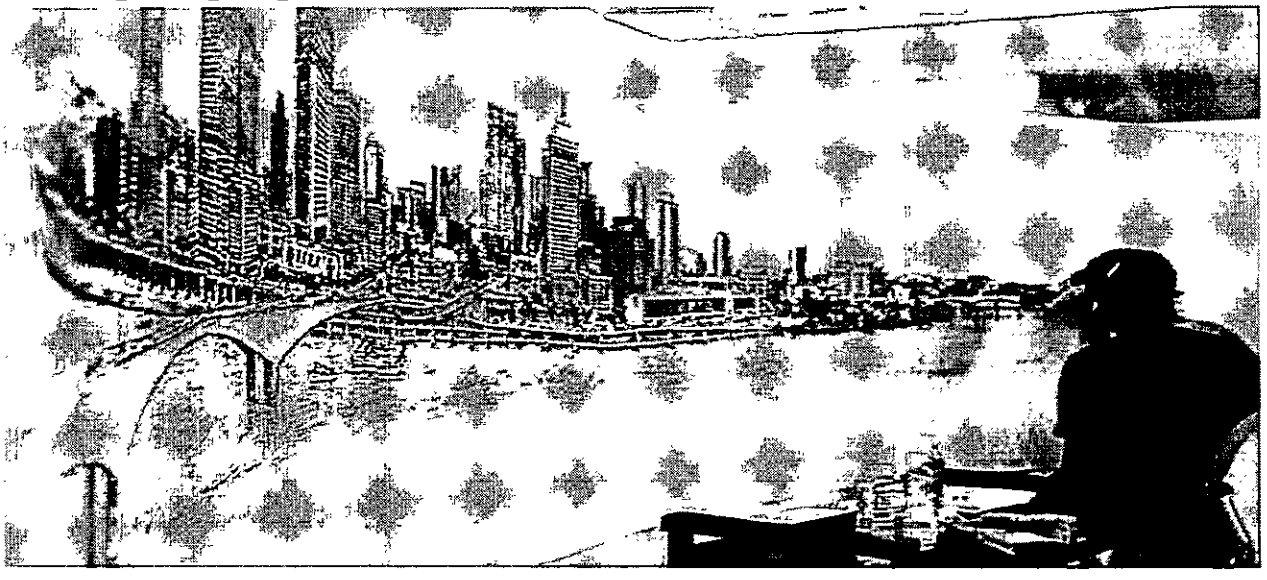
We already know that a 5-point drawing lets us view everything in front, in a 180° perspective. But the one thing that is missing here is the view that is exactly behind us. This is the sixth vanishing point, which is located exactly opposite the fifth vanishing point (behind the viewer), and it gives a 360° view, but a six-point perspective requires two separate illustrations. It is not as difficult as it might sound, as this kind of perspective is actually 2 five-point perspective drawings put together. One sphere covers what is in front and the other covers what is at the back of the viewer.

7. Zero-point perspective



Although not heard of much, this kind of perspective is actually more common than the previous ones. It does not have any parallel lines fading at the vanishing points, hence, the name zero-point perspective. This type of perspective is used in a nonlinear scene, where there are no parallel lines meeting at a distant point; for example, in landscape drawings like valleys, mountain ranges, etc. However, a perspective projection without any vanishing points would still be able to produce an illusion of depth. For instance, when you look at a drawing or a picture of a mountain range, the mountains which are at a distance will appear smaller than the ones that are actually closer to you.

8. Infinite-point perspective

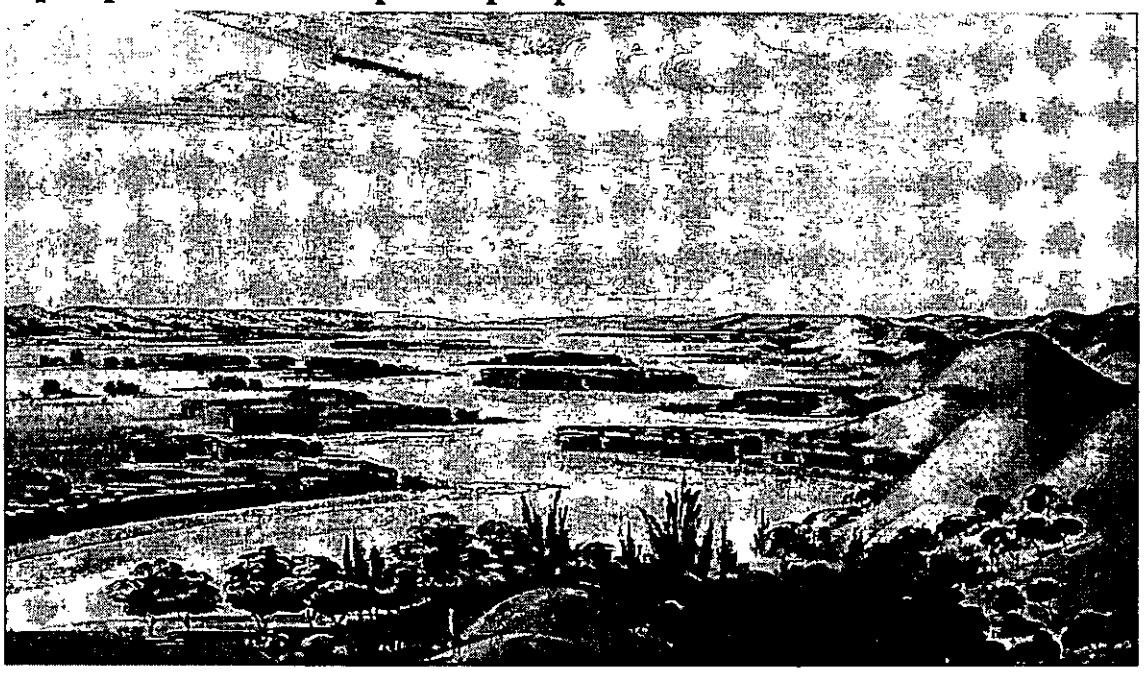


Four-point perspective, also called infinite-point perspective, is the curvilinear variant of two-point perspective. As the result when made into an infinite point version (i.e. when the amount of vanishing points exceeds the minimum amount required), a four point perspective image becomes a panorama that can go to a 360 degree view and beyond – when going beyond the 360 degree view the artist might depict an "impossible" room as the artist might depict something new when it's supposed to show part of what already exists within those 360 degrees. This elongated frame can be used both horizontally and vertically and when used vertically can be described as an image that depicts both a worm's- and bird's-eye view of a scene at the same time.

Like all other foreshortened variants of perspective (respectively one- to six-point perspective), it starts off with a horizon line, followed by four equally spaced vanishing points to delineate four vertical lines.

The vanishing points made to create the curvilinear orthogonal are thus made ad hoc on the four vertical lines placed on the opposite side of the horizon line. The only dimension not foreshortened in this type of perspective is the rectilinear and parallel lines perpendicular to the horizon line – similar to the vertical lines used in two-point perspective.

10.Aerial perspective or Atmospheric perspective



It is the technique used in painting to create the illusion of depth or recession by depicting distant objects as paler, less detailed and bluer than near objects. As the distance between an object and a viewer increases, the contrast between the object and its background decreases. The contrast of any markings or details on the object also decreases. The colors of the object become less saturated and shift towards blue. It is important to emphasize that this does not blur the outlines of the markings of objects.

(1)

a) A rectangular block 30×50×20 (ht) is resting with its larger surface on the ground, with a longer vertical face inclined at 30° to Picture Plane, and a vertical edge in Picture Plane. The station point is situated at 10mm to the right of the vertical edge in the Picture Plane, 70 mm infront of Picture Plane and 100mm above the ground, Draw its Perspective view

b) A block 30×50×40(ht) is placed behind the block as in Problem 1(a) and another block 30×50×60 (ht) behind the second block. Draw the Perspective view of the stepped block.

(2) A hexagonal plane of 30 mm side has its plane 1er to Ground, an edge in the Picture Plane, a corner on the ground and the hexagonal plane is inclined at 30 to Picture Plane. The station point is 10mm to the right of the edge in Picture Plane, 90 mm in front of Picture Plane and 100 mm above ground.

(3) The hexagonal plane in Problem (2) is parallel to and 10mm behind Picture Plane. Draw its Perspective projection.

(4) Draw the Perspective view of a circle 50ϕ, lying on the ground plane and touching the Picture Plane. The station point is 80 mm above ground and the central plane passes through the centre of the ⊙le.

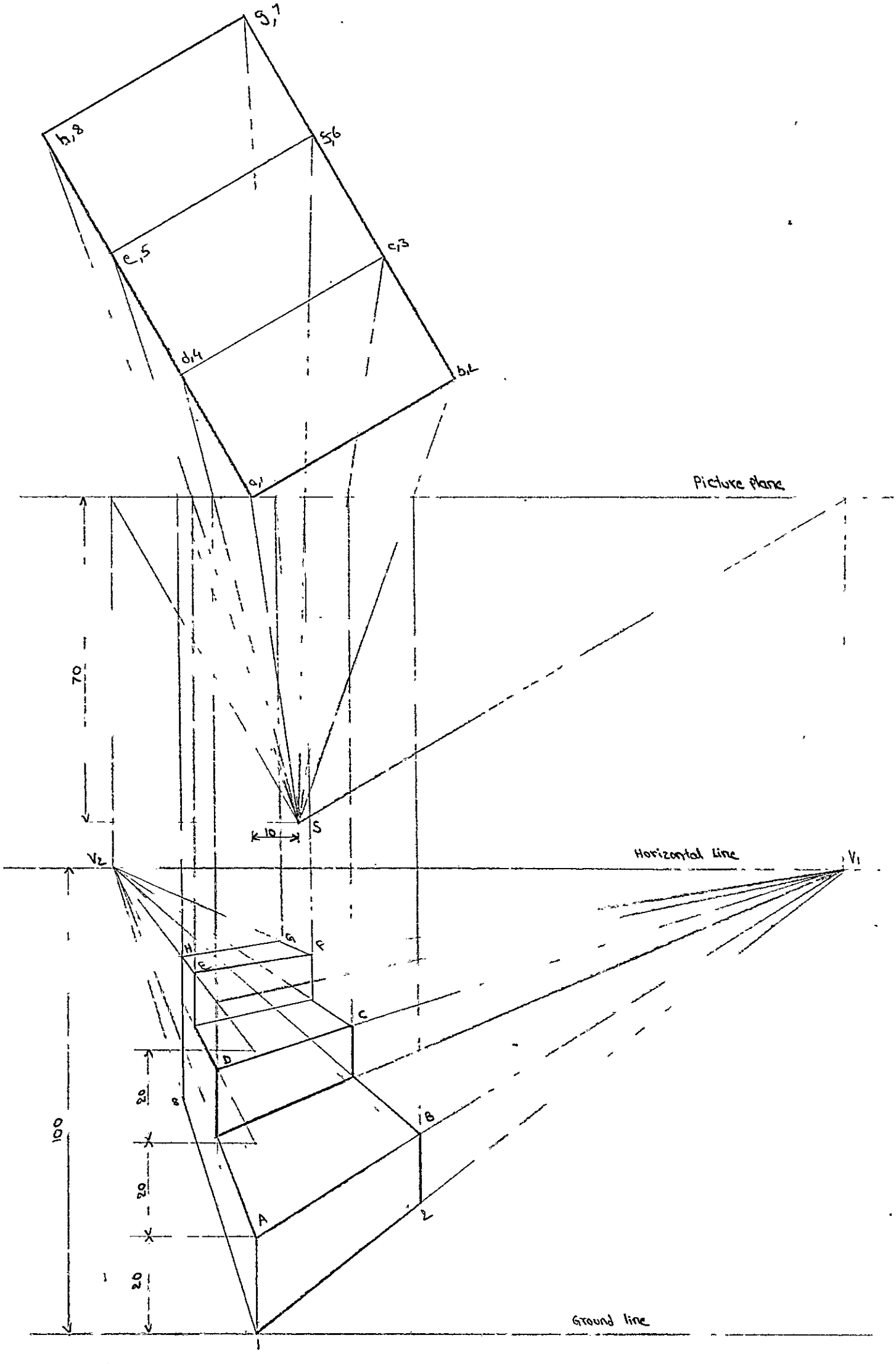
(5) Draw the perspective view of a ⊙le of 50ϕ, having its surface vertical but inclined at 45° to Picture Plane. The centre of the circle is 40mm above ground and 35 mm behind Picture Plane. The central plane passes through the right extreme point on the ⊙le but 40mm infront of Picture Plane and 80 mm above ground.

(6) A square pyramid 40 mm side 70mm ht rests on its base in the ground, with the base sides equally inclined to Picture Plane. on corner of the base is 20 mm to the left of station point and in Picture Plane. The station point is 50mm from Picture Plane and 90 mm above ground. Draw the Perspective view.

P.T.O

(7) Draw the perspective view of a hexagonal ~~Pr~~ Prism, 30mm side of base and 50mm long axis lying on the ground plane on one of its rectangular faces, the axis being inclined at 30° to the Picture Plane and a corner of the hexagon touching the Picture Plane. The ~~station~~ Point is 40mm in front of the Picture Plane, (extreem Right corner) ~~the station point is~~ 10 above the ground. ~~and the central plane bisects the axis of the~~

(8) A frustum of square pyramid base 40mm and top 20mm side with the height of the frustum 55 mm is resting on the ground & its 40 mm side base. All the 4 sides of the base are equally inclined to the Picture Plane and the station Point is located on the central plane passing through the centre of the base 70 mm infront of the Picture Plane, 80 mm above the ground. Draw the perspective view.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g,6
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d,4
b,2
a,1
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70
10
S
V2
Horizontal line
V1
H
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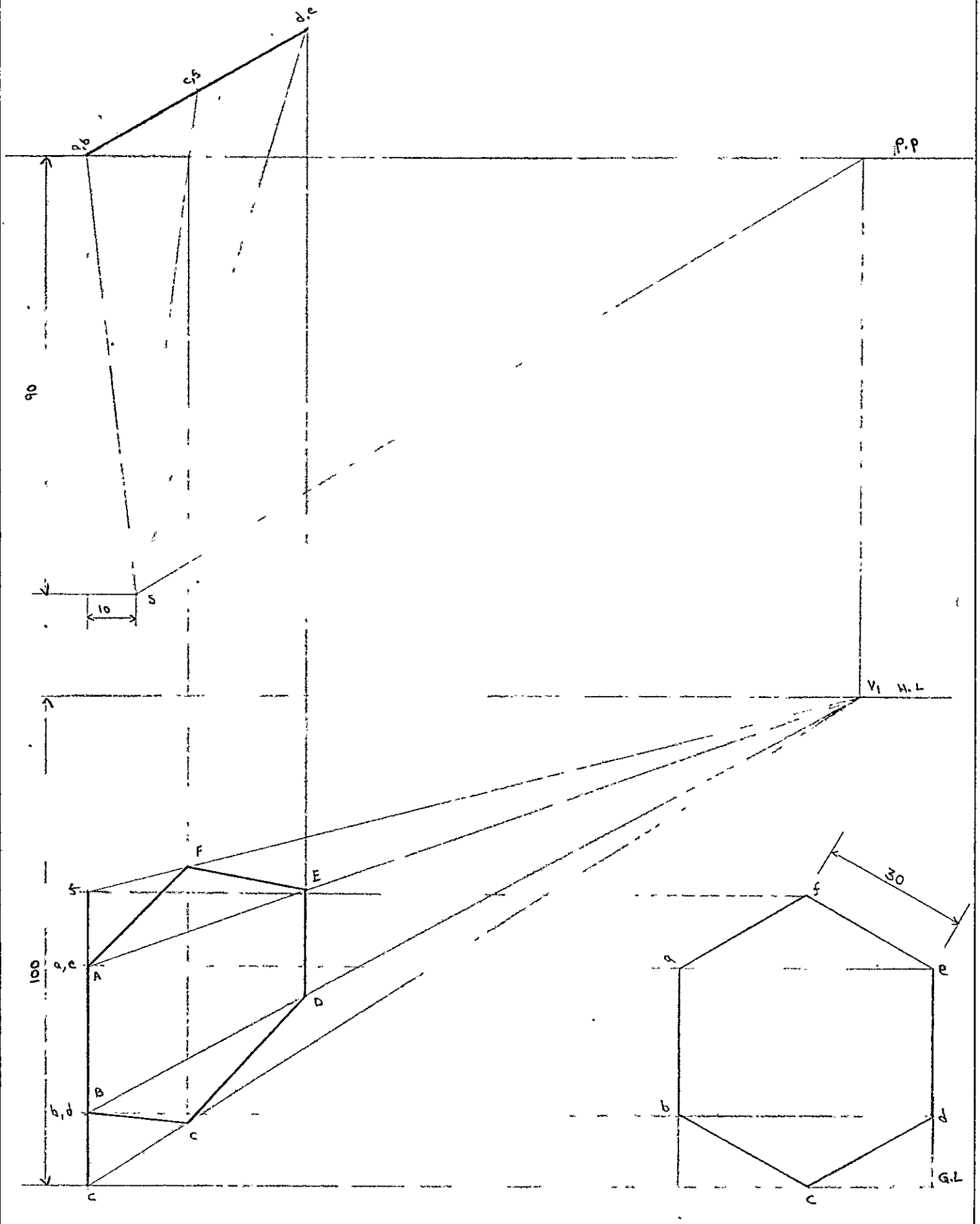
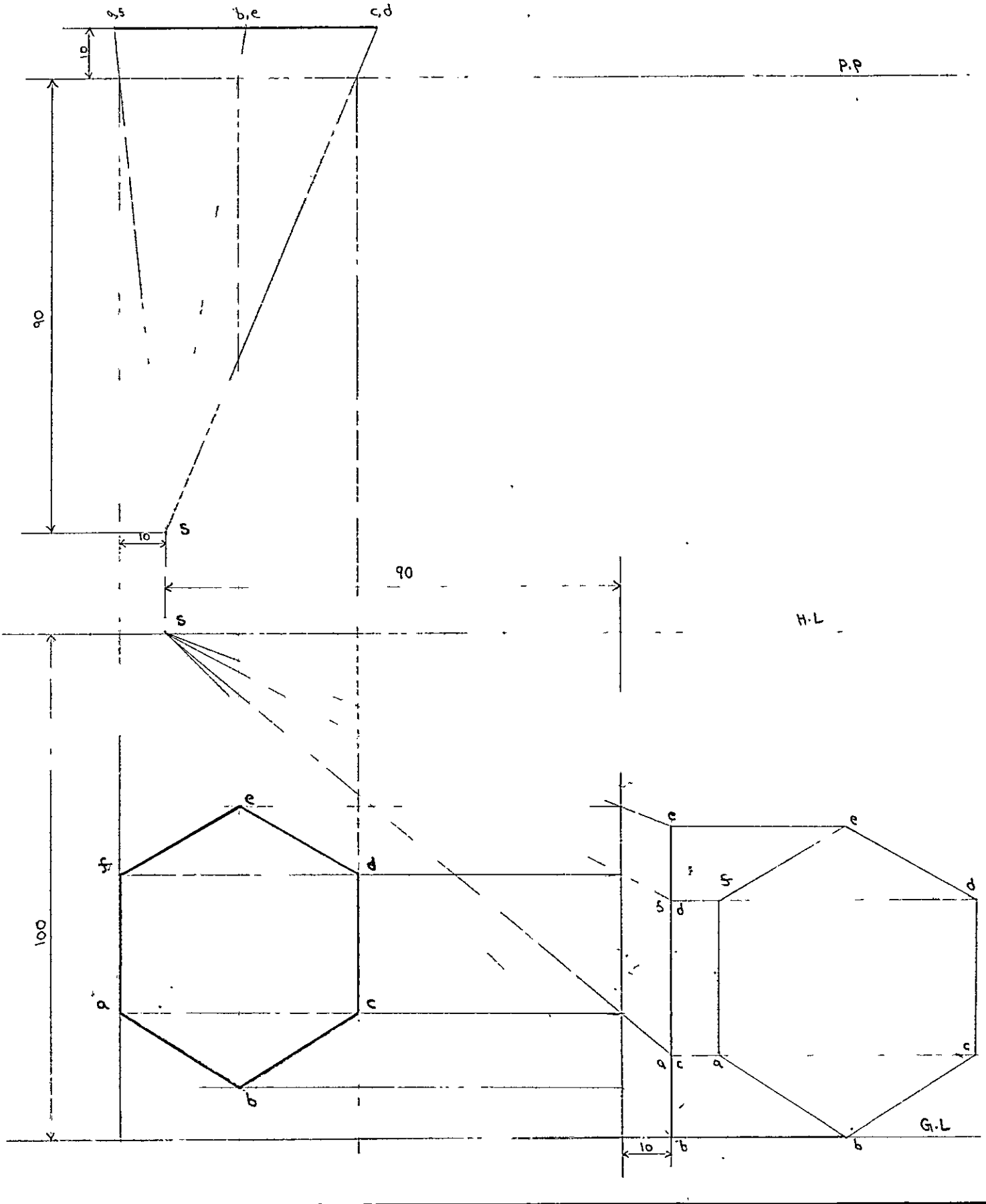
20
8
20
20
100
B
A
2
1
Ground line

(2)

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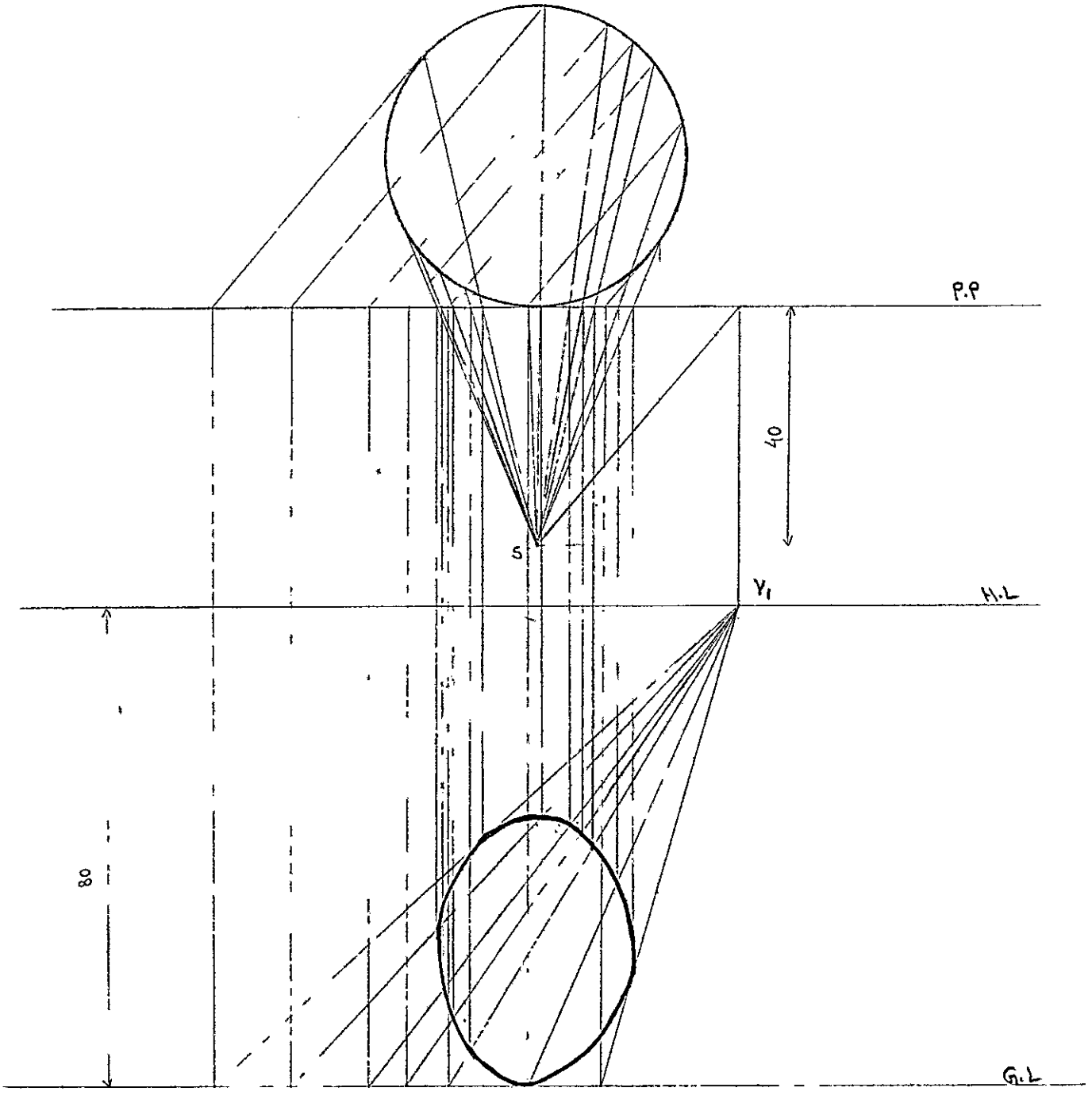
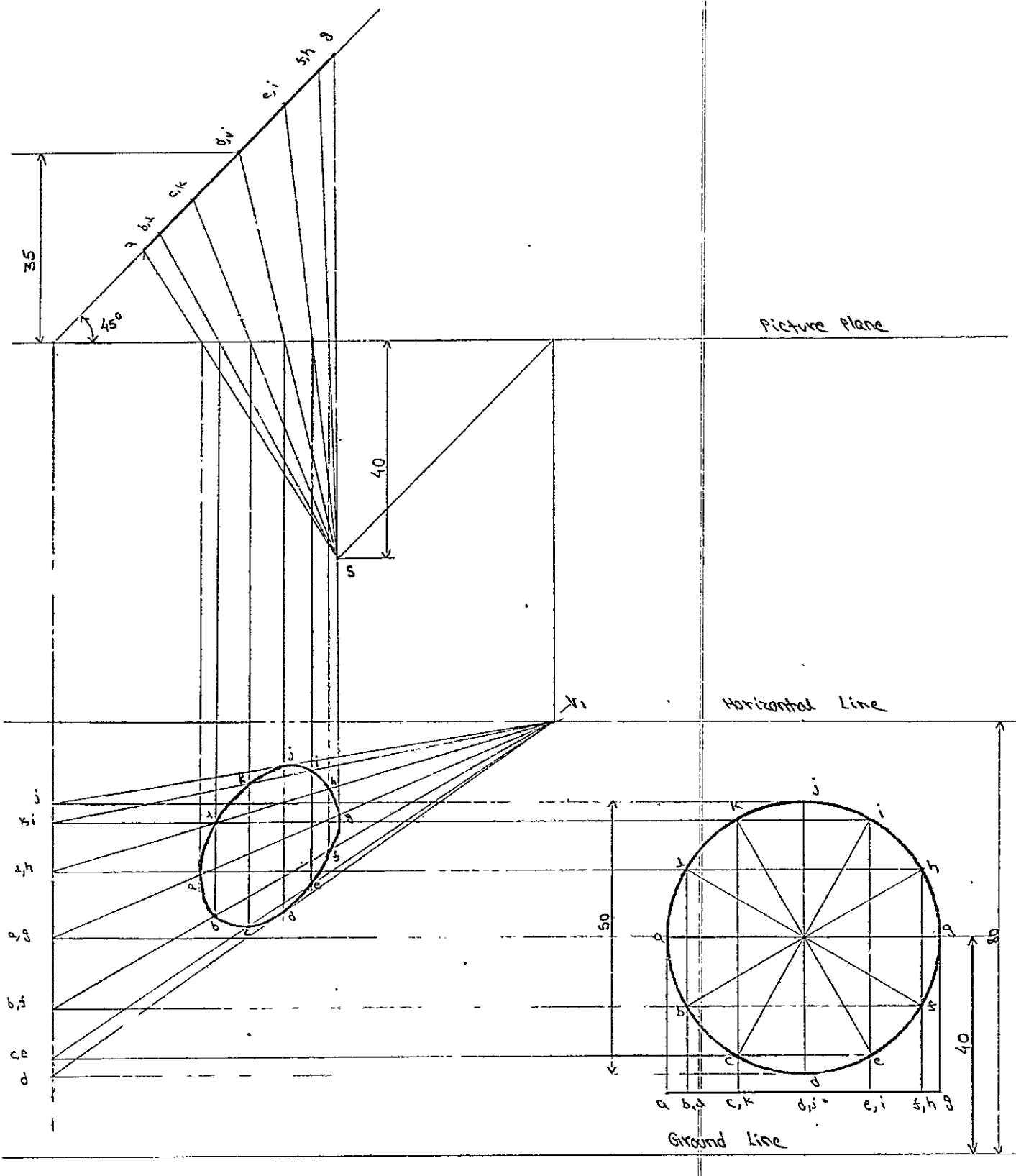
④




35
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Horizontal Line
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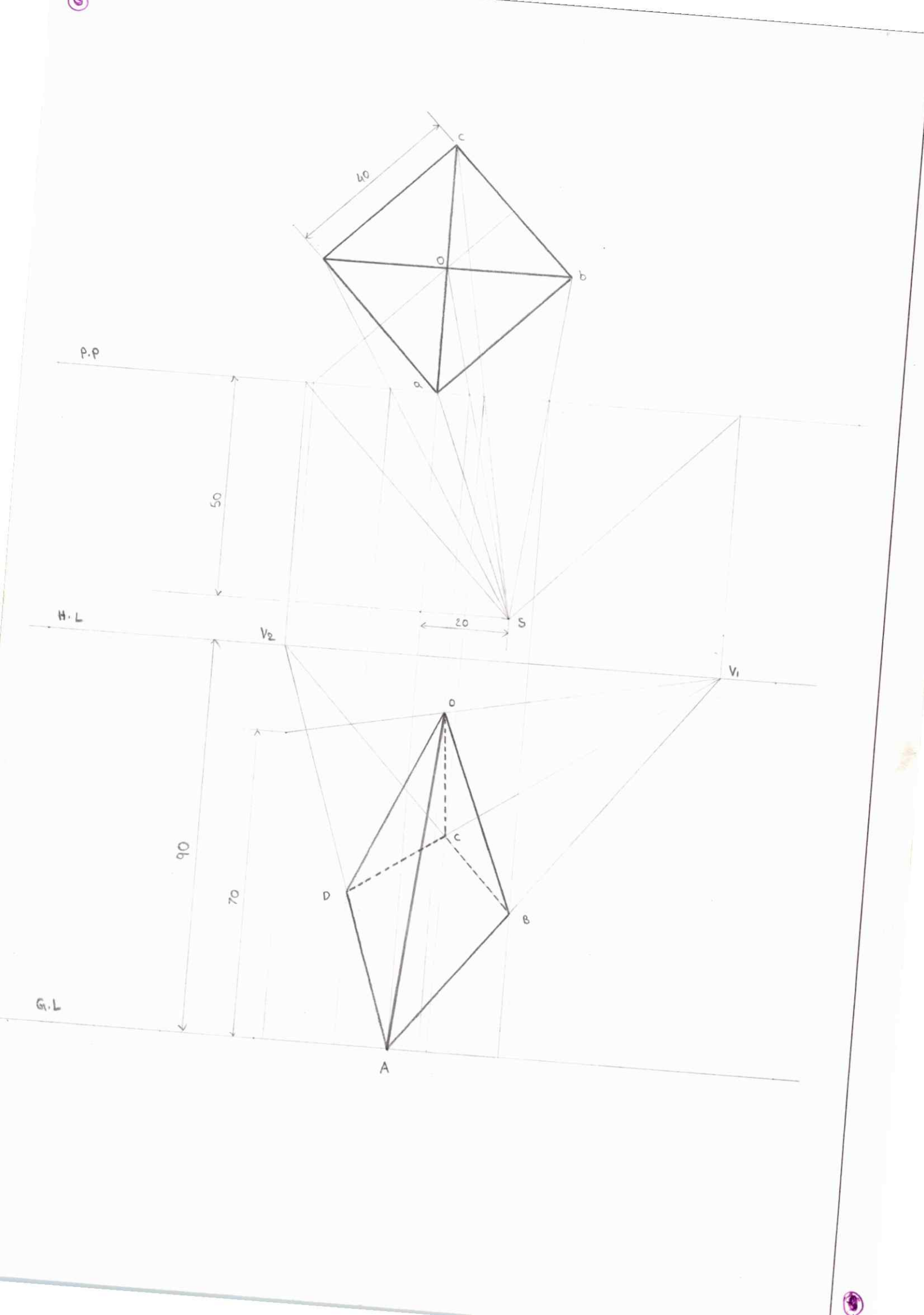
Ground Line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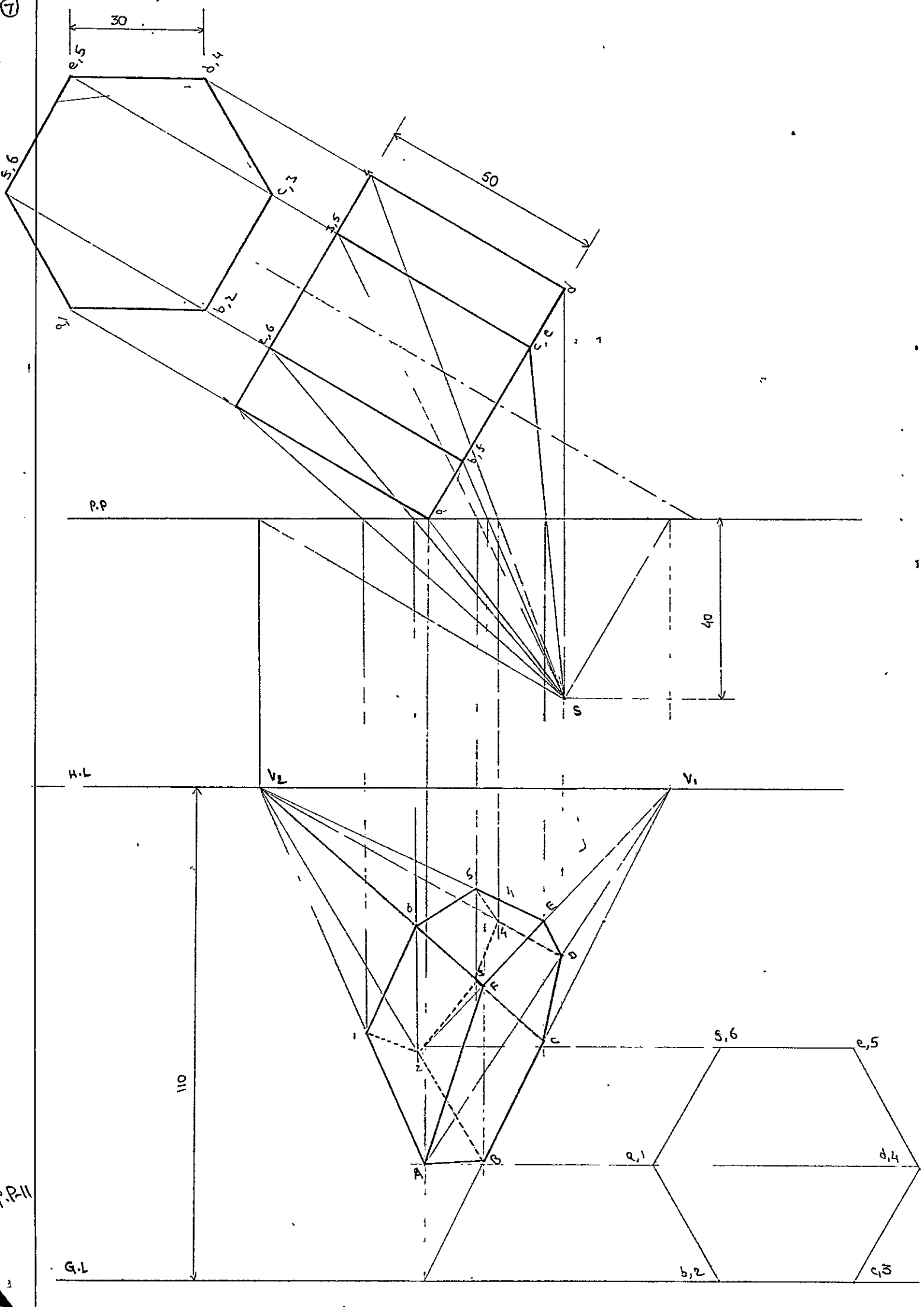
(7)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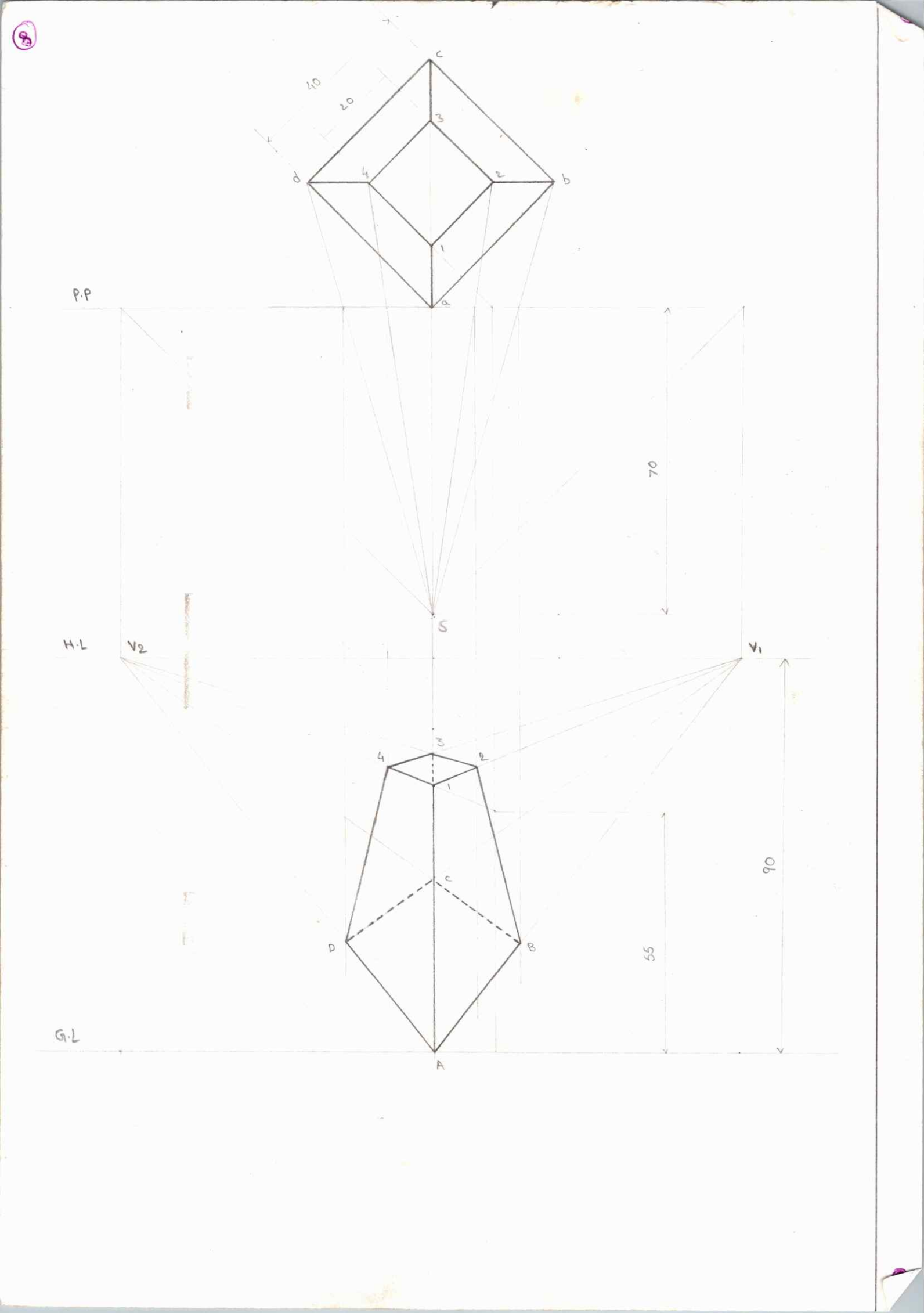
P.P-11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