DARBHANGA COLLEGE OF ENGINEERING, DARBHANGA

COURSE FILE

OF

ENGINEERING GRAPHICS AND DESIGN

FACULTY NAME:

Dr. MD ASJAD MOKHTAR

ASSISTANT PROFESSOR

DEPARTMENT OF MECHANICAL ENGINEERING

Time Table, Asjad, Mechanical Engineering, DCE Darbhanga						
Class Day	**I** 10:00AM to 10:50AM	**II** 10:50AM to 11:40AM	**III** 11:40AM to 12:30AM	**IV** 12:30AM to 01:20PM	**Lunch** 01:20AM to 01:50PM	**V-VII** 02:00 PM to 04:30PM
Mon				EG&D	LUNCH BREAK	M/c Drawing
Tue	PE-II (Mechatronics)		PE-VI (8th sem)			
Wed	Engg. Mech.	PE-VI (8th sem)		PE-II (Mechatronics)		M/c Drawing
Thurs						EG&D (ME)
Fri		PE-VI (8th sem)		PE-II (Mechatronics)		EG&D (ME)
Sat			Engg. Mech.			

Institute / College Name	Darbhanga College of Engineering, Darbhanga	
Program Name	B. Tech	
Course Code	200102, 200102P	
Course Name	ENGINEERING GRAPHICS & DESIGN	
Lecture/Tutorial/Practical (per week)	L-T-P: 1-0-4	**Course Credits: 3**
Course Coordinator Name	Dr. Md Asjad Mokhtar	

1. Scope and Objectives of the course

Machine drawing is the indispensable communicating medium employed in industries, to furnish all the information required for the manufacture and assembly of the components of a machine. The aim of this course is to equip the students with proper knowledge of design and drawing that will help them excel in their work. The focus is on blending fundamental development of concepts with practical specification of components. Students of this course should find that it inherently directs them into familiarity with both the basis for decisions and the standards of industrial components. For this reason, as students transition to practicing engineers, they will find that this course indispensable. The objective of this course is to:

- Cover the basics of machine drawing and makes the student familiar with technical terms and standards used in the drawing of machine elements.
- Offer a practical approach for technical communication during design and development of any mechanical engineering component.
- Encourage students to link fundamental concepts with practical component specification.

Course Outcomes

CO1: Comprehend basic sheet layouts, lines, dimensioning and engineering curves and construct conic sections.

CO2: Understand orthographic projection of points, lines, planes and solids inclined to both the planes.

CO3: Analyse section of solids (Prism, pyramids, cone, and cylinder) with axis inclined to one axis.

CO4: Develop isometric projection of objects and intersection of surfaces.

CO5: Simulate the pictorial view into orthographic view by three principal views.

ESC	Engineering Graphics & Design	L:1	T:0	P:4	Credit:3

TRADITIONAL ENGINEERING GRAPHICS:

PRINCIPLES OF ENGINEERING GRAPHICS; ORTHOGRAPHIC PROJECTION; DESCRIPTIVE GEOMETRY; DRAWING PRINCIPLES; ISOMETRIC PROJECTION; SURFACE DEVELOPMENT; PERSPECTIVE; READING A DRAWING; SECTIONAL VIEWS; DIMENSIONING & TOLERANCES; TRUE LENGTH, ANGLE; INTERSECTION, SHORTEST DISTANCE.

COMPUTER GRAPHICS:

ENGINEERING GRAPHICS SOFTWARE; -SPATIAL TRANSFORMATIONS; ORTHOGRAPHIC PROJECTIONS; MODEL VIEWING; CO-ORDINATE SYSTEMS; MULTI-VIEW PROJECTION; EXPLODED ASSEMBLY; MODEL VIEWING; ANIMATION; SPATIAL MANIPULATION; SURFACE MODELLING; SOLID MODELLING, INTRODUCTION TO BUILDING INFORMATION MODELLING (BIM).

(EXCEPT THE BASIC ESSENTIAL CONCEPTS, MOST OF THE TEACHING PART CAN HAPPEN CONCURRENTLY IN THE LABORATORY)

MODULE 1: INTRODUCTION TO ENGINEERING DRAWING

PRINCIPLES OF ENGINEERING GRAPHICS AND THEIR SIGNIFICANCE, USAGE OF DRAWING INSTRUMENTS, LETTERING, CONIC SECTIONS INCLUDING THE RECTANGULAR HYPERBOLA (GENERAL METHOD ONLY); CYCLOID, EPICYCLOID, HYPOCYCLOID AND INVOLUTE; SCALES – PLAIN, DIAGONAL AND VERNIER SCALES

MODULE 2: ORTHOGRAPHIC PROJECTIONS

PRINCIPLES OF ORTHOGRAPHIC PROJECTIONS-CONVENTIONS -PROJECTIONS OF POINTS AND LINES INCLINED TO BOTH PLANES; PROJECTIONS OF PLANES INCLINED PLANES - AUXILIARY PLANES

MODULE 3: PROJECTIONS OF REGULAR SOLIDS

THOSE INCLINED TO BOTH THE PLANES- AUXILIARY VIEWS; DRAW SIMPLE ANNOTATION, DIMENSIONING AND SCALE. FLOOR PLANS THAT INCLUDE: WINDOWS, DOORS, AND FIXTURES SUCH AS WC, BATH, SINK, SHOWER, ETC.

MODULE 4: SECTIONS AND SECTIONAL VIEWS OF RIGHT ANGULAR SOLIDS

COVERING, PRISM, CYLINDER, PYRAMID, CONE – AUXILIARY VIEWS; DEVELOPMENT OF SURFACES OF RIGHT REGULAR SOLIDS- PRISM, PYRAMID, CYLINDER AND CONE; DRAW THE SECTIONAL ORTHOGRAPHIC VIEWS OF GEOMETRICAL SOLIDS, OBJECTS FROM INDUSTRY AND DWELLINGS (FOUNDATION TO SLAB ONLY)

MODULE 5: ISOMETRIC PROJECTIONS

PRINCIPLES OF ISOMETRIC PROJECTION – ISOMETRIC SCALE, ISOMETRIC VIEWS, CONVENTIONS; ISOMETRIC VIEWS OF LINES, PLANES, SIMPLE AND COMPOUND SOLIDS; CONVERSION OF ISOMETRIC VIEWS TO ORTHOGRAPHIC VIEWS AND VICE-VERSA, CONVENTIONS

MODULE 6: OVERVIEW OF COMPUTER GRAPHICS

LISTING THE COMPUTER TECHNOLOGIES THAT IMPACT ON GRAPHICAL COMMUNICATION, DEMONSTRATING KNOWLEDGE OF THE THEORY OF CAD SOFTWARE [SUCH AS: THE MENU SYSTEM, TOOLBARS (STANDARD, OBJECT PROPERTIES, DRAW, MODIFY AND DIMENSION), DRAWING AREA (BACKGROUND, CROSSHAIRS, COORDINATE SYSTEM), DIALOG BOXES AND WINDOWS, SHORTCUT MENUS (BUTTON BARS), THE COMMAND LINE (WHERE APPLICABLE), THE STATUS BAR, DIFFERENT METHODS OF ZOOM AS USED IN CAD, SELECT AND ERASE OBJECTS.; ISOMETRIC VIEWS OF LINES, PLANES, SIMPLE AND COMPOUND SOLIDS]

MODULE 7: CUSTOMISATION& CAD DRAWING

CONSISTING OF SET UP OF THE DRAWING PAGE AND THE PRINTER, INCLUDING SCALE SETTINGS, SETTING UP OF UNITS AND DRAWING LIMITS; ISO AND ANSI STANDARDS FOR COORDINATE DIMENSIONING AND TOLERANCING; ORTHOGRAPHIC CONSTRAINTS, SNAP TO OBJECTS MANUALLY AND AUTOMATICALLY; PRODUCING DRAWINGS BY USING VARIOUS COORDINATE INPUT ENTRY METHODS TO DRAW STRAIGHT LINES, APPLYING VARIOUS WAYS OF DRAWING CIRCLES.

MODULE 8: ANNOTATIONS, LAYERING & OTHER FUNCTIONS

COVERING APPLYING DIMENSIONS TO OBJECTS, APPLYING ANNOTATIONS TO DRAWINGS; SETTING UP AND USE OF LAYERS, LAYERS TO CREATE DRAWINGS, CREATE, EDIT AND USE CUSTOMIZED LAYERS; CHANGING LINE LENGTHS THROUGH MODIFYING EXISTING LINES (EXTEND/LENGTHEN); PRINTING DOCUMENTS TO PAPER USING THE PRINT COMMAND; ORTHOGRAPHIC PROJECTION TECHNIQUES; DRAWING SECTIONAL VIEWS OF COMPOSITE RIGHT REGULAR GEOMETRIC SOLIDS AND PROJECT THE TRUE SHAPE OF THE SECTIONED SURFACE; DRAWING ANNOTATION, COMPUTER-AIDED DESIGN (CAD) SOFTWARE MODELING OF PARTS AND ASSEMBLIES. PARAMETRIC AND NON-PARAMETRIC SOLID, SURFACE, AND WIREFRAME MODELS. PART EDITING AND TWO-DIMENSIONAL DOCUMENTATION OF MODELS. PLANAR PROJECTION THEORY, INCLUDING SKETCHING OF PERSPECTIVE, ISOMETRIC, MULTIVIEW, AUXILIARY, AND SECTION VIEWS. SPATIAL VISUALIZATION EXERCISES. DIMENSIONING GUIDELINES, TOLERANCING TECHNIQUES; DIMENSIONING AND SCALE MULTI VIEWS OF DWELLING.

MODULE 9: DEMONSTRATION OF A SIMPLE TEAM DESIGN PROJECT THAT ILLUSTRATES

GEOMETRY AND TOPOLOGY OF ENGINEERED COMPONENTS: CREATION OF ENGINEERING MODELS AND THEIR PRESENTATION IN STANDARD 2D BLUEPRINT FORM AND AS 3D WIRE-FRAME AND SHADED SOLIDS; MESHED TOPOLOGIES FOR ENGINEERING ANALYSIS AND TOOL-PATH GENERATION FOR COMPONENT MANUFACTURE; GEOMETRIC DIMENSIONING AND TOLERANCING; USE OF SOLID-MODELING SOFTWARE FOR CREATING ASSOCIATIVE MODELS AT THE COMPONENT AND ASSEMBLY LEVELS. FLOOR PLANS THAT INCLUDE: WINDOWS, DOORS, AND FIXTURES SUCH AS WC, BATH, SINK, SHOWER, ETC. APPLYING COLOUR CODING ACCORDING TO BUILDING DRAWING PRACTICE; DRAWING SECTIONAL ELEVATION SHOWING FOUNDATION TO CEILING; INTRODUCTION TO BUILDING INFORMATION MODELLING (BIM).

SUGGESTED TEXT/REFERENCE BOOKS:

- *BHATT N.D., PANCHAL V.M. & INGLE P.R., (2014), ENGINEERING DRAWING, CHAROTAR PUBLISHING HOUSE*
- *SHAH, M.B. &RANA B.C. (2008), ENGINEERING DRAWING AND COMPUTER GRAPHICS, PEARSON EDUCATION*
- *AGRAWAL B. & AGRAWAL C. M. (2012), ENGINEERING GRAPHICS, TMH PUBLICATION*
- *NARAYANA, K.L. & P KANNAIAH (2008), TEXT BOOK ON ENGINEERING DRAWING, SCITECHPUBLISHERS*
- *(CORRESPONDING SET OF) CAD SOFTWARE THEORY AND USER MANUALS*

COURSE OUTCOMES

ALL PHASES OF MANUFACTURING OR CONSTRUCTION REQUIRE THE CONVERSION OF NEW IDEAS AND DESIGN CONCEPTS INTO THE BASIC LINE LANGUAGE OF GRAPHICS. THEREFORE, THERE ARE MANY AREAS (CIVIL, MECHANICAL, ELECTRICAL, ARCHITECTURAL AND INDUSTRIAL) IN WHICH THE SKILLS OF THE CAD TECHNICIANS PLAY MAJOR ROLES IN THE DESIGN AND DEVELOPMENT OF NEW PRODUCTS OR CONSTRUCTION. STUDENTS PREPARE FOR ACTUAL WORK SITUATIONS THROUGH PRACTICAL TRAINING IN A NEW STATE-OF-THE-ART COMPUTER DESIGNED CAD LABORATORY USING ENGINEERING SOFTWARE

THIS COURSE IS DESIGNED TO ADDRESS:

- TO PREPARE YOU TO DESIGN A SYSTEM, COMPONENT, OR PROCESS TO MEET DESIRED NEEDS WITHIN REALISTIC CONSTRAINTS SUCH AS ECONOMIC, ENVIRONMENTAL, SOCIAL, POLITICAL, ETHICAL, HEALTH AND SAFETY, MANUFACTURABILITY, AND SUSTAINABILITY
- TO PREPARE YOU TO COMMUNICATE EFFECTIVELY
- TO PREPARE YOU TO USE THE TECHNIQUES, SKILLS, AND MODERN ENGINEERING TOOLS NECESSARY FOR ENGINEERING PRACTICE

THE STUDENT WILL LEARN:

- INTRODUCTION TO ENGINEERING DESIGN AND ITS PLACE IN SOCIETY
- EXPOSURE TO THE VISUAL ASPECTS OF ENGINEERING DESIGN
- EXPOSURE TO ENGINEERING GRAPHICS STANDARDS
- EXPOSURE TO SOLID MODELLING
- EXPOSURE TO COMPUTER-AIDED GEOMETRIC DESIGN
- EXPOSURE TO CREATING WORKING DRAWINGS
- EXPOSURE TO ENGINEERING COMMUNICATION

2. <u>Textbooks</u>

TB1: Engineering drawing by ND Bhatt
TB2: Engineering drawing by KL Narayna & Kanaiah

3. <u>Reference Books</u>

RB1: Engineering Drawing by P. S. Gill

4. <u>Other reading and relevant websites</u>

SN	Link of Journals, Magazines, Websites and Research Papers
1	http://nptel.ac.in/courses/112103019/
2	https://swayam.gov.in/courses/1370-engineering-graphics
3	https://www.youtube.com/watch?v=z4xZmBpXIzQ
4	https://www.youtube.com/watch?v=P2p6CtxOAX4
5	https://en.wikipedia.org/wiki/Engineering_drawing
6	http://nptel.ac.in/courses/105104148

5. <u>Course Plan</u>

Lecture Number	Date of Lecture	Topics	Web Links for video Lecture	Text Book/ Reference Book, etc.	Page numbers of Text Books
1-2		Drawing instruments, sheet layout, lines, lettering, dimensioning, engineering curves (ellipse, parabola, hyperbola, spiral)		TB1, TB2	Ch. 1, 4-32
3		**Orthographic projection**			
4-5		Projection of points, projection of straight line			
6		**Projection of planes**			
7-8		**Projection of solids** (Prism, Pyramid, Cone, Cylinder) Axis inclined to one reference plane.			
Mid- Semester Exam (Syllabus covered from 1-8 lectures)					
9		**Section of solid**			
10		(Prism, Pyramid, Cone, Cylinder) Axis inclined to one reference plane.			
11		**Development of surface**			
12		**Intersection of surfaces**			
13		Axes of both solids at right angles			
14		**Isometric projection**			

15-16		**Conversion of pictorial view into orthographic view-** Simple cases.			
17		**Introduction to computer aided drawing.**			
18-19		**CUSTOMISATION & CAD DRAWING**			
20		**ANNOTATIONS, LAYERING & OTHER FUNCTIONS**			
21		**DEMONSTRATION OF A SIMPLE TEAM DESIGN PROJECT THAT ILLUSTRATES**			

6. Evaluation Scheme (theory)

Component 1	Mid Semester Examination	20
Component 2	Assignment Evaluation and class performances, Attendence	10
Component 3	End Term Examination**	70
	Total	100

Evaluation Scheme (Practical)

Component 1	Assignment Evaluation and class performances, Attendence	20
Component 2	External Examination and viva-voce	30
	Total	50

****** The End term Comprehensive Examination will be held at the end of the semester. The mandatory requirement of 75% attendance in all theory and practical classes is to be met for being eligible to appear in this component.

SYLLABUS

Module	Topics	No. of Lectures	Weightage
1	INTRODUCTION TO ENGINEERING DRAWING	2	20 %
2	ORTHOGRAPHIC PROJECTIONS	3	15 %
3	PROJECTIONS OF REGULAR SOLIDS	2	15 %
4	SECTIONS AND SECTIONAL VIEWS OF RIGHT ANGULAR SOLIDS	2	15 %
5	ISOMETRIC PROJECTIONS	1	15 %
6	OVERVIEW OF COMPUTER GRAPHICS	1	8 %
7	CUSTOMISATION & CAD DRAWING	1	4 %
8	ANNOTATIONS, LAYERING & OTHER FUNCTIONS	1	4 %
9	DEMONSTRATION OF A SIMPLE TEAM DESIGN PROJECT THAT ILLUSTRATES	1	4 %

This Document is approved by:

Designation	Name	Signature
Course Coordinator	Dr. Md Asjad Mokhtar Mr. Vikash Kumar	
HOD, ME	Dr. Md Asjad Mokhtar	
Principal	Dr. Vikash Kumar	
Date		

Evaluation and Examination Blue Print:

Internal assessment is done through quiz test, assignments and practical work. Two sets of question paper are asked from each faculty and out of these two, without the knowledge of faculty, one question paper is chosen for concerned examination. Examination rules are uploaded on the student's portal. Evaluation is a very important process and the answer sheets of sessional tests, internal assessment assignments are returned back to the students.
The component of evaluations along with their weightage followed by the university is given below.

Mid semester Test 1	20%
Assignments/ Quiz Tests/ Seminars	10%
End Term Examination	70%

1^{st} Sem. Branch:- Mechanical Engineering Batch (2021-25)

SN	Name	Class Roll No.	Category	Mob. No.
1.	RAVI KUMAR YADAV	21-M-02	EBC	9102864348
2.	CHANDAN KUMAR	21-M-03	SC	7631894205
3.	VIKASH RAJ	21-M-04	EBC	8409852500
4.	ANIL KUMAR	21-M-05	SC	9304933990
5.	ANIL KUMAR DAS	21-M-06	SC	7280962533
6.	SHIVAM KUMAR	21-M-07	EWS	6200115787
7.	JITENDRA KUMAR YADAV	21-M-08	BC	7859097170
8.	RANJEET KUMAR	21-M-10	EWS	9771723264
9.	SURYA KANT SHARMA	21-M-11	EBC	9117764702
10.	MD FAHIM ZAFAR	21-M-12	EWS	7492970543
11.	AYUSH	21-M-13	BC	7992473988
12.	ABHISHEK KUMAR	21-M-16	EBC	8789003282
13.	AMARJEET KUMAR	21-M-17	EBC	9523242642
14.	AAVYA SHARMA	21-M-18	EBC	7667594969
15.	ADITYA KUMAR	21-M-19	BC	6209420264
16.	PRIYANKA GUPTA	21-M-20	BC	9142235447
17.	ANKIT JAGAT	21-M-21	EWS	6299517194
18.	SHUBHAM KUMARI	21-M-22	BC	7992413243
19.	PRABHAT KUMAR	21-M-23	BC	9525974101
20.	ANKITA KUMARI	21-M-24	GEN	8709622365
21.	AJEET KUMAR PANDIT	21-M-25	EBC	6209238485
22.	AMAN KUMAR	21-M-26	BC	9162801172
23.	SUMAN KUMAR	21-M-27	EWS	6203107244
24.	PUSHKAR JHA	21-M-28	UR	9608724790
25.	GAUTAM SACHIDEV	21-M-29	SC	8809972339
26.	MALA KUMARI	21-M-30	EWS	7370977408
27.	MD RAIHAN AHMAD	21-M-32	EBC	8271633406
28.	ANUJ KUMAR	21-M-33	EBC	8678896478
29.	RAMAN KUMAR	21-M-34	EWS	9117577346
30.	AKSHAY KUMAR	21-M-35	EBC	7004338840
31.	KOMAL KUMARI	21-M-36	EBC	9472215176
32.	MD HASSAN	21-M-37	EWS	8016593472
33.	AYUSHA KUMARI	21-M-38	BC	7282897160
34.	JAYANT KUMAR	21-M-39	EWS	8210174860
35.	SALMAN ARSHAD	21-M-40	EWS	8603315820
36.	KUNAL PRATAP SINGH	21-M-42	EWS	7250711719
37.	NISHANT KUMAR	21-M-44	EWS	6299021662
38.	AMARNATH KUMAR	21-M-45	SC	9798747337
39	AMAN SINGH	21-M-46	EWS	9955662401

40	SARVODAY PRATAP	21-M-47	GEN	7856031271
41	ANKIT RAJ	21-M-48	BC	7209275600
42	SHIVADITYA KUMAR	21-M-50	SC	9693283003
43	RAJU KUMAR	21-M-51	EBC	9201989840
44	ARADHYA KUMARI	21-M-52	BC	9931911745
45	ANSHU KUMAR	21-M-53	BC	9525470855
46	PRIYANSHU KUMAR	21-M-54	EWS	7461818651
47	SAJAN KUMAR	21-M-55	BC	7491894639
48	SATYAM KUMAR JHA	21-M-56	EWS	8448620692
49	JUHI KUMARI	21-M-57	BC	7856016487
50	SABIHA JAMIL	21-M-58	RCG	6209229474
51	NAJASHI AKHTAR	21-M-59	EBC	9523019049
52	KESHAV KUMAR ROY	21-M-60	EBC	8603414641
53	SADHAVI KUMARI	21-M-61	EWS	9508864797
54	ABHISHEK KUMAR	21-M-62	SC	7654517576
55	ANKITA KUMARI	21-M-63	EWS	6205310648
56	VIVEK KUMAR	21-M-64	SC	8986241061
57	SANYAM RAJ	21-M-65	EBC	9122257461
58	GULSHAN KUMAR	21-M-66	ST	9576028038
59	DHEERAJ KUMAR	21-M-67	SC	7673082969

Pre-requisite test

DCE, Darbhanga, Pre-requisite test for EG&D, Batch 2021-25, ME, 1st semester,

Marks: 10, time: 1hr

1. Draw a straight line segment and find its shortest distance from a specified point.
[1]
2. Draw the Cartesian coordinate system (in three perpendicular dimension, X, Y & Z) and then draw a cuboid of side 4×7×10 (cm) with one edge parallel to x-axis.
[2]
3. Draw a line segment of 75 mm length and construct a perpendicular bisector of it.
[1]
4. Draw a line segment of 11 cm and divide it into a ratio of 5/7.
[1]
5. Draw a circle of 50 mm radius with its centre at (15, 20) and construct a tangent on any point on the circumference of the circle.
[2]
6. Construct a hexagon of side 30mm and draw a circle inscribed in it.
[1]
7. Construct neatly an angle of 45 degree.
[1]
8. Draw a right handed Cartesian coordinate system (in three perpendicular dimension, X, Y & Z) and mark point P1 at (5, 8, 0), P2 at (8, 0, 5), P3 at (0, 8, 5) and P4 at (3, 5, 8)
[2]

Mechanical Engineering Department

Assignment no. 1

Subject: EG&D, Topic: Scale

1. **The distance between Delhi and Agra is 200 km. In a railway map it is represented by a line 5 cm long. Find it's R.F. Draw a diagonal scale to show single km. And maximum 600 km. Indicate on it following distances.**

   a. 222 km, b. 336 km, c. 459 km, d. 569 km

2. **A map of size 500cm X 50cm wide represents an area of 6250 km2. Construct a vernier scale to measure kilometers, hectometers and decameters and long enough to measure upto 7 km. Indicate on it**

   a. 5.33 km, b. 59 decameters.

3. **Point F is 50 mm from a line AB. A point P is moving in a plane such that the ratio of it's distances from F and line AB remains constant and equals to 2/3 draw locus of point P.**

Mechanical Engineering Department

Assignment no. 2

Subject: EG&D, Topic: Conic Section

1. A fixed point F is 7.5 cm from a fixed straight line. Draw the locus of a point P moving in such a way that its distance from the fixed straight line is 2/3 times the distance from focus. Name the curve. Draw the tangent and normal at any point on the curve.
2. A point moves such that its distance from a fixed straight line to its distance from a fixed point is equal. Draw the locus of the curve traced by that point. Add a normal and tangent to the curve at 40mm above the axis.
3. Draw hyperbola whose distance of focus is 55 mm and e = 1.5. Draw the tangent and normal 50 mm from the directrix.

<u>Darbhanga College of Engineering, Darbhanga</u>

Subject: Engineering Graphics and Design

Branch: ME, Batch 2021-25, Semester – 1st

Assignment no. 3

Module 03: ***Projections of Regular Solids***

1. A cone 40 mm diameter and 50 mm axis is resting on one generator on HP which makes 30^o inclination with the VP. Draw it's projections.
2. A right circular cone, 40 mm base diameter and 60 mm long axis is resting on HP on one point of base circle such that it's axis makes 45^o inclination with HP and 40^o inclination with VP. Draw it's projections.
3. Draw all three projections of the following parts.

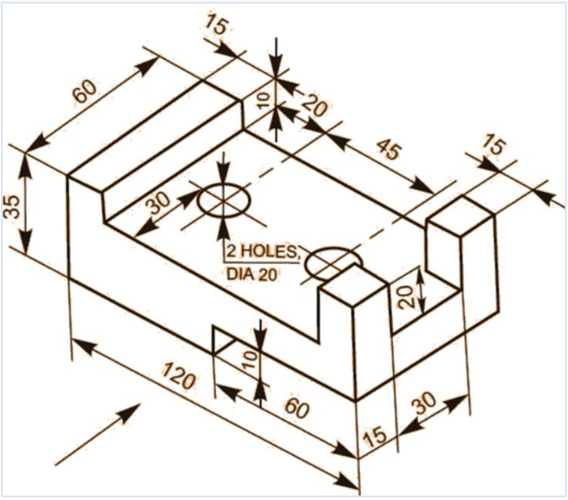

Figure for Problem no. 3

DARBHANGA COLLEGE OF ENGINEERING, DARBHANGA

Mid Semester examination - 2021-22, Mechanical Engineering Department

Subject: Engineering Graphics & Design. Max. marks: 20, Duration: 2hrs

Attempt all four questions

Q1. Short Answer question: **[5×1 = 5]**

a) Write the names of four types of scales.
b) A rectangular plot of land measuring 1.28 hectors is represented on a map by a similar rectangle of 8 sq. cm. Calculate RF of the scale.
c) Draw the symbol for 1st angle projection.
d) Write the size of A3 sheet.
e) What are the other names for front view and top view.

Q2. A map 320 cm × 100 cm represents an area of 8000 km^2. Construct a diagonal scale to measure Kms, Hectometers (hm) and Decameters (dm). Find its RF value and Indicate on this scale a distance of 6 km, 5 hm and 7 dm. **[5]**

Q3. Draw an ellipse by Concentric circle method **OR** Arc of circle method having major and minor axis 100 mm and 70 mm respectively. **[5]**

Q4. The top view (TV) of a 75 mm long line AB measures 65 mm, while the length of its front view (FV) is 50 mm. Its one end A is in the H.P. and 12 mm in-front of V.P. Draw the projections of AB and determine its inclination with the Horizontal Plane and the Vertical Plane. **[5]**

OR

A Regular Pentagon of 25 mm side has one side resting on H.P. and surface of the plane is inclined by 45^o to the Horizontal Plane and perpendicular to the Vertical Plane. Draw its projections and show its traces. **[5]**

Darbhanga College of Engineering, Darbhanga

Subject: Engineering Graphics and Design

Branch: ME, Batch 2021-25, Semester – 1st

Assignment no. 4

Module 04: ***Sections and Sectional Views and development of surfaces***

4. A pentagonal prism, 30 mm base side & 50 mm axis is standing on HP on it's base whose one side is perpendicular to VP. It is cut by a section plane 45° inclined to HP, through mid point of axis. Draw FV, Sec.TV & Sec. Side view. Also draw true shape of section and Development of surface of remaining solid.
5. A cylinder of 80 mm diameter and 100 mm axis is completely penetrated by a cone of 80 mm diameter and 120 mm long axis horizontally. Both axes intersect & bisect each other. Draw projections showing curve of intersections.
6. Draw full section and half section of the following part. Assume all dimensions suitably according to the size of your drawing sheet.

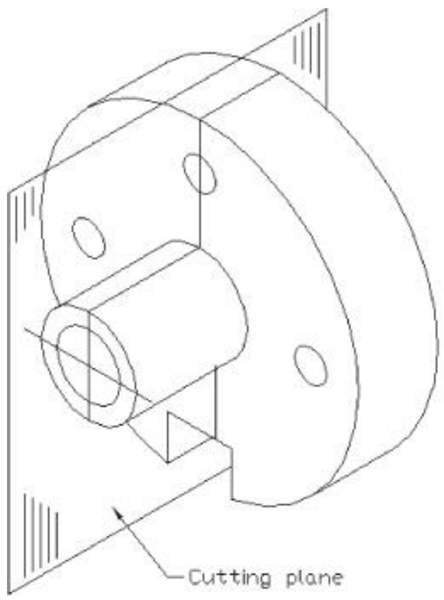

Figure for Problem no. 3

Mechanical Engineering Department

Darbhanga College of Engineering, Darbhanga

Subject: Engineering Graphics and Design

Branch: ME, Batch 2021-25, Semester – 1st

Assignment no. 5

Module 03: ***Projections of Regular Solids***

7. A cone 40 mm diameter and 50 mm axis is resting on one generator on HP which makes 30^{o} inclination with the VP. Draw it's projections.
8. A right circular cone, 40 mm base diameter and 60 mm long axis is resting on HP on one point of base circle such that it's axis makes 45^{o} inclination with HP and 40^{o} inclination with VP. Draw it's projections.
9. Draw all three projections of the following parts.

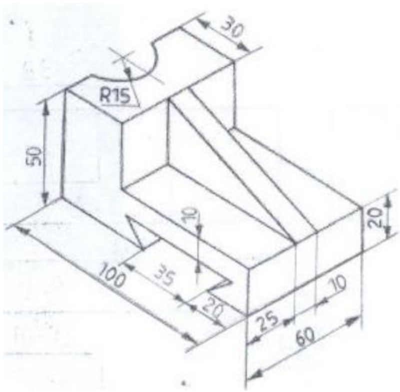

Figure for Problem no. 3

❖ **LAST DATE FOR THE SUBMISSION OF ASSIGNMENT 01-05 IS 18-04-2022**

ENGINEERING GRAPHICS

(Engineering Drawing is the language of Engineers)

UNIT 1

Conic Section (Ellipse, Parabola & Hyperbola) - Cycloids, epicycloids, hypocycloids & Involutes around circle and square – scales – diagonal – vernier scale – Free hand sketching

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Definition: Engineering graphical language for effective communication among engineers which elaborates the details of any component, structure or circuit at its initial drawing through drawing.

The following are the various drafting tools used in engineering graphics.

- Drawing Board
- Mini drafter or T- square
- Drawing Instrument box
- Drawing Pencils
- Eraser
- Templates
- Set squares
- Protractor
- Scale Set
- French curves
- Drawing clips
- Duster piece of cloth (or) brush
- Sand-paper (or) Emery sheet block
- Drawing sheet

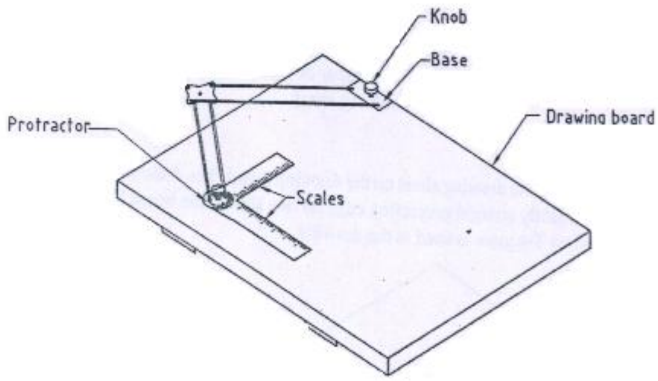
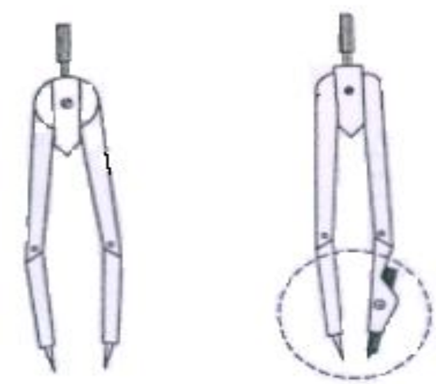


Figure Minidrafter fixed on drawing board

Drawing board and mini drafter

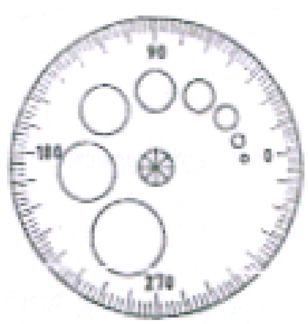
Above figure shows drawing board and mini drafter. A mini drafter is a drafting instrument which is a combination of scale, protractor and set square. It is used for drawing parallel, perpendicular and angular at any place in the drawing sheet.

Divider and compass



(i) Large size divider (ii) Large size compass

Pro-circle



Protractor with procircles

Set squares

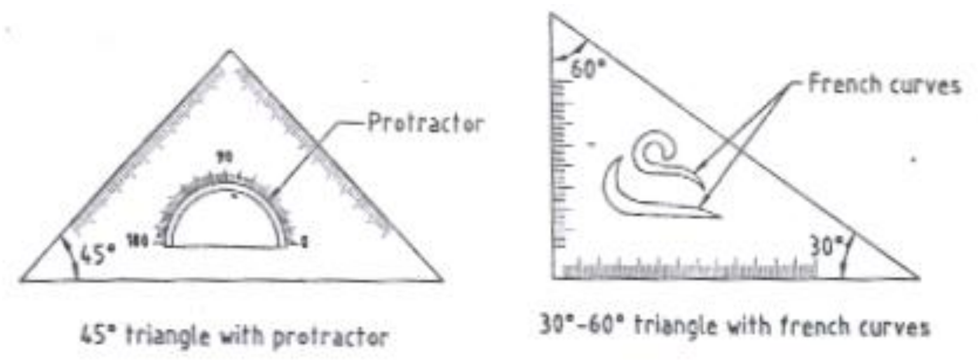


Figure Set squares

Sizes of drawing sheet

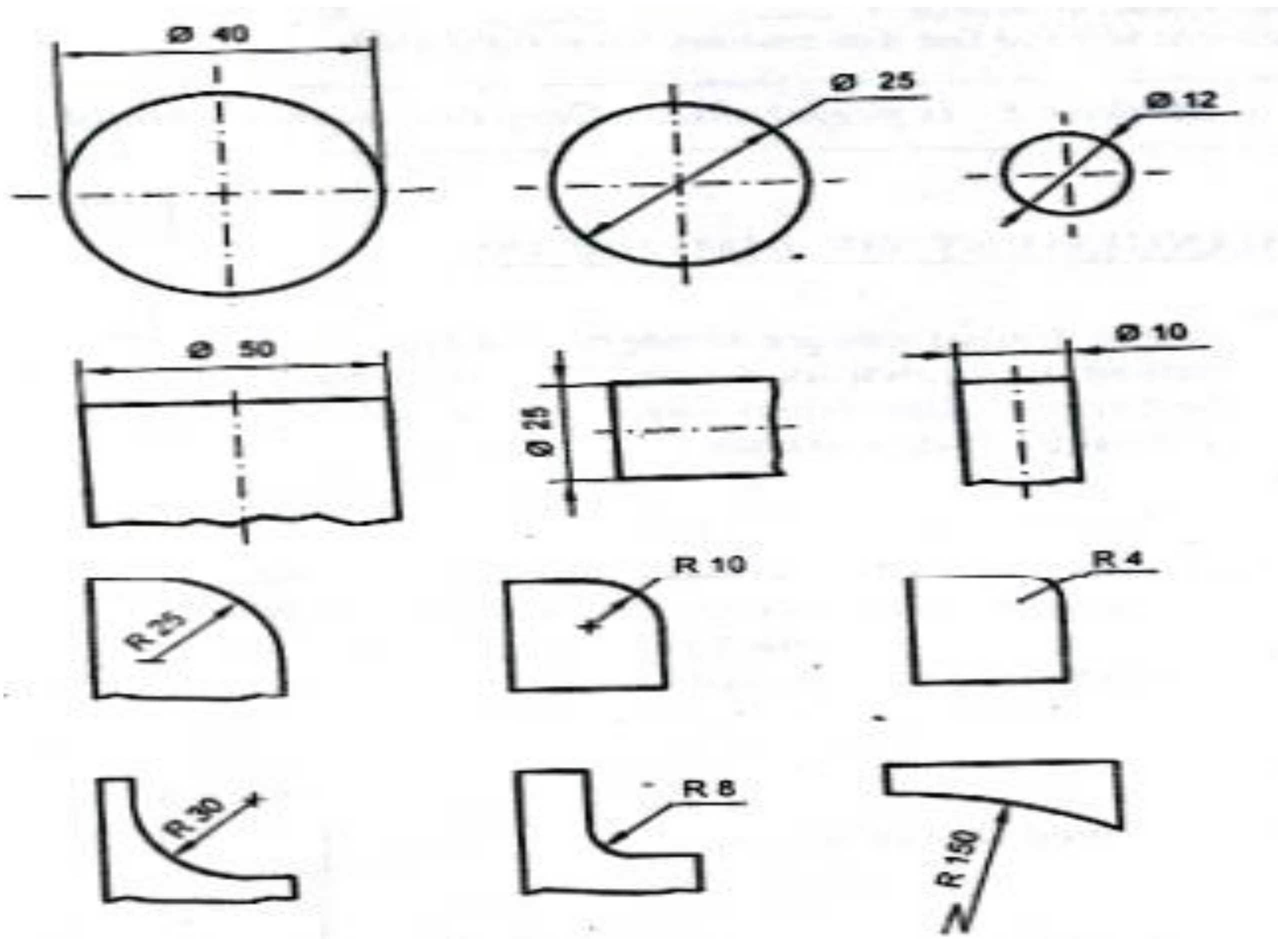
The table shows the designation of drawing sheet and its size in millimeter.

Designation	Dimension, mm Trimmed size
A0	841 x 1189
A1	594 x 841
A2	420 x 594
A3	297 x 420
A4	210 x 297

Method of dimensioning for circle, arc, semicircle:

Φ – diameter

R - radius



CONIC SECTIONS

The figure 1 shows the terminologies used in engineering graphics for a cone. Generators are the lines which are assumed that they are present on the surface of cone. These lines are called as "*generators*", because it is generated by the user.

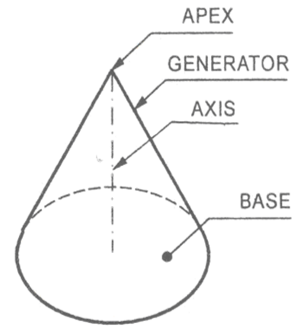
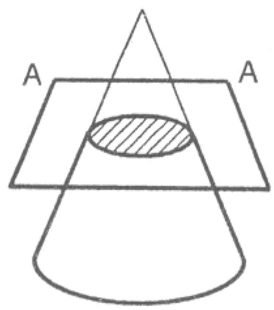
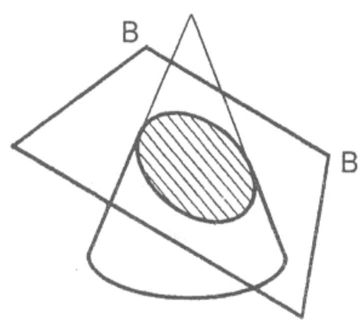


Figure 1

1. When the cutting plane cuts the cone parallel to its base then the shape obtained will be a **circle.**

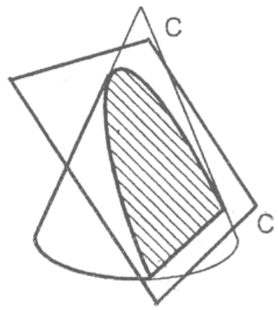


2. When the cutting plane BB is inclined to the axis of the cone and cuts all the generators on one side of the apex, the section obtained is an **Ellipse**



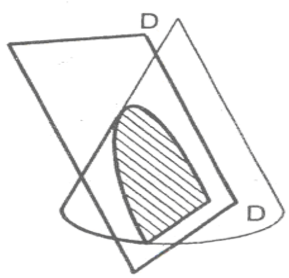
ELLIPSE

3. When the cutting plane CC is inclined to the axis of the cone and parallel to one of the generators, the section obtained is a **Parabola**



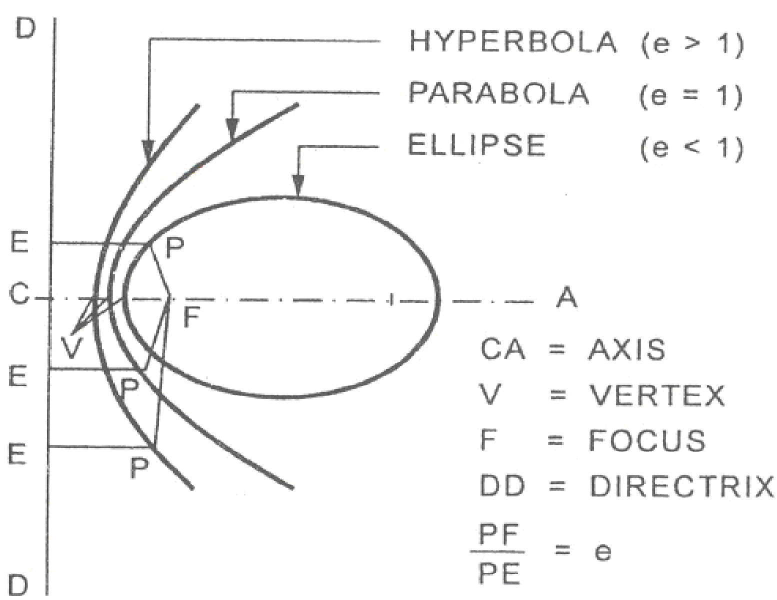
PARABOLA

4. When the cutting plane DD makes a smaller angle with the axis than that of the angle made by the generator of the cone, the section obtained is a **Hyperbola.**



HYPERBOLA

<u>Construction of conic curves by eccentricity method</u>



Eccentricity is defined as the ratio between distance of vertex from focus and distance of vertex from the directrix.

$$Eccentricity = \frac{Distance\ of\ moving\ point\ from\ focus}{Distance\ of\ moving\ point\ from\ directrix}$$

Important Hints

If e < 1, curve obtained is Ellipse

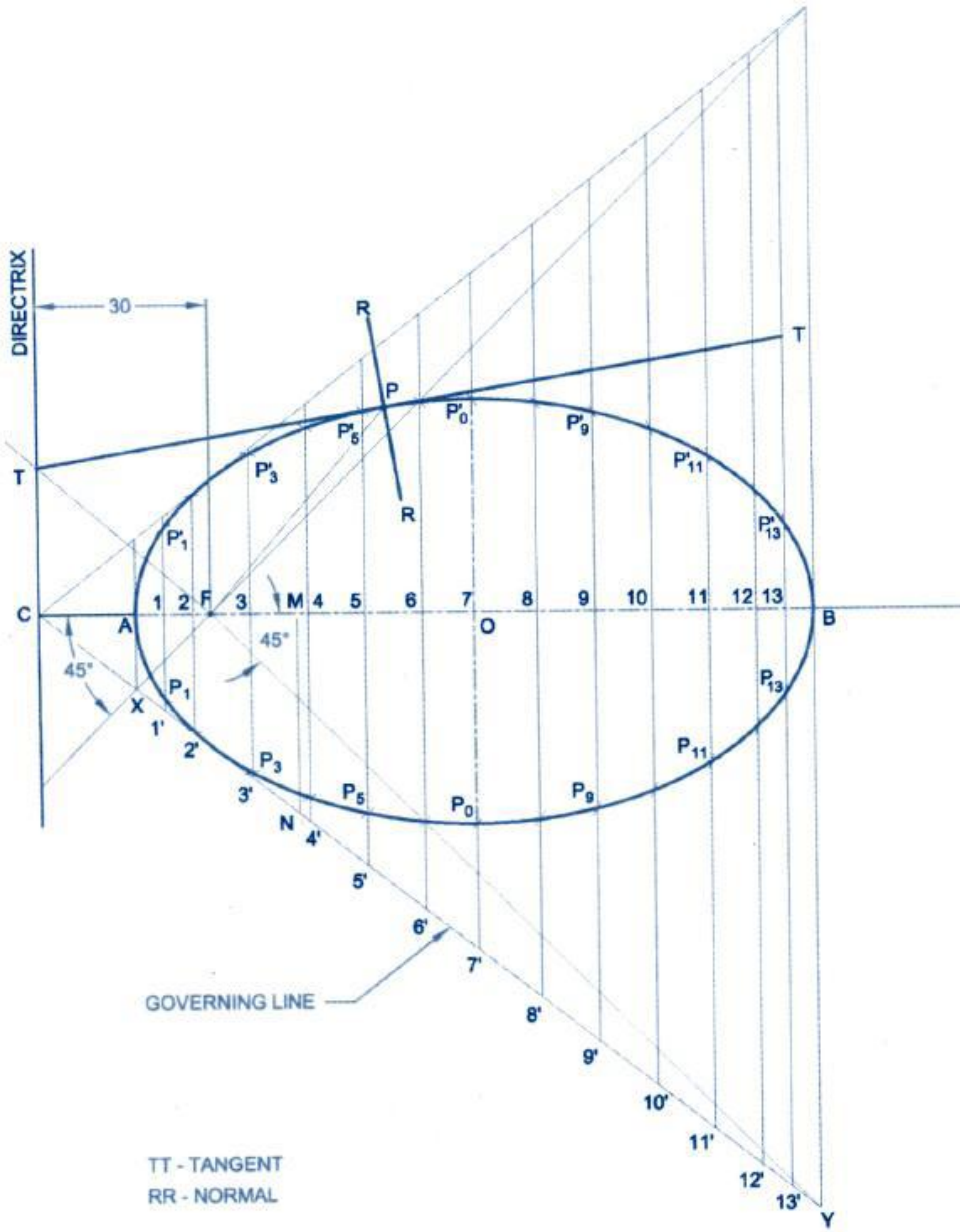
If e = 1, curve obtained is Parabola

If e > 1, curve obtained is Hyperbola

<u>**SOLVED EXAMPLES**</u>

CONIC SECTIONS

1. The focus of a conic is 30 mm from directrix. Draw the locus of a point P moving in such a way that eccentricity is 2/3. Also draw a tangent and normal at any point on the curve.



<u>Procedure to find number of divisions and size of each division</u>

Given,

$$\text{Eccentricity} = \frac{2}{3}$$

$$\text{Number of division} = \text{Numerator value} + \text{Denominator Value}$$
$$= 2 + 3$$
$$= 5 \text{ divisions}$$

$$\text{Size of each divison} = \frac{30}{5} = 6\,\text{mm}$$

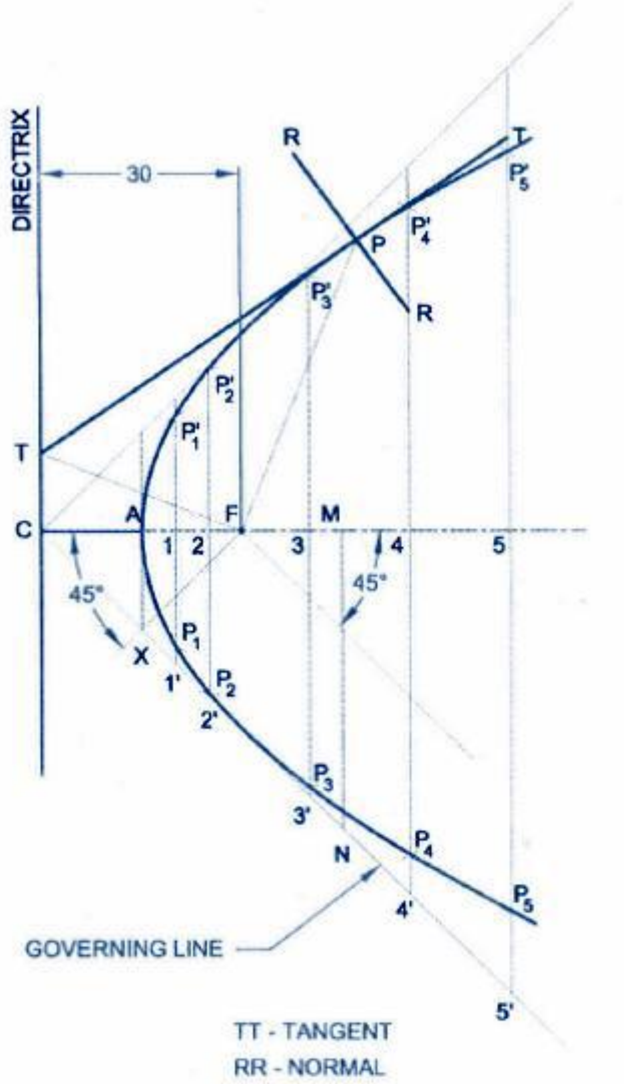
<u>Procedure :</u>

1. Draw the directrix.
2. Draw a horizontal (axis) line perpendicular from a point C on directrix.
3. Mark a point F (Focus) at a distance on the horizontal line at a distance of 30 mm from directrix.
4. Mark a point A (Vertex) by leaving two divisions from focus (each of size 6 mm) and the name the divisions as 1 and 2. Mark the remaining three divisions from A.
5. Draw a vertical line from A, so that AX is equal to FA.
6. Draw a line joining C and X and extend it in the same angle and direction.
7. After focus mark the points 3,4,5 etc. so that each division is of 6 mm.
8. Draw vertical lines crossing the points 1,2,3,4,5 etc.
9. Mark the points 1', 2', 3' etc., on the inclined line.
10. With 1-1' as radius F as centre draw the arcs above below the horizontal line on the line 1-1' and name the points as P_1' and P_1 respectively.
11. Follow the same procedure and mark the points P_2' and P_2 and so on.
12. Join all the points with a single stroke smooth curve to get an ellipse.

Procedure to draw tangent and normal

1. Mark a point P on the ellipse.
2. Join P and F.
3. Draw a perpendicular to the line PF till the line meets the directrix at the point T
4. Join the points T and P for getting a tangent for the ellipse.
5. Keep the protractor parallel to the line TP and draw the perpendicular line from P for getting a normal.

2. The distance of focus for a conic curve from directrix is 30 mm. Draw the locus of a point P so that the distance moving point from directrix and focus is unity.



<u>Procedure to find number of divisions and size of each division</u>

$$\text{Eccentricity} = \frac{1}{1}$$

$$\text{Number of division} = \text{Numerator value} + \text{Denominator Value}$$

$$= 1 + 1$$

$$= 2 \text{ divisions}$$

$$\text{Size of each divison} = \frac{30}{2} = 15 \text{ mm}$$

Procedure :

1. Draw the directrix d-d'.
2. Draw a horizontal (axis) line perpendicular from a point C on directrix.
3. Mark a point F (Focus) at a distance on the horizontal line at a distance of 30 mm from directrix.
4. Mark a point A (Vertex) by leaving two divisions from focus (each of size 6 mm) and the name the divisions as 1 and 2. Mark the remaining three divisions from A.
5. Draw a vertical line from A, so that AX is equal to FA.
6. Draw a line joining C and X and extend it in the same angle and direction.
7. After focus mark the points 3,4,5 etc. so that each division is of 6 mm.
8. Draw vertical lines crossing the points 1,2,3,4,5 etc.
9. Mark the points 1', 2', 3' etc., on the inclined line.
10. With 1-1' as radius F as centre draw the arcs above below the horizontal line on the line 1-1' and name the points as P_1' and P_1 respectively.
11. Follow the same procedure and mark the points P_2' and P_2 and so on.
12. Join all the points with a single stroke smooth curve to get a parabola.

Procedure to draw tangent and normal

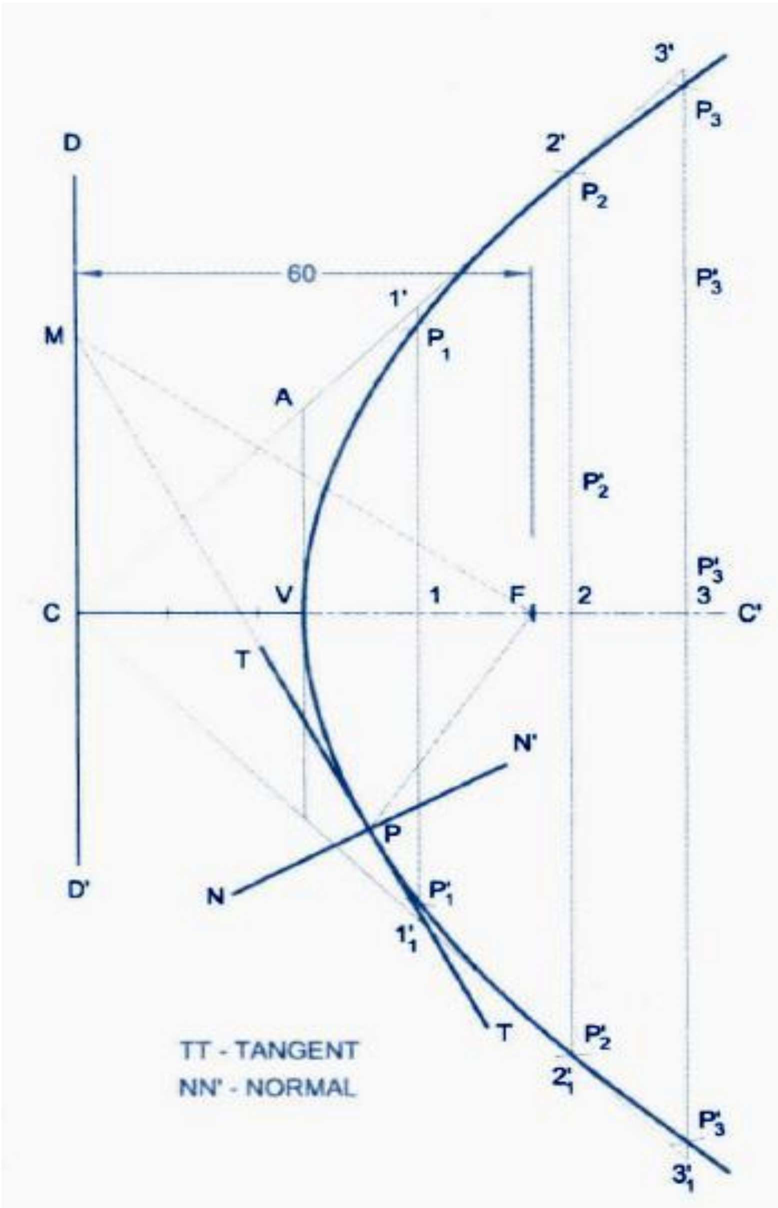
1. Mark a point P on the ellipse.
2. Join P and F.
3. Draw a perpendicular to the line PF till the line meets the directrix at the point T
4. Join the points T and P for getting a tangent for the ellipse.
5. Keep the protractor parallel to the line TP and draw the perpendicular line from P for getting a normal.

3. Draw a hyperbola whose distance of focus from directrix is 60 mm. The eccentricity is 3/2. Also draw a tangent and normal at any point P on the curve.

$$\text{Eccentricity} = \frac{3}{2}$$

$$\begin{aligned}\text{Number of division} &= \text{Numerator value} + \text{Denominator Value}\\ &= 3 + 2\\ &= 5 \text{ divisions}\end{aligned}$$

$$\text{Size of each divison} = \frac{30}{5} = 6 \text{ mm}$$



Procedure:

1. Draw the directrix d-d'.
2. Draw a horizontal (axis) line perpendicular from a point C on directrix.
3. Mark a point F (Focus) at a distance on the horizontal line at a distance of 30 mm from directrix.
4. Mark a point V (Vertex) by leaving two divisions from focus (each of size 6 mm) and the name the divisions as 1 and 2. Mark the remaining three divisions fromV.
5. Draw a vertical line from V, so that VA is equal to FV.
6. Draw a line joining C and A and extend it in the same angle and direction.
7. After focus mark the points 3,4,5 etc. so that each division is of 6 mm.
8. Draw vertical lines crossing the points 1,2,3,4,5 etc.

9. Mark the points 1’, 2’, 3’ etc., on the inclined line.
10. With 1-1’ as radius F as centre draw the arcs above below the horizontal line on the line 1-1’ and name the points as P_1’ and P_1 respectively.
11. Follow the same procedure and mark the points P_2’ and P_2 and so on.
12. Join all the points with a single stroke smooth curve to get a hyperbola.

Procedure to draw tangent and normal

1. Mark a point P on the hyperbola.
2. Join P and F.
3. Draw a perpendicular to the line PF till the line meets the directrix at the point T
4. Join the points T and P for getting a tangent for the ellipse.
5. Keep the protractor parallel to the line TP and draw the perpendicular line from P for getting a normal.

PROBLEMS FOR PRACTICE

1. A fixed point F is 7.5 cm from a fixed straight line. Draw the locus of a point P moving in such a way that its distance from the fixed straight line is 2/3 times the distance from focus. Name the curve. Draw the tangent and normal at any point on the curve.

2. Draw the path traced by a point P moving in such a way that the distance of the focus from directrix is 40 mm. The eccentricity is unity.

3. A point moves such that its distance from a fixed straight line to its distance from a fixed point is equal. Draw the locus of the curve traced by that point. Add a normal and tangent to the curve at 40mm above the axis

4. Draw an ellipse when the distance of focus from the directrix is equal to 35 mm and eccentricity is 3/4. Draw a tangent and normal at a point P located at 30mm above the major axis.

5. Draw an ellipse whose focus distance from is 70 mm and e is 0.5. Draw the tangent and normal 40 mm above the axis.

6. Draw hyperbola whose distance of focus is 55 mm and e = 1.5. Draw the tangent and normal 50 mm from the directrix.

CYCLOIDS

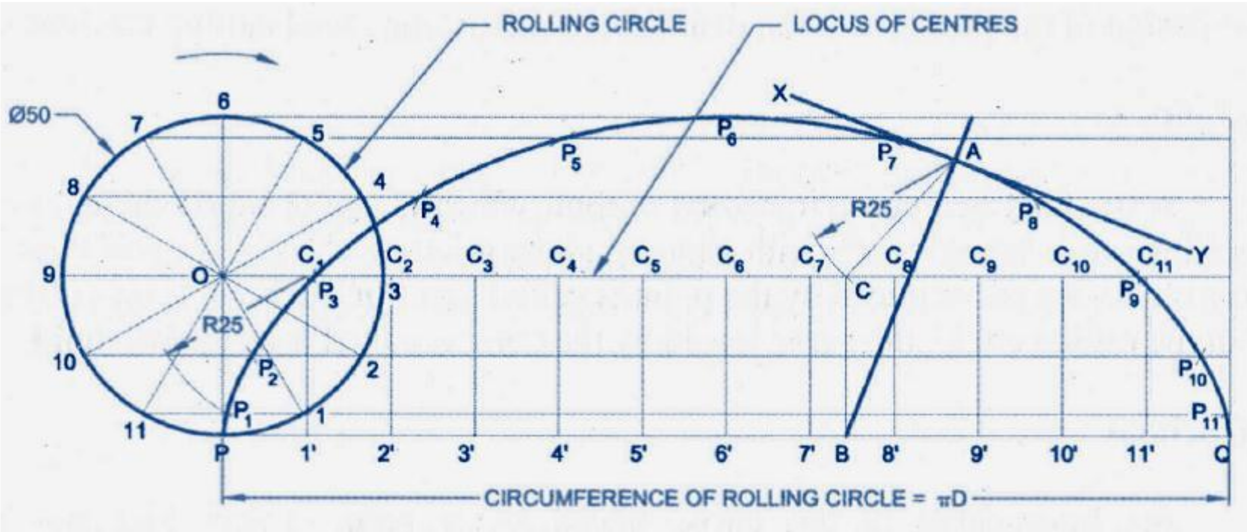
Cycloid : It is a curve traced by a point on the circumference of a circle which rolls along a straight line without slipping.

Epicycloid : It is a curve traced by a point on the circumference of a circle which rolls outside another circle**.**

Hypocycloid : It is a curve traced by a point on the circumference of a circle which rolls inside another circle.

SOLVED EXAMPLES

1. A circle of diameter 50 mm rolls on a straight line without slipping. Trace the locus of a point on the circumference of the circler rolling for one complete revolution. Name the curve, draw the tangent and normal at any point on the curve.



Procedure :

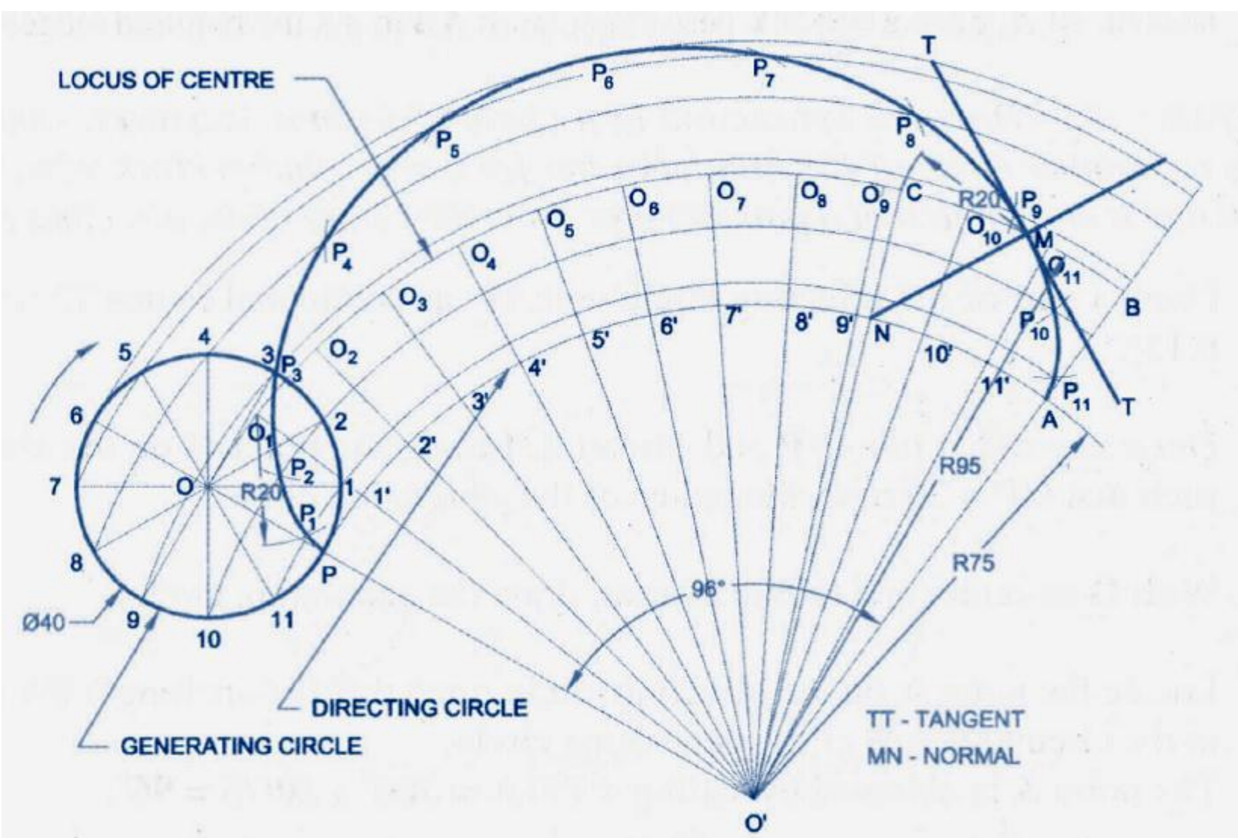
1. Draw a circle of diameter 50 mm.
2. Divide the circle into 12 equal parts, by taking an angle of 30^o each.
3. Name the divisions as 1,2,3 in anticlock wise direction from the division next to the bottom most one.
4. Name the bottom most division as P.
5. Draw a horizontal line as a tangent from P, for a length of L = πd, where d is diameter of circle.
6. Divide the horizontal line into 12 equal divisions and the name the points as 1', 2', 3', etc.
7. Draw lines passing through 11 and 1, 10 and 2, 8 and 3 and so on.
8. Draw vertical lines from 1', 2', 3', etc., so that they meet the horizontal line from 9.
9. Name the meeting points as C_1, C_2, C_3, etc.

10. With C_1 as centre 25 mm (radius of circle) as the radius, draw the arc on the horizontal line drawn from 1. Name the cutting point as P_1.
11. Follow the same procedure and get the points P_2, P_3,P_4, etc.
12. Join all the points with a single stroke smooth curve to get a cycloid.

Procedure to draw a tangent and normal to a cycloid

1. Mark a point A on the cycloid.
2. With A as centre, 25 mm as the radius draw an arc on the horizontal line drawn from 9.
3. Name the cutting point as C.
4. Draw a perpendicular line from C to the horizontal line drawn from P.
5. Name the cutting point as B.
6. Join B and A, which will be the normal to cycloid
7. Keep the protractor parallel to the line BA and draw a perpendicular line from P, which will be the tangent to cycloid.

2. Draw epicycloid of a circle of 40 mm diameter, which rolls outside on another circle of 150 mm diameter for one revolution clockwise. Draw a tangent and normal to it at a point 95 mm from the center of the directing circle.



To calculate θ:

$$\theta = \frac{r}{R} \times 360$$

where,

r – radius of rolling circle

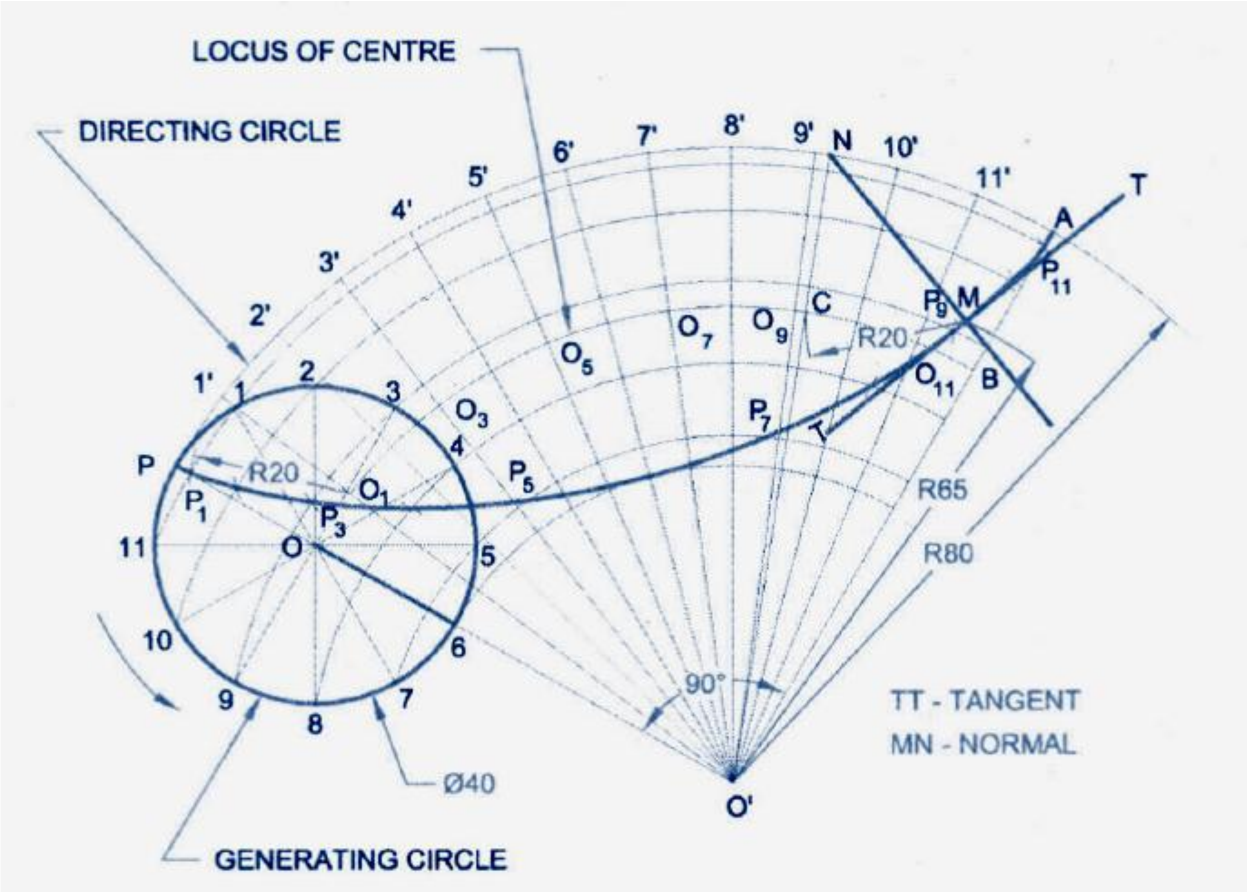
R – radius of directing circle

$$\theta = \frac{20}{75} \times 360$$
$$= 98°$$

Procedure :

1. Mark a point O’.
2. With O’ as centre draw a sector ((O’PA) with radius of generating circle 75 mm for an angle of 98^o.
3. Extend the line from P for a distance of 20 mm (radius of rolling circle) and the mark the point O at the end.
4. With O as centre, draw the rolling circle of diameter 20 mm.
5. Divide the circle into 12 equal parts and name the points as 1,2,3..etc., in the anticlockwise direction from the point next to the bottom most one.
6. With O’ as centre, draw the arcs passing through the points 11-1, 10-2, 9-3 etc.
7. Divide the sector in to 12 equal angles and draw the lines starting from O’.
8. Mark the cutting points of the lines on the arc starting from 3-9, as O_1, O_2 etc.
9. O_1 as centre, 20 mm as radius draw an arc on the curve drawn from 11. Name the cutting point as P_1.
10. Similarly mark the other points P_2,P_3,P_4,.. etc.
11. Join all the points by a smooth curve to get a hypocycloid.

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



<u>Calculation :</u>

$$\theta = \frac{r}{R} \times 360$$

where,

$r -$ *radius of rolling circle*

$R -$ *radius of directing circle*

$$\theta = \frac{20}{80} \times 360$$

$$= 90^\circ$$

Procedure :

1. Mark a point O'.
2. With O' as centre draw a sector (O'PA) with radius of generating circle 80 mm for an angle of 98^o.
3. Mark P on the line PO' so that OP = radius of rolling circle.
4. With O as centre, draw the rolling circle of diameter 20 mm.
5. Divide the circle into 12 equal parts and name the points as 1,2,3..etc., in the clockwise direction from the point next to the top most one.
6. With O' as centre, draw the arcs passing through the points 11-1, 10-2, 9-3 etc.
7. Divide the sector in to 12 equal angles and draw the lines starting from O'.
8. Mark the cutting points of the lines on the arc starting from 3-9, as O_1, O_2 etc.
9. O_1 as centre, 20 mm as radius draw an arc on the curve drawn from 11. Name the cutting point as P_1.
10. Similarly mark the other points P_2,P_3,P_4,.. etc.
11. Join all the points by a smooth curve to get an epicycloid.

PROBLEMS FOR PRACTICE

1. Draw epicycloids of a circle of 40 mm diameter, which rolls outside on another circle of 150 mm diameter for one revolution clockwise. Draw a a tangent and normal to it at a point 95 mm from the center of the directing circle.

2. Draw hypocycloids of a circle of 40 mm diameter, which rolls inside of another circle of 160 mm diameter for one revolution counter clockwise. Draw a a tangent and normal to it at a point 65 mm from the center of the directing circle.

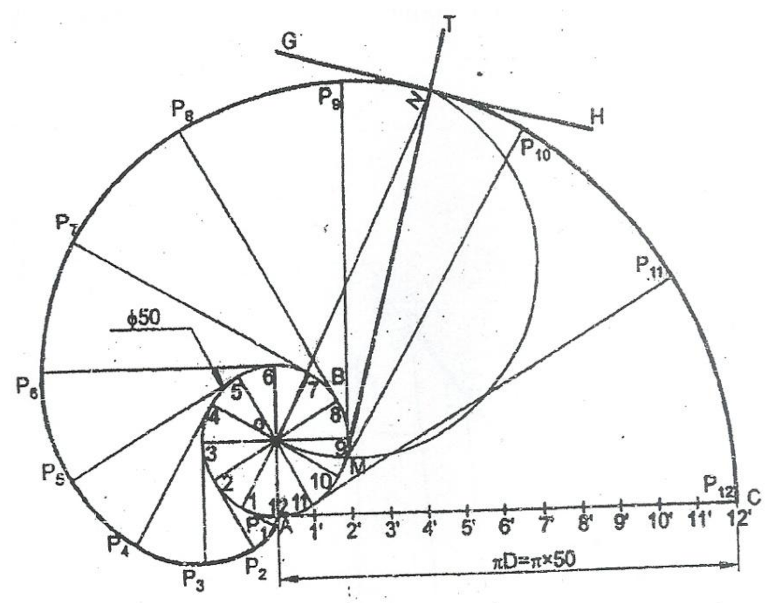
3. A roller of 40 mm diameter rolls over a horizontal table without slipping. A point on the circumference of the roller is in contact with the table surface in the beginning till one end of revolution. Draw the path traced by the point.

INVOLUTE

Definition : Involute is a path traced a point at the end of the string when it is wound or unwound from a cylindrical drum, cuboid or any tubular object.

SOLVED EXAMPLES

1. Draw an involute of a circle of 50mm diameter. Also, draw a tangent and normal at any point on the curve.



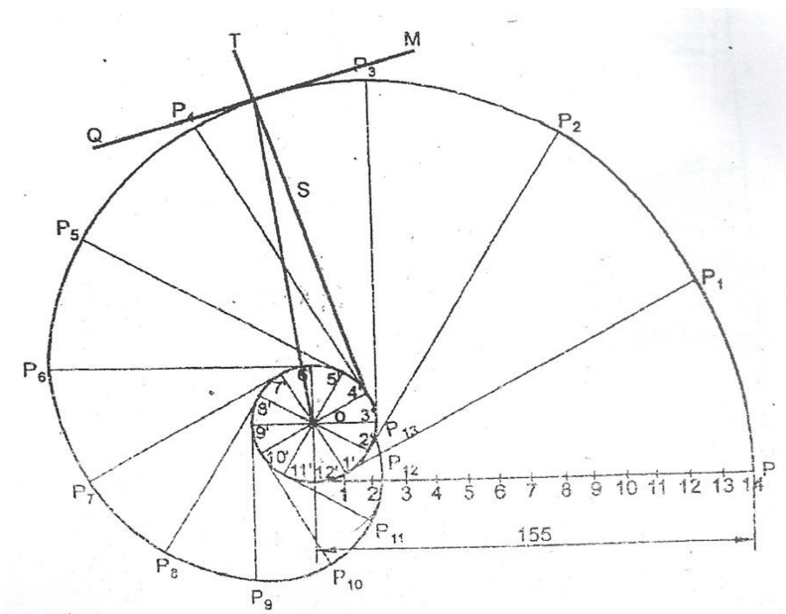
Procedure :

1. Draw a circle of diameter 50 mm.
2. Divide the circle into 12 equal parts and mark the names 1,2,3, etc., in clockwise direction starting from a point next to the bottom most one. Mark the centre point of the circle as O.
3. Draw a tangent AC from point 12 for a length of L = πd, (d – diameter of circle).
4. Divide AC into 12 equal points and the name points 1’,2’,3’..etc.,
5. Draw tangents from 1, 2, 3, etc., as shown in figure.
6. With 11-11’ as radius 11 as centre cut an arc on the tangent drawn from 11 and name the point as P_{11}.
7. Similarly obtain other points P_{10}, P_{11}, ..etc.,
8. Join all the points by a smooth curve to obtain an involute.

<u>Procedure to draw a tangent and normal to an involute :</u>

1. Mark a point N on the involute.
2. Join N and O. With the midpoint of ON as centre, half of ON as the radius, draw a semicircle on the opening side of the involute.
3. Mark the cutting point of the semicircle and circle as M.
4. Join M and N, which will be the normal.
5. Keep the protractor parallel to MN and draw a perpendicular from N, to draw the tangent.

2. An inelastic string 155 mm long has one stone end attached to the circumference of a circular disc of 40 mm diameter. Draw the curve traced out by the end of the string, when it is completely wound around the disc keeping it always tight (wound method)

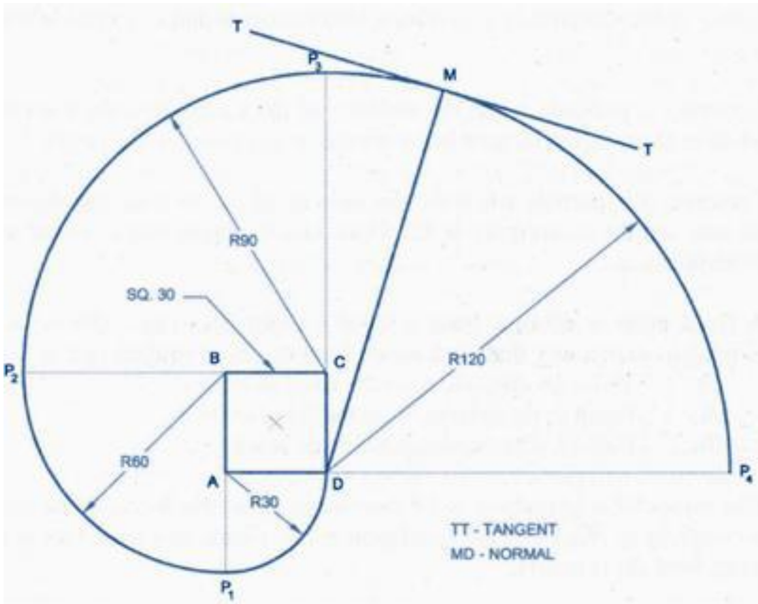


Hints :

- Draw a line 12-P tangent to 12. Divide the line 12 equal parts only for a distance of L= πd (d – diameter of circle).
- Mark the same divisions after that till p.
- Follow the same procedure with the starting radius of 12-14 with 1’ as centre.
- The involute will be closed after 12’, since the length of chord is more than circumference of the circle.

Tutorial: (Students are requested to refer the book and write the procedure for problem 3)

3. Draw the path traced by a point at the end of a string, when it is wound around a square of size 40 mm.



PROBLEMS FOR PRACTICE

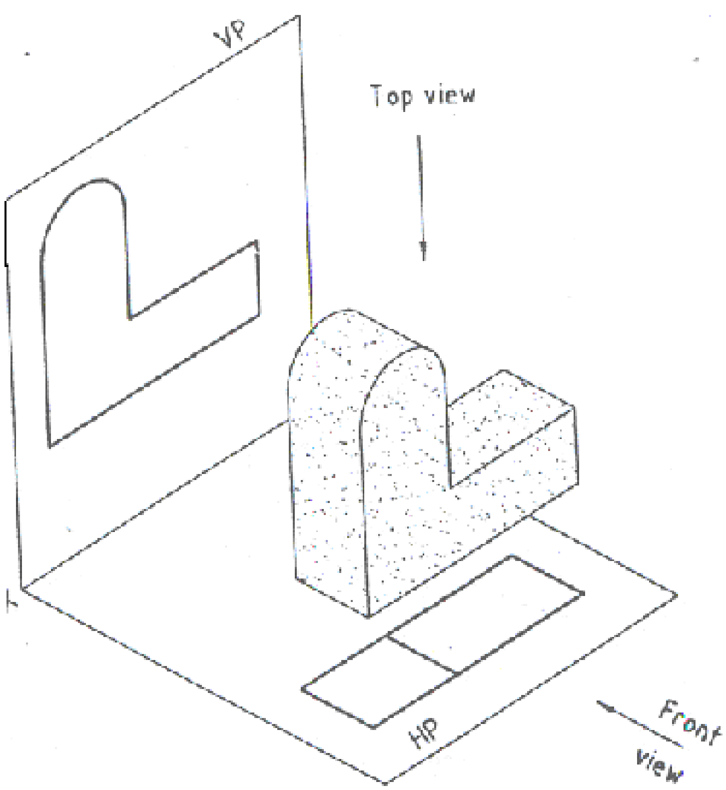
1. Draw the path traced by the end of a string when it is wound around a cylindrical drum of diameter 40 mm.

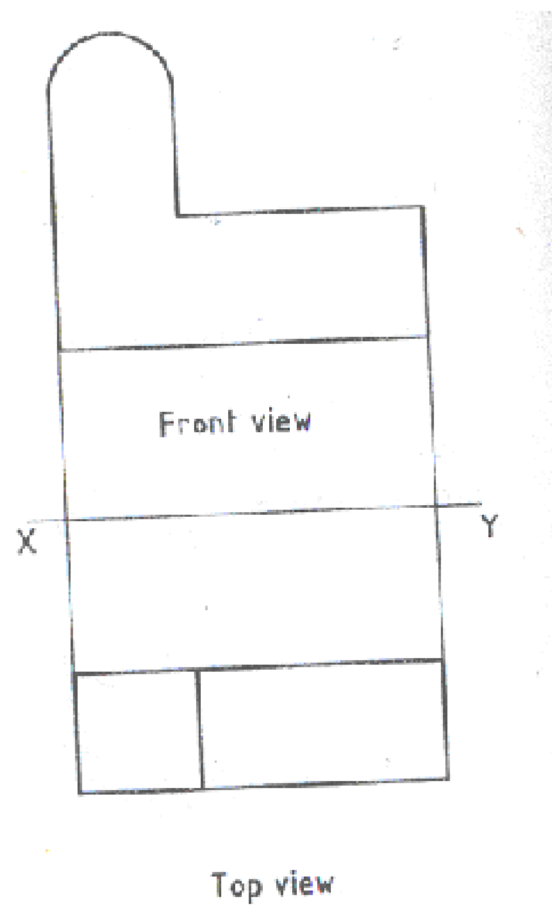
2. Draw an involute around a hexagon of side 25 mm.

ORTHOGRAPHIC PROJECTION

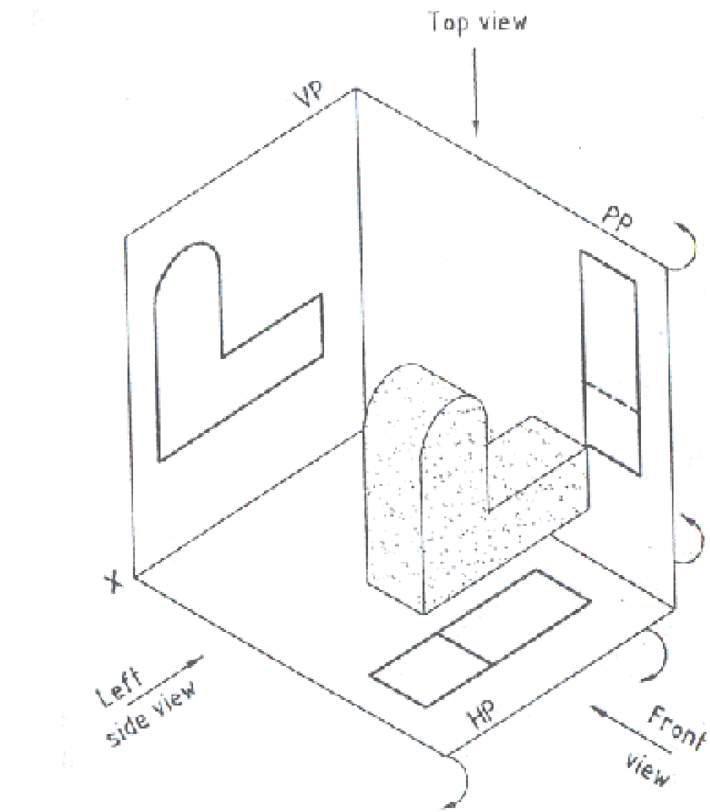
- ORTHO means Right-angle.
- GRAPHIC means Drawing.
- ORTHO GRAPHIC means Right-angled Drawing.

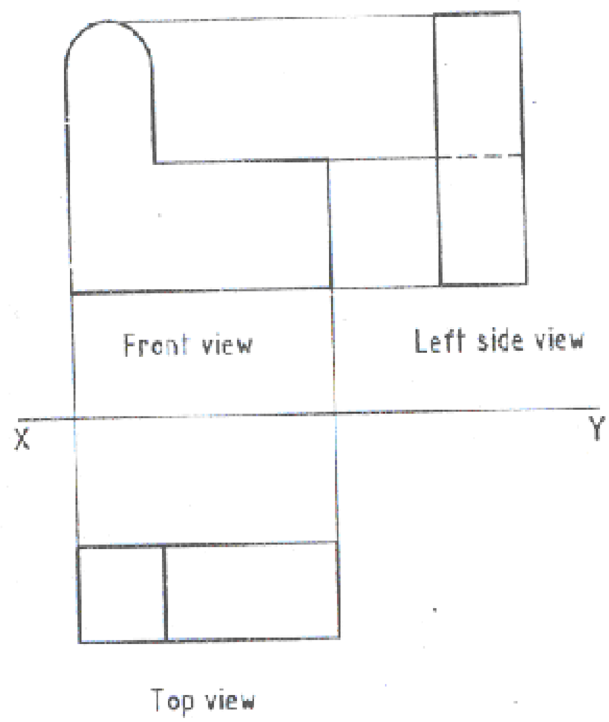
How to draw the front view (elevation) and top view (plan) in first angle projection?



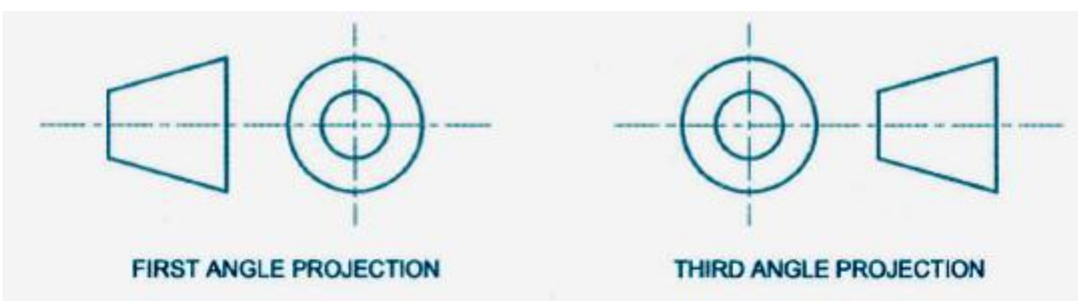


Obtaining right side view on left of the object in first angle projection

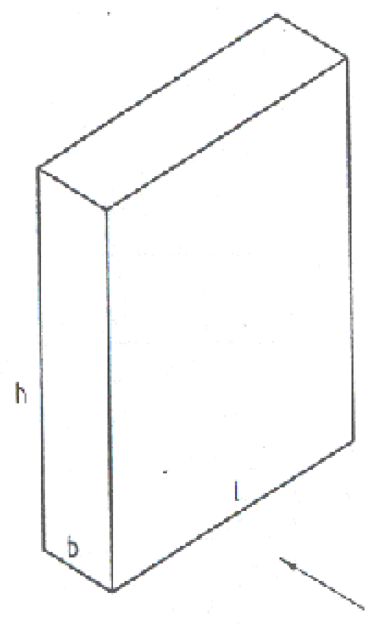




Symbol for I angle and III angle projection

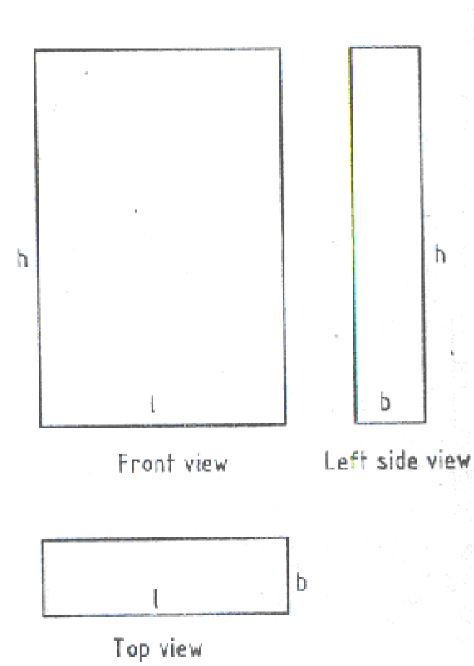


Example 1 : Draw the elevation, plan and left side view of the rectangle shown in the figure.

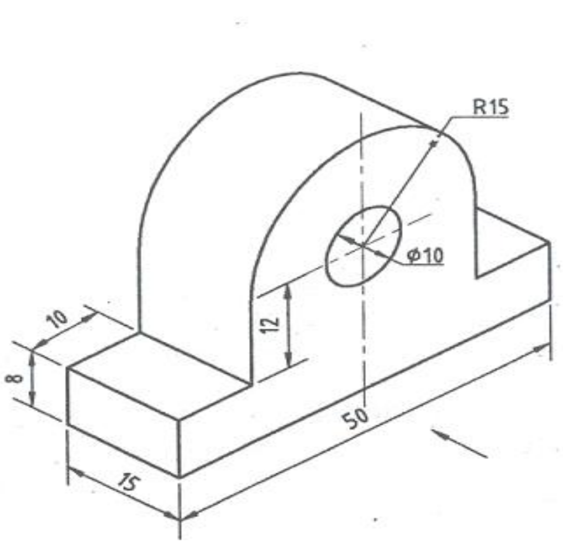


] d plan of the block given

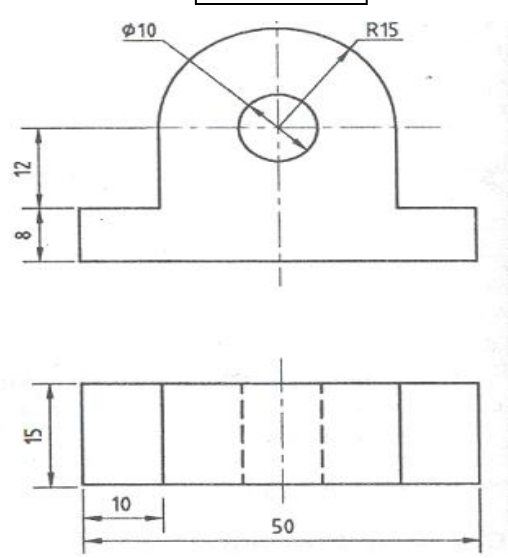
Answer



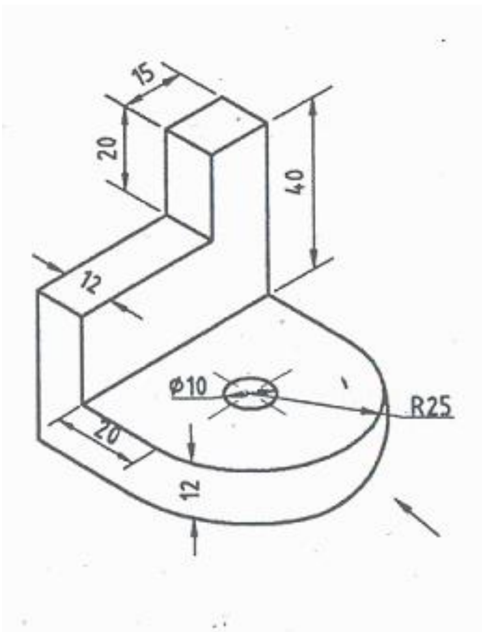
Example 2 : Draw the elevation and plan of the block shown below.



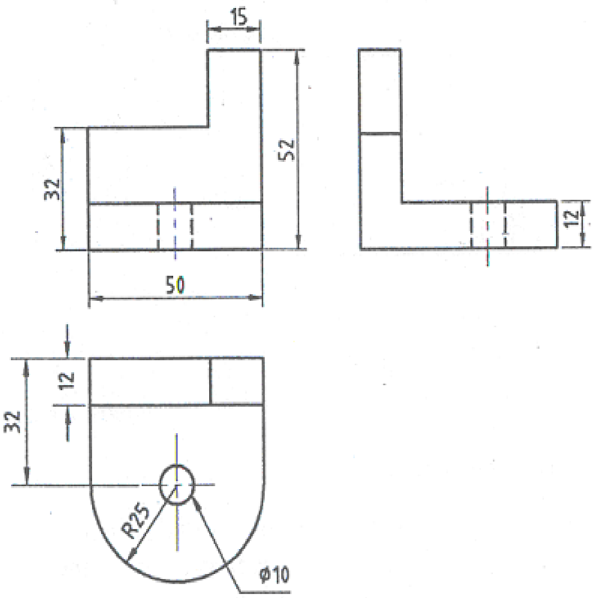
Answer



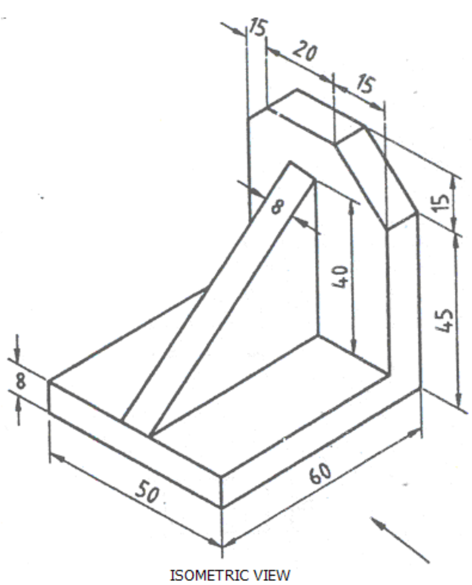
Example 3 : Draw the elevation, plan and left end view of the object shown below.



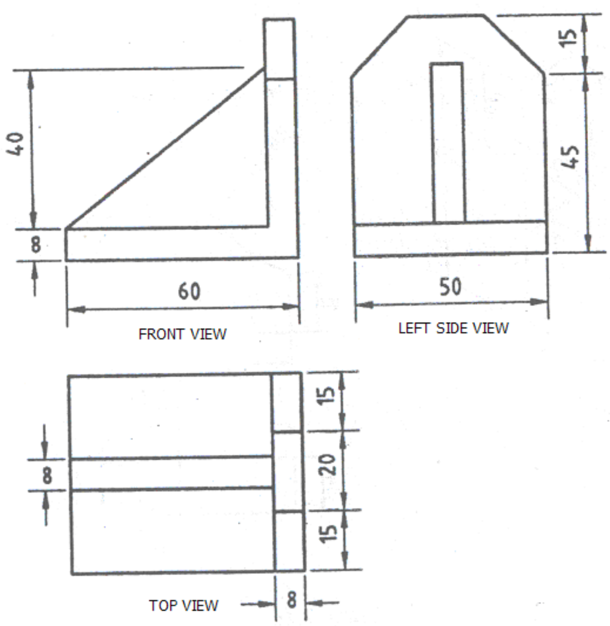
Answer



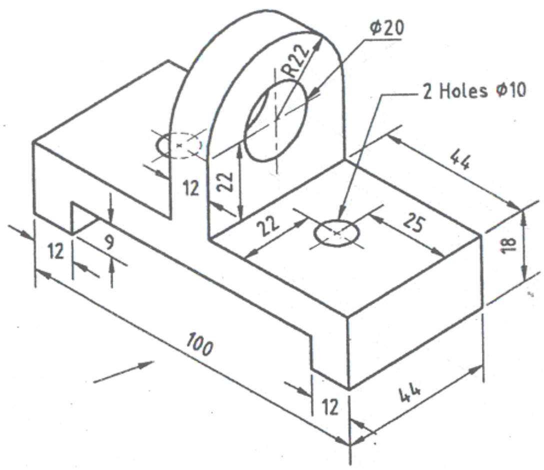
Example 4: Draw the front view, top view and left side view of the block shown below.



Answer

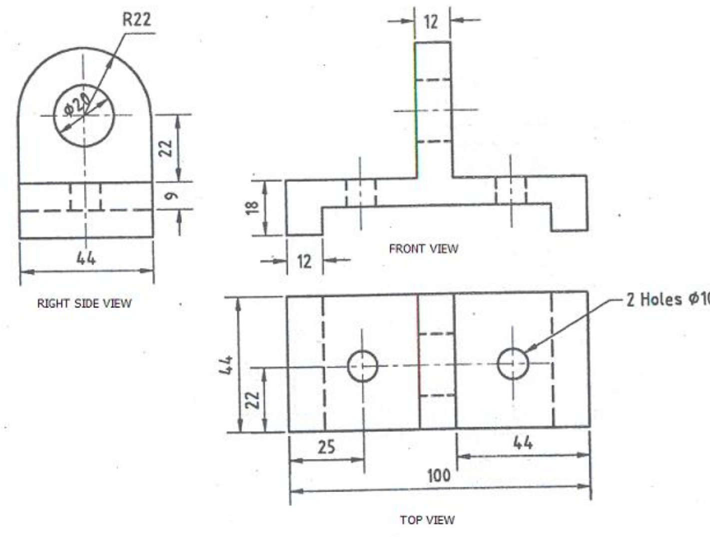


Example 5: Draw the front, top and right end view of the block shown below.



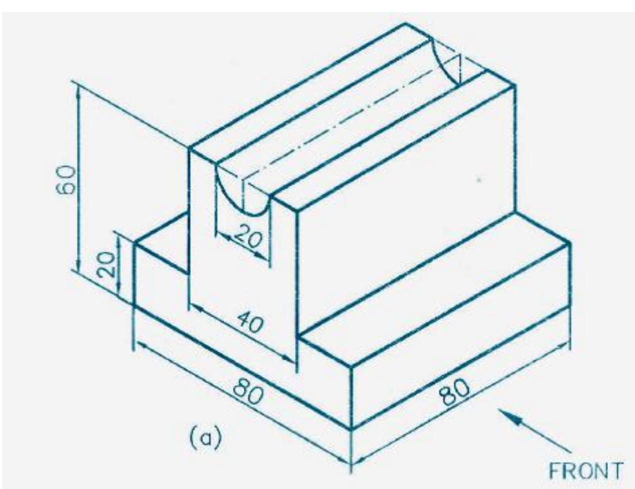
ISOMETRIC VIEW

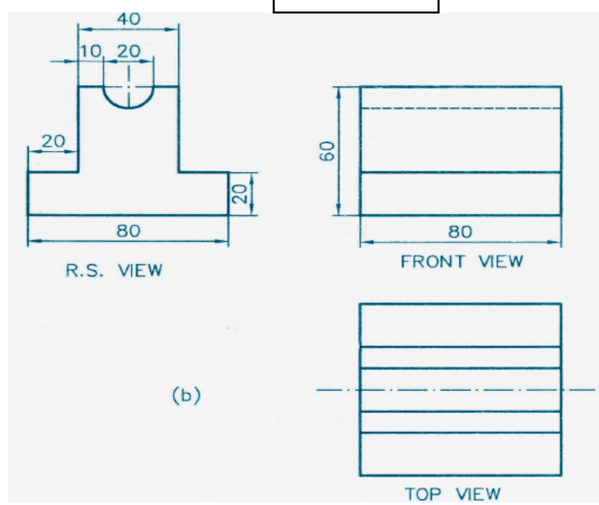
Answer



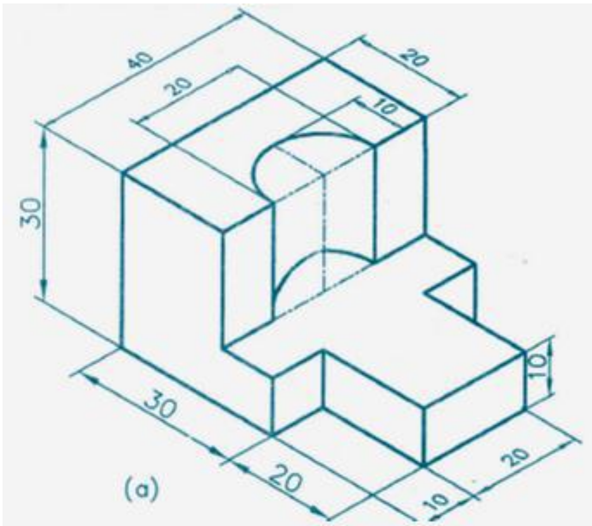
Example 6: Draw the elevation, plan and right side view of the object.

Answer

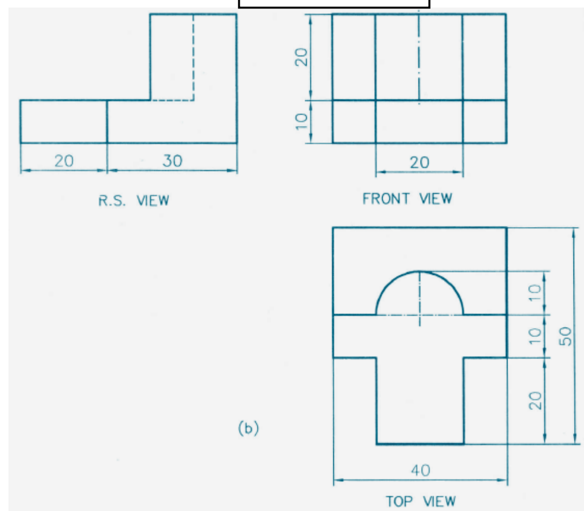




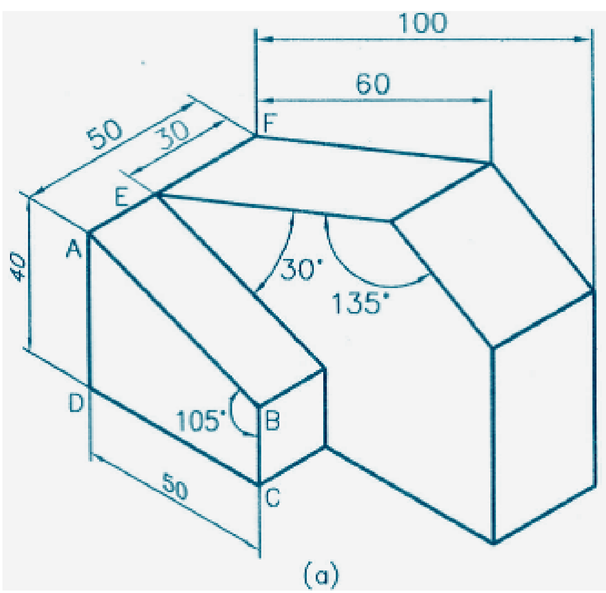
Example 7 : Draw the elevation, plan and right side view.



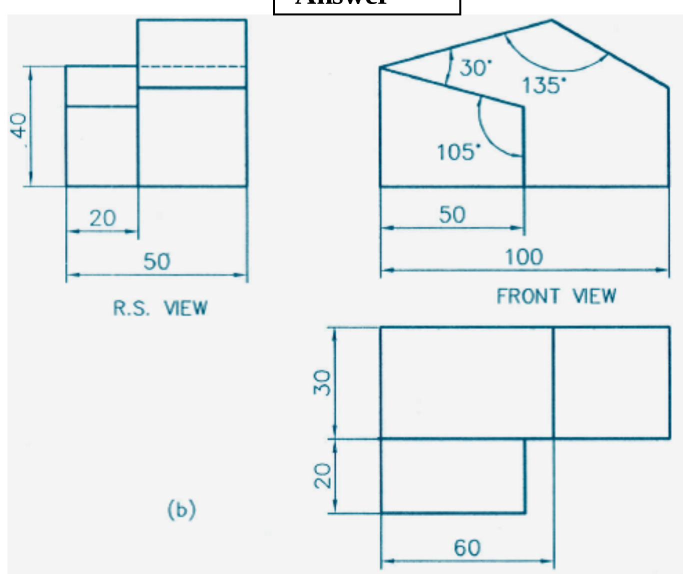
Answer



8. Draw the plan, elevation and left end view of the block shown below.

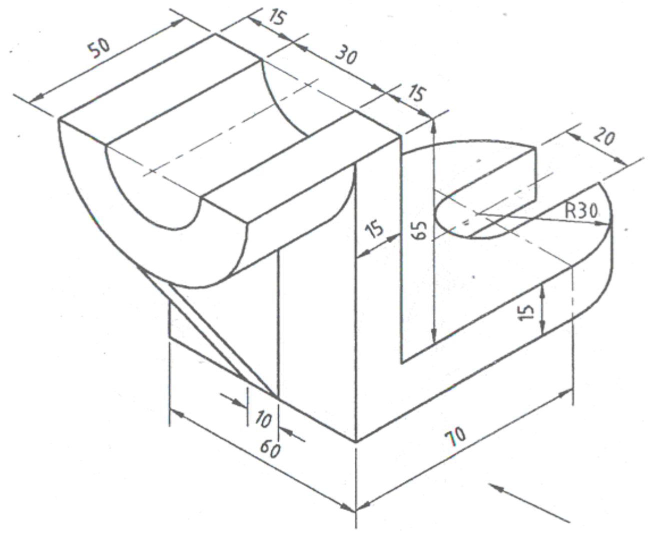


Answer



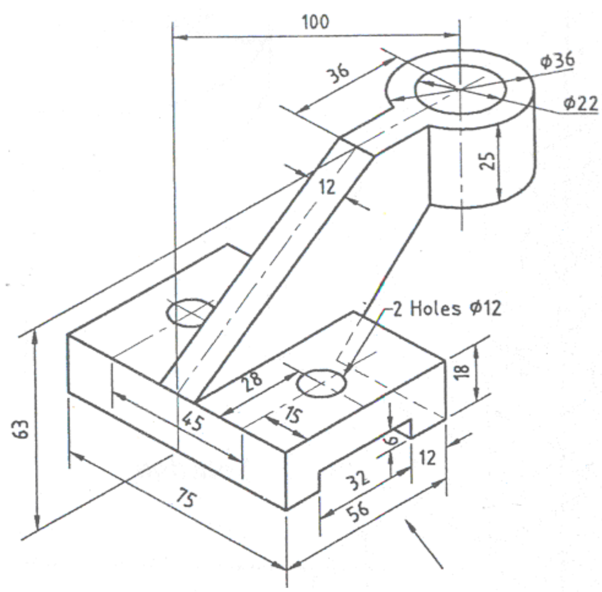
PROBLEMS FOR PRACTICE

1. Draw the elevation, plan and left end view of the block shown below.



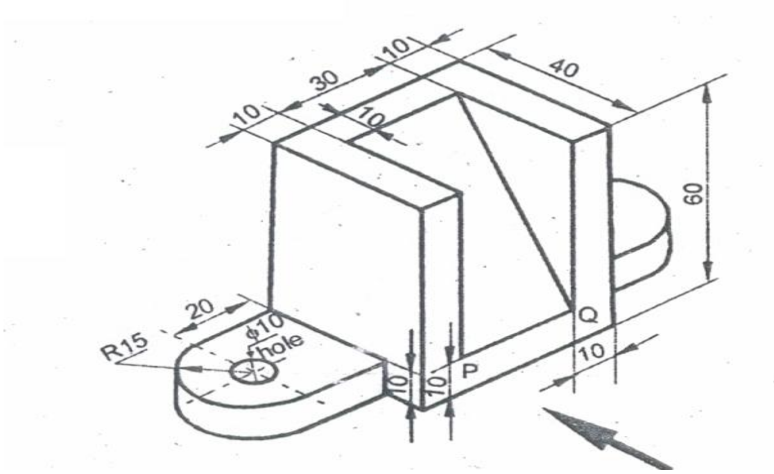
ISOMETRIC VIEW

2. Draw the elevation, plan and left side view of the object given below.

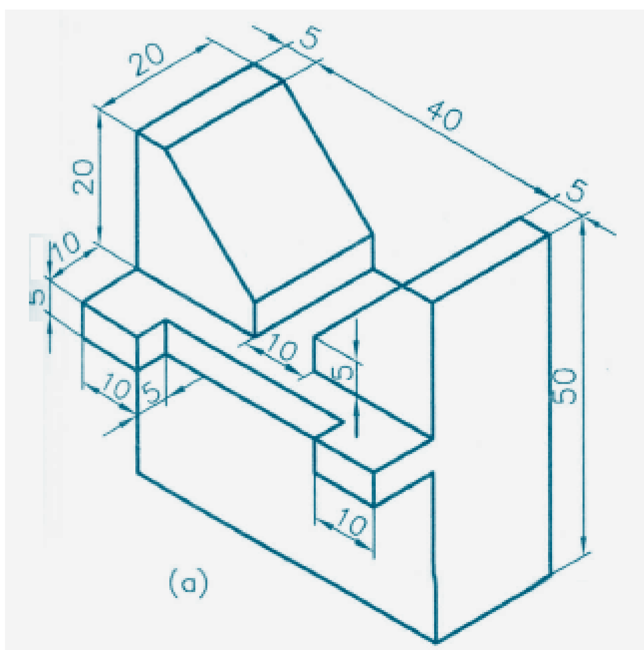


ISOMETRIC VIEW

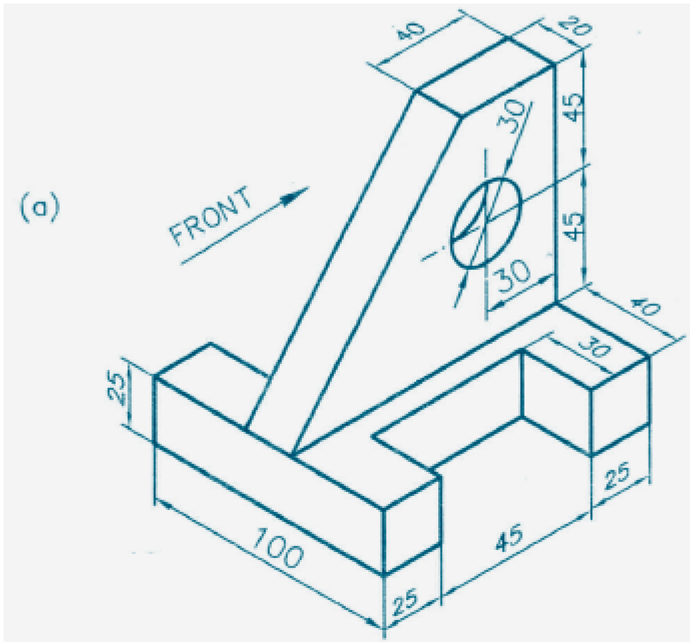
3. Draw the front, top and left side view of the block shown below.



4. Draw the plan, elevation and right end view of the object shown below.



5. Draw the front view, top view and right side view of the block shown below.



SCALES

Introduction

What is a scale?

It is not always possible or convenient to draw drawings of an object to its actual size. For instance, drawings of very big objects like buildings, machines etc., cannot be prepared in full size because they would be too big to accommodate on the drawing sheet.

Drawings of very small objects like precision instruments, namely, watches, electronic devices etc., also cannot be prepared in full size because they would be too small to draw and to read. Therefore a convenient scale is always chosen to prepare the drawings of big as well as small objects in proportional with smaller or larger sizes. So the scales are used to prepare a drawing at a full size, reduced size or enlarged size.

Definition :

Scale is defined as the ratio of the linear dimension of an element of an object as represented in the original drawing to the linear dimension of the same element of the object itself.

Full size scale

If we show the actual length of an object on a drawing, then the scale used is called full size scale.

Reducing scale

If we reduce the actual length of an object so as to accommodate that object on drawing, then scale used is called reducing scale. Such scales are used for the preparation of drawings of large machine parts, buildings, bridges, survey maps, architectural drawings etc.

Enlarging scale

Drawings of smaller machine parts, mechanical instruments, watches, etc. are made larger than their real size. These are said to be drawn in an increasing or enlarging scale.

Note: The scale of a drawing is always indicated on the drawing sheet at a suitable place either below the drawing or near the title thus "scale 1:2". Representative Fraction (R.F)

The ratio of the drawing of an object to its actual size is called the representative fraction, usually referred to as R.F.

R.F = Drawing of an object/ Its actual size (in same units)

For reducing scale, the drawings will have R.F. values of less than unity.

For example, if 1 cm on drawing represents 1 m length of an object,

$$R.F = \frac{1cm}{(1 \times 100\,cm)}$$

$$R.F = \frac{1}{100} < 1$$

For drawings using increasing or enlarging scale, the R.F values will be greater than unity.

For example, when 1 mm length of an object is shown by a length of 1cm on the drawing, then

$$R.F = \frac{1 \times 10}{1mm} = \frac{10}{1} > 1$$

The engineering scales recommended by BIS (Bureau of Indian Standards) are as follows

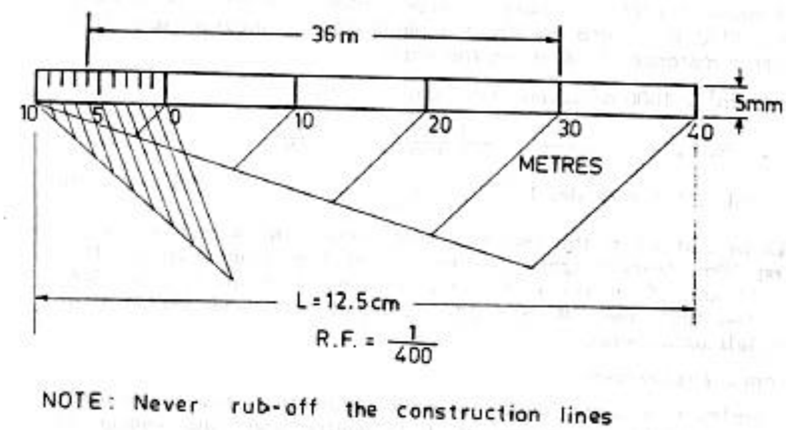
Types of Scales

1. Simple scales
2. Diagonal scales
3. Vernier scales

Plain Scale

A plain scale is simply a line, which is divided into a suitable number of equal parts, the first of which is further sub-divided into small parts. It is used to represent either two units or a unit and its fraction such as km, m and dm, etc.

Example 1: Construct a plain scale to show meters when 1cm represents 4 meters and long enough to measure up to 50 metres. Find the R.F. and mark on it a distance of 36 meters.



PLAIN SCALE

Procedure:

$$1.\ R.F = \frac{\text{Drawing size}}{\text{Actual size (in same units)}} = \frac{1\,cm}{(4 \times 100\ cm)} = \frac{1}{400}$$

2. Length of scale = R.F × Maximum length to be measured

Maximum length to be measured = 50 m.

$$\text{Therefore length of scale, } L = \left(\frac{1}{400}\right) \times 50\,m = \left(\frac{1}{400}\right) \times 50 \times 100\,cm = 12.5\,cm$$

3. Draw a horizontal line of length 12.5 (L).
4. Draw a rectangle of size 12.5×0.5 cm on the horizontal line drawn above
5. Total length to be measured is 50m.therefore divide the rectangle into 5(n) equal divisions, each division representing 10 m.

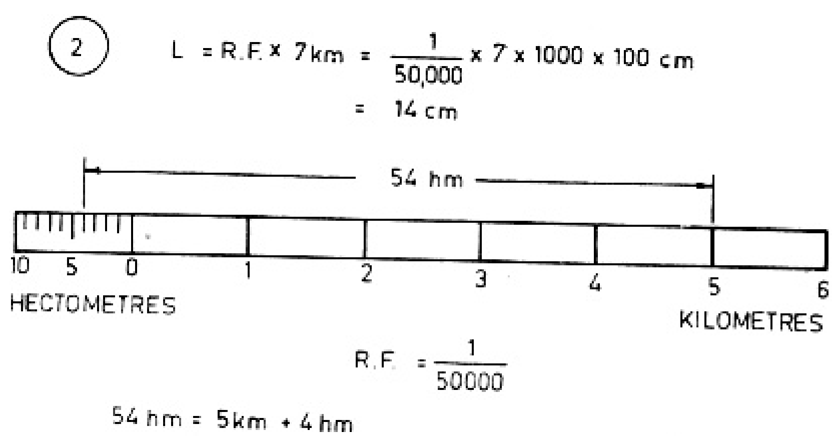
6. Mark 0 at the end of the first main division.
7. From 0, number 10, 20, 30 and 40 at the end of subsequent main divisions towards right as shown.
8. Then sub-divide the first main division into 10 subdivisions to represent metres (using geometrical construction).
9. Number the sub-divisions i.e. metres to the left of 0 as shown.
10.Write the names of main units and sub-units (METRES) below the scale. Also mention the R.F. as shown.
11. Indicate on the scale a distance of 36metres [=3main divisions to the right side of 0+6 subdivisions to the left of 0 (zero)]

Example 2 : Construct a plain scale of R.F. = 1:50,000 to show kilometers and hectometers and long enough to measure upto 7 kilometres. Measure a distance of 54 hectometers on your scale.

Procedure:

1. $\text{Length of scale} = \left(\frac{1}{50000}\right) \times 7 \text{ km} \times 7 \times 1000 \times 100\,\text{cm} = 14\,\text{cm}$

2. Draw a rectangle of size 14cmx0.5cm.divide the rectangle into 7 equal divisions, each representing 1km or 10 hm.
3. Mark 0 at the end of first main division and 1,2,3…6 at the end of subsequent main divisions towards right. Sub-divide the first division into 10 sub-divisions, each representing 1 hm. Number the sub-divisions to the left of 0 (zero).



Example 3 : A room of 1000 m^3 volume is represented by a block of 125 cm^3 volume. Find R.F. and construct a plain scale to measure upto 30 m. Measure a distance of 18 m on the scale.

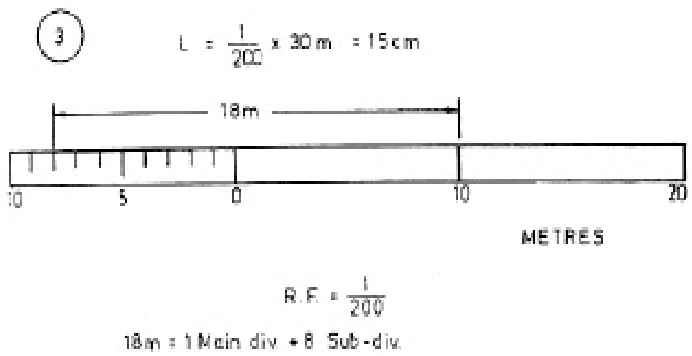
Procedure:

1. 125 cm^3 =1000 m^3 (*given*) i.e. 5 cm=10 m.

$$2.\text{Therefore R.F} = \frac{1\text{cm}}{(2\times100\,\text{cm})} = \frac{1}{200}$$

$$3.\text{Length of the scale, } L = \frac{1}{200}\times30\times100 = 15\,\text{cm}$$

Note: While doing problems on volume /area, change the units of volume/area into the corresponding linear measures in order to find the length of the scale to construct the plain scale.



Diagonal Scales

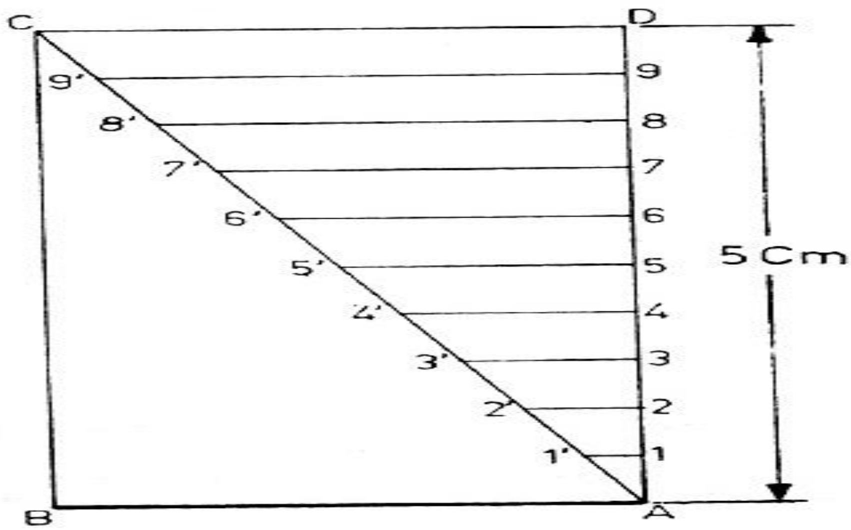
Plain scales are used to read lengths in two units such as metres and decimeters or to read the accuracy correct to first decimal. Diagonal scales are used to represent either three units of measurements such as metres, decimeters, centimeters or to read to the accuracy correct to two decimals.

Principle of Diagonal Scale

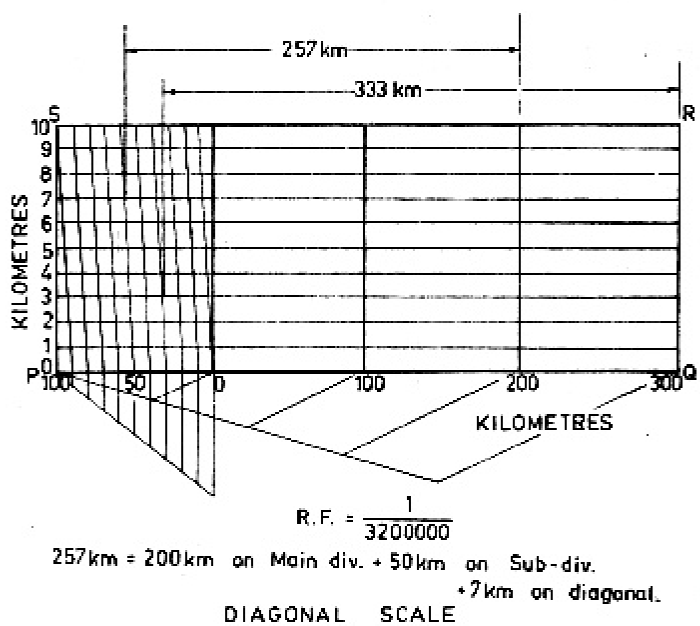
It consists of a line divided into required number of equal parts. The first part is sub-divided into smaller parts by diagonals.

1. Draw vertical lines at A and B. Divide AD into ten equal divisions of any convenient length (say 5cm) and complete the rectangle ABCD.
2. Join the diagonal AC.

3. Draw horizontal lines through the division points to meet AC at 1', 2', 3', 4', 5', & 6'.
4. Consider the similar triangles ADC and A88'. 88'/DC =A8/AD; but A8=8/10 AD. Therefore 88'/DC =8/10 i.e.. 88'=8/10 DC =0.8 DC=0.8 AB.
5. Thus the horizontal lengths 11',22', 33' etc. are equal to 0.1 AB, 0.2 AB, 0.3 AB etc. respectively, i.e. the horizontal line below CD becomes progressively shorter in length by 1/10 CD. This principle is used in constructing the diagonal scale



Example 4: Construct a diagonal scale of R.F.= 1:32,00,000 to show kilometers and long enough to measure upto 400 km. Show distances of 257 km on your scale.



Procedure :

1. R.F. =1:32,00,000 (Given).

2. $\text{Length of the scale} = \text{R.F} \times \text{Maximum distance to be measured} = \frac{1}{3200000} \times 400\,\text{km}$

$$= \frac{1}{3200000} \times 400 \times 1000 \times 100\,\text{cm} = 12.5\,\text{cm}$$

3. Draw a line PQ of 12.5 cm long.
4. Maximum length to be measured is 400 km. Minimum distance to be measured =1 km (which is obtained from data $\frac{257}{333}$ km)

Therefore $\frac{\text{Maximum distance}}{\text{Minimum distance}} = 400.$ This can be obtained in 3 steps as $4 \times 10 \times 10$

5. Therefore by geometrical construction divide PQ into 4 main divisions, each main division representing 100 km. Mark 0 (zero) at the end of the first main division. Also mark 100, 200 and 300 towards the right of zero.

6. Using geometrical construction sub-divide the main division into 10 sub-divisions, each representing 10 km. To avoid crowding of numbers, mark only 50,100 towards the left of zero.

7. Draw a line PS of 5cm long perpendicular to PQ.

8. Complete the rectangle PQRS and draw vertical lines from each main division on PQ.

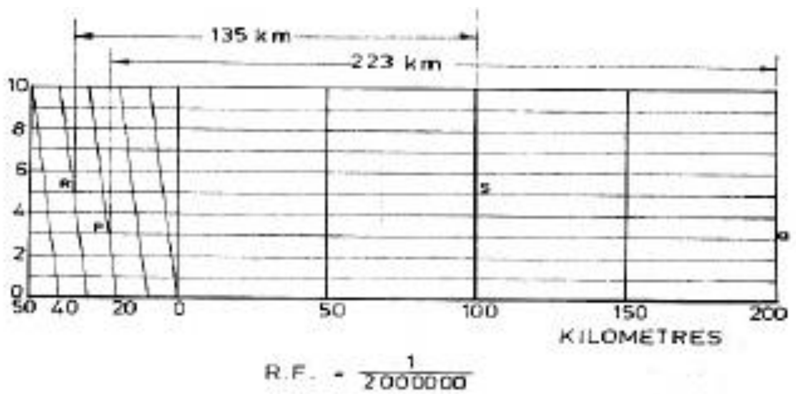
9. Divide PS into 10 equal divisions and name the divisions as 0,1,2,3…10 from P to S.

10. Draw horizontal lines from each division on PS.

11. Join S to the first sub-division from P on the main scale PQ.Thus the first diagonal line is drawn.

12. Similarly draw the remaining 9 diagonals parallel to the first diagonal. Thus each 10 km is divided into 10 equal parts by diagonals.

Example 5: The distance between Coimbatore and Madurai is 200 km and its equivalent distance on the map measures 10 cm. Draw a diagonal scale to indicate 223 km and 135 km.



Procedure:

$$1. 10\,\text{cm on the map represents } 200\,\text{km. So } R > F >= \frac{10\,\text{cm}}{200\,\text{km}}\ 2000000$$

$$2. \text{So, take the length of the scale as } 12.5\,\text{cm to represent the actual distance } \frac{12.5\,\text{cm} \times 200\,\text{km}}{10\,\text{cm}} = 250\,\text{km}$$

$$3. \text{Max} = 250\,\text{km}; \text{Min} = 1\,\text{km}; \frac{\text{Max}}{\text{Min}} = 250 = 5 \times 5 \times 10$$

Vernier Scales

Like diagonal scales, vernier scales are used to read very small units with accuracy. They are used, when a diagonal scale is inconvenient to use due to lack of space. A vernier scale consists of two parts, i.e., Main scale and a vernier. The main scale is a Plain scale divided into minor divisions.

The vernier is also a scale used along with the main scale to read the third unit, which is the fraction of the second unit on the main scale.

Least count: Least count the smallest distance that can be measured accurately by the vernier scale and is the vernier scale and is the difference between a main scale division and a vernier scale division.

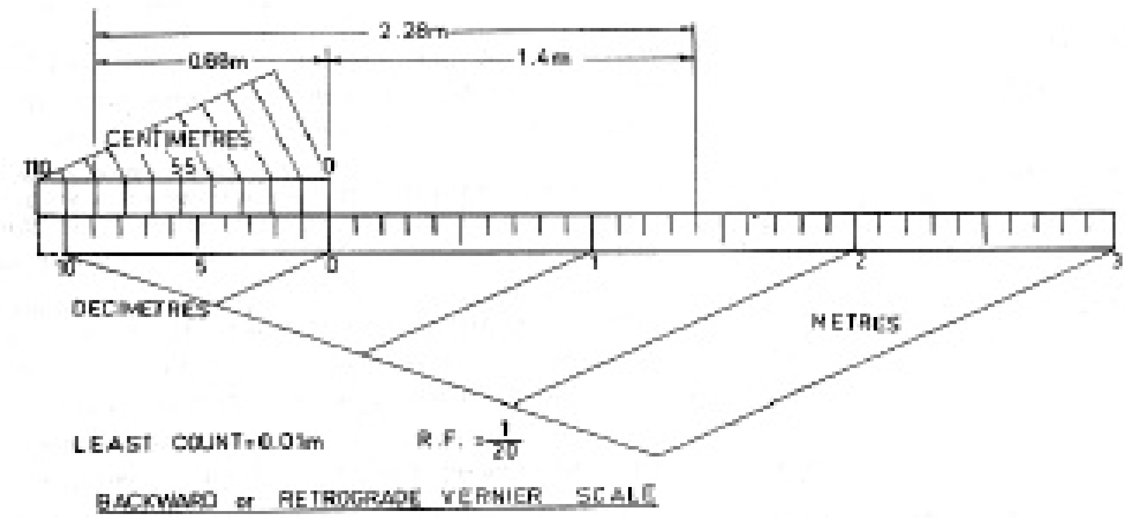
Types of Verniers:

1. Forward vernier or direct vernier
2. Backward vernier or retrograde vernier

Backward / Retrograde Vernier

In this type, the markings on the vernier are in a direction opposite to that of the main scale and (n+1) main scale divisions are divided into n vernier scale divisions.

Example 6: Construct a vernier scale to read meters, decimeters and centimeters and long enough to measure upto 4 m. R >F> of the scale is 1/20. Mark on your scale a distance of 2.28 m.



Procedure:

1. **Least count:** It is required to measure metres, decimeters and centimeters, i.e., the smallest measurement on the scale is cm. Therefore, L.C .= smallest distance to be measured = 1cm = 0.01m.

2. $\text{Length of the scale} = R > F > \text{maximum distance to be measured} = \left(\frac{1}{20}\right) \times 4\,\text{cm}$

3. $\text{Main scale: Draw a line of } 20\,\text{cm length. Complete the rectangle of } 20\,\text{cm} \times 0.5\,\text{cm}$ $\text{and divide this into 4 equal parts each representing 1 metre.}$

$\text{Sub-divide each part into 10 main scale divisions. } 1\,\text{m.s.d} = \frac{1\text{m}}{10} = 1\,\text{dm}$

To construct the vernier to centimeter:

4. Take1division on themain scale and divide it into10equal partson thevernier scale by geometrical construction. So1 V.S.D = $\frac{11M.S.D}{10}$ =11×1dm

5. Mark 0,55,1106 towards the left from 0on the vernier scale as shown.

6. Name the units of the main divisions, sub-divisions and vernier divisions on the figure as shown.

7. 2.28 m = (V.S.D x 8) + (M.S.D x14) = (0.11 m x 14) = 90.88 =1.4) m.

References

- *K.V, Natarajan, Engineering graphics, Dhanalakhshmi Publications, 2012.*
- *Venugopal, Engineering graphics, New age international, 2010.*

SCALES

DIMENSIONS OF LARGE OBJECTS MUST BE REDUCED TO ACCOMMODATE ON STANDARD SIZE DRAWING SHEET.THIS REDUCTION CREATES A SCALE OF THAT REDUCTION RATIO, WHICH IS GENERALLY A FRACTION..

SUCH A SCALE IS CALLED REDUCING SCALE

AND

THAT RATIO IS CALLED REPRESENTATIVE FACTOR.

SIMILARLY IN CASE OF TINY OBJECTS DIMENSIONS MUST BE INCREASED FOR ABOVE PURPOSE. HENCE THIS SCALE IS CALLED ENLARGING SCALE. HERE THE RATIO CALLED REPRESENTATIVE FACTOR IS MORE THAN UNITY.

FOR FULL SIZE SCALE
R.F.=1 OR (1:1)
MEANS DRAWING & OBJECT ARE OF SAME SIZE.
Other RFs are described as
1:10, 1:100,
1:1000, 1:1,00,000

USE FOLLOWING FORMULAS FOR THE CALCULATIONS IN THIS TOPIC.

A REPRESENTATIVE FACTOR (R.F.) =

$$\frac{\text{DIMENSION OF DRAWING}}{\text{DIMENSION OF OBJECT}} = \frac{\text{LENGTH OF DRAWING}}{\text{ACTUAL LENGTH}} = \sqrt{\frac{\text{AREA OF DRAWING}}{\text{ACTUAL AREA}}} = \sqrt[3]{\frac{\text{VOLUME AS PER DRWG.}}{\text{ACTUAL VOLUME}}}$$

B LENGTH OF SCALE = R.F. X MAX. LENGTH TO BE MEASURED.

BE FRIENDLY WITH THESE UNITS.

1 KILOMETRE	= 10 HECTOMETRES
1 HECTOMETRE	= 10 DECAMETRES
1 DECAMETRE	= 10 METRES
1 METRE	= 10 DECIMETRES
1 DECIMETRE	= 10 CENTIMETRES
1 CENTIMETRE	= 10 MILIMETRES

TYPES OF SCALES:

1. PLAIN SCALES (FOR DIMENSIONS UP TO SINGLE DECIMAL)
2. DIAGONAL SCALES (FOR DIMENSIONS UP TO TWO DECIMALS)
3. VERNIER SCALES (FOR DIMENSIONS UP TO TWO DECIMALS)
4. COMPARATIVE SCALES (FOR COMPARING TWO DIFFERENT UNITS)
5. SCALE OF CORDS (FOR MEASURING/CONSTRUCTING ANGLES)

PLAIN SCALE:-This type of scale represents two units or a unit and it's sub-division.

PROBLEM NO.1:- Draw a scale 1 cm = 1m to read decimeters, to measure maximum distance of 6 m.
Show on it a distance of 4 m and 6 dm.

CONSTRUCTION:-

a) Calculate R.F.= $\frac{\text{DIMENSION OF DRAWING}}{\text{DIMENSION OF OBJECT}}$

PLAIN SCALE

R.F.= 1cm/ 1m = 1/100

Length of scale = R.F. X max. distance

= 1/100 X 600 cm

= 6 cms

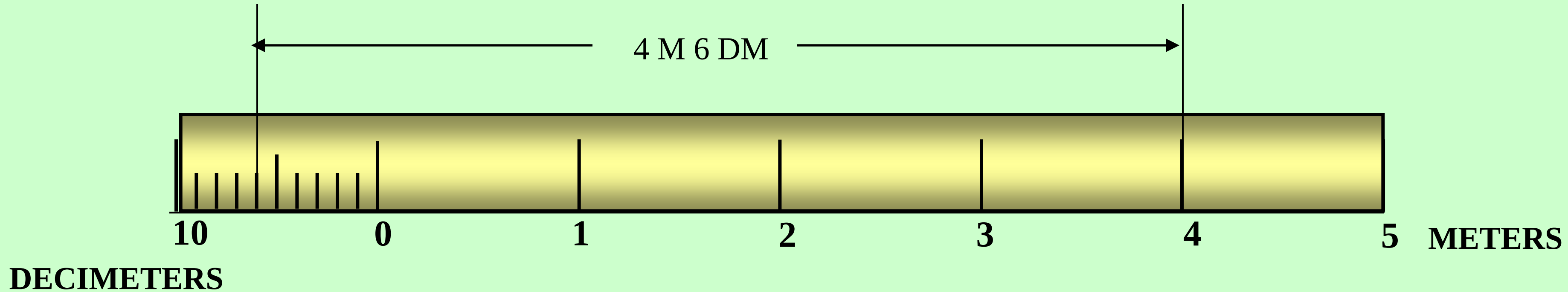
b) Draw a line 6 cm long and divide it in 6 equal parts. Each part will represent larger division unit.

c) Sub divide the first part which will represent second unit or fraction of first unit.

d) Place (0) at the end of first unit. Number the units on right side of Zero and subdivisions on left-hand side of Zero. Take height of scale 5 to 10 mm for getting a look of scale.

e) After construction of scale mention it's RF and name of scale as shown.

f) Show the distance 4 m 6 dm on it as shown.



R.F. = 1/100

PLANE SCALE SHOWING METERS AND DECIMETERS.

PROBLEM NO.2:- In a map a 36 km distance is shown by a line 45 cms long. Calculate the R.F. and construct a plain scale to read kilometers and hectometers, for max. 12 km. Show a distance of 8.3 km on it.

PLAIN SCALE

CONSTRUCTION:-

a) Calculate R.F.

R.F.= 45 cm/ 36 km = 45/ 36 . 1000 . 100 = 1/ 80,000

Length of scale = R.F. $\times$ max. distance

= 1/ 80000 $\times$ 12 km

= 15 cm

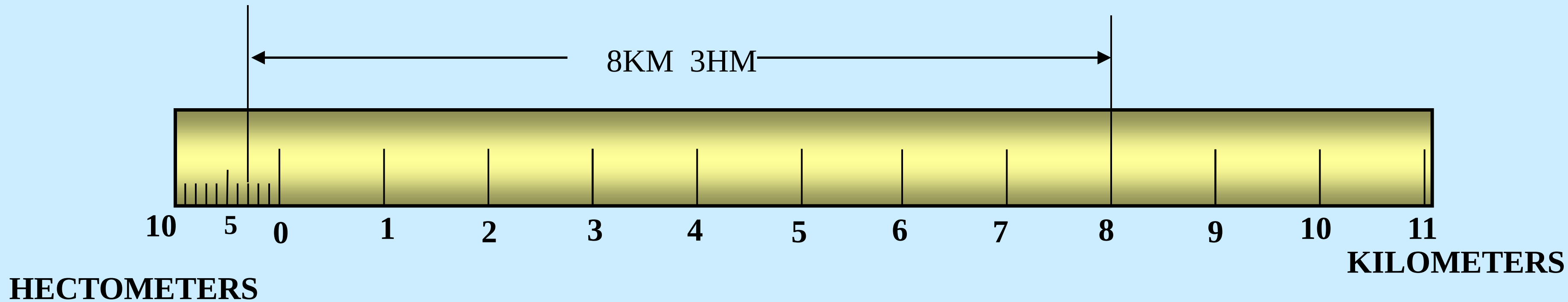
b) Draw a line 15 cm long and divide it in 12 equal parts. Each part will represent larger division unit.

c) Sub divide the first part which will represent second unit or fraction of first unit.

d) Place (0) at the end of first unit. Number the units on right side of Zero and subdivisions on left-hand side of Zero. Take height of scale 5 to 10 mm for getting a look of scale.

e) After construction of scale mention it's RF and name of scale as shown.

f) Show the distance 8.3 km on it as shown.



R.F. = 1/80,000

PLANE SCALE SHOWING KILOMETERS AND HECTOMETERS

PROBLEM NO.3:- The distance between two stations is 210 km. A passenger train covers this distance in 7 hours. Construct a plain scale to measure time up to a single minute. RF is 1/200,000 Indicate the distance traveled by train in 29 minutes.

PLAIN SCALE

CONSTRUCTION:-

a) 210 km in 7 hours. Means speed of the train is 30 km per hour (60 minutes)

Length of scale = R.F. $\times$ max. distance per hour
= 1/ 2,00,000 $\times$ 30km
= 15 cm

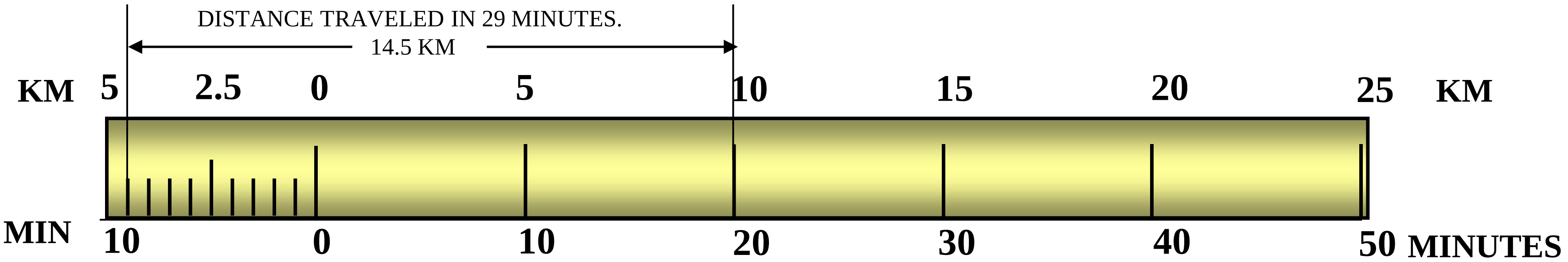
b) 15 cm length will represent 30 km and 1 hour i.e. 60 minutes.
Draw a line 15 cm long and divide it in 6 equal parts. Each part will represent 5 km and 10 minutes.

c) Sub divide the first part in 10 equal parts,which will represent second unit or fraction of first unit.
Each smaller part will represent distance traveled in one minute.

d) Place (0) at the end of first unit. Number the units on right side of Zero and subdivisions on left-hand side of Zero. Take height of scale 5 to 10 mm for getting a proper look of scale.

e) Show km on upper side and time in minutes on lower side of the scale as shown.
After construction of scale mention it's RF and name of scale as shown.

f) Show the distance traveled in 29 minutes, which is 14.5 km, on it as shown.



R.F. = 1/100

PLANE SCALE SHOWING METERS AND DECIMETERS.

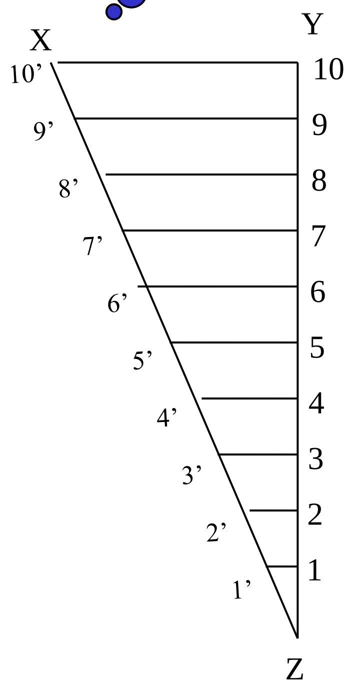
DIAGONAL SCALE

We have seen that the plain scales give only two dimensions, such as a unit and it's subunit or it's fraction.

The diagonal scales give us three successive dimensions that is a unit, a subunit and a subdivision of a subunit.

The principle of construction of a diagonal scale is as follows.
Let the XY in figure be a subunit.
From Y draw a perpendicular YZ to a suitable height.
Join XZ. Divide YZ in to 10 equal parts.
Draw parallel lines to XY from all these divisions and number them as shown.
From geometry we know that similar triangles have their like sides proportional.

Consider two similar triangles XYZ and 7' 7Z,
we have 7Z / YZ = 7'7 / XY (each part being one unit)
Means 7' 7 = 7 / 10. x X Y = 0.7 XY
:.
Similarly
1' – 1 = 0.1 XY
2' – 2 = 0.2 XY
Thus, it is very clear that, the sides of small triangles, which are parallel to divided lines, become progressively shorter in length by 0.1 XY.



The solved examples ON NEXT PAGES will make the principles of diagonal scales clear.

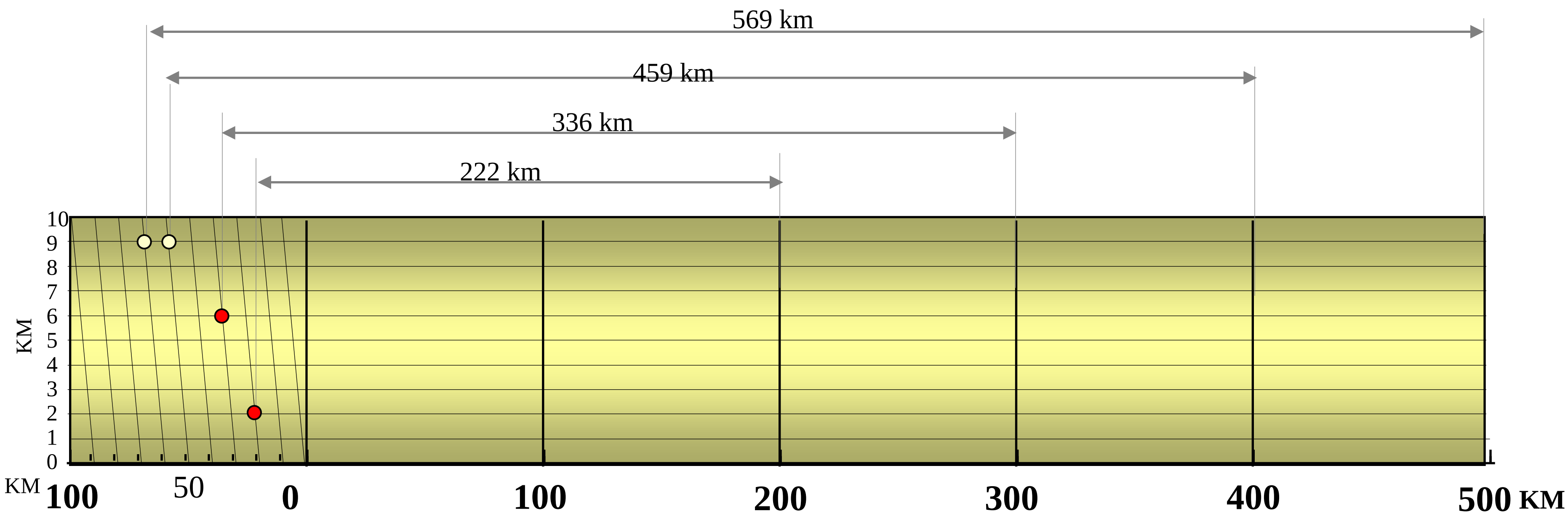
DIAGONAL SCALE

PROBLEM NO. 4 : The distance between Delhi and Agra is 200 km.
In a railway map it is represented by a line 5 cm long. Find it's R.F.
Draw a diagonal scale to show single km. And maximum 600 km.
Indicate on it following distances. 1) 222 km 2) 336 km 3) 459 km 4) 569 km

SOLUTION STEPS: RF = 5 cm / 200 km = 1 / 40, 00, 000

Length of scale = 1 / 40, 00, 000 X 600 X 10^5 = 15 cm

Draw a line 15 cm long. It will represent 600 km.Divide it in six equal parts.(each will represent 100 km.)
Divide first division in ten equal parts.Each will represent 10 km.**Draw** a line upward from left end and mark 10 parts on it of any distance. **Name** those parts 0 to 10 as shown.Join 9th sub-division of horizontal scale with 10th division of the vertical divisions. **Then** draw parallel lines to this line from remaining sub divisions and complete diagonal scale.



R.F. = 1 / 40,00,000

DIAGONAL SCALE SHOWING KILOMETERS.

PROBLEM NO.5: A rectangular plot of land measuring 1.28 hectors is represented on a map by a similar rectangle of 8 sq. cm. Calculate RF of the scale. Draw a diagonal scale to read single meter. Show a distance of 438 m on it.

DIAGONAL SCALE

SOLUTION :

1 hector = 10, 000 sq. meters

1.28 hectors = 1.28 X 10, 000 sq. meters

$= 1.28 \times 10^4 \times 10^4$ sq. cm

8 sq. cm area on map represents

$= 1.28 \times 10^4 \times 10^4$ sq. cm on land

1 cm sq. on map represents

$= 1.28 \times 10^4 \times 10^4 / 8$ sq cm on land

1 cm on map represent

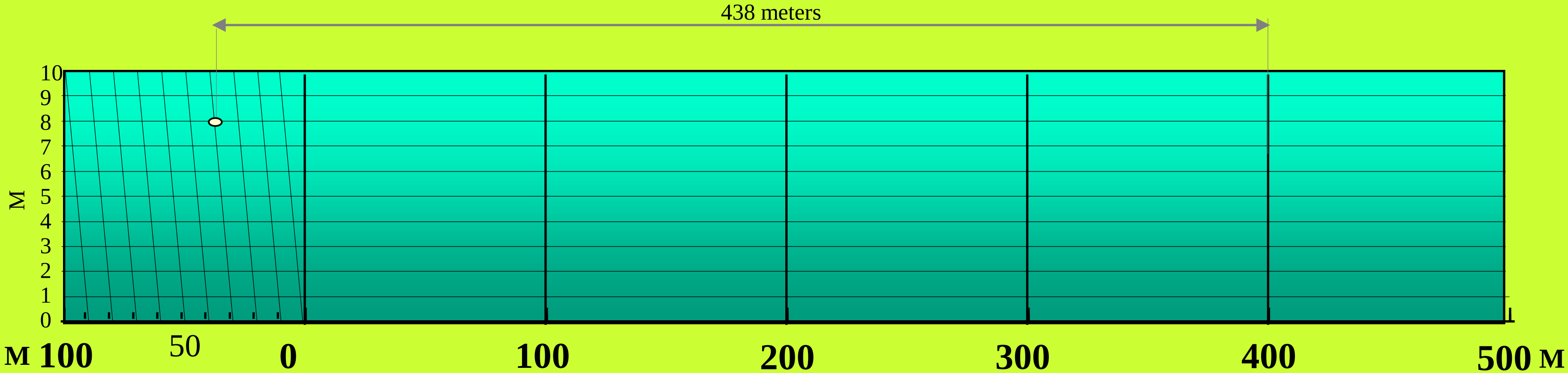
$= \sqrt{1.28 \times 10^4 \times 10^4 / 8}$ cm

= 4, 000 cm

1 cm on drawing represent 4, 000 cm, Means RF = 1 / 4000

Assuming length of scale 15 cm, it will represent 600 m.

Draw a line 15 cm long.
It will represent 600 m.Divide it in six equal parts.
(each will represent 100 m.)
Divide first division in ten equal parts.Each will represent 10 m.
Draw a line upward from left end and mark 10 parts on it of any distance.
Name those parts 0 to 10 as shown.Join 9th sub-division of horizontal scale with 10th division of the vertical divisions.
Then draw parallel lines to this line from remaining sub divisions and complete diagonal scale.



R.F. = 1 / 4000

DIAGONAL SCALE SHOWING METERS.

PROBLEM NO.6:. Draw a diagonal scale of R.F. 1: 2.5, showing centimeters and millimeters and long enough to measure up to 20 centimeters.

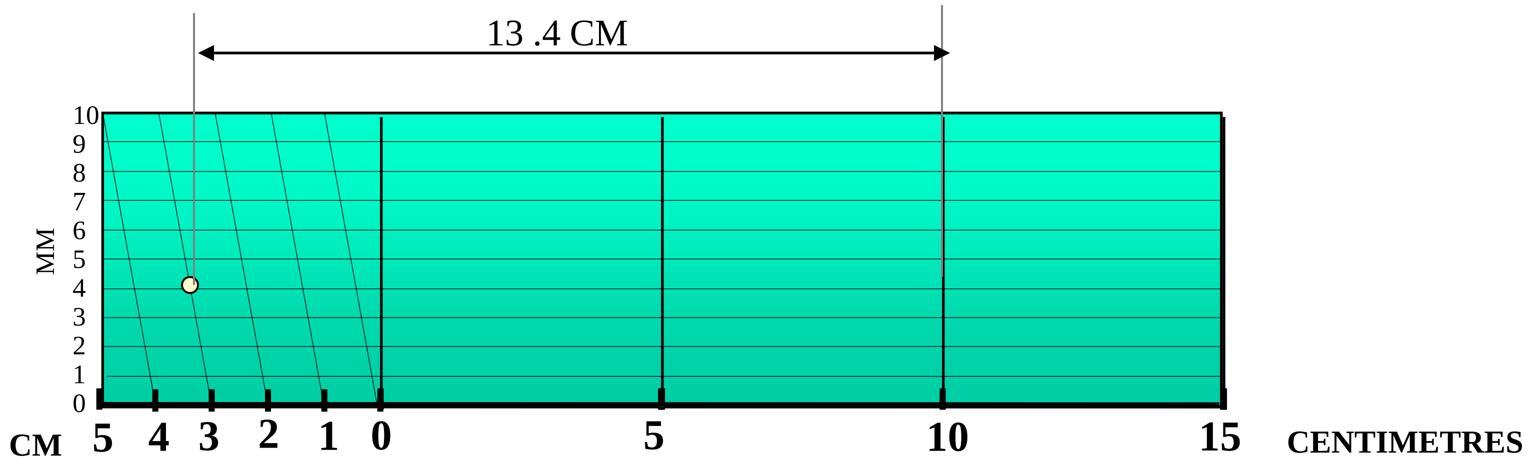
SOLUTION STEPS:

R.F. = 1 / 2.5

Length of scale = 1 / 2.5 X 20 cm.

= 8 cm.

1. Draw a line 8 cm long and divide it in to 4 equal parts.
   (Each part will represent a length of 5 cm.)
2. Divide the first part into 5 equal divisions.
   (Each will show 1 cm.)
3. At the left hand end of the line, draw a vertical line and on it step-off 10 equal divisions of any length.
4. Complete the scale as explained in previous problems.
   Show the distance 13.4 cm on it.



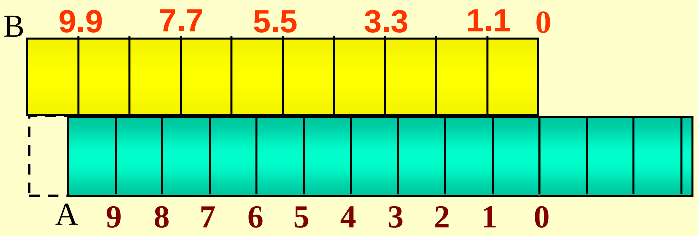
R.F. = 1 / 2.5

DIAGONAL SCALE SHOWING CENTIMETERS.

Vernier Scales:

These scales, like diagonal scales , are used to read to a very small unit with great accuracy.
It consists of two parts – a primary scale and a vernier. The primary scale is a plain scale fully divided into minor divisions.
As it would be difficult to sub-divide the minor divisions in ordinary way, it is done with the help of the vernier. The graduations on vernier are derived from those on the primary scale.

Figure to the right shows a part of a plain scale in which length A-O represents 10 cm. If we divide A-O into ten equal parts, each will be of 1 cm. Now it would not be easy to divide each of these parts into ten equal divisions to get measurements in millimeters.



Now if we take a length BO equal to 10 + 1 = 11 such equal parts, thus representing 11 cm, and divide it into ten equal divisions, each of these divisions will represent 11 / 10 – 1.1 cm.

The difference between one part of AO and one division of BO will be equal 1.1 – 1.0 = 0.1 cm or 1 mm.
This difference is called Least Count of the scale.
Minimum this distance can be measured by this scale.
The upper scale BO is the vernier.The combination of plain scale and the vernier is vernier scale.

Example 10:
Draw a vernier scale of RF = 1 / 25 to read centimeters upto 4 meters and on it, show lengths 2.39 m and 0.91 m

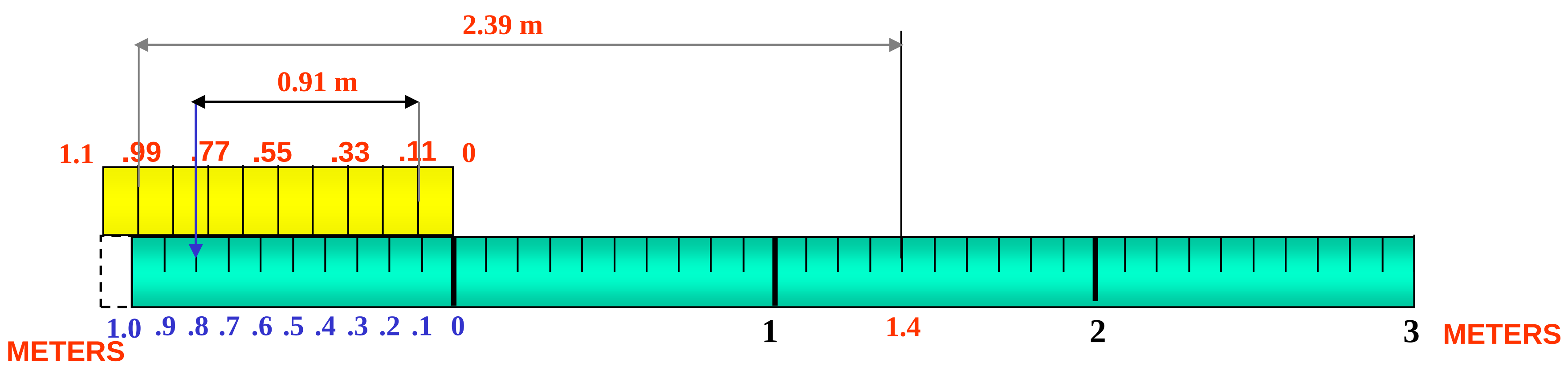
Vernier Scale

SOLUTION:
Length of scale = RF X max. Distance
= 1 / 25 X 4 X 100
= 16 cm

CONSTRUCTION: ***(Main scale)***
Draw a line 16 cm long.
Divide it in 4 equal parts.
(each will represent meter)
Sub-divide each part in 10 equal parts.
(each will represent decimeter)
Name those properly.

CONSTRUCTION: ***(vernier)***
Take 11 parts of Dm length and divide it in 10 equal parts.
Each will show 0.11 m or 1.1 dm or 11 cm and construct a rectangle
Covering these parts of vernier.

TO MEASURE GIVEN LENGTHS:
(1) For 2.39 m : Subtract 0.99 from 2.39 i.e. 2.39 - .99 = 1.4 m
The distance between 0.99 (left of Zero) and 1.4 (right of Zero) is 2.39 m
(2) For 0.91 m : Subtract 0.11 from 0.91 i.e. 0.91 – 0.11 =0.80 m
The distance between 0.11 and 0.80 (both left side of Zero) is 0.91 m



Example 11: A map of size 500cm X 50cm wide represents an area of 6250 sq.Kms. Construct a vernier scaleto measure kilometers, hectometers and decameters and long enough to measure upto 7 km. Indicate on it a) 5.33 km b) 59 decameters.

Vernier Scale

SOLUTION:

$$RF = \sqrt{\frac{\text{AREA OF DRAWING}}{\text{ACTUAL AREA}}}$$

$$= \sqrt{\frac{500 \text{ X } 50 \text{ cm sq.}}{6250 \text{ km sq.}}}$$

$$= 2 / 10^5$$

Length of scale = RF X max. Distance

$= 2 / 10^5$ X 7 kms

= 14 cm

CONSTRUCTION: ***(Main scale)***

Draw a line 14 cm long.
Divide it in 7 equal parts.
(each will represent km)
Sub-divide each part in 10 equal parts.
(each will represent hectometer)
Name those properly.

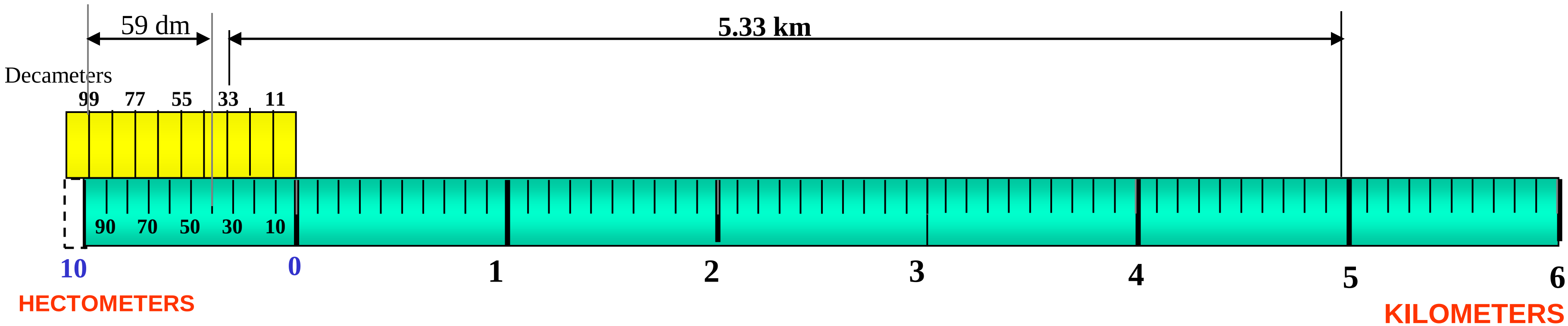
CONSTRUCTION: ***(vernier)***

Take 11 parts of hectometer part length and divide it in 10 equal parts.
Each will show 1.1 hm m or 11 dm and Covering in a rectangle complete scale.

TO MEASURE GIVEN LENGTHS:

a) For 5.33 km :
Subtract 0.33 from 5.33
i.e. 5.33 - 0.33 = 5.00
The distance between 33 dm (left of Zero) and 5.00 (right of Zero) is 5.33 k m

(b) For 59 dm :
Subtract 0.99 from 0.59
i.e. 0.59 – 0.99 = - 0.4 km
(- ve sign means left of Zero)
The distance between 99 dm and - .4 km is 59 dm
(both left side of Zero)



COMMON DEFINATION OF ELLIPSE, PARABOLA & HYPERBOLA:

These are the loci of points moving in a plane such that the ratio of it's distances from a ***fixed point*** And a ***fixed line*** always remains constant.

The Ratio is called **ECCENTRICITY. (E)**

A) For Ellipse E<1

B) For Parabola E=1

C) For Hyperbola E>1

Refer Problem nos. 6. 9 & 12

SECOND DEFINATION OF AN ELLIPSE:-

It is a locus of a point moving in a plane such that the SUM of it's distances from TWO fixed points always remains constant.

{And this ***sum equals*** to the length of ***major axis***.}

These TWO fixed points are FOCUS 1 & FOCUS 2

Refer Problem no.4

Ellipse by Arcs of Circles Method.

ELLIPSE

BY CONCENTRIC CIRCLE METHOD

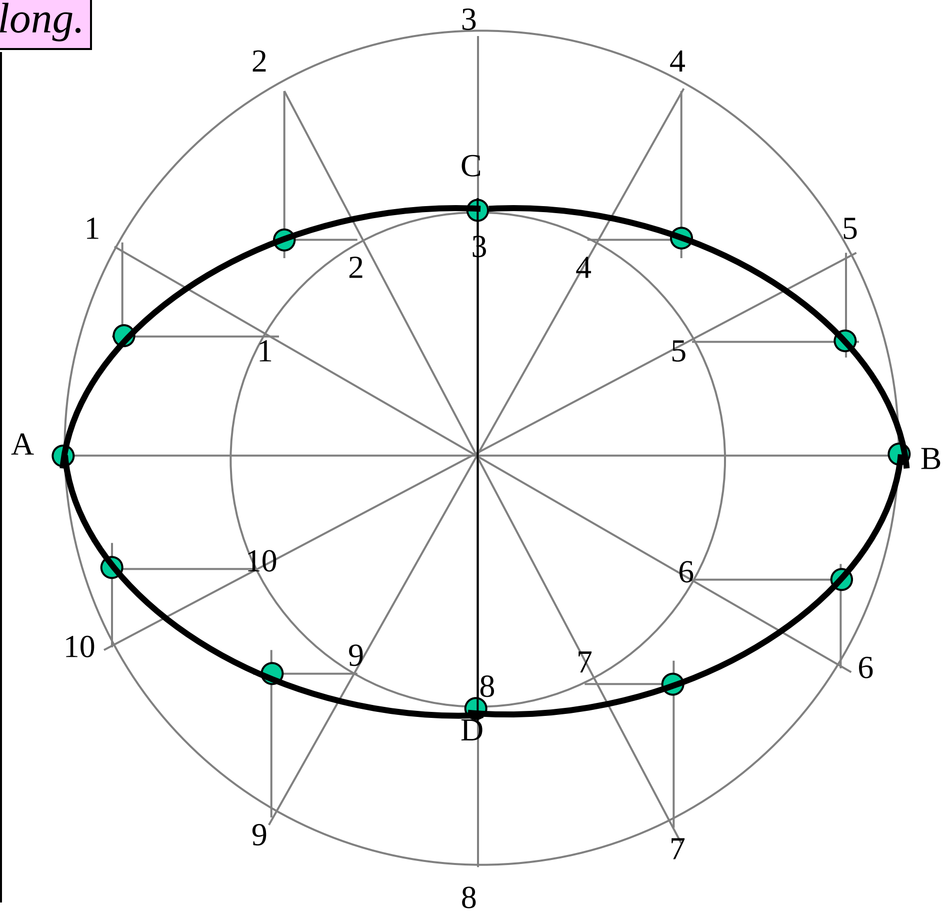
Problem 1 :-

Draw ellipse by **concentric circle method**.

Take major axis 100 mm and minor axis 70 mm long.

Steps:

1. Draw both axes as perpendicular bisectors of each other & name their ends as shown.
2. Taking their intersecting point as a center, draw two concentric circles considering both as respective diameters.
3. Divide both circles in 12 equal parts & name as shown.
4. From all points of outer circle draw vertical lines downwards and upwards respectively.
5. From all points of inner circle draw horizontal lines to intersect those vertical lines.
6. Mark all intersecting points properly as those are the points on ellipse.
7. Join all these points along with the ends of both axes in smooth possible curve. It is required ellipse.



Steps:

1 Draw a rectangle taking major and minor axes as sides.

2. In this rectangle draw both axes as perpendicular bisectors of each other..

3. For construction, select upper left part of rectangle. Divide vertical small side and horizontal long side into same number of equal parts.(here divided in four parts)

4. Name those as shown..

5. Now join all vertical points 1,2,3,4, to the upper end of minor axis. And all horizontal points i.e.1,2,3,4 to the lower end of minor axis.

6. Then extend C-1 line upto D-1 and mark that point. Similarly extend C-2, C-3, C-4 lines up to D-2, D-3, & D-4 lines.

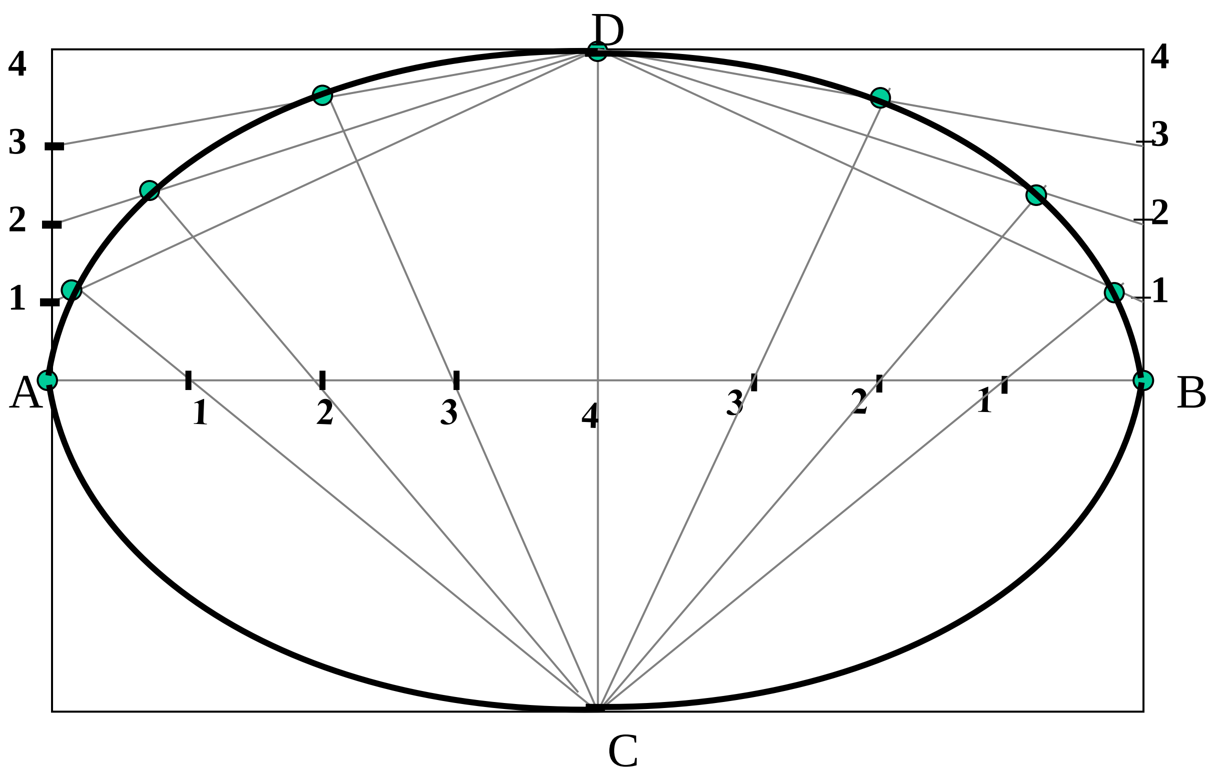
7. Mark all these points properly and join all along with ends A and D in smooth possible curve. Do similar construction in right side part.along with lower half of the rectangle.Join all points in smooth curve.

It is required ellipse.

Problem 2

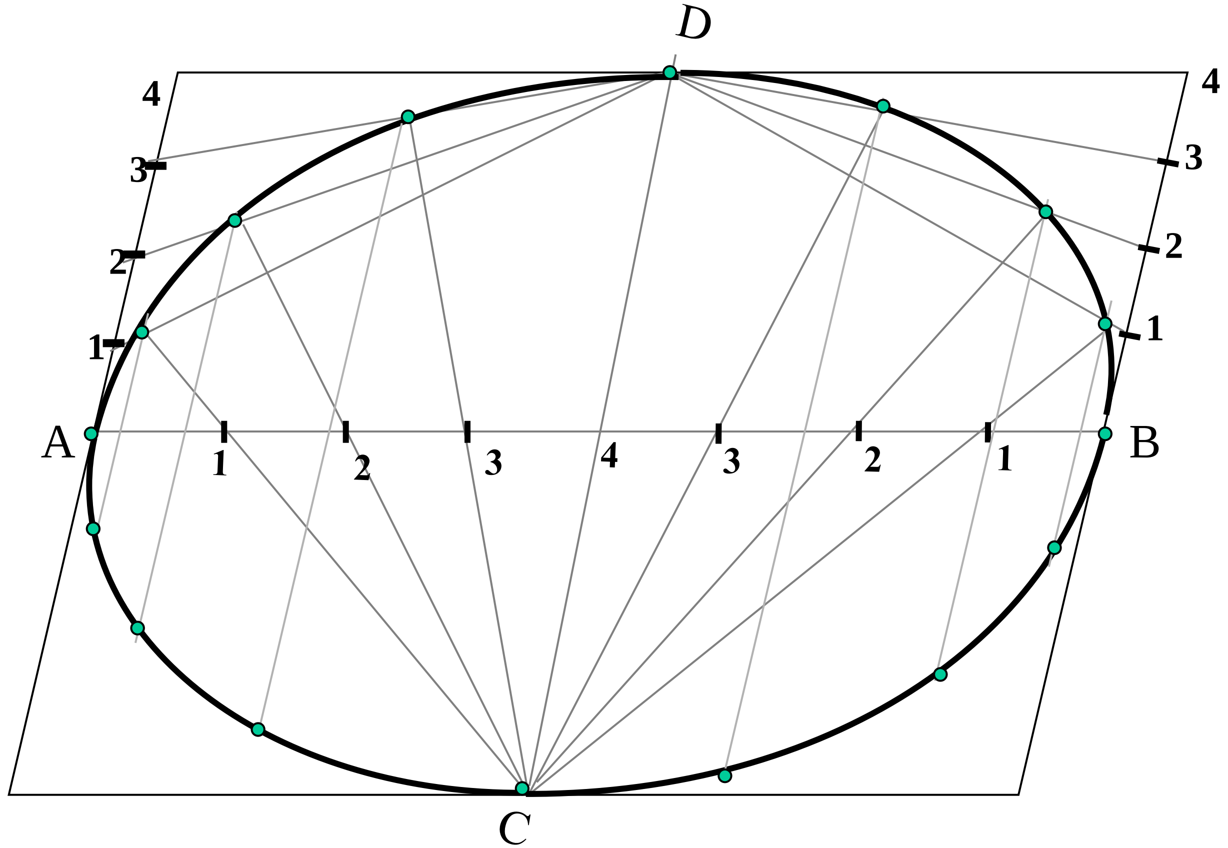
Draw ellipse by **Rectangle** *method.*

Take major axis 100 mm and minor axis 70 mm long.



Problem 3:-
Draw ellipse by **Oblong method.**
Draw a parallelogram of 100 mm and 70 mm long sides with included angle of 75⁰. Inscribe Ellipse in it.

STEPS ARE SIMILAR TO THE PREVIOUS CASE (RECTANGLE METHOD) ONLY IN PLACE OF RECTANGLE, HERE IS A PARALLELOGRAM.



PROBLEM 4.
MAJOR AXIS AB & MINOR AXIS CD ARE 100 AMD 70MM LONG RESPECTIVELY .DRAW ELLIPSE BY ARCS OF CIRLES METHOD.

ELLIPSE

BY ARCS OF CIRCLE METHOD

STEPS:

1.Draw both axes as usual.Name the ends & intersecting point

2.Taking AO distance I.e.half major axis, from C, mark F_1 & F_2 On AB . (focus 1 and 2.)

3.On line F_1- O taking any distance, mark points 1,2,3, & 4

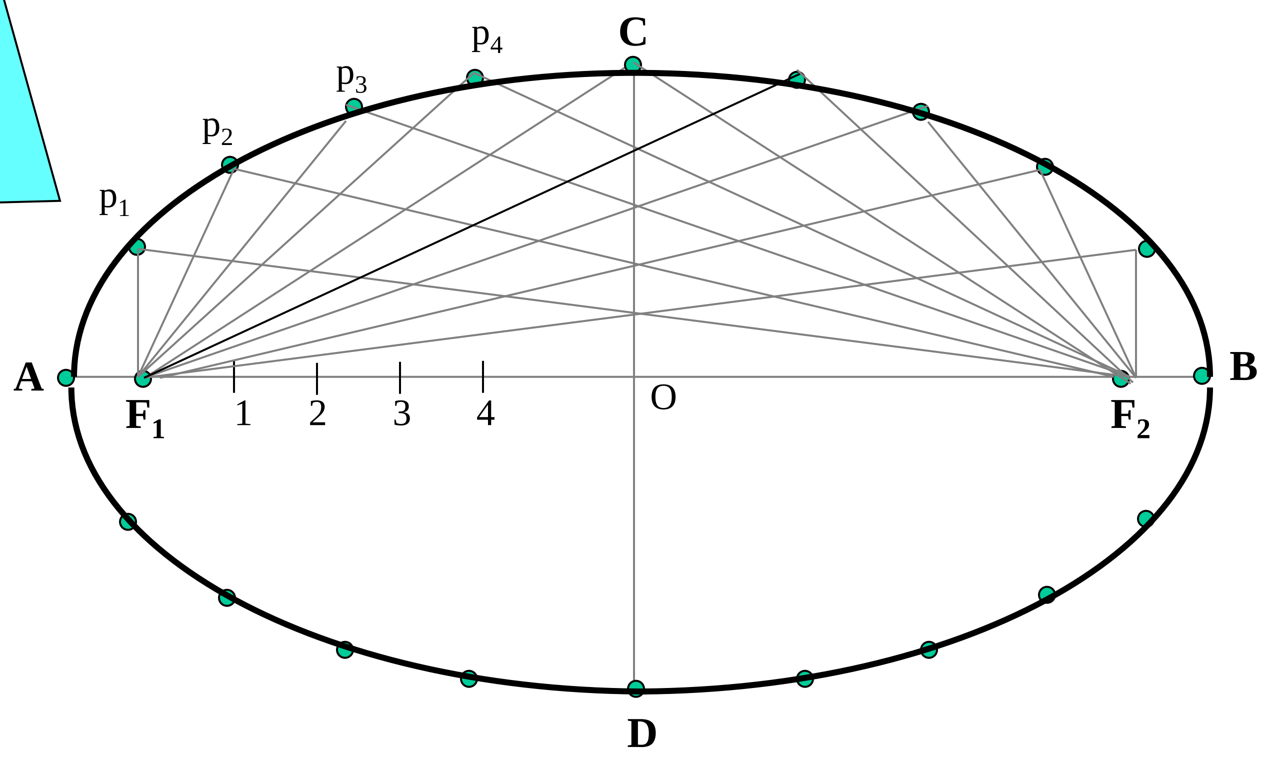
4.Taking F_1 center, with distance A-1 draw an arc above AB and taking F_2 center, with B-1 distance cut this arc. Name the point p_1

5.Repeat this step with same centers but taking now A-2 & B-2 distances for drawing arcs. Name the point p_2

6.Similarly get all other P points. With same steps positions of P can be located below AB.

7.Join all points by smooth curve to get an ellipse/

As per the definition Ellipse is locus of point P moving in a plane such that the SUM of it's distances from two fixed points (F_1 & F_2) remains constant and equals to the length of major axis AB.(Note A .1+ B .1=A . 2 + B. 2 = AB)



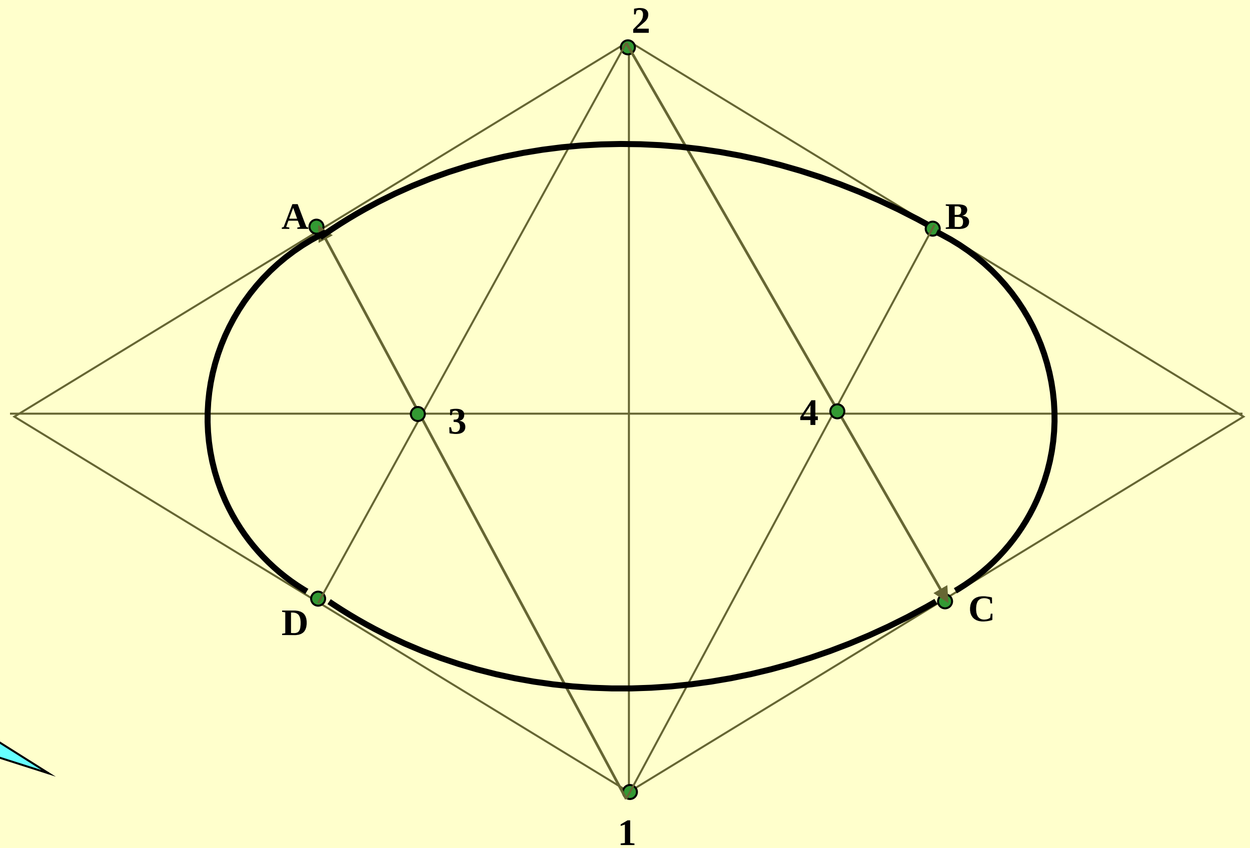
PROBLEM 5.
DRAW RHOMBUS OF 100 MM & 70 MM LONG DIAGONALS AND INSCRIBE AN ELLIPSE IN IT.

ELLIPSE

BY RHOMBUS METHOD

STEPS:

1. Draw rhombus of given dimensions.
2. Mark mid points of all sides & name Those A,B,C,& D
3. Join these points to the ends of smaller diagonals.
4. Mark points 1,2,3,4 as four centers.
5. Taking 1 as center and 1-A radius draw an arc AB.
6. Take 2 as center draw an arc CD.
7. Similarly taking 3 & 4 as centers and 3-D radius draw arcs DA & BC.



PROBLEM 6:- POINT **F** IS 50 MM FROM A LINE **AB.** A POINT **P** IS MOVING IN A PLANE SUCH THAT THE ***RATIO*** OF IT'S DISTANCES FROM **F** AND LINE **AB** REMAINS CONSTANT AND EQUALS TO **2/3** DRAW LOCUS OF POINT **P.** **{ ECCENTRICITY = 2/3 }**

ELLIPSE

DIRECTRIX-FOCUS METHOD

STEPS:

1 .Draw a vertical line AB and point F 50 mm from it.

2 .Divide 50 mm distance in 5 parts.

3 .Name 2nd part from F as V. It is 20mm and 30mm from F and AB line resp. It is first point giving ratio of it's distances from F and AB 2/3 i.e 20/30

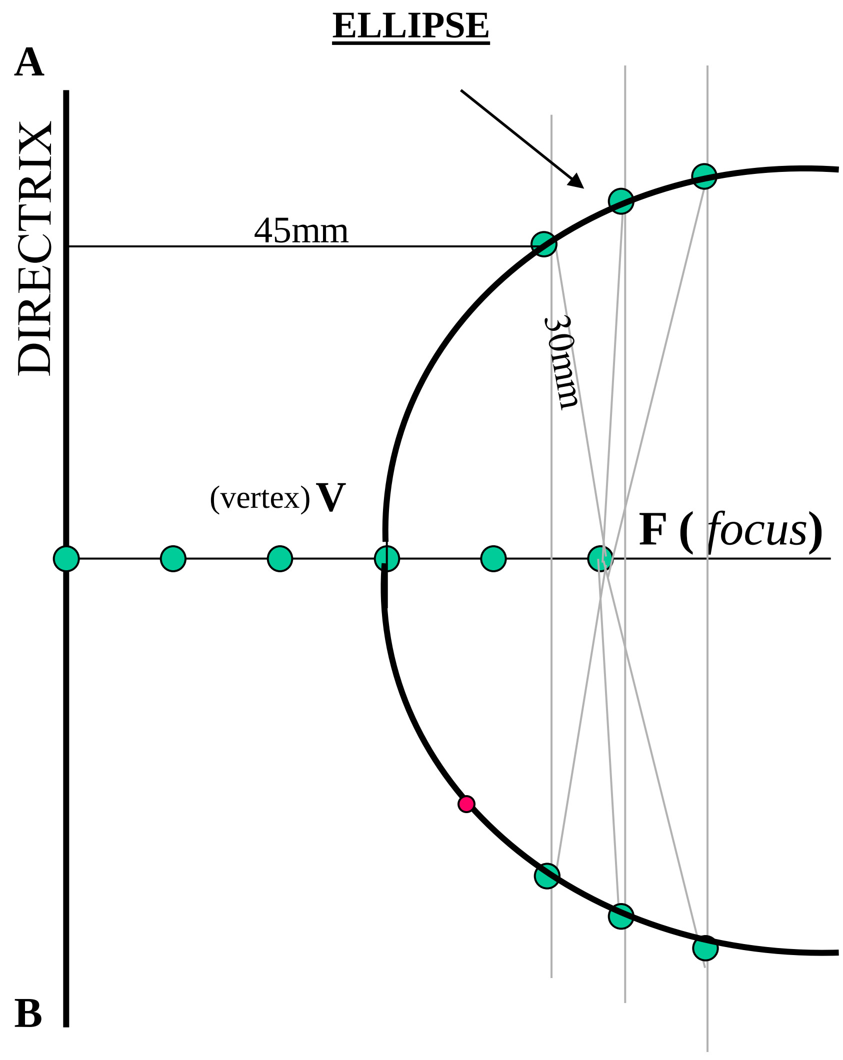
4 Form more points giving same ratio such as 30/45, 40/60, 50/75 etc.

5.Taking 45,60 and 75mm distances from line AB, draw three vertical lines to the right side of it.

6. Now with 30, 40 and 50mm distances in compass cut these lines above and below, with F as center.

7. Join these points through V in smooth curve.

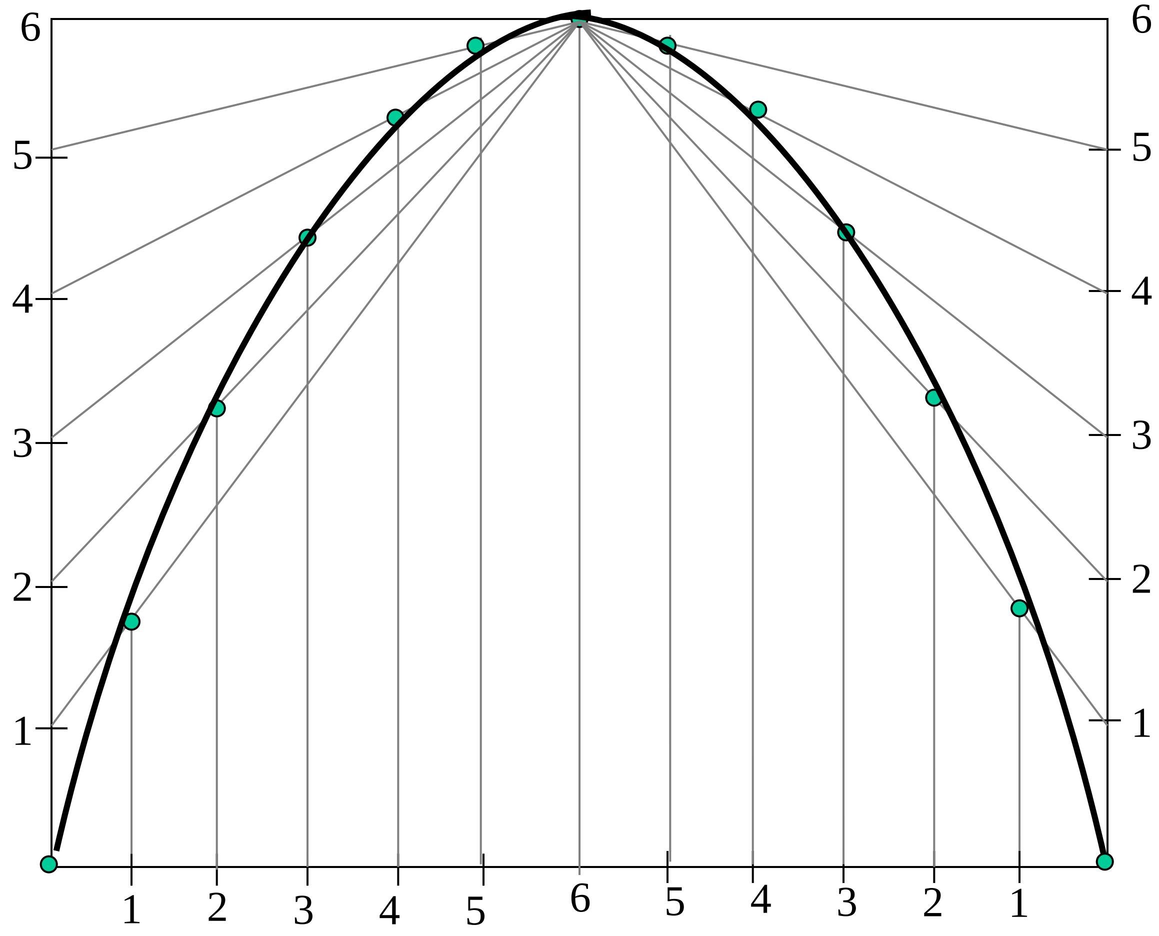
This is required locus of P.It is an ELLIPSE.



PROBLEM 7: A BALL THROWN IN AIR ATTAINS 100 M HIEGHT AND COVERS HORIZONTAL DISTANCE 150 M ON GROUND. Draw the path of the ball (projectile)-

PARABOLA
RECTANGLE METHOD

STEPS:
1.Draw rectangle of above size and divide it in two equal vertical parts
2.Consider left part for construction. Divide height and length in equal number of parts and name those 1,2,3,4,5& 6
3.Join vertical 1,2,3,4,5 & 6 to the top center of rectangle
4.Similarly draw upward vertical lines from horizontal1,2,3,4,5 And wherever these lines intersect previously drawn inclined lines in sequence Mark those points and further join in smooth possible curve.
5.Repeat the construction on right side rectangle also.Join all in sequence. **This locus is Parabola.**
.

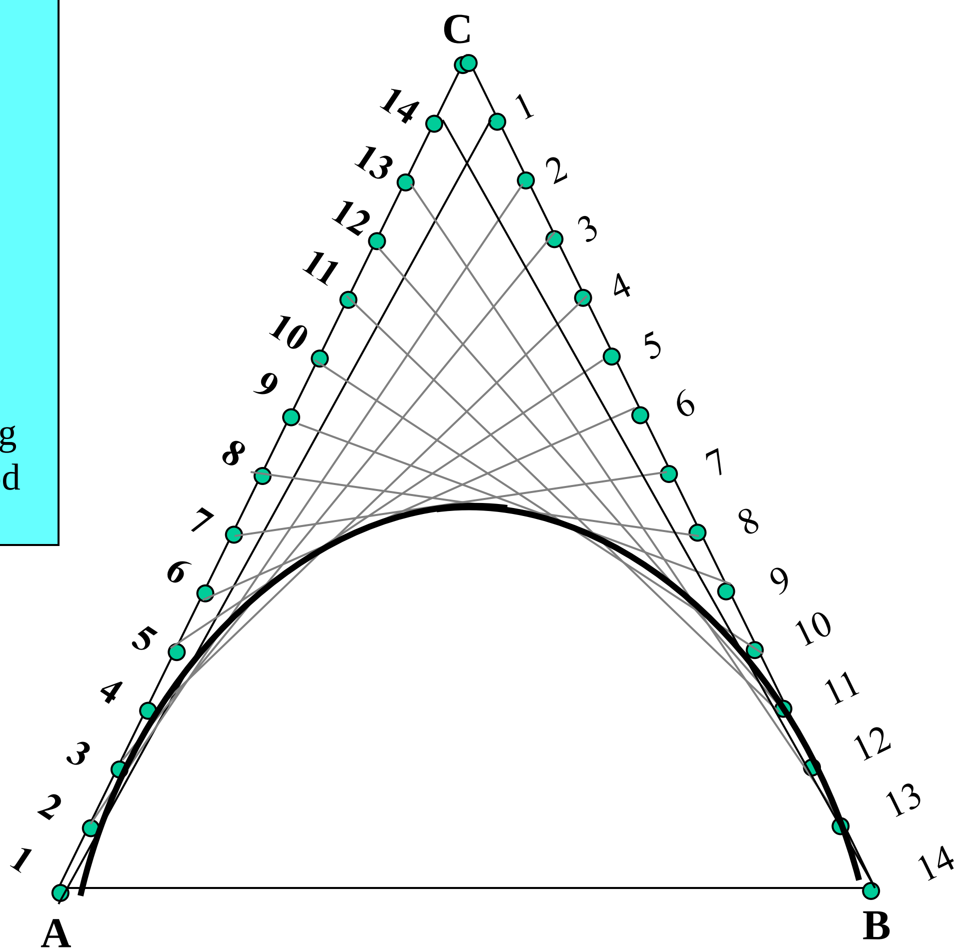


Problem no.8: Draw an isosceles triangle of 100 mm long base and 110 mm long altitude.Inscribe a parabola in it by method of tangents.

PARABOLA
METHOD OF TANGENTS

Solution Steps:

1. Construct triangle as per the given dimensions.
2. Divide it's both sides in to same no.of equal parts.
3. Name the parts in ascending and descending manner, as shown.
4. Join 1-1, 2-2,3-3 and so on.
5. Draw the curve as shown i.e.tangent to all these lines. The above all lines being tangents to the curve, it is called method of tangents.



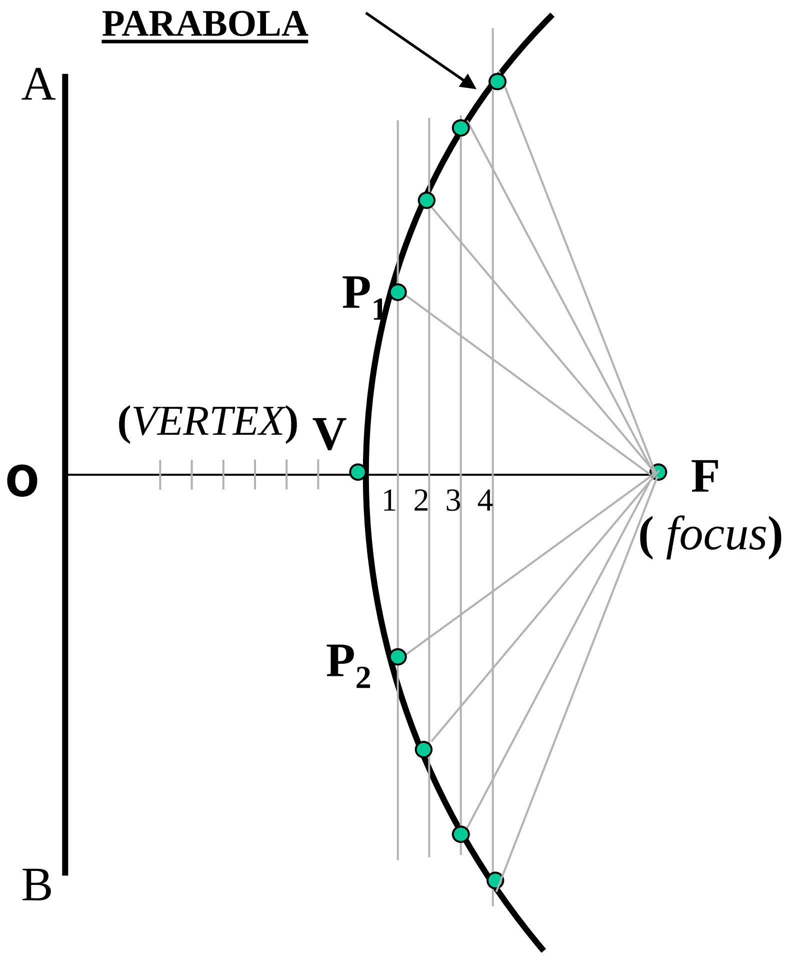
PROBLEM 9: Point F is 50 mm from a vertical straight line AB. Draw locus of point P, moving in a plane such that it always remains equidistant from point F and line AB.

PARABOLA
DIRECTRIX-FOCUS METHOD

SOLUTION STEPS:

1. Locate center of line, perpendicular to AB from point F. This will be initial point P and also the vertex.
2. Mark 5 mm distance to its right side, name those points 1,2,3,4 and from those draw lines parallel to AB.
3. Mark 5 mm distance to its left of P and name it 1.
4. Take O-1 distance as radius and F as center draw an arc cutting first parallel line to AB. Name upper point P_1 and lower point P_2. (FP_1=O1)

5. Similarly repeat this process by taking again 5mm to right and left and locate P_3P_4.
6. Join all these points in smooth curve.



It will be the locus of P equidistance from line AB and fixed point F.

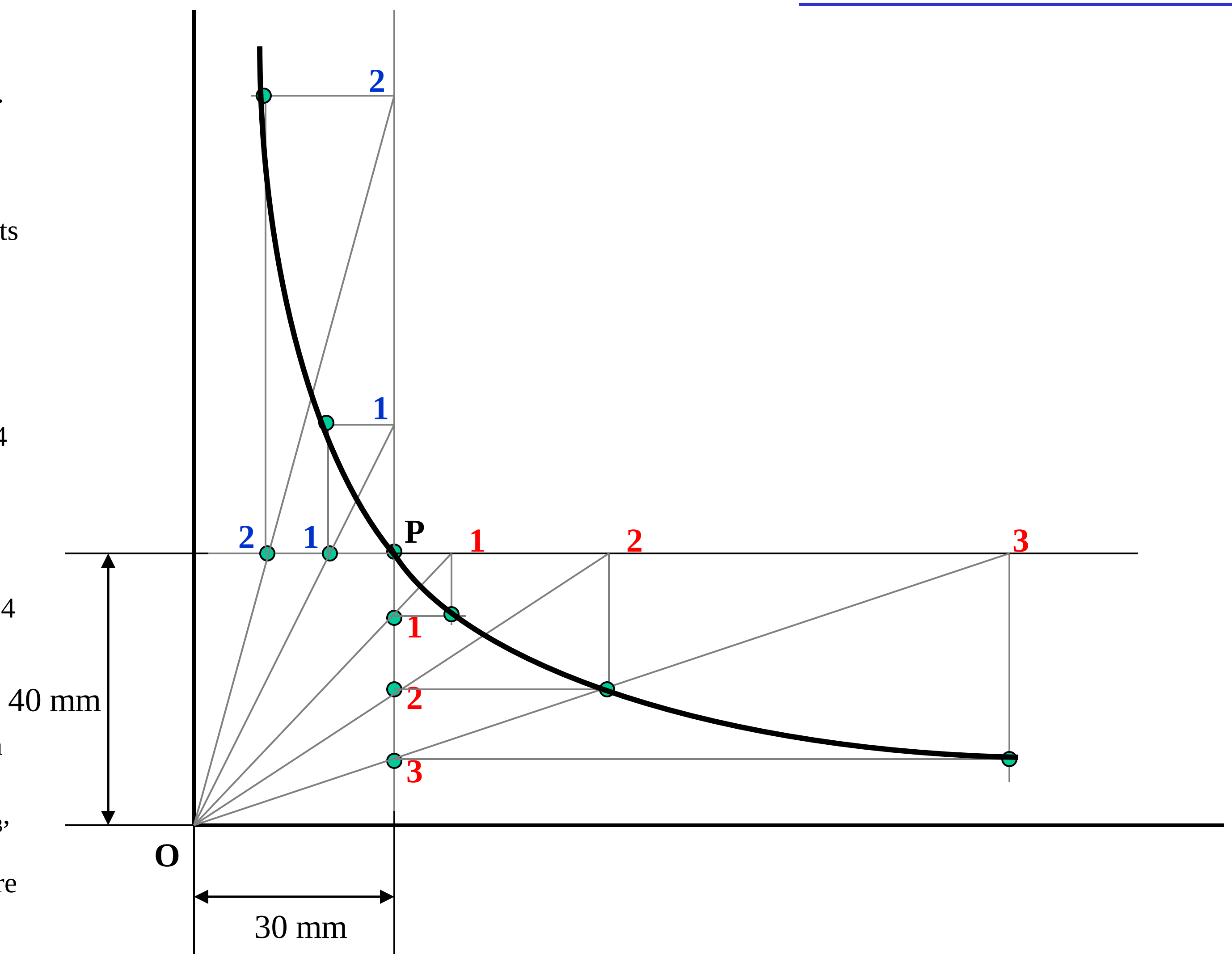
Problem No.10: Point P is 40 mm and 30 mm from horizontal and vertical axes respectively.Draw Hyperbola through it.

HYPERBOLA

THROUGH A POINT OF KNOWN CO-ORDINATES

Solution Steps:

1) Extend horizontal line from P to right side.
2) Extend vertical line from P upward.
3) On horizontal line from P, mark some points taking any distance and name them after P-1, 2,3,4 etc.
4) Join 1-2-3-4 points to pole O. Let them cut part [P-B] also at 1,2,3,4 points.
5) From horizontal 1,2,3,4 draw vertical lines downwards and
6) From vertical 1,2,3,4 points [from P-B] draw horizontal lines.
7) Line from 1 horizontal and line from 1 vertical will meet at P_1.Similarly mark P_2, P_3, P_4 points.
8) Repeat the procedure by marking four points on upward vertical line from P and joining all those to pole O. Name this points P_6, P_7, P_8 etc. and join them by smooth curve.



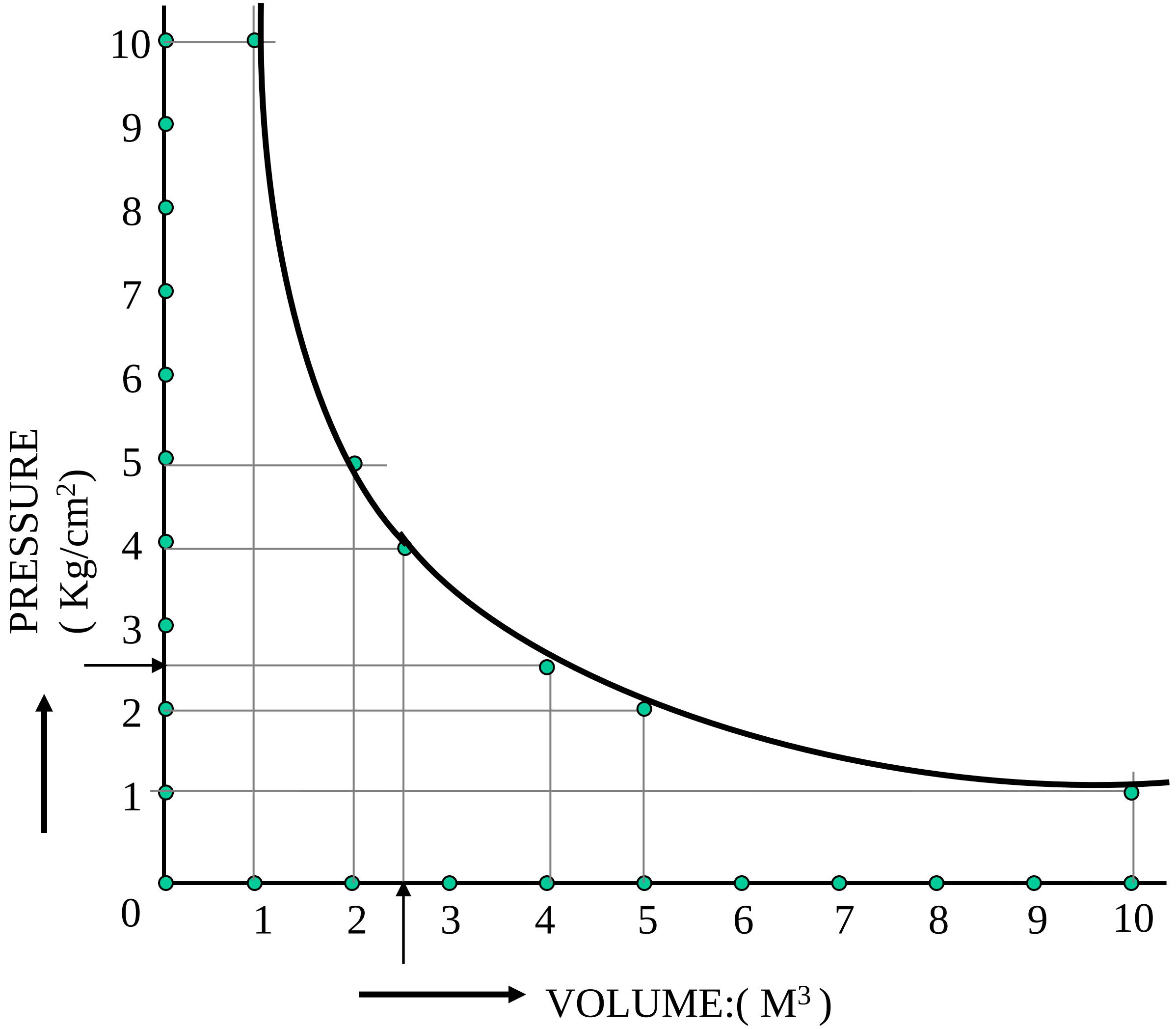
Problem no.11: A sample of gas is expanded in a cylinder from 10 unit pressure to 1 unit pressure.Expansion follows law PV=Constant.If initial volume being 1 unit, draw the curve of expansion. Also Name the curve.

HYPERBOLA
P-V DIAGRAM

Form a table giving few more values of P & V

P × V	= C
10 × 1	= 10
5 × 2	= 10
4 × 2.5	= 10
2.5 × 4	= 10
2 × 5	= 10
1 × 10	= 10

Now draw a Graph of
Pressure against Volume.
It is a PV Diagram and it is Hyperbola.
Take pressure on vertical axis and
Volume on horizontal axis.



PROBLEM 12:- POINT **F** IS 50 MM FROM A LINE **AB.**A POINT **P** IS MOVING IN A PLANE SUCH THAT THE ***RATIO*** OF IT'S DISTANCES FROM **F** AND LINE **AB** REMAINS CONSTANT AND EQUALS TO **2/3** DRAW LOCUS OF POINT **P. { ECCENTRICITY = 2/3 }**

HYPERBOLA
DIRECTRIX FOCUS METHOD

STEPS:

1 .Draw a vertical line AB and point F 50 mm from it.

2 .Divide 50 mm distance in 5 parts.

3 .Name 2nd part from F as V. It is 20mm and 30mm from F and AB line resp. It is first point giving ratio of it's distances from F and AB 2/3 i.e 20/30

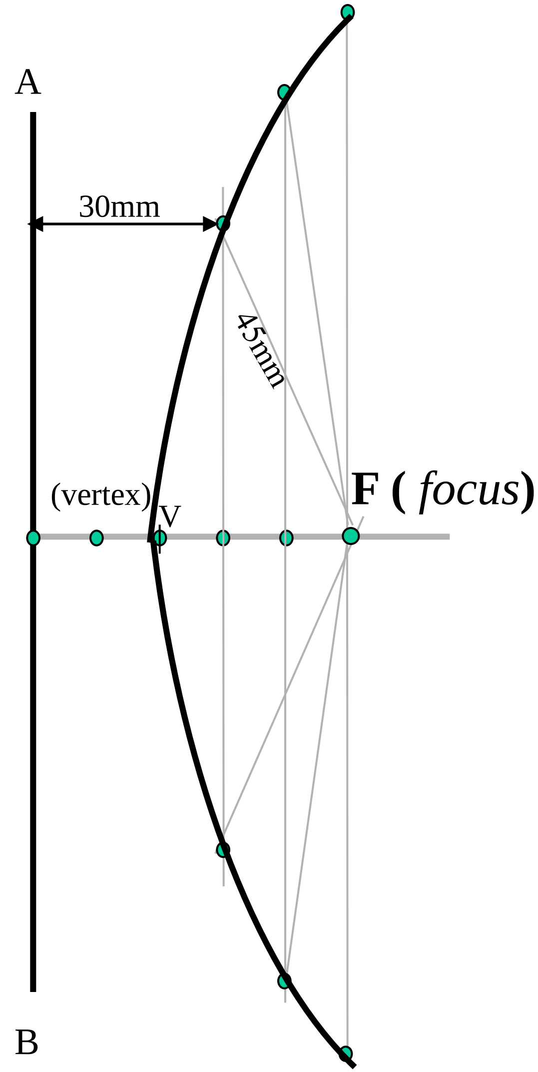
4 Form more points giving same ratio such as 30/45, 40/60, 50/75 etc.

5.Taking 45,60 and 75mm distances from line AB, draw three vertical lines to the right side of it.

6. Now with 30, 40 and 50mm distances in compass cut these lines above and below, with F as center.

7. Join these points through V in smooth curve.

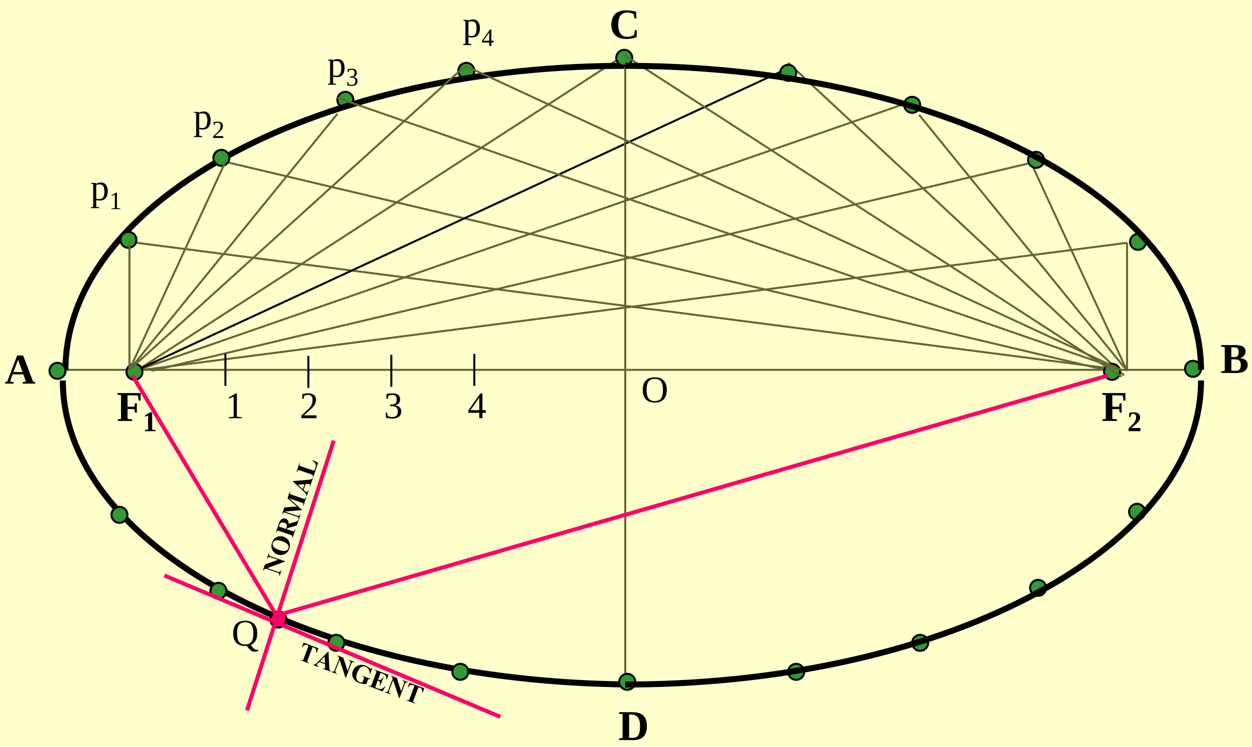
This is required locus of P.It is an ELLIPSE.



Problem 13:

TO DRAW TANGENT & NORMAL TO THE CURVE FROM A GIVEN POINT (Q)

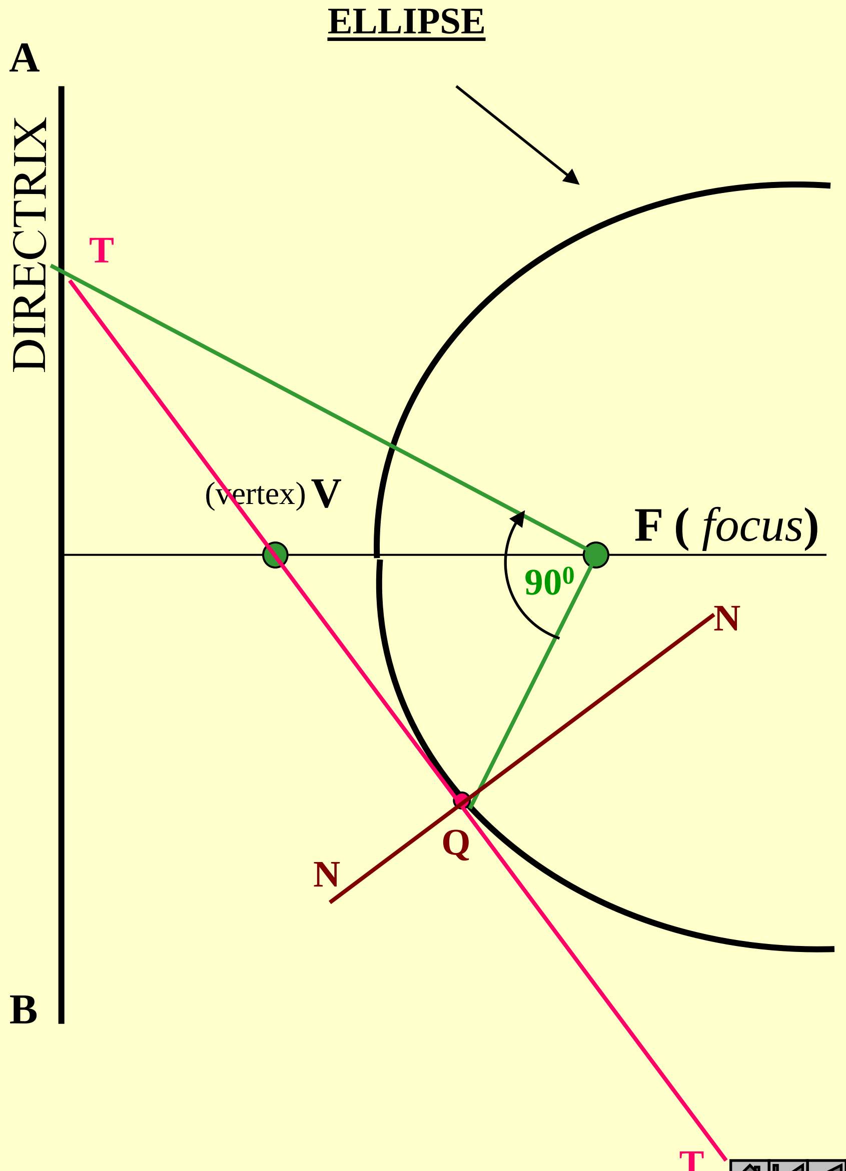
1. JOIN POINT Q TO F_1 & F_2
2. BISECT ANGLE $F_1Q\ F_2$ THE ANGLE BISECTOR IS NORMAL
3. A PERPENDICULAR LINE DRAWN TO IT IS TANGENT TO THE CURVE.



Problem 14:

TO DRAW TANGENT & NORMAL TO THE CURVE FROM A GIVEN POINT (Q)

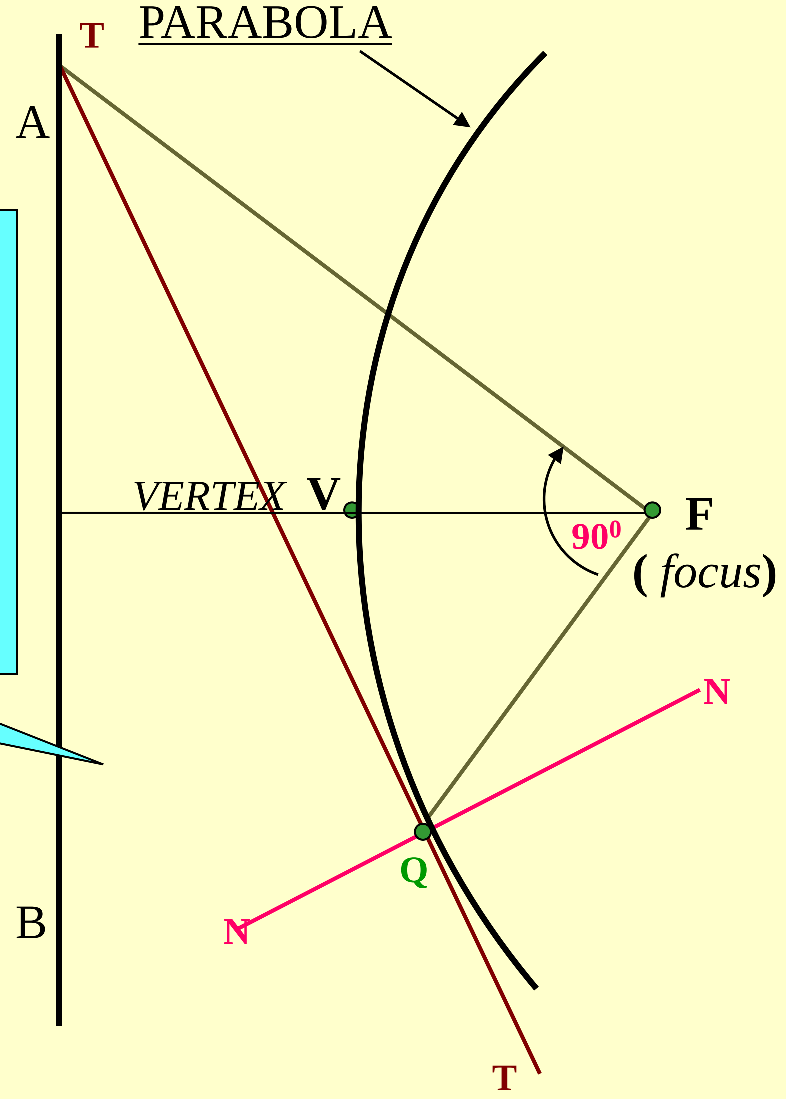
1.JOIN POINT **Q** TO **F.**
2.CONSTRUCT 900 ANGLE WITH THIS LINE AT POINT **F**
3.EXTEND THE LINE TO MEET DIRECTRIX AT **T**
4. JOIN THIS POINT TO Q AND EXTEND. THIS IS TANGENT TO ELLIPSE FROM Q
5.TO THIS TANGENT DRAW PERPENDICULAR LINE FROM Q. IT IS NORMAL TO CURVE.



Problem 15:

TO DRAW TANGENT & NORMAL TO THE CURVE FROM A GIVEN POINT (Q)

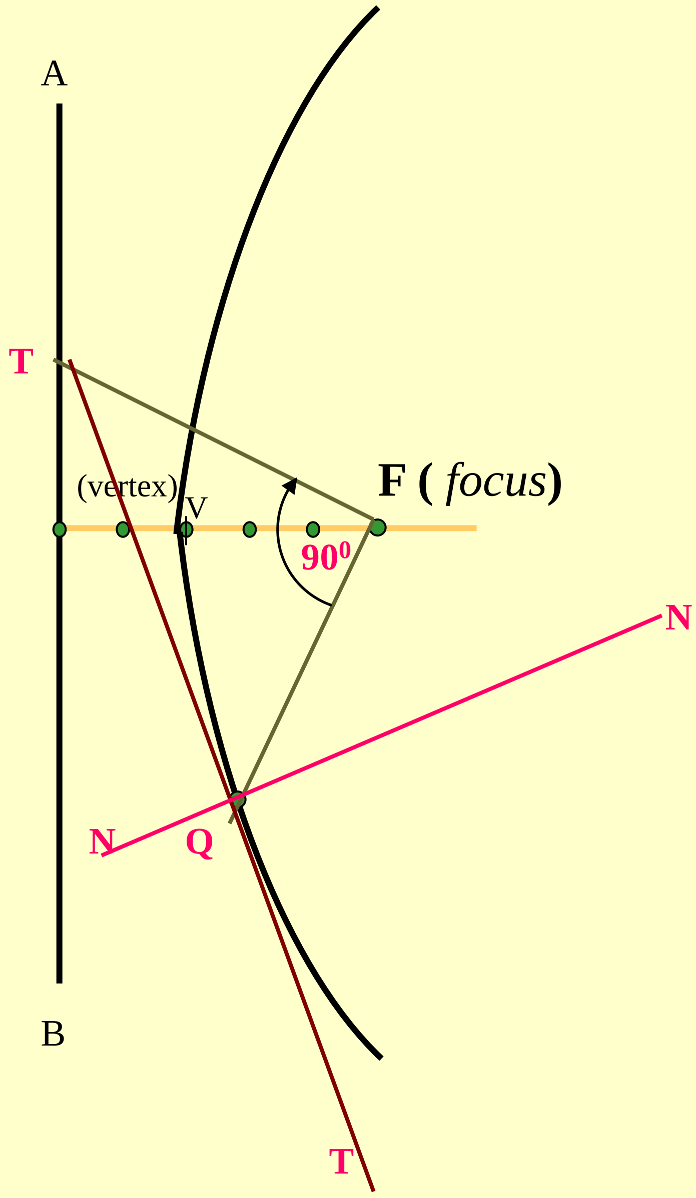
1.JOIN POINT **Q** TO **F.**
2.CONSTRUCT **90^0** ANGLE WITH THIS LINE AT POINT **F**
3.EXTEND THE LINE TO MEET DIRECTRIX AT **T**
4. JOIN THIS POINT TO Q AND EXTEND. THIS IS TANGENT TO THE CURVE FROM Q
5.TO THIS TANGENT DRAW PERPENDICULAR LINE FROM Q. IT IS NORMAL TO CURVE.



Problem 16

TO DRAW TANGENT & NORMAL TO THE CURVE FROM A GIVEN POINT (Q)

1.JOIN POINT **Q** TO **F.**
2.CONSTRUCT 90^0 ANGLE WITH THIS LINE AT POINT **F**
3.EXTEND THE LINE TO MEET DIRECTRIX AT **T**
4. JOIN THIS POINT TO **Q** AND EXTEND. THIS IS TANGENT TO CURVE FROM **Q**
5.TO THIS TANGENT DRAW PERPENDICULAR LINE FROM **Q**. IT IS NORMAL TO CURVE.



ENGINEERING CURVES

Part-II

(Point undergoing two types of displacements)

INVOLUTE

1. Involute of a circle
   a)String Length $= \pi D$
   b)String Length $> \pi D$
   c)String Length $< \pi D$
2. Pole having Composite shape.
3. Rod Rolling over a Semicircular Pole.

CYCLOID

1. General Cycloid
2. Trochoid (superior)
3. Trochoid (Inferior)
4. Epi-Cycloid
5. Hypo-Cycloid

SPIRAL

1. Spiral of One Convolution.
2. Spiral of Two Convolutions.

HELIX

1. On Cylinder
2. On a Cone

AND

Methods of Drawing Tangents & Normals To These Curves.

DEFINITIONS

CYCLOID:

IT IS A LOCUS OF A POINT ON THE PERIPHERY OF A CIRCLE WHICH ROLLS ON A STRAIGHT LINE PATH.

SUPERIORTROCHOID:
IF THE POINT IN THE DEFINATION OF CYCLOID IS OUTSIDE THE CIRCLE

INFERIOR TROCHOID.:
IF IT IS INSIDE THE CIRCLE

EPI-CYCLOID
IF THE CIRCLE IS ROLLING ON ANOTHER CIRCLE FROM OUTSIDE

HYPO-CYCLOID.
IF THE CIRCLE IS ROLLING FROM INSIDE THE OTHER CIRCLE,

INVOLUTE:

IT IS A LOCUS OF A FREE END OF A STRING WHEN IT IS WOUND ROUND A CIRCULAR POLE

SPIRAL:

IT IS A CURVE GENERATED BY A POINT WHICH REVOLVES AROUND A FIXED POINT AND AT THE SAME MOVES TOWARDS IT.

HELIX:

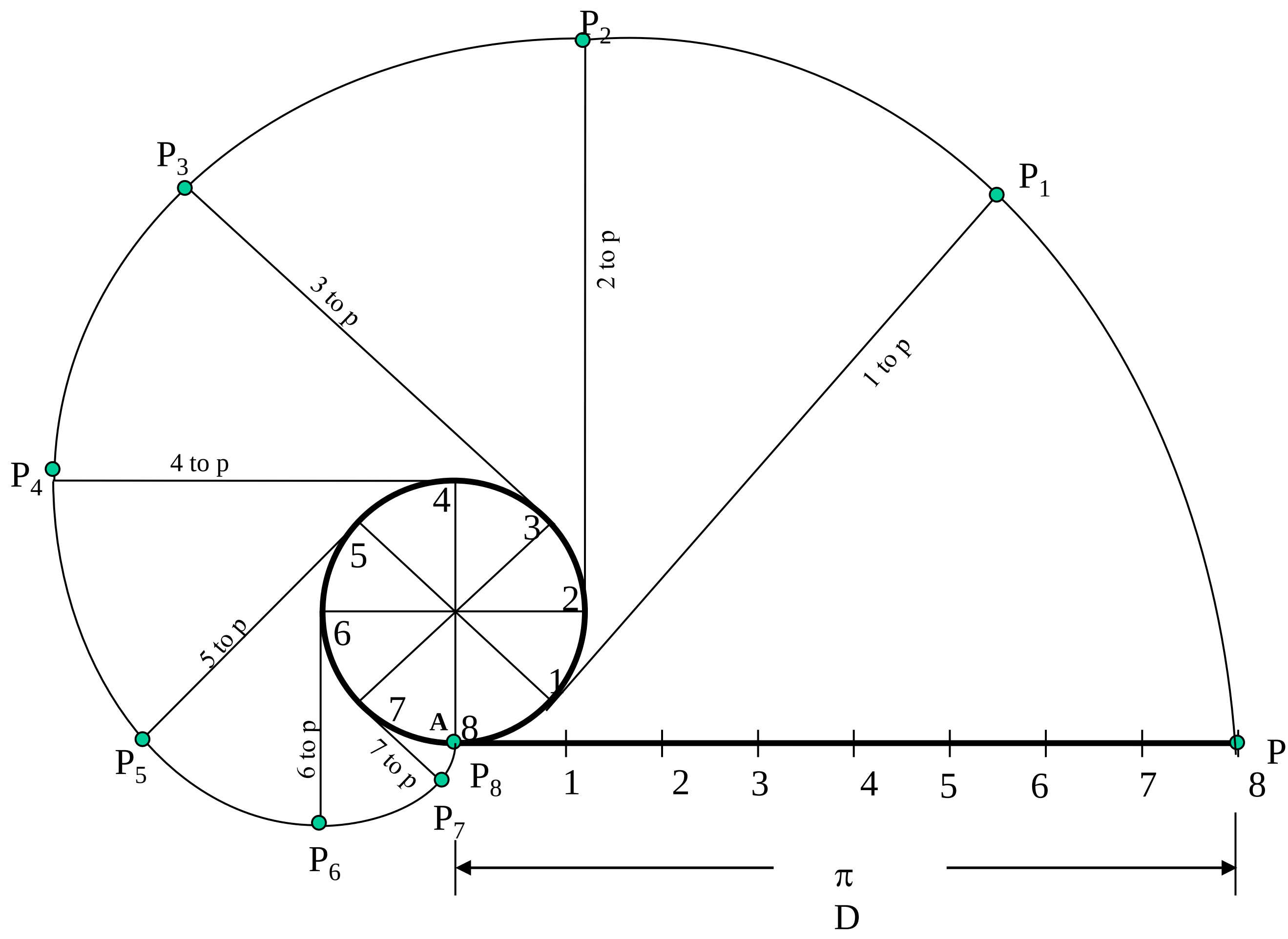
IT IS A CURVE GENERATED BY A POINT WHICH MOVES AROUND THE SURFACE OF A RIGHT CIRCULAR CYLINDER / CONE AND AT THE SAME TIME ADVANCES IN AXIAL DIRECTION AT A SPEED BEARING A CONSTANT RATIO TO THE SPPED OF ROTATION.
(for problems refer topic Development of surfaces)

INVOLUTE OF A CIRCLE

Problem no 17: Draw Involute of a circle.
String length is equal to the circumference of circle.

Solution Steps:

1) Point or end P of string AP is exactly πD distance away from A. Means if this string is wound round the circle, it will completely cover given circle. B will meet A after winding.
2) Divide πD (AP) distance into 8 number of equal parts.
3) Divide circle also into 8 number of equal parts.
4) Name after A, 1, 2, 3, 4, etc. up to 8 on πD line AP as well as on circle (in anticlockwise direction).
5) To radius C-1, C-2, C-3 up to C-8 draw tangents (from 1,2,3,4,etc to circle).
6) Take distance 1 to P in compass and mark it on tangent from point 1 on circle (means one division less than distance AP).
7) Name this point P1
8) Take 2-B distance in compass and mark it on the tangent from point 2. Name it point P2.
9) Similarly take 3 to P, 4 to P, 5 to P up to 7 to P distance in compass and mark on respective tangents and locate P3, P4, P5 up to P8 (i.e. A) points and join them in smooth curve it is an INVOLUTE of a given circle.



Problem 18: Draw Involute of a circle.
String length is MORE than the circumference of circle.

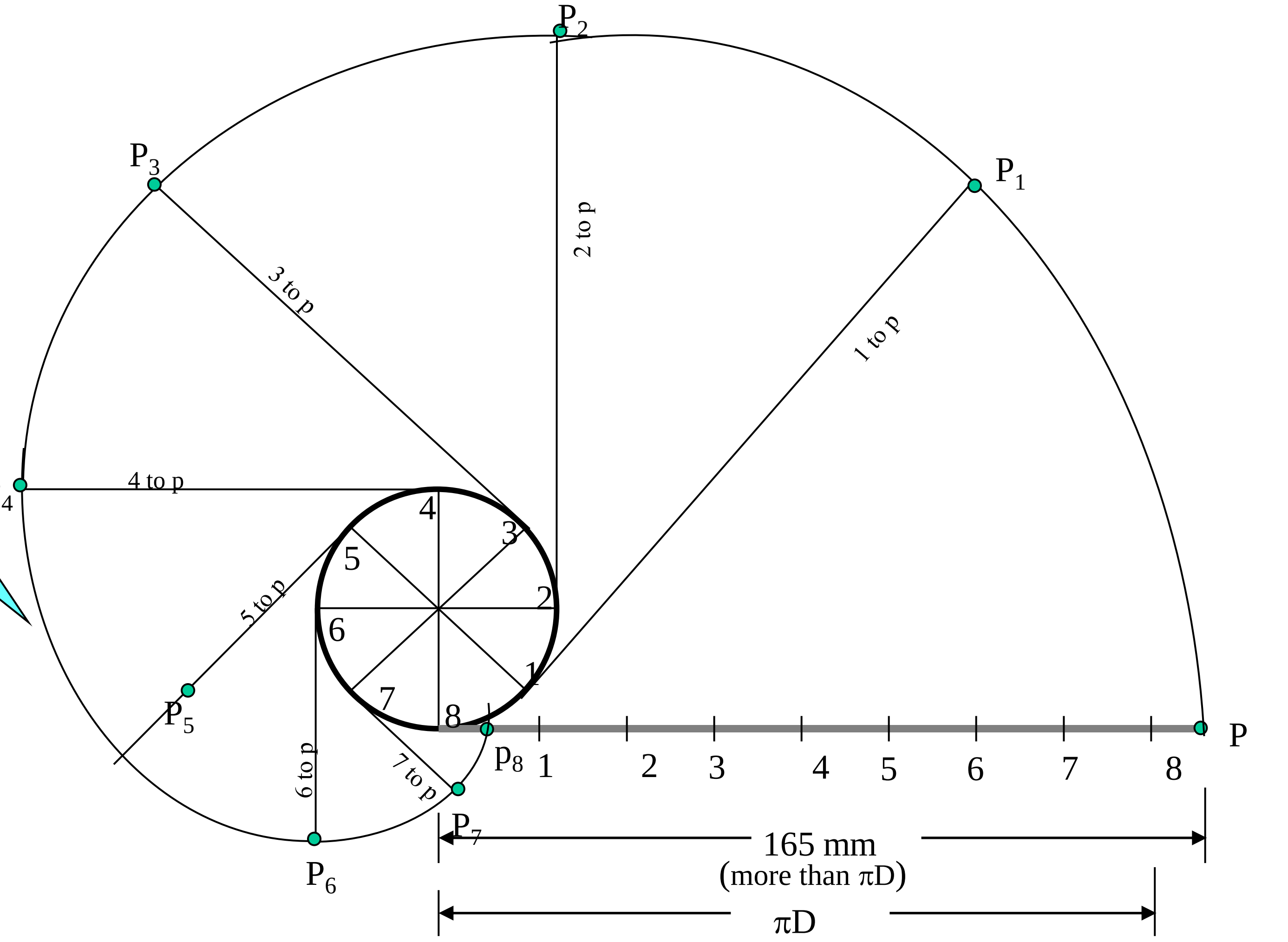
INVOLUTE OF A CIRCLE

String length MORE than πD

Solution Steps:
In this case string length is more than Π D.

But remember!

Whatever may be the length of string, mark Π D distance horizontal i.e.along the string and divide it in 8 number of equal parts, and not any other distance. Rest all steps are same as previous INVOLUTE. Draw the curve completely.

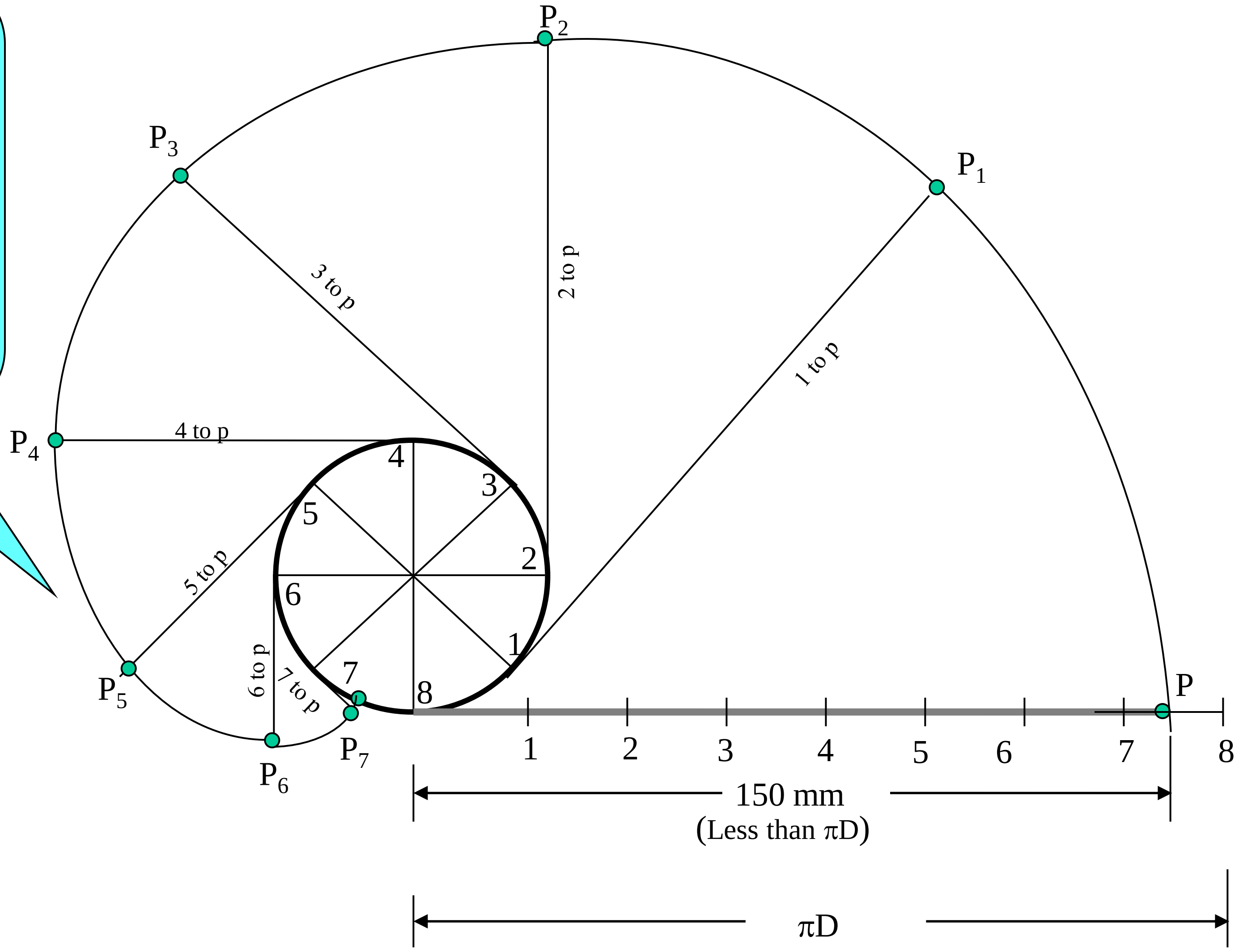


Problem 19: Draw Involute of a circle.
String length is LESS than the circumference of circle.

INVOLUTE OF A CIRCLE

String length LESS than πD

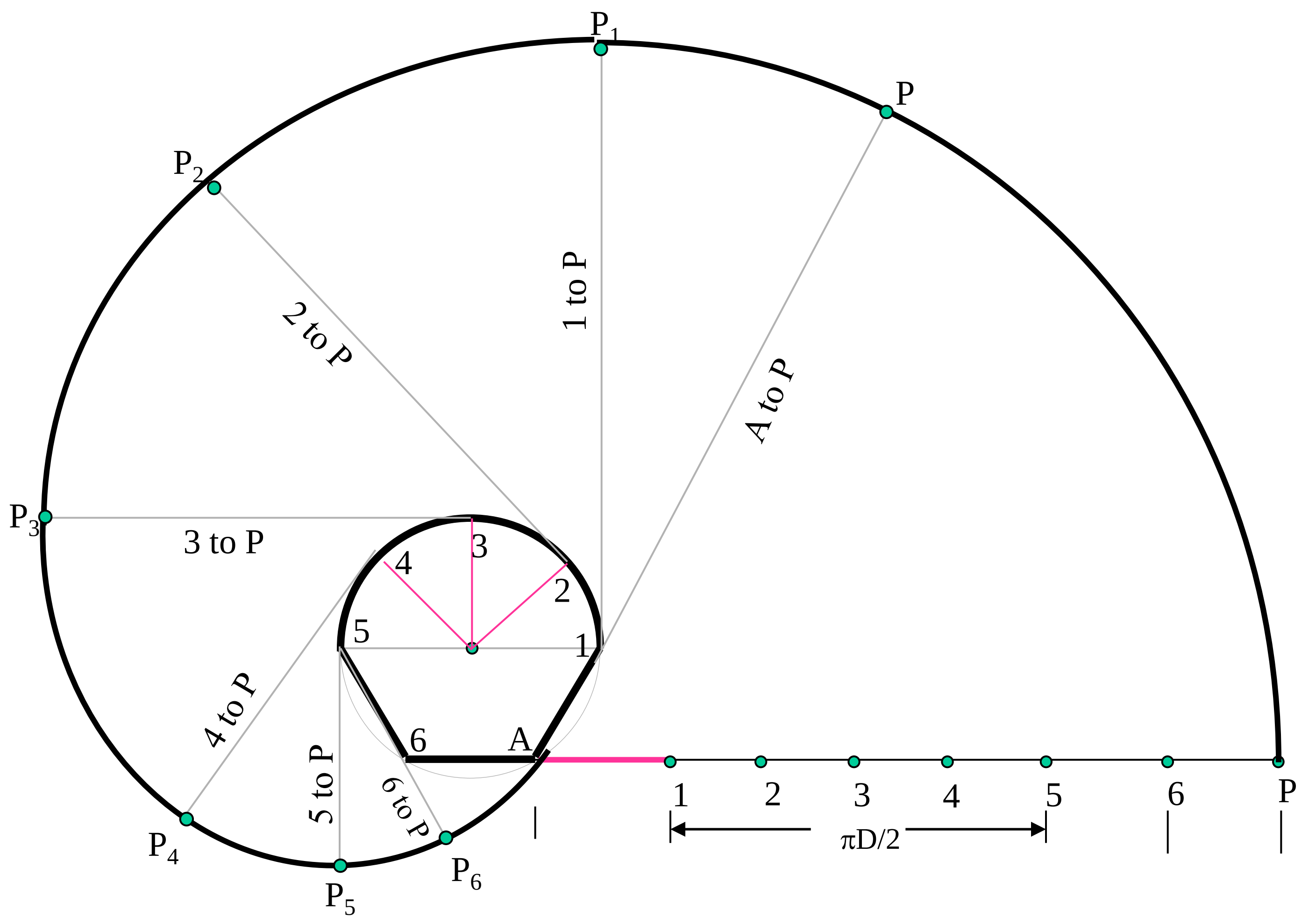
Solution Steps:
In this case string length is Less than Π D.
But remember!
Whatever may be the length of string, mark Π D distance horizontal i.e.along the string and divide it in 8 number of equal parts, and not any other distance. Rest all steps are same as previous INVOLUTE. Draw the curve completely.



PROBLEM 20 : A POLE IS OF A SHAPE OF HALF HEXABON AND SEMICIRCLE. ASTRING IS TO BE WOUND HAVING LENGTH EQUAL TO THE POLE PERIMETER DRAW PATH OF FREE END *P* OF STRING WHEN WOUND COMPLETELY.
(Take hex 30 mm sides and semicircle of 60 mm diameter.)

INVOLUTE OF COMPOSIT SHAPED POLE

SOLUTION STEPS:
Draw pole shape as per dimensions.
Divide semicircle in 4 parts and name those along with corners of hexagon.
Calculate perimeter length.
Show it as string AP.
On this line mark 30mm from A
Mark and name it 1
Mark πD/2 distance on it from 1
And dividing it in 4 parts name 2,3,4,5.
Mark point 6 on line 30 mm from 5
Now draw tangents from all points of pole and proper lengths as done in all previous involute's problems and complete the curve.

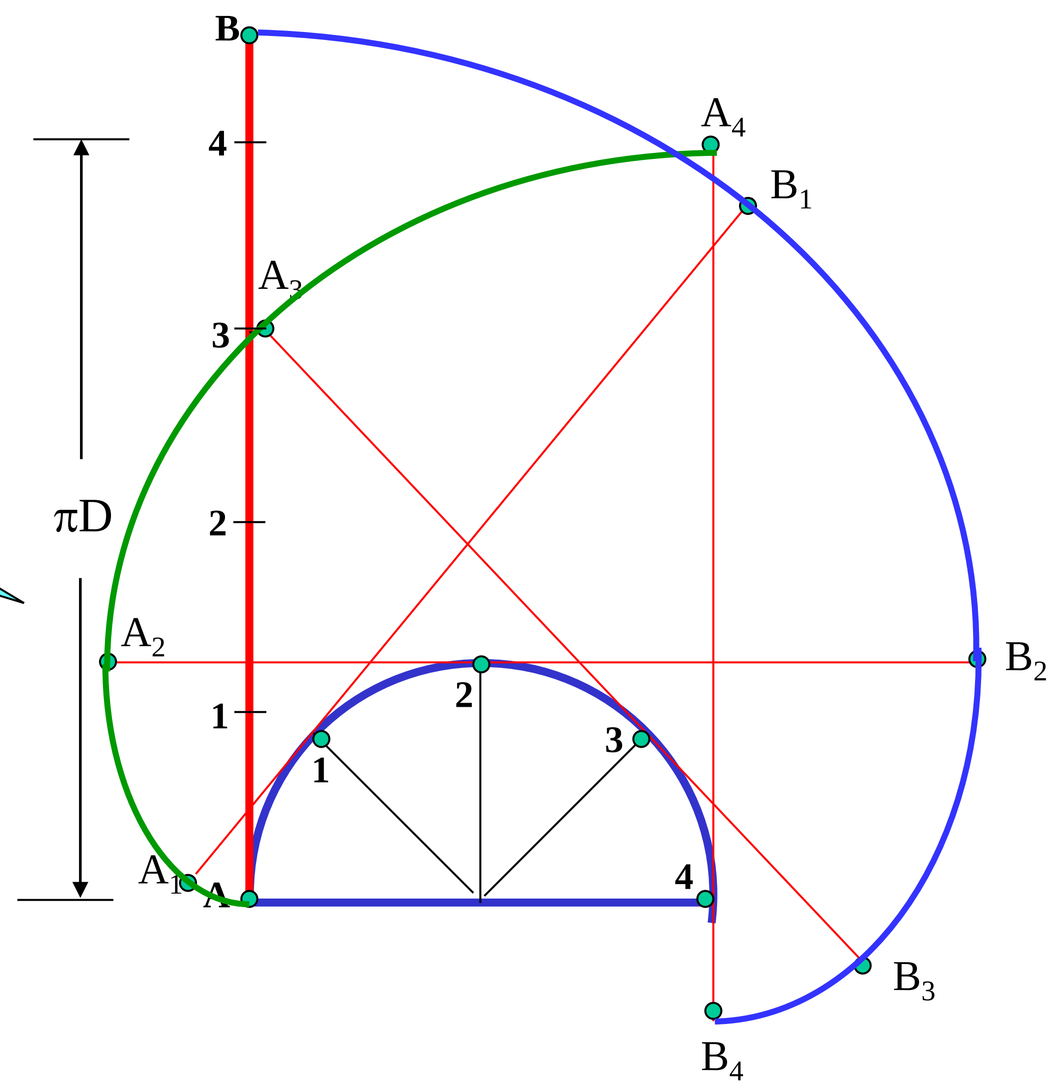


PROBLEM 21 : Rod AB 85 mm long rolls over a semicircular pole without slipping from it's initially vertical position till it becomes up-side-down vertical.
Draw locus of both ends A & B.

Solution Steps?

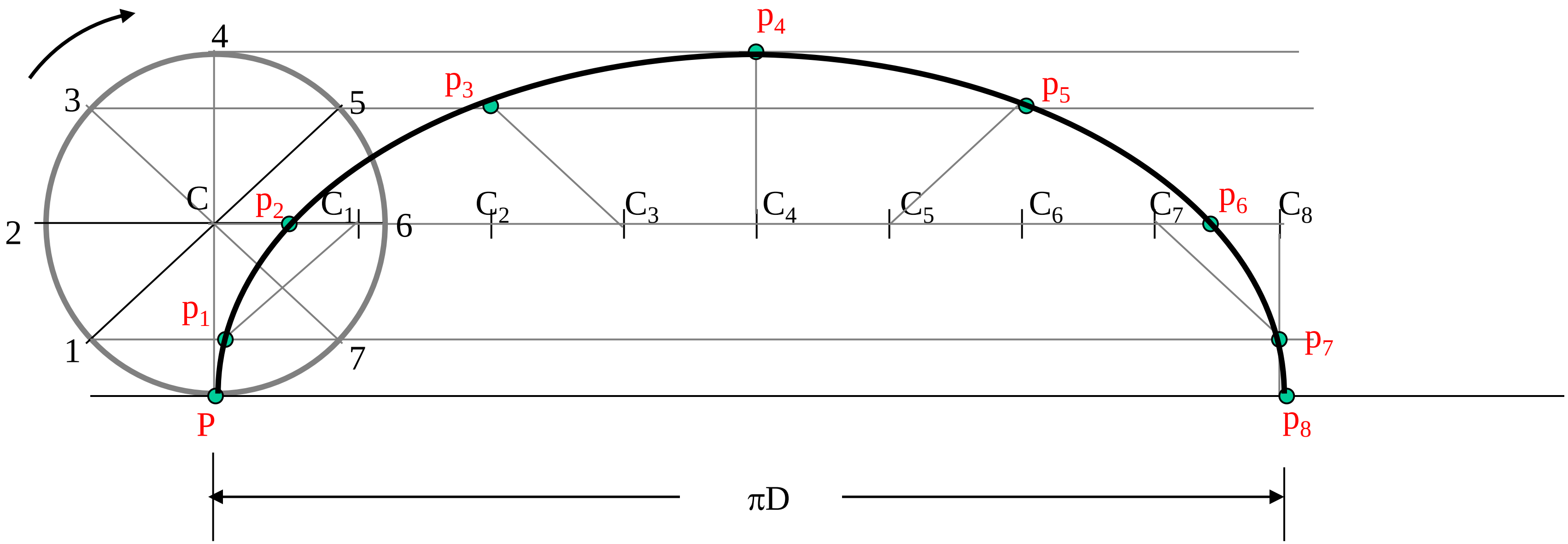
If you have studied previous problems properly, you can surely solve this also.
Simply remember that this being a rod, it will roll over the surface of pole.
Means when one end is approaching, other end will move away from poll.

OBSERVE ILLUSTRATION CAREFULLY!



PROBLEM 22: DRAW LOCUS OF A POINT ON THE PERIPHERY OF A CIRCLE WHICH ROLLS ON STRAIGHT LINE PATH. Take Circle diameter as 50 mm

CYCLOID



Solution Steps:

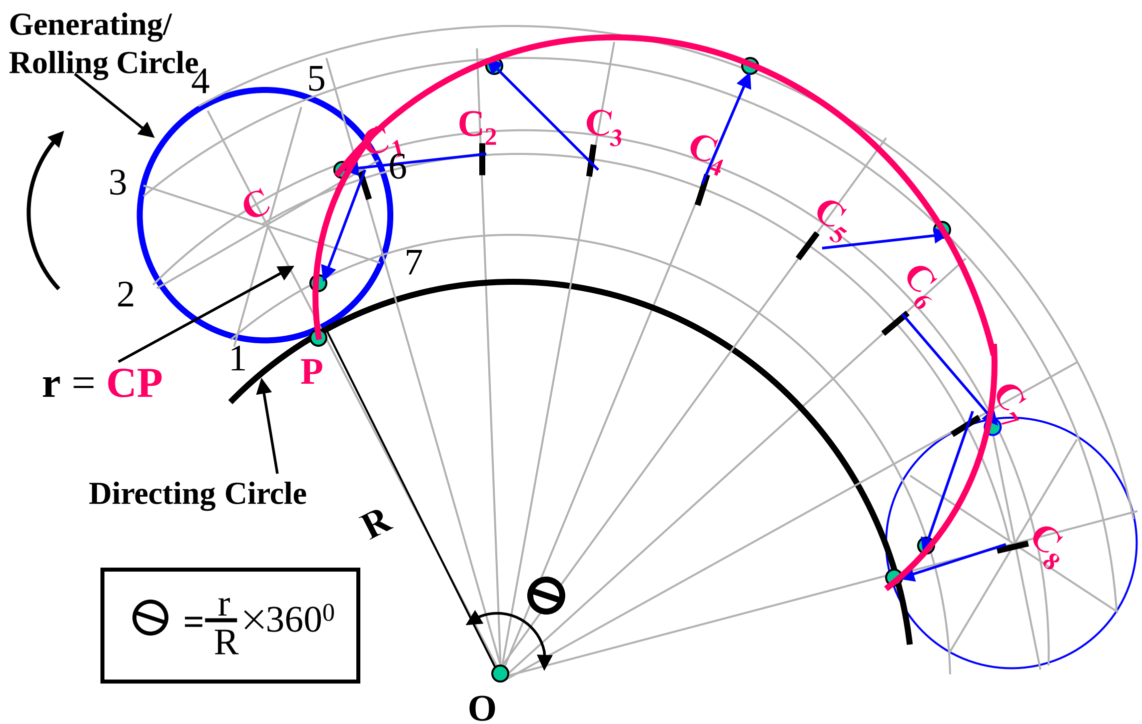
1) From center C draw a horizontal line equal to πD distance.
2) Divide πD distance into 8 number of equal parts and name them C1, C2, C3__ etc.
3) Divide the circle also into 8 number of equal parts and in clock wise direction, after P name 1, 2, 3 up to 8.
4) From all these points on circle draw horizontal lines. (parallel to locus of C)
5) With a fixed distance C-P in compass, C1 as center, mark a point on horizontal line from 1. Name it P.
6) Repeat this procedure from C2, C3, C4 upto C8 as centers. Mark points P2, P3, P4, P5 up to P8 on the horizontal lines drawn from 2, 3, 4, 5, 6, 7 respectively.
7) Join all these points by curve. **It is Cycloid**.

PROBLEM 25: DRAW LOCUS OF A POINT ON THE PERIPHERY OF A CIRCLE WHICH ROLLS ON A CURVED PATH. **Take diameter of rolling Circle 50 mm And radius of directing circle i.e. curved path, 75 mm.**

EPI CYCLOID :

Solution Steps:

1) When smaller circle will roll on larger circle for one revolution it will cover Π D distance on arc and it will be decided by included arc angle θ.
2) Calculate θ by formula θ = (r/R) x 3600.
3) Construct angle θ with radius OC and draw an arc by taking O as center OC as radius and form sector of angle θ.
4) Divide this sector into 8 number of equal angular parts. And from C onward name them C1, C2, C3 up to C8.
5) Divide smaller circle (Generating circle) also in 8 number of equal parts. And next to P in clockwise direction name those 1, 2, 3, up to 8.
6) With O as center, O-1 as radius draw an arc in the sector. Take O-2, O-3, O-4, O-5 up to O-8 distances with center O, draw all concentric arcs in sector. Take fixed distance C-P in compass, C1 center, cut arc of 1 at P1. Repeat procedure and locate P2, P3, P4, P5 unto P8 (as in cycloid) and join them by smooth curve. This is EPI – CYCLOID.

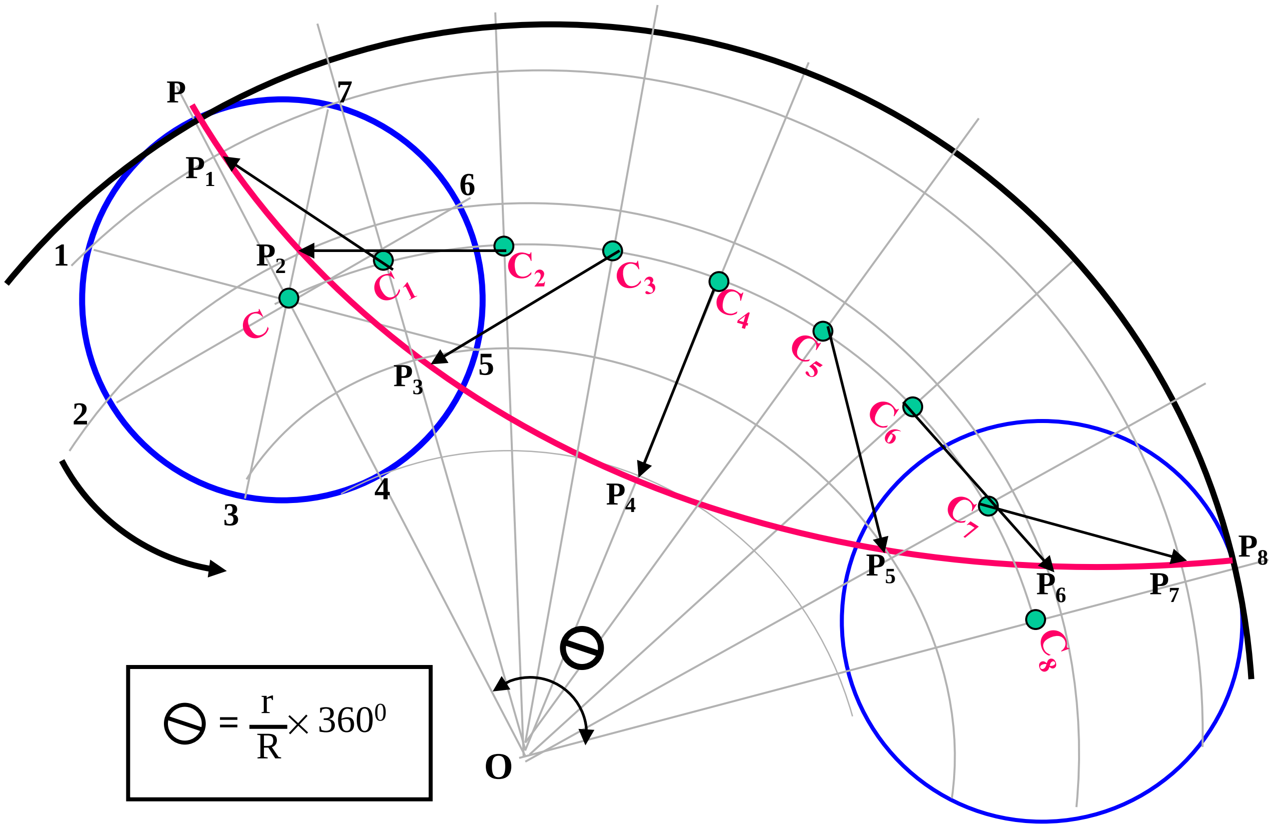


PROBLEM 26: DRAW LOCUS OF A POINT ON THE PERIPHERY OF A CIRCLE WHICH ROLLS FROM THE INSIDE OF A CURVED PATH. **Take diameter of rolling circle 50 mm and radius of directing circle (curved path) 75 mm.**

HYPO CYCLOID

Solution Steps:

1) Smaller circle is rolling here, inside the larger circle. It has to rotate anticlockwise to move ahead.
2) Same steps should be taken as in case of EPI – CYCLOID. Only change is in numbering direction of 8 number of equal parts on the smaller circle.
3) From next to P in anticlockwise direction, name 1,2,3,4,5,6,7,8.
4) Further all steps are that of epi – cycloid. **This is called HYPO – CYCLOID.**



$$\theta = \frac{r}{R} \times 360^0$$

OC = R (Radius of Directing Circle)

CP = r (Radius of Generating Circle)

ORTHOGRAPHIC PROJECTIONS

OF POINTS, LINES, PLANES, AND SOLIDS.

TO DRAW PROJECTIONS OF ANY OBJECT, ONE MUST HAVE FOLLOWING INFORMATION

A) **OBJECT**

{ WITH IT'S DESCRIPTION, WELL DEFINED.}

B) **OBSERVER**

{ ALWAYS OBSERVING PERPENDICULAR TO RESP. REF.PLANE}.

C) **LOCATION OF OBJECT**,

{ MEANS IT'S POSITION WITH REFFERENCE TO H.P. & V.P.}

TERMS 'ABOVE' & 'BELOW' WITH RESPECTIVE TO H.P.
AND TERMS 'INFRONT' & 'BEHIND' WITH RESPECTIVE TO V.P
FORM 4 QUADRANTS.
OBJECTS CAN BE PLACED IN ANY ONE OF THESE 4 QUADRANTS.

IT IS INTERESTING TO LEARN THE EFFECT ON THE POSITIONS OF VIEWS (FV, TV) OF THE OBJECT WITH RESP. TO X-Y LINE, WHEN PLACED IN DIFFERENT QUADRANTS.

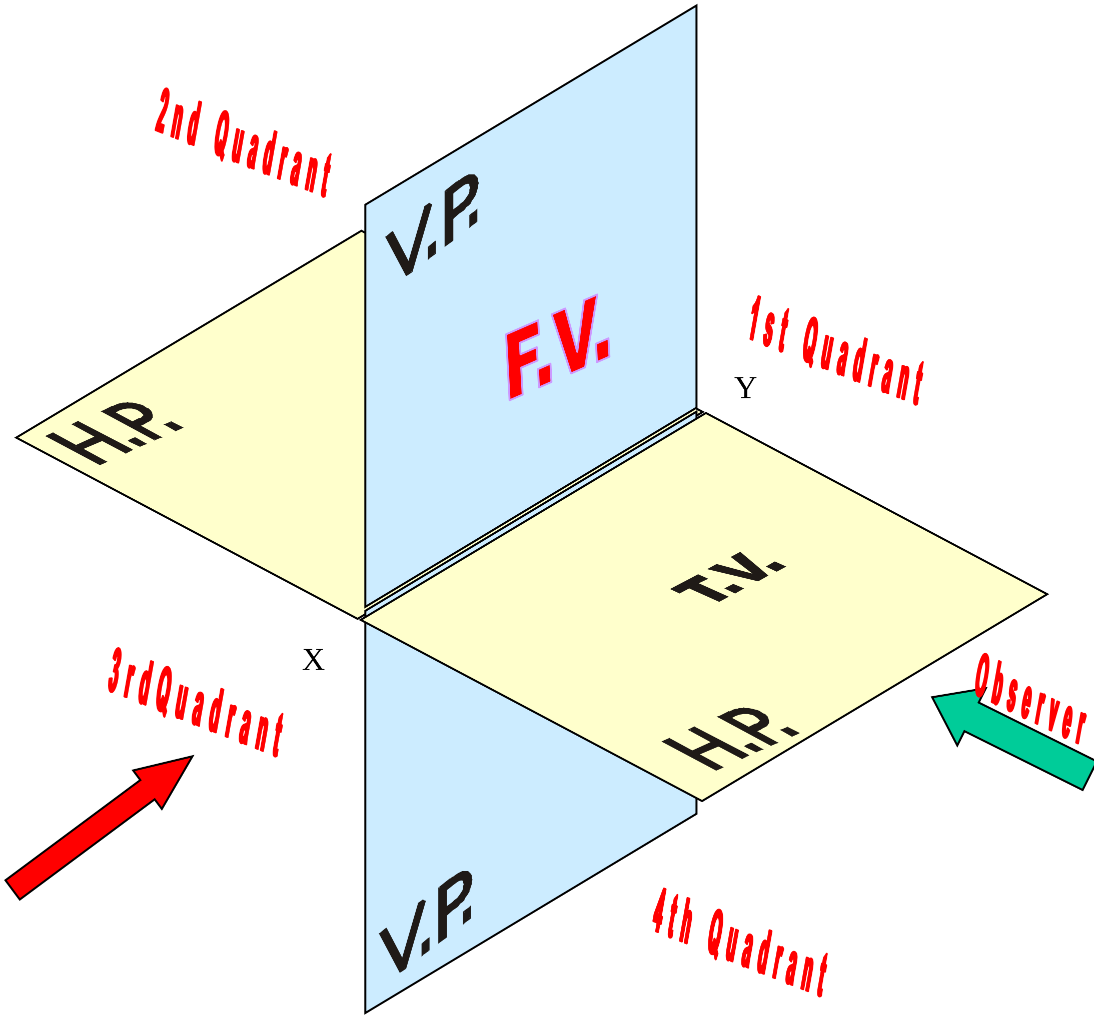
STUDY ILLUSTRATIONS GIVEN ON HEXT PAGES AND NOTE THE RESULTS.TO MAKE IT EASY HERE A POINT (A) IS TAKEN AS AN OBJECT. BECAUSE IT'S ALL VIEWS ARE JUST POINTS.

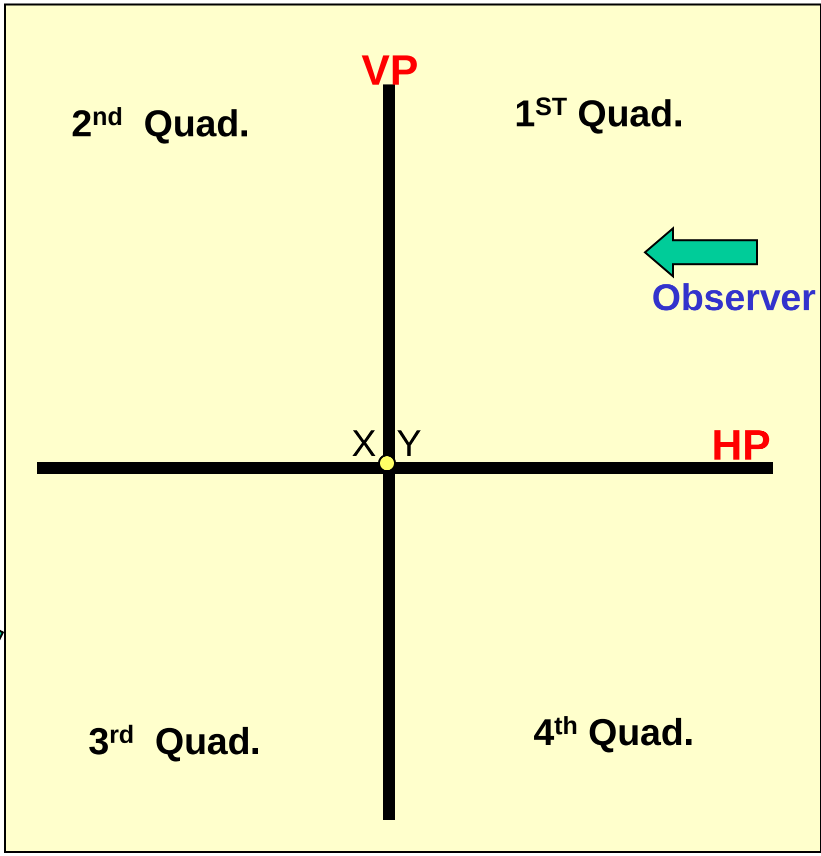
NOTATIONS

FOLLOWING NOTATIONS SHOULD BE FOLLOWED WHILE NAMEING DIFFERENT VIEWS IN ORTHOGRAPHIC PROJECTIONS.

OBJECT	POINT A	LINE AB
IT'S TOP VIEW	a	a b
IT'S FRONT VIEW	a'	a' b'
IT'S SIDE VIEW	a"	a" b"

SAME SYSTEM OF NOTATIONS SHOULD BE FOLLOWED INCASE NUMBERS, LIKE 1, 2, 3 – ARE USED.



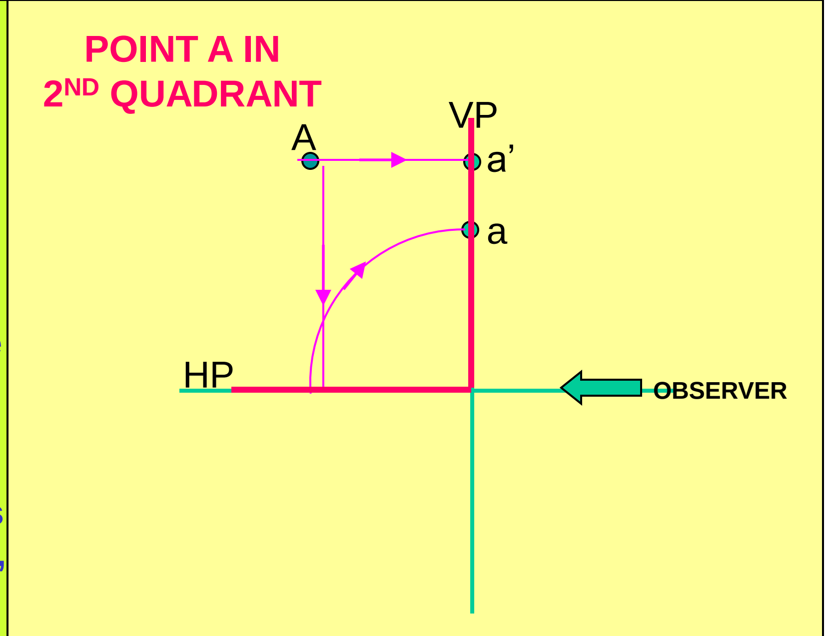


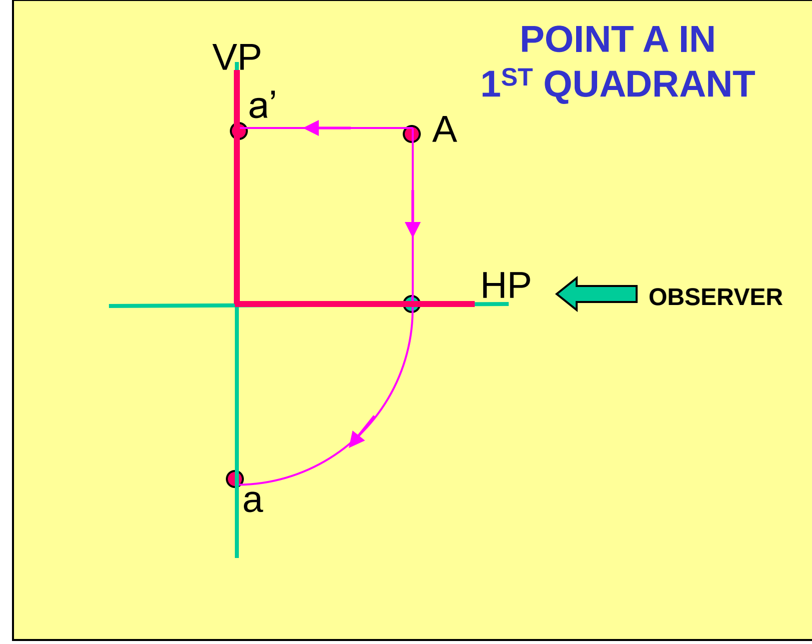
THIS QUADRANT PATTERN,
IF OBSERVED ALONG X-Y LINE (IN RED ARROW DIRECTION)
WILL EXACTLY APPEAR AS SHOWN ON RIGHT SIDE AND HENCE,
IT IS FURTHER USED TO UNDERSTAND ILLUSTRATION PROPERLLY.

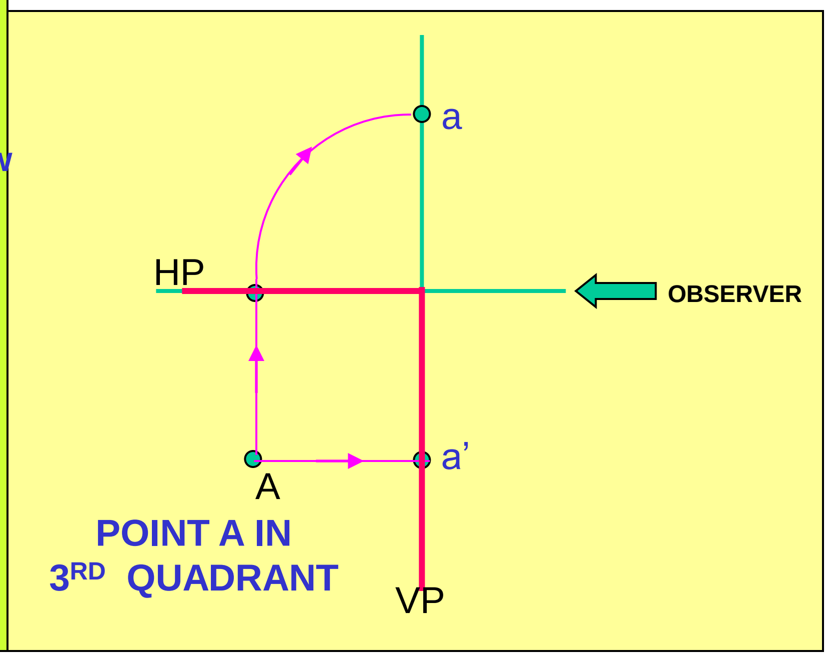
Point A is Placed In different quadrants and it’s Fv & Tv are brought in same plane for Observer to see clearly.

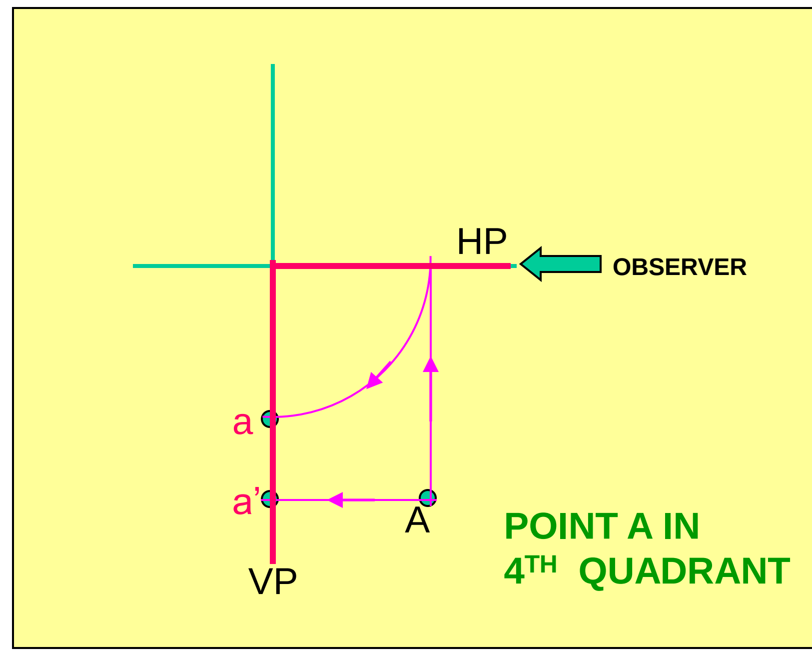
Fv is visible as it is a view on VP. But as Tv is is a view on Hp, it is rotated downward 90^0, In clockwise direction.The In front part of Hp comes below xy line and the part behind Vp comes above.

Observe and note the process.



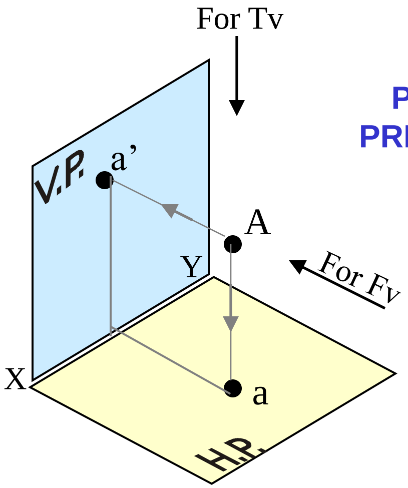






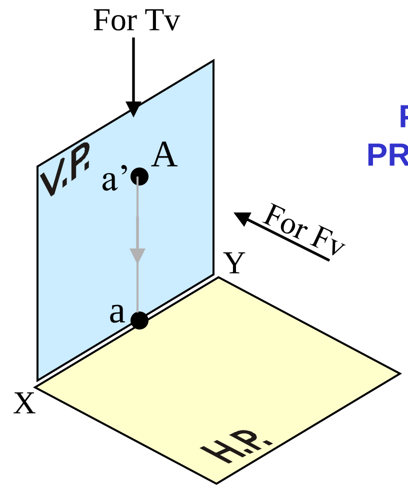
PROJECTIONS OF A POINT IN FIRST QUADRANT.

POINT A ABOVE HP & INFRONT OF VP



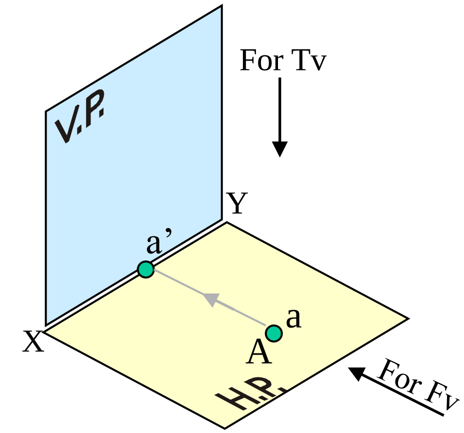
PICTORIAL PRESENTATION

POINT A ABOVE HP & IN VP



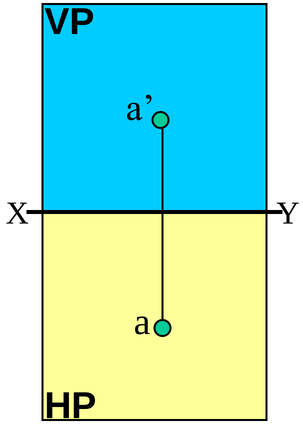
PICTORIAL PRESENTATION

POINT A IN HP & INFRONT OF VP

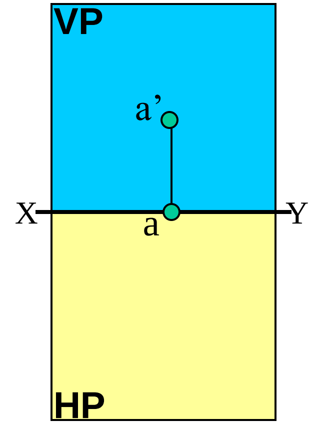


ORTHOGRAPHIC PRESENTATIONS OF ALL ABOVE CASES.

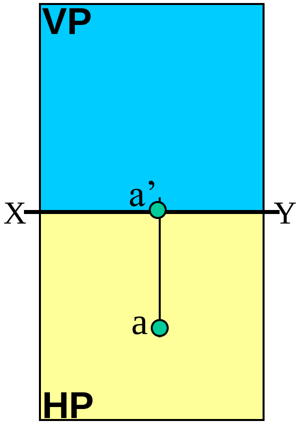
Fv above xy, Tv below xy.



Fv above xy, Tv on xy.



Fv on xy, Tv below xy.



PROJECTIONS OF STRAIGHT LINES.

INFORMATION REGARDING A LINE *means*
IT'S LENGTH,
POSITION OF IT'S ENDS WITH HP & VP
IT'S INCLINATIONS WITH HP & VP WILL BE GIVEN.
AIM:- TO DRAW IT'S PROJECTIONS - MEANS FV & TV.

SIMPLE CASES OF THE LINE

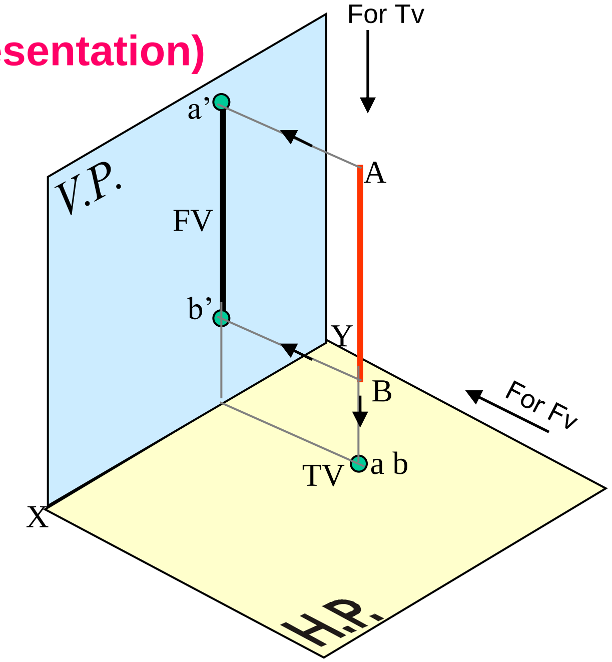
1. A VERTICAL LINE (LINE PERPENDICULAR TO HP & // TO VP)
2. LINE PARALLEL TO BOTH HP & VP.
3. LINE INCLINED TO HP & PARALLEL TO VP.
4. LINE INCLINED TO VP & PARALLEL TO HP.
5. LINE INCLINED TO BOTH HP & VP.

STUDY ILLUSTRATIONS GIVEN ON NEXT PAGE SHOWING CLEARLY THE NATURE OF FV & TV OF LINES LISTED ABOVE AND NOTE RESULTS.

(Pictorial Presentation)

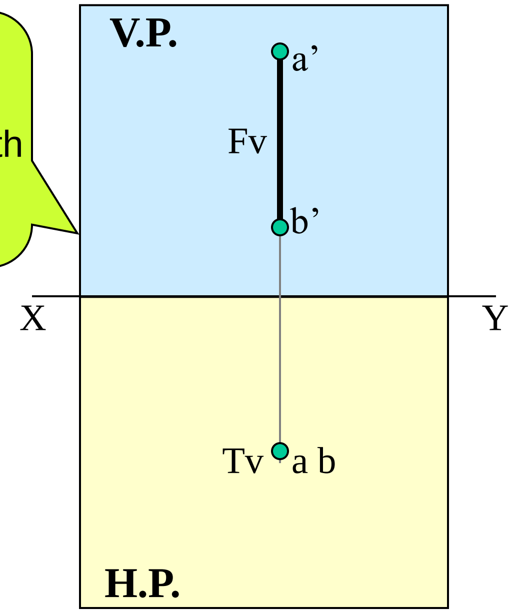
1.

A Line perpendicular to Hp & // to Vp



Note:
Fv is a vertical line
Showing True Length
&
Tv is a point.

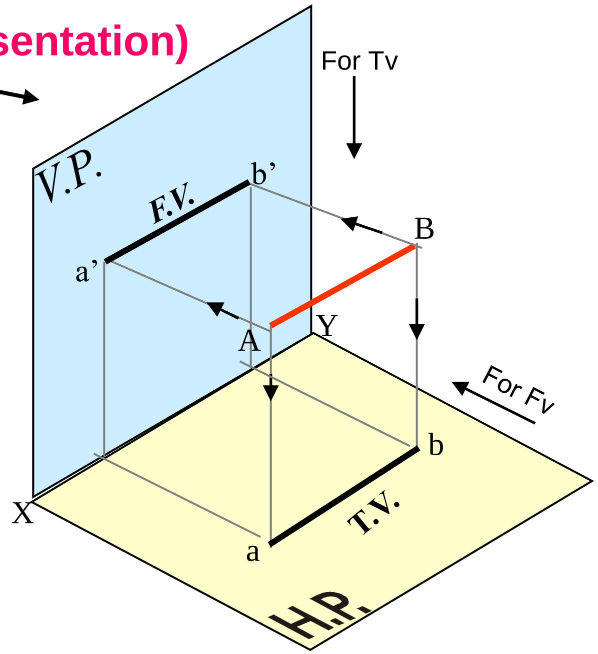
Orthographic Pattern



(Pictorial Presentation)

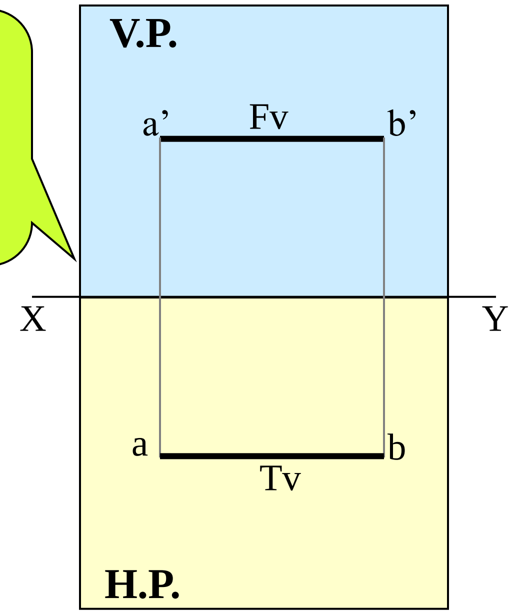
2.

A Line // to Hp & // to Vp



Note:
Fv & Tv both are
// to xy
&
both show T. L.

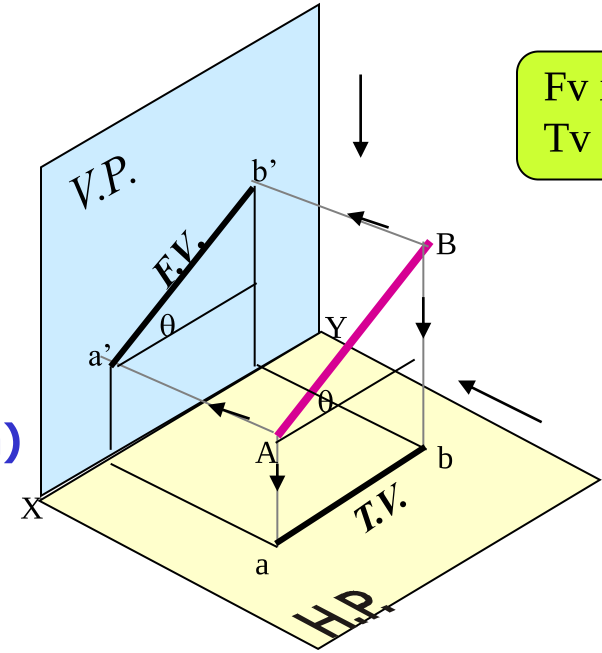
Orthographic Pattern

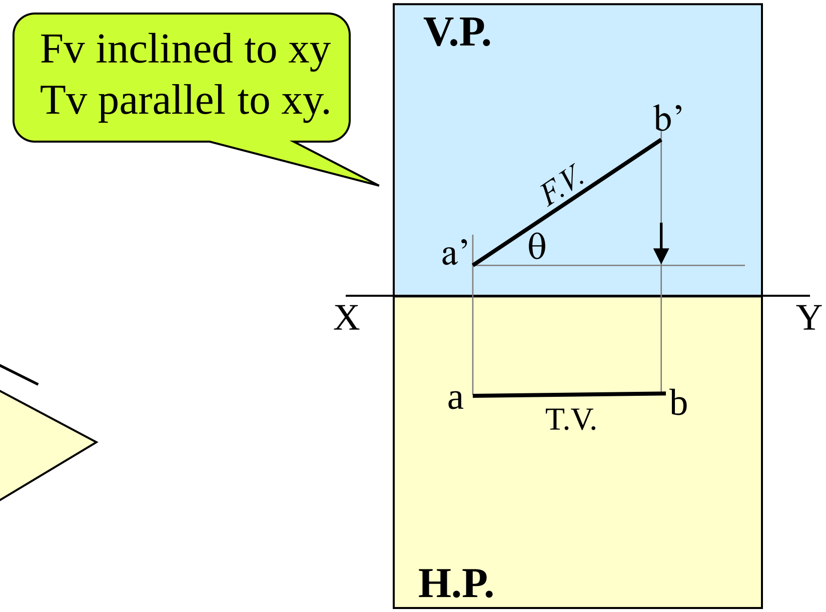


3.

A Line inclined to Hp
and
parallel to Vp

(Pictorial presentation)



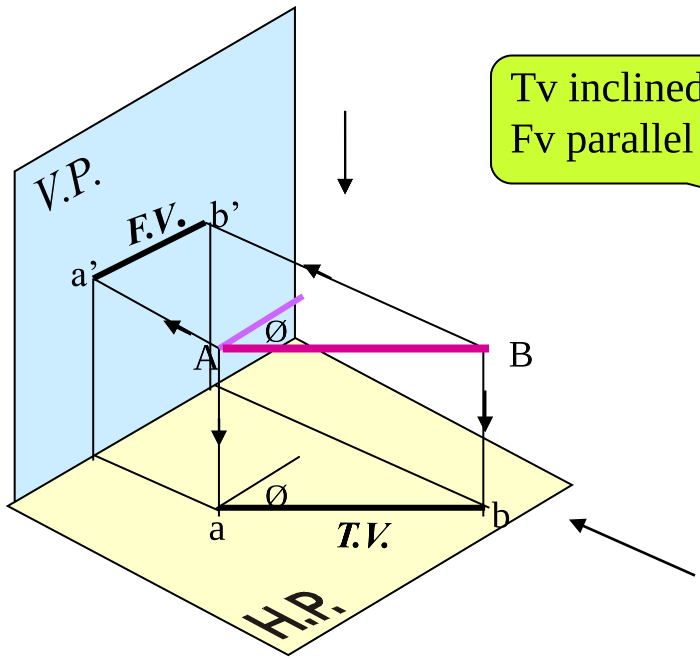


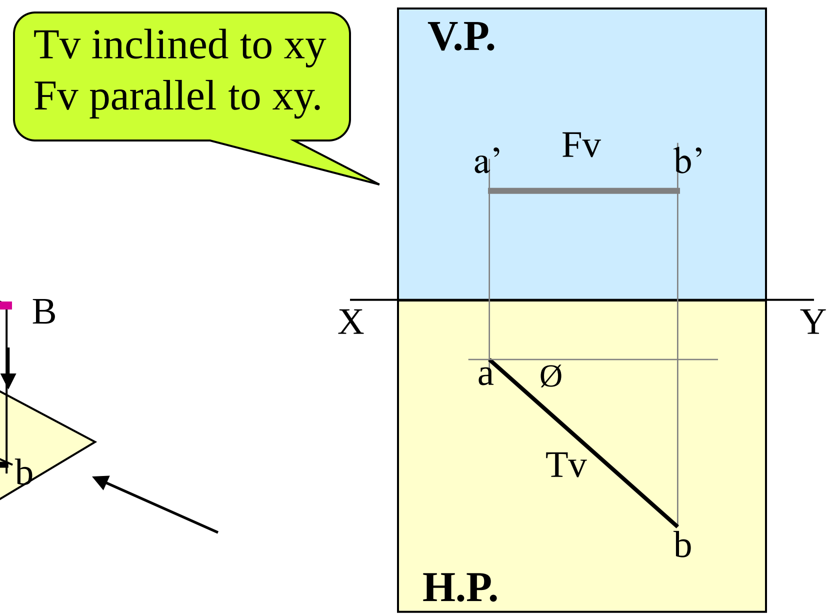
Orthographic Projections

4.

A Line inclined to Vp
and
parallel to Hp

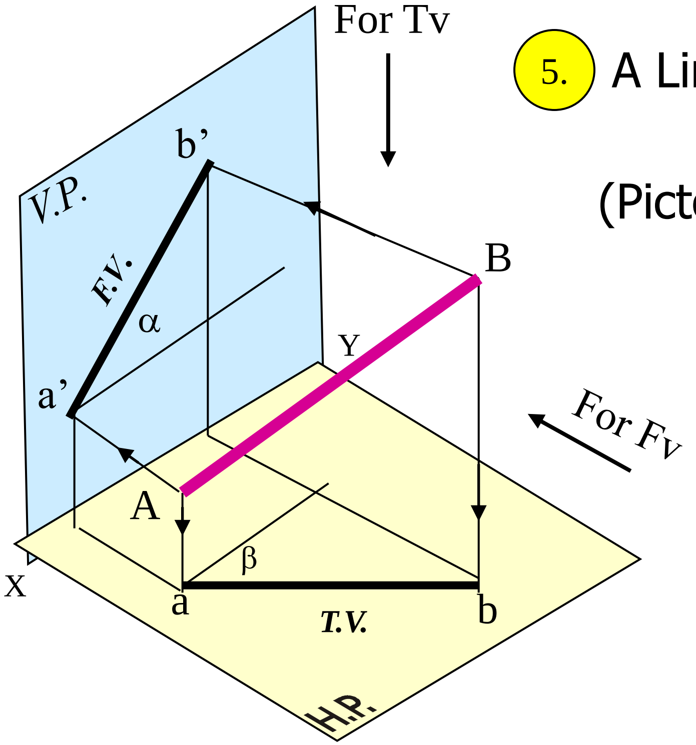
(Pictorial presentation)



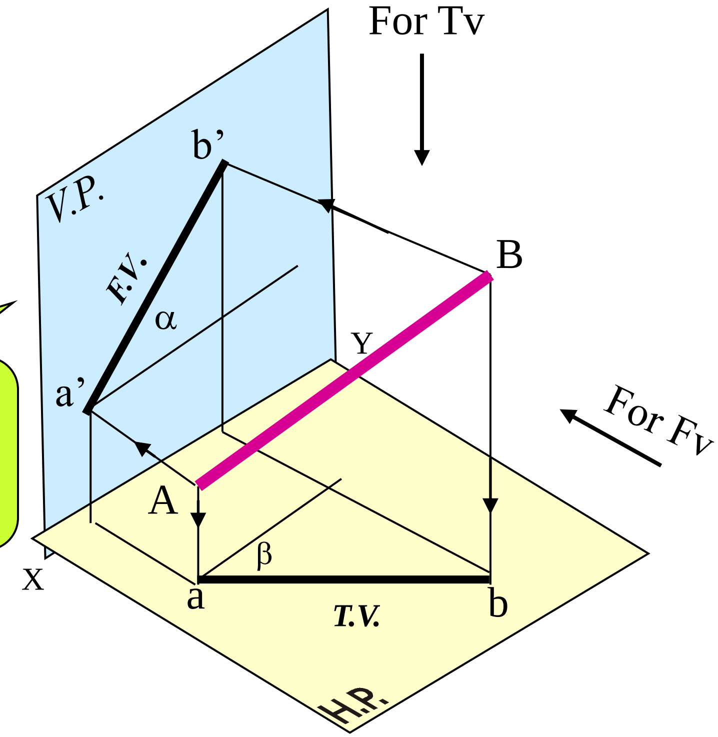


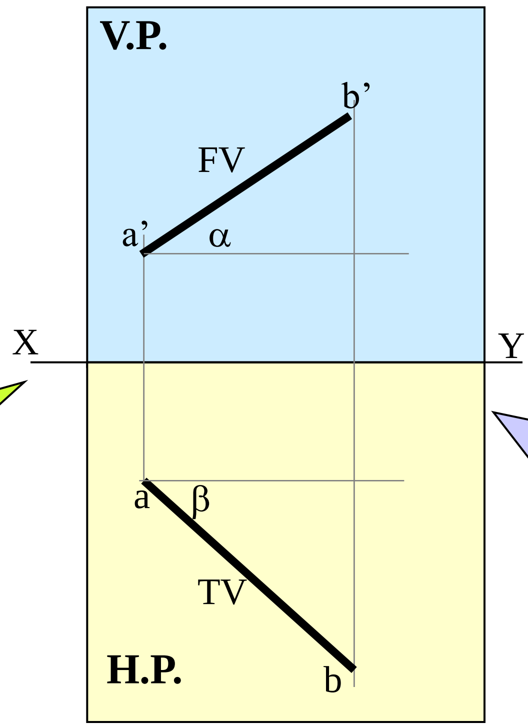
5. A Line inclined to both Hp and Vp

(Pictorial presentation)



On removal of object i.e. Line AB
Fv as a image on Vp.
Tv as a image on Hp,

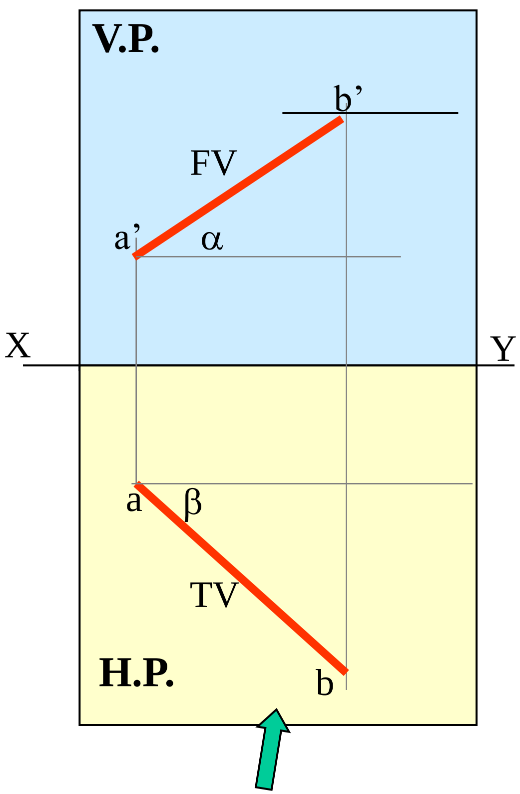




Orthographic Projections
Fv is seen on Vp clearly.
To see Tv clearly, HP is rotated 90^0 downwards,
Hence it comes below xy.

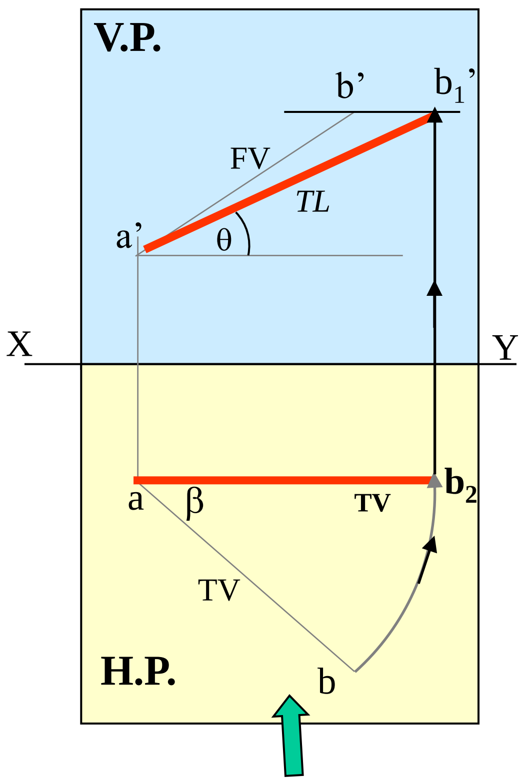
Note These Facts:-
Both Fv & Tv are inclined to xy.
(No view is parallel to xy)
Both Fv & Tv are reduced lengths.
(No view shows True Length)

Orthographic Projections
Means Fv & Tv of Line AB
are shown below,
with their apparent Inclinations
α & β



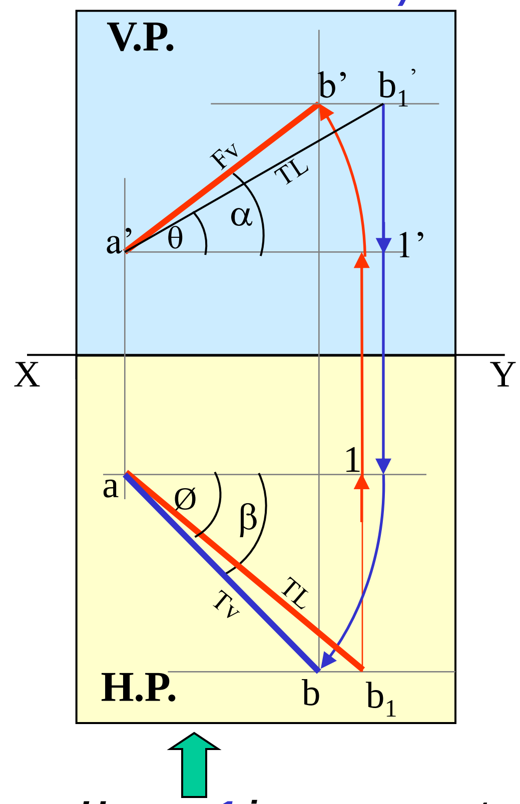
Here TV (ab) is not // to XY line
Hence it’s corresponding FV
a’ b’ is not showing
True Length &
True Inclination with Hp.

Note the procedure
When Fv & Tv known,
How to find True Length.
(Views are rotated to determine
True Length & it’s inclinations
with Hp & Vp).



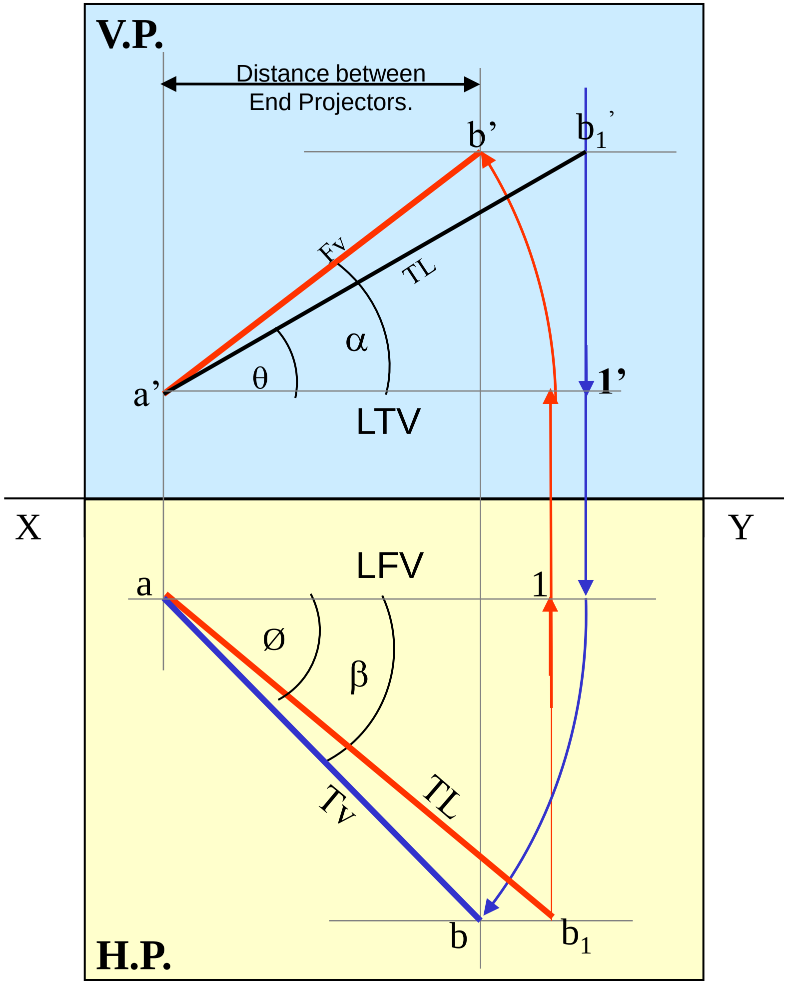
In this sketch, TV is rotated
and made // to XY line.
Hence it’s corresponding
FV a’ b_1’ Is showing
True Length
&
True Inclination with Hp.

Note the procedure
When True Length is known,
How to locate Fv & Tv.
(Component a-1 of TL is drawn
which is further rotated
to determine Fv)



Here a -1 is component
of TL ab_1 gives length of Fv.
Hence it is brought Up to
Locus of a’ and further rotated
to get point b’. a’ b’ will be Fv.
Similarly drawing component
of other TL(a’ b_1‘) Tv can be drawn.

The most important diagram showing graphical relations among all important parameters of this topic.
Study and memorize it as a ***CIRCUIT DIAGRAM***
And use in solving various problems.



1) True Length (TL) – a' b_1' & a b1
2) Angle of TL with Hp - θ
3) Angle of TL with Vp – Ø
4) Angle of FV with xy – α
5) Angle of TV with xy – β
6) LTV (length of FV) – Component **(a-1)**
7) LFV (length of TV) – Component **(a'-1')**
8) Position of A- **Distances of a & a' from xy**
9) Position of B- **Distances of b & b' from xy**
10) Distance between End Projectors

Important TEN parameters to be remembered with Notations used here onward

NOTE this

θ & α Construct with ***a'***
Ø & β Construct with ***a***
b' & b_1' on same locus.
b & b_1 on same locus.

Also Remember

True Length is never rotated. It's horizontal component is drawn & it is further rotated to locate view.

Views are always rotated, made horizontal & further extended to locate TL, θ & Ø

GROUP (A)

GENERAL CASES OF THE LINE INCLINED TO BOTH HP & VP

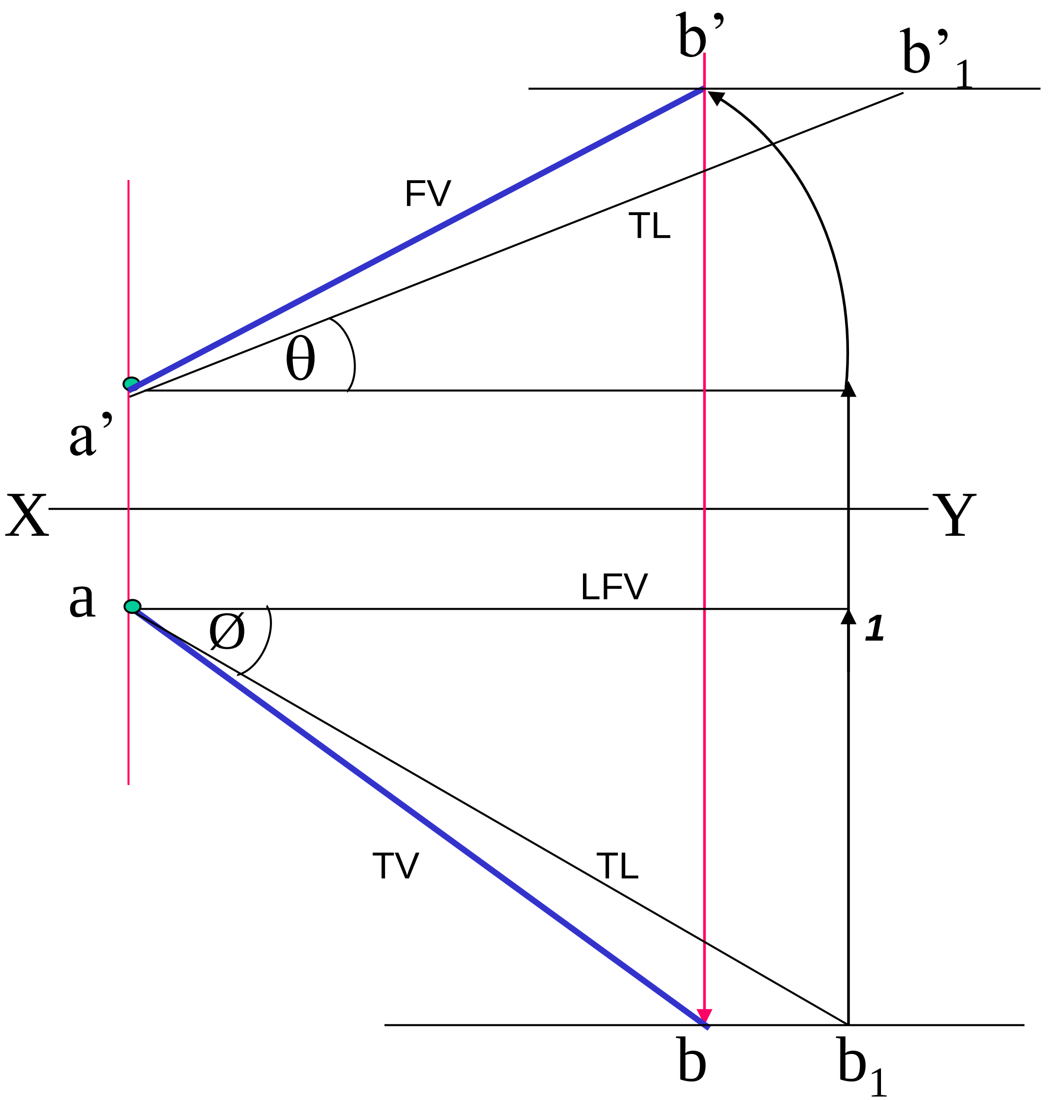
(based on 10 parameters).

PROBLEM 1)

Line AB is 75 mm long and it is 30^0 & 40^0 Inclined to Hp & Vp respectively. End A is 12mm above Hp and 10 mm in front of Vp. Draw projections. Line is in 1st quadrant.

SOLUTION STEPS:

1) Draw xy line and one projector.
2) Locate a' 12mm above xy line & a 10mm below xy line.
3) Take 30^0 angle from a' & 40^0 from a and mark TL I.e. 75mm on both lines. Name those points b_1' and b_1 respectively.
4) Join both points with a' and a resp.
5) Draw horizontal lines (Locus) from both points.
6) Draw horizontal component of TL a b_1 from point b_1 and name it 1. (the length a-1 gives length of Fv as we have seen already.)
7) Extend it up to locus of a' and rotating a' as center locate b' as shown. Join a' b' as Fv.
8) From b' drop a projector down ward & get point b. Join a & b I.e. Tv.

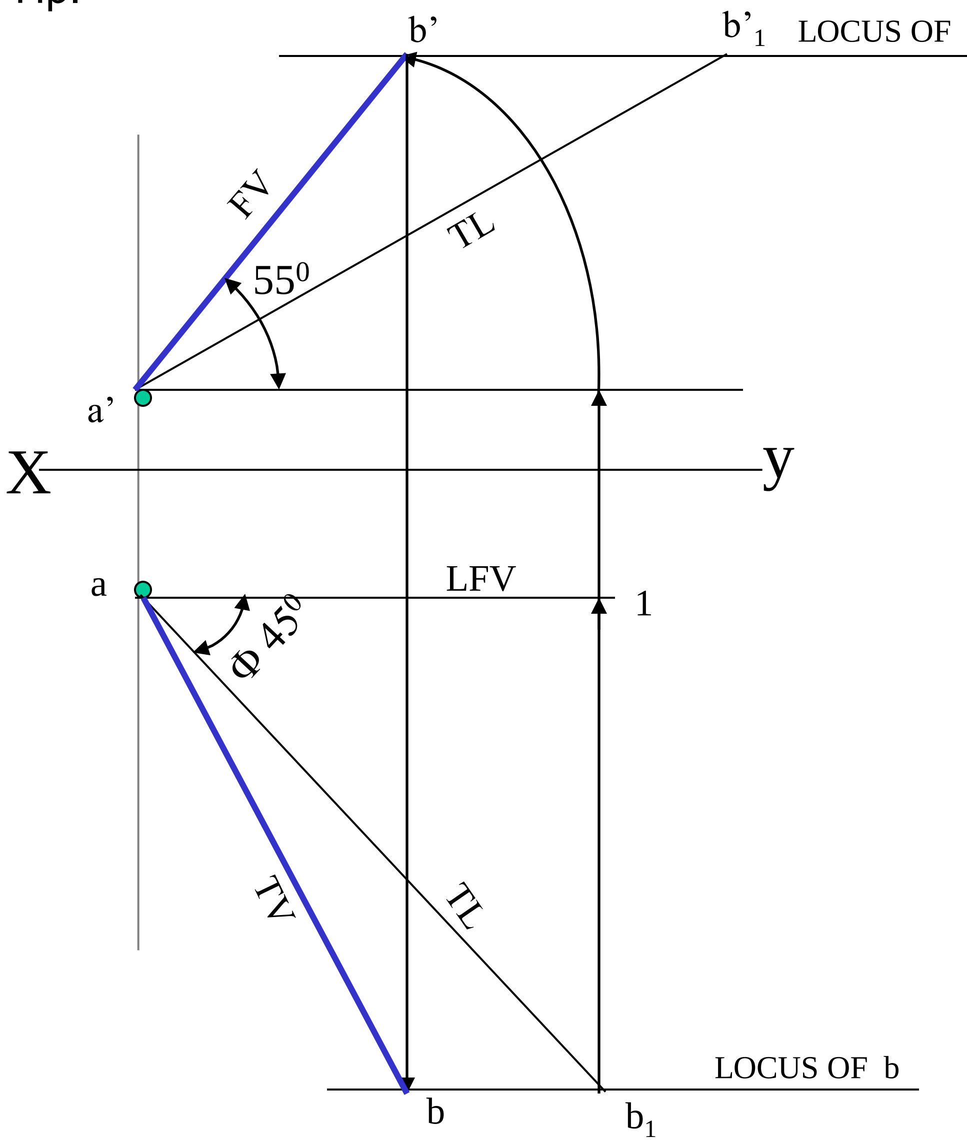


PROBLEM 2:

Line AB 75mm long makes 45^0 inclination with Vp while it's Fv makes 55^0. End A is 10 mm above Hp and 15 mm in front of Vp.If line is in 1st quadrant draw it's projections and find it's inclination with Hp.

Solution Steps:-

1.Draw x-y line.
2.Draw one projector for a' & a
3.Locate *a'* 10mm above x-y & Tv *a* 15 mm below xy.
4.Draw a line 45^0 inclined to xy from point *a* and cut TL 75 mm on it and name that point b_1 Draw locus from point b_1
5.Take 55^0 angle from *a'* for Fv above xy line.
6.Draw a vertical line from b_1 up to locus of a and name it *1*. It is horizontal component of TL & is LFV.
7.Continue it to locus of *a'* and rotate upward up to the line of Fv and name it *b'*.This *a' b'* line is Fv.
8. Drop a projector from b' on locus from point b_1 and name intersecting point *b*. Line *a b* is Tv of line AB.
9.Draw locus from *b'* and from *a'* with TL distance cut point b_1'
10.Join *a' b_1'* as TL and measure it's angle at *a'*.
It will be true angle of line with HP.

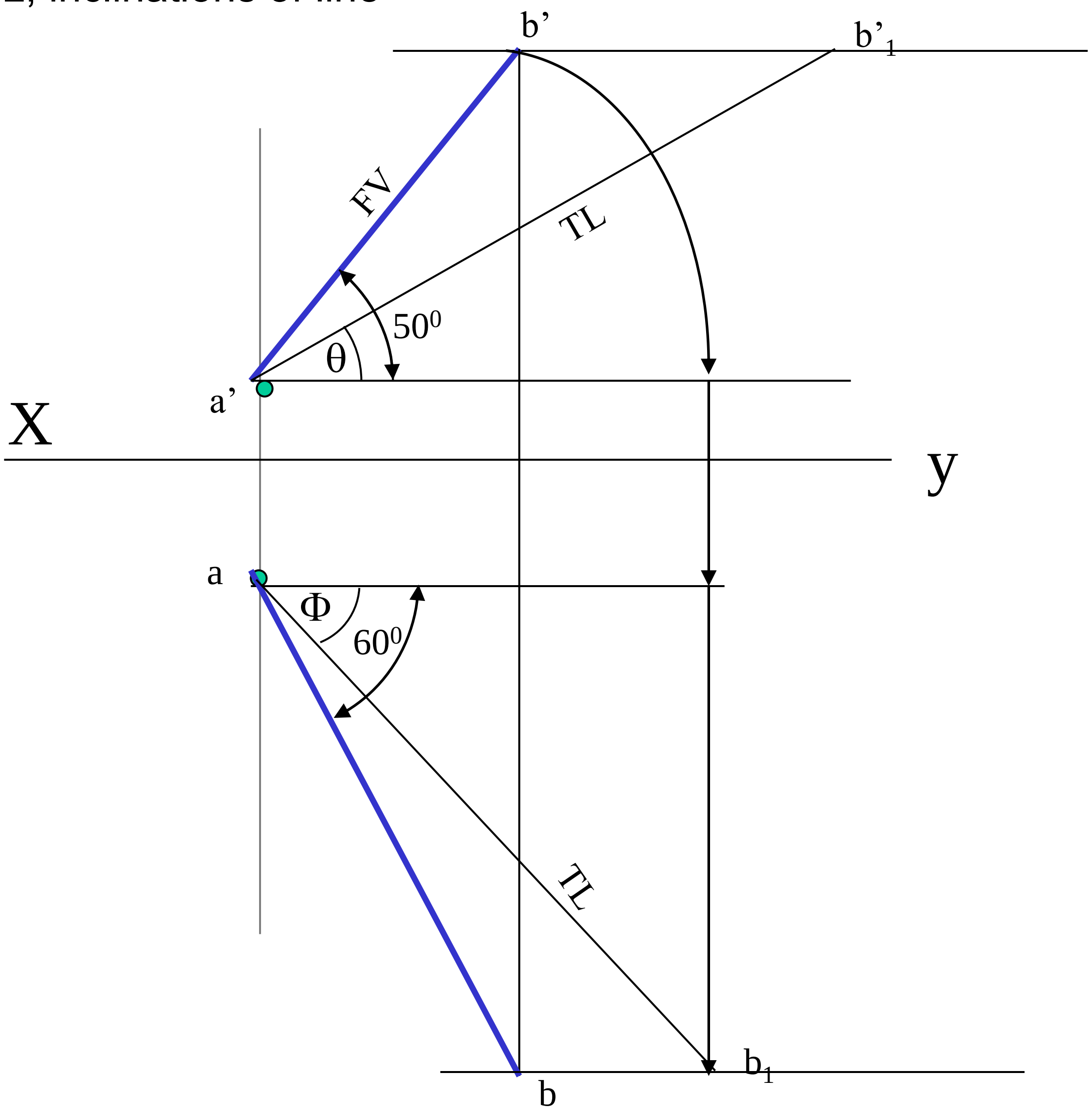


PROBLEM 3:

Fv of line AB is 50^0 inclined to xy and measures 55 mm long while it's Tv is 60^0 inclined to xy line. If end A is 10 mm above Hp and 15 mm in front of Vp, draw it's projections,find TL, inclinations of line with Hp & Vp.

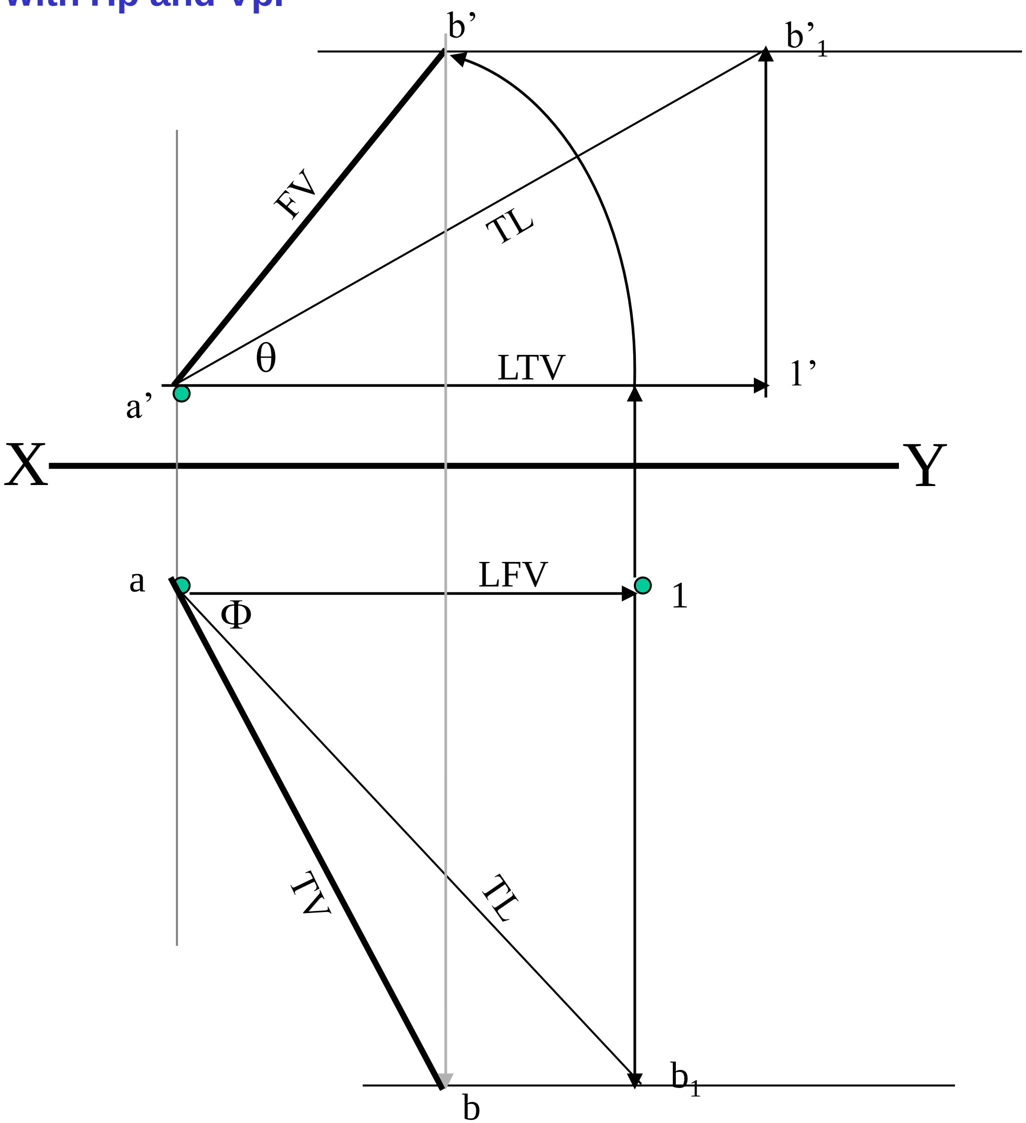
SOLUTION STEPS:

1.Draw xy line and one projector.
2.Locate a' 10 mm above xy and a 15 mm below xy line.
3.Draw locus from these points.
4.Draw Fv 50^0 to xy from a' and mark b' Cutting 55mm on it.
5.Similarly draw Tv 60^0 to xy from a & drawing projector from b' Locate point b and join a b.
6.Then rotating views as shown, locate True Lengths ab_1 & $a'b_1'$ and their angles with Hp and Vp.



PROBLEM 4 :-

Line AB is 75 mm long .It's Fv and Tv measure 50 mm & 60 mm long respectively. End A is 10 mm above Hp and 15 mm in front of Vp. Draw projections of line AB if end B is in first quadrant.Find angle with Hp and Vp.



SOLUTION STEPS:

1.Draw xy line and one projector.

2.Locate a' 10 mm above xy and a 15 mm below xy line.

3.Draw locus from these points.

4.Cut 60mm distance on locus of a' & mark 1' on it as it is LTV.

5.Similarly Similarly cut 50mm on locus of a and mark point 1 as it is LFV.

6.From 1' draw a vertical line upward and from a' taking TL (75mm) in compass, mark b'_1 point on it. Join a' b'_1 points.

7. Draw locus from b'_1

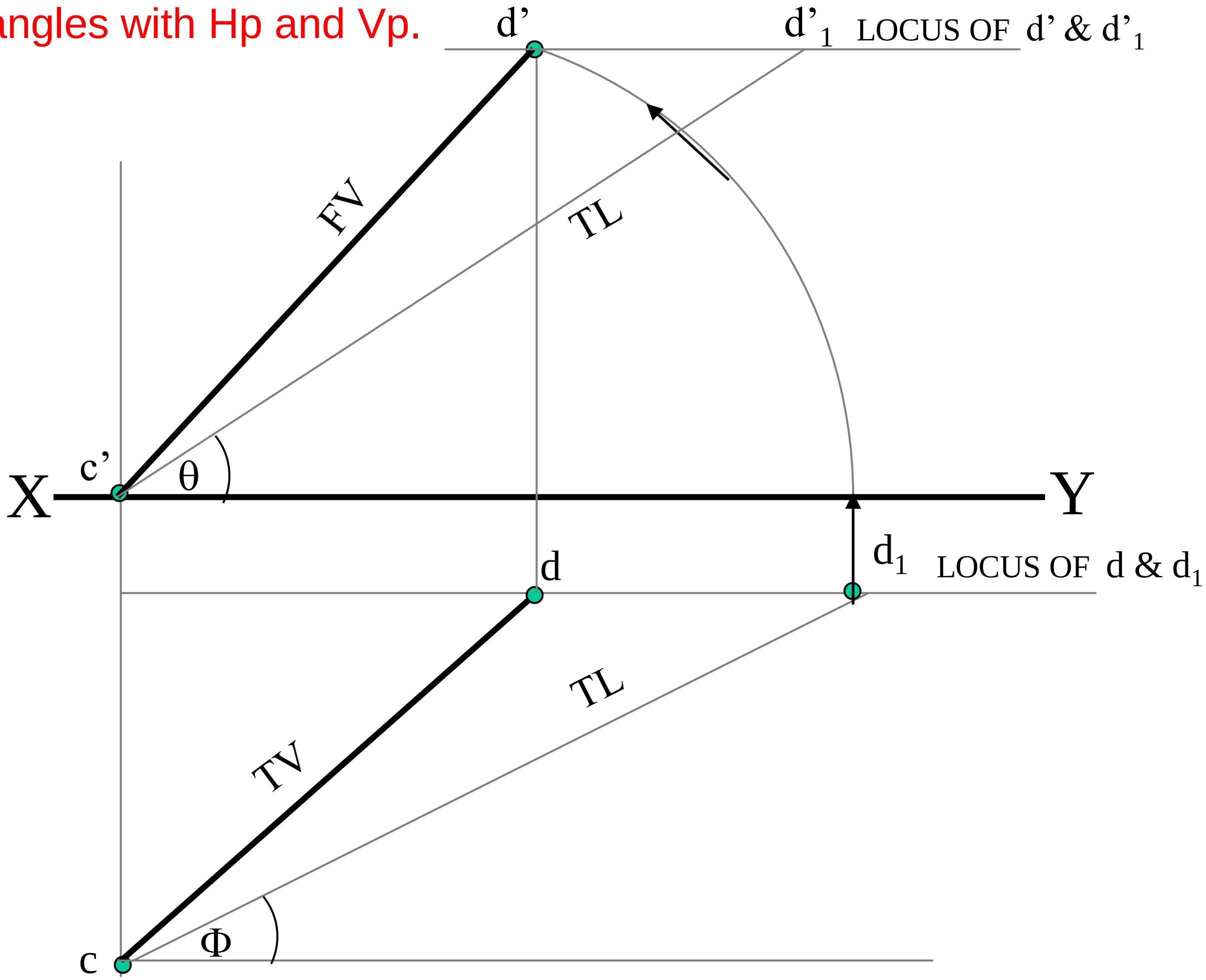
8. With same steps below get b_1 point and draw also locus from it.

9. Now rotating one of the components I.e. a-1 locate b' and join a' with it to get Fv.

10. Locate tv similarly and measure Angles θ & Φ

PROBLEM 5 :-

T.V. of a 75 mm long Line CD, measures 50 mm.
End C is in Hp and 50 mm in front of Vp.
End D is 15 mm in front of Vp and it is above Hp.
Draw projections of CD and find angles with Hp and Vp.



SOLUTION STEPS:

1.Draw xy line and one projector.
2.Locate c' on xy and
c 50mm below xy line.
3.Draw locus from these points.
4.Draw locus of d 15 mm below xy
5.Cut 50mm & 75 mm distances on locus of d from c and mark points d & d_1 as these are Tv and line CD lengths resp.& join both with c.
6.From d_1 draw a vertical line upward up to xy I.e. up to locus of c' and draw an arc as shown.
7 Then draw one projector from d to meet this arc in d' point & join c' d'
8. Draw locus of d' and cut 75 mm on it from c' as TL
9.Measure Angles θ & Φ

GROUP (B)
PROBLEMS INVOLVING TRACES OF THE LINE.

TRACES OF THE LINE:-

THESE ARE THE POINTS OF INTERSECTIONS OF A LINE (OR IT'S EXTENSION) WITH RESPECTIVE REFFERENCE PLANES.

A LINE ITSELF OR IT'S EXTENSION, WHERE EVER TOUCHES H.P., THAT POINT IS CALLED TRACE OF THE LINE ON H.P.(IT IS CALLED H.T.)

SIMILARLY, A LINE ITSELF OR IT'S EXTENSION, WHERE EVER TOUCHES V.P., THAT POINT IS CALLED TRACE OF THE LINE ON V.P.(IT IS CALLED V.T.)

V.T.:- It is a point on **Vp**.
Hence it is called ***Fv*** of a point in **Vp.**
Hence it's ***Tv*** comes on XY line.(Here onward named as **v)**

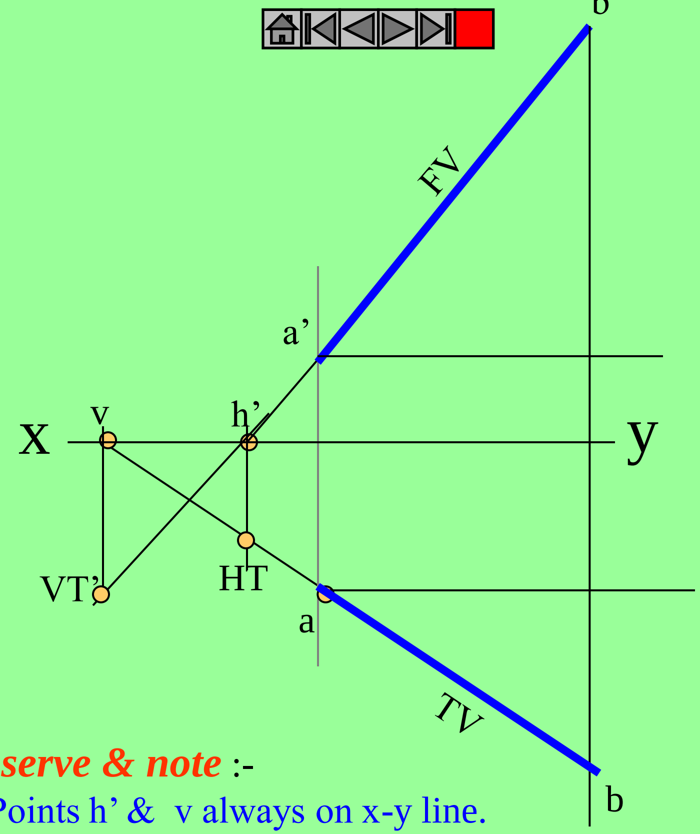
H.T.:- It is a point on **Hp.**
Hence it is called ***Tv*** of a point in **Hp**.
Hence it's ***Fv*** comes on **XY line**.(Here onward named as **'h')**

STEPS TO LOCATE HT.
(WHEN PROJECTIONS ARE GIVEN.)

1. **Begin with FV. Extend FV up to XY line.**
2. **Name this point h'**
   (as it is a Fv of a point in Hp)
3. **Draw one projector from h'.**
4. **Now extend Tv to meet this projector.**
   This point is HT

STEPS TO LOCATE VT.
(WHEN PROJECTIONS ARE GIVEN.)

1. **Begin with TV. Extend TV up to XY line.**
2. **Name this point v**
   (as it is a Tv of a point in Vp)
3. **Draw one projector from v.**
4. **Now extend Fv to meet this projector.**
   This point is VT

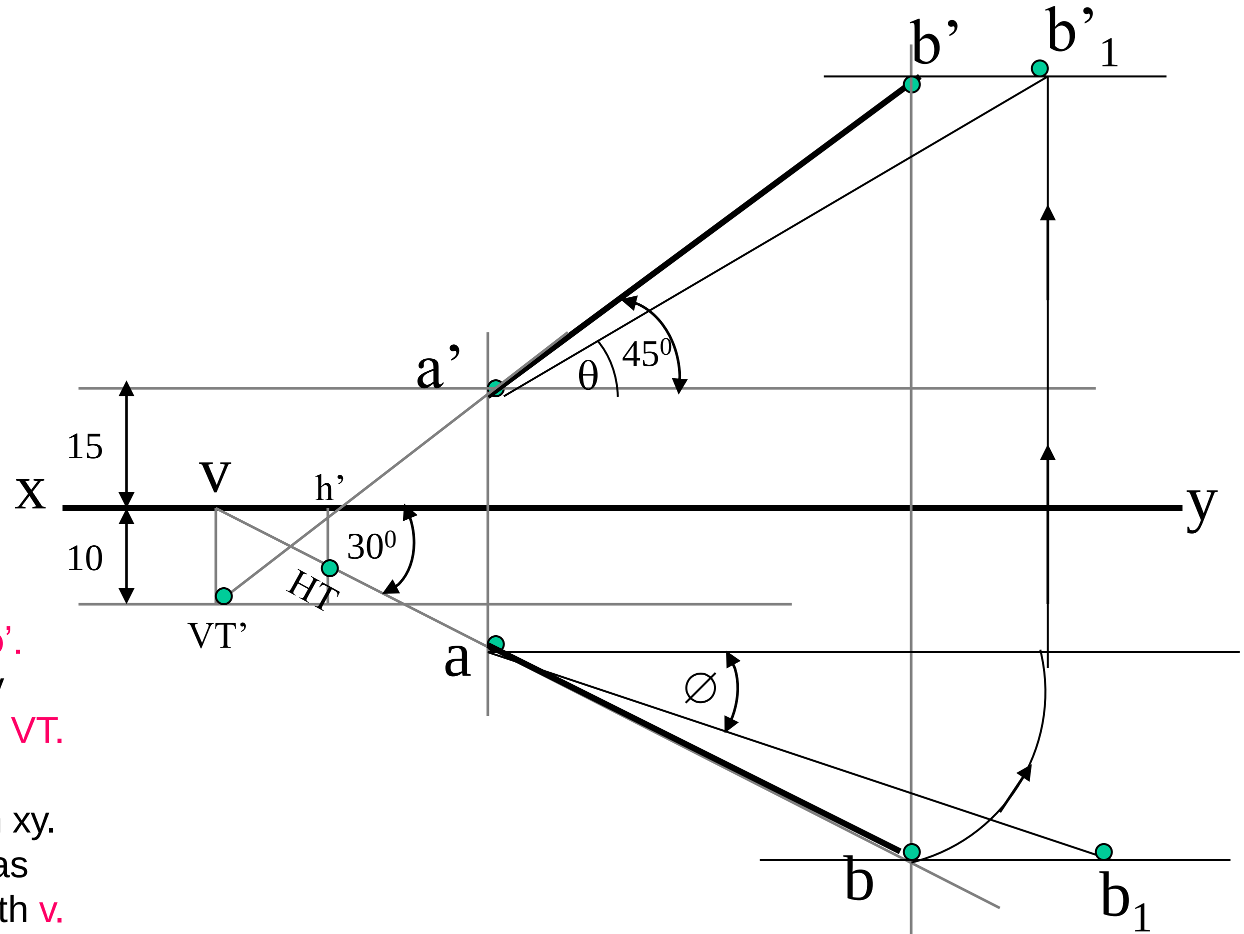


Observe & note :-

1. Points h' & v always on x-y line.
2. VT' & v always on one projector.
3. HT & h' always on one projector.
4. FV - h'- VT' always co-linear.
5. TV - v - HT always co-linear.

These points are used to solve next three problems.

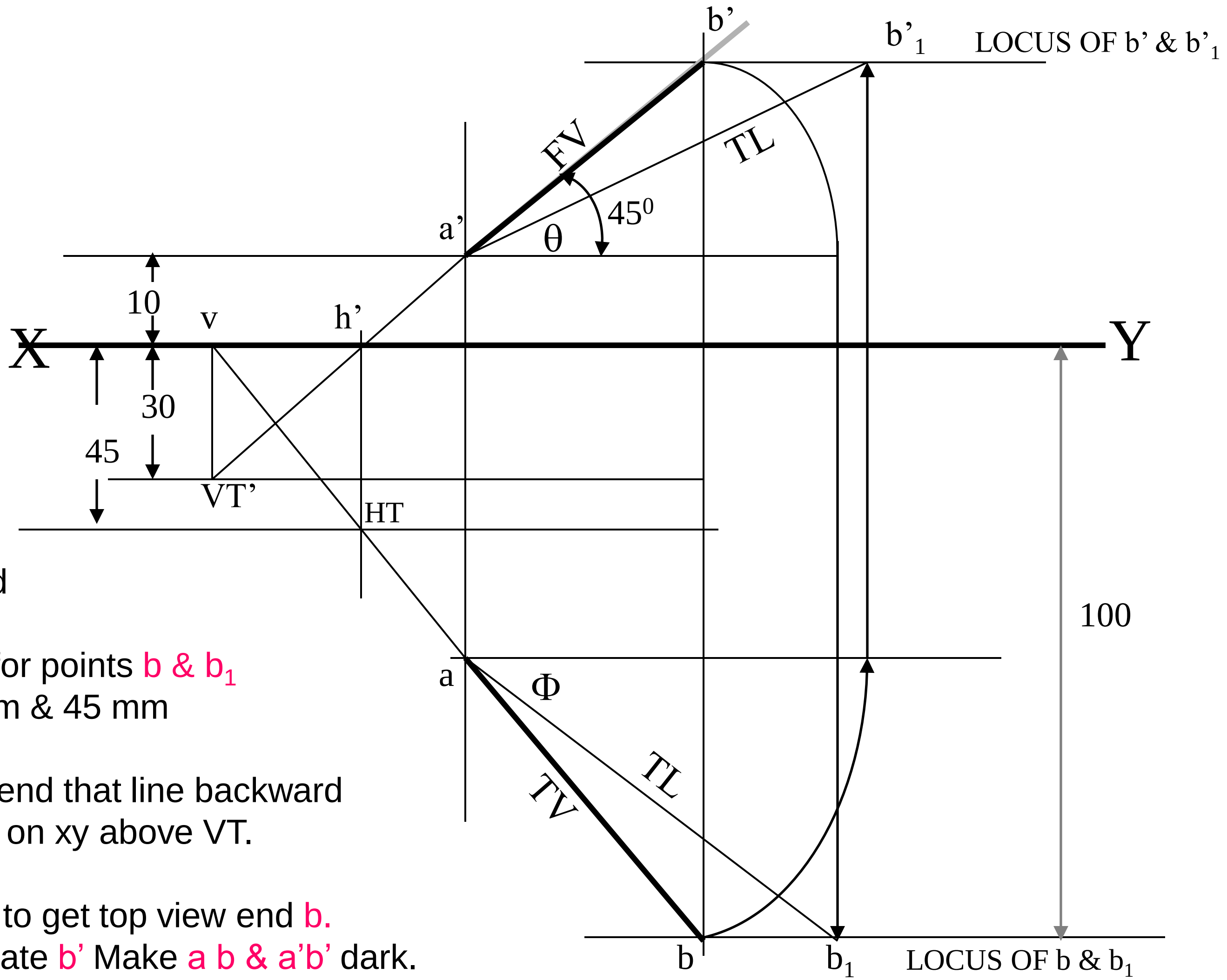
PROBLEM 6 :- Fv of line AB makes 45^0 angle with XY line and measures 60 mm. Line's Tv makes 30^0 with XY line. End A is 15 mm above Hp and it's VT is 10 mm below Hp. Draw projections of line AB,determine inclinations with Hp & Vp and locate HT, VT.



SOLUTION STEPS:-

Draw xy line, one projector and locate fv a' 15 mm above xy.
Take 45^0 angle from a' and marking 60 mm on it locate point b'.
Draw locus of VT, 10 mm below xy & extending Fv to this locus locate VT.
as fv-h'-vt' lie on one st.line.
Draw projector from vt, locate v on xy.
From v take 30^0 angle downward as Tv and it's inclination can begin with v.
Draw projector from b' and locate b I.e.Tv point.
Now rotating views as usual TL and it's inclinations can be found.
Name extension of Fv, touching xy as h' and below it, on extension of Tv, locate HT.

PROBLEM 7 :
One end of line AB is 10mm above Hp and other end is 100 mm in-front of Vp.
It's Fv is 45^0 inclined to xy while it's HT & VT are 45mm and 30 mm below xy respectively.
Draw projections and find TL with it's inclinations with Hp & VP.



SOLUTION STEPS:-
Draw xy line, one projector and locate a' 10 mm above xy.
Draw locus 100 mm below xy for points b & b_1
Draw loci for VT and HT, 30 mm & 45 mm below xy respectively.
Take 45^0 angle from a' and extend that line backward to locate h' and VT, & Locate v on xy above VT.
Locate HT below h' as shown.
Then join v – HT – and extend to get top view end b.
Draw projector upward and locate b' Make a b & a'b' dark.
Now as usual rotating views find TL and it's inclinations.

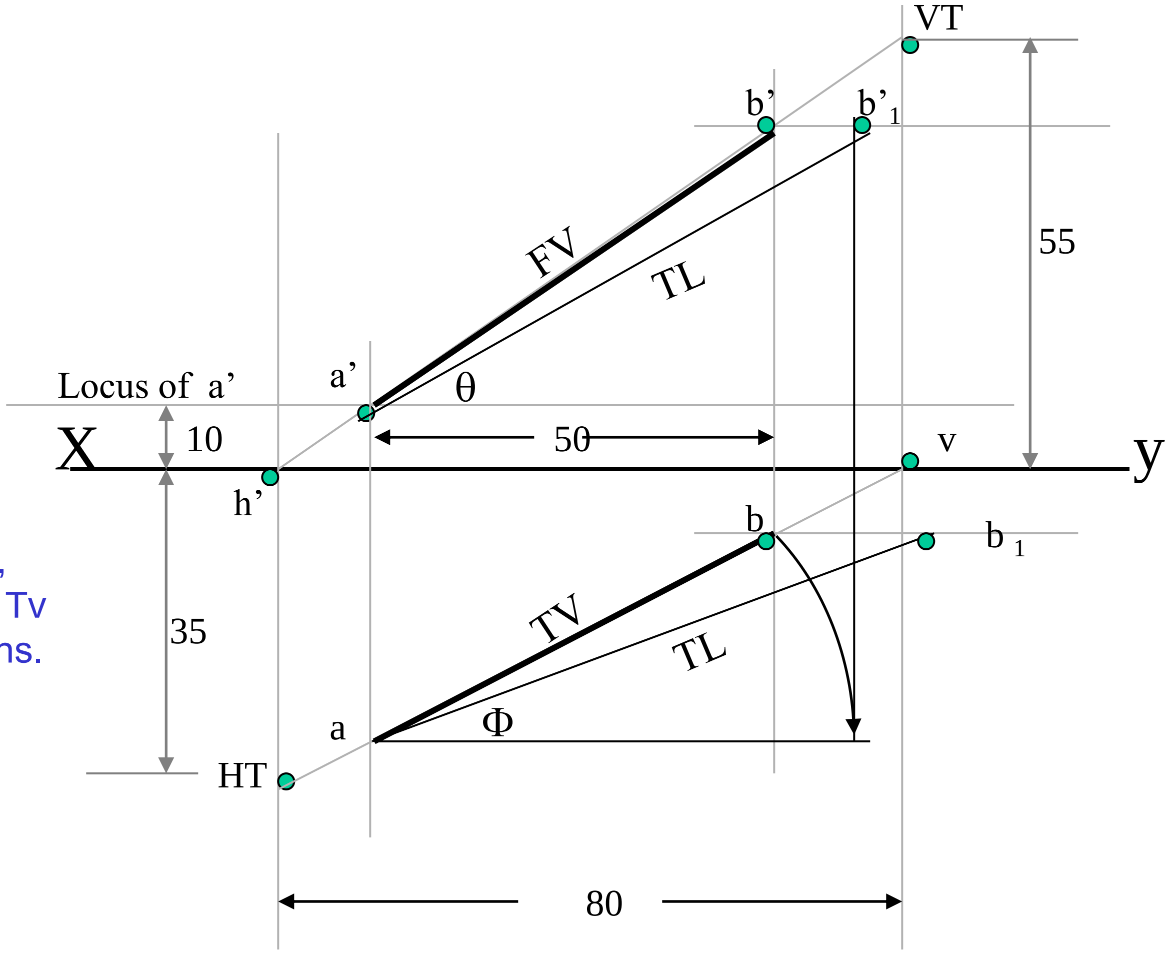
PROBLEM 8 :- Projectors drawn from HT and VT of a line AB are 80 mm apart and those drawn from it's ends are 50 mm apart. End A is 10 mm above Hp, VT is 35 mm below Hp while it's HT is 45 mm in front of Vp. Draw projections, locate traces and find TL of line & inclinations with Hp and Vp.

SOLUTION STEPS:-

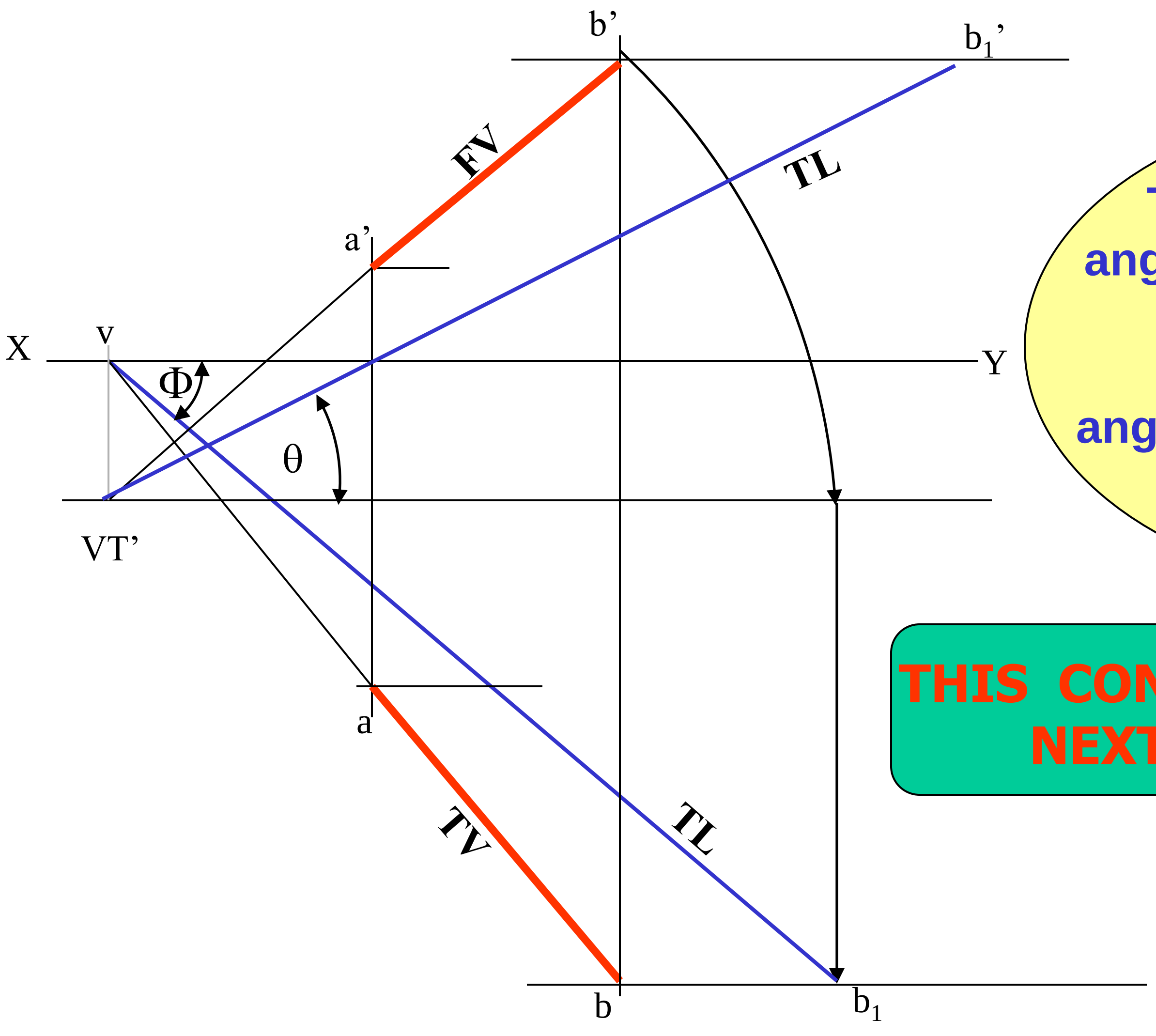
1.Draw xy line and two projectors, 80 mm apart and locate HT & VT , 35 mm below xy and 55 mm above xy respectively on these projectors.

2.Locate h' and v on xy as usual.

3.Now just like previous two problems, Extending certain lines complete Fv & Tv And as usual find TL and it's inclinations.



Instead of considering a & a' as projections of first point, if v & VT' are considered as first point , then true inclinations of line with Hp & Vp i.e. angles θ & Φ can be constructed with points VT' & V respectively.

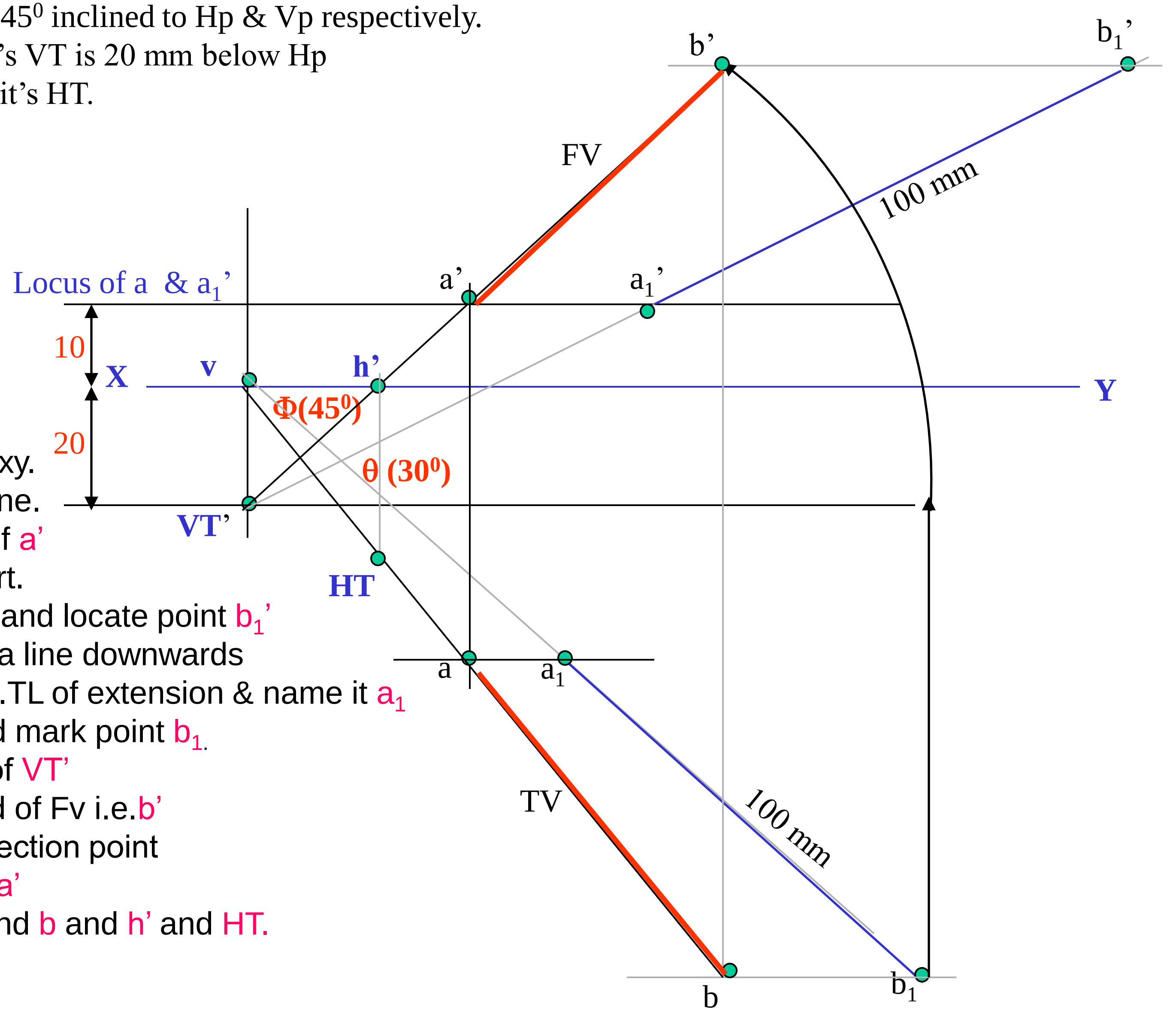


Then from point v & HT angles β & Φ can be drawn.
&
From point VT' & h' angles α & θ can be drawn.

THIS CONCEPT IS USED TO SOLVE NEXT *THREE* PROBLEMS.

PROBLEM 9 :-

Line AB 100 mm long is 30^0 and 45^0 inclined to Hp & Vp respectively.
End A is 10 mm above Hp and it's VT is 20 mm below Hp
.Draw projections of the line and it's HT.

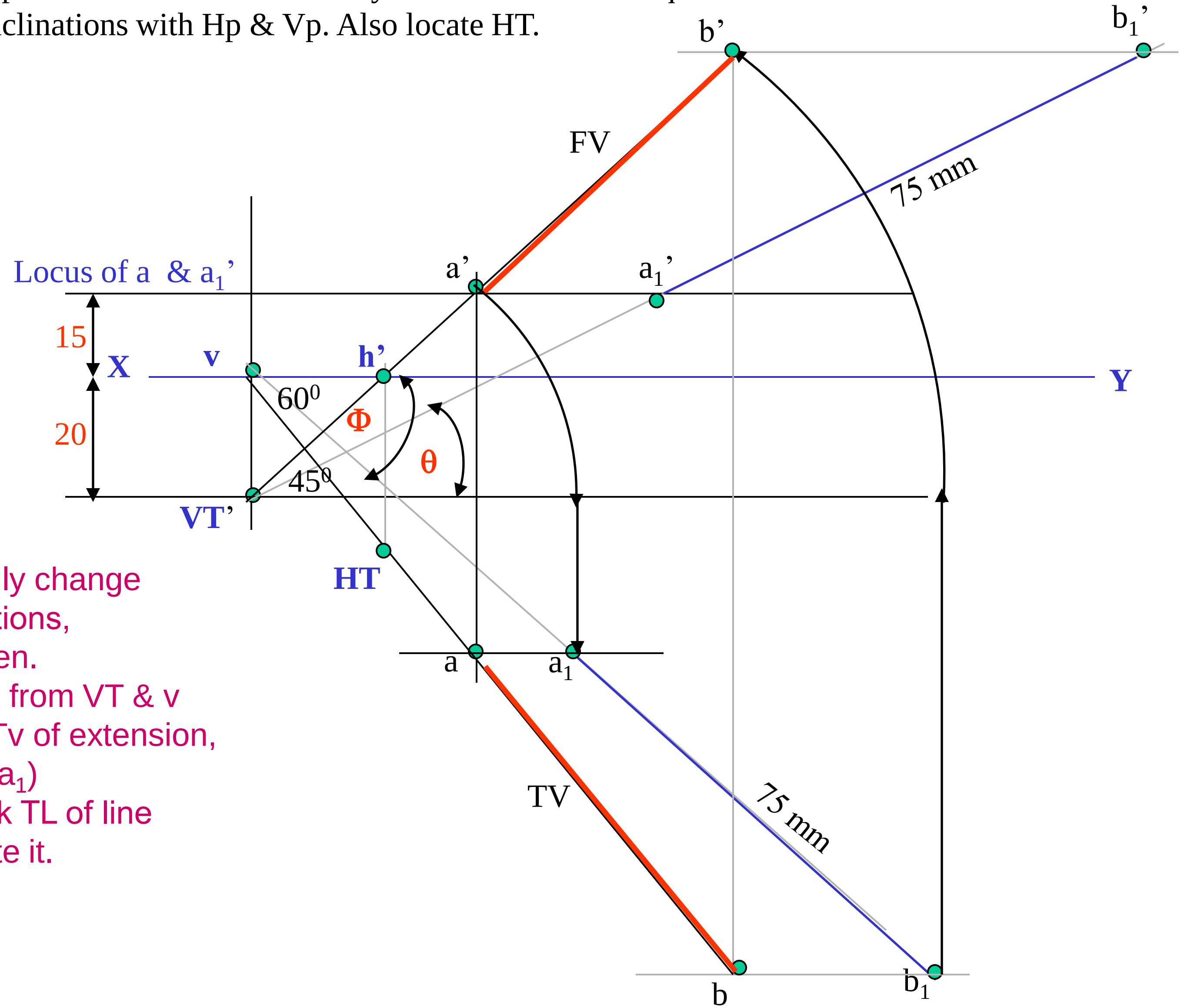


SOLUTION STEPS:-

Draw xy, one projector and locate on it VT and V.
Draw locus of a' 10 mm above xy.
Take 30^0 from VT and draw a line.
Where it intersects with locus of a' name it a_1' as it is TL of that part.
From a_1' cut 100 mm (TL) on it and locate point b_1'
Now from v take 45^0 and draw a line downwards
& Mark on it distance VT-a_1' I.e.TL of extension & name it a_1
Extend this line by 100 mm and mark point b_1.
Draw it's component on locus of VT'
& further rotate to get other end of Fv i.e.b'
Join it with VT' and mark intersection point
(with locus of a_1') and name it a'
Now as usual locate points a and b and h' and HT.

PROBLEM 10 :-

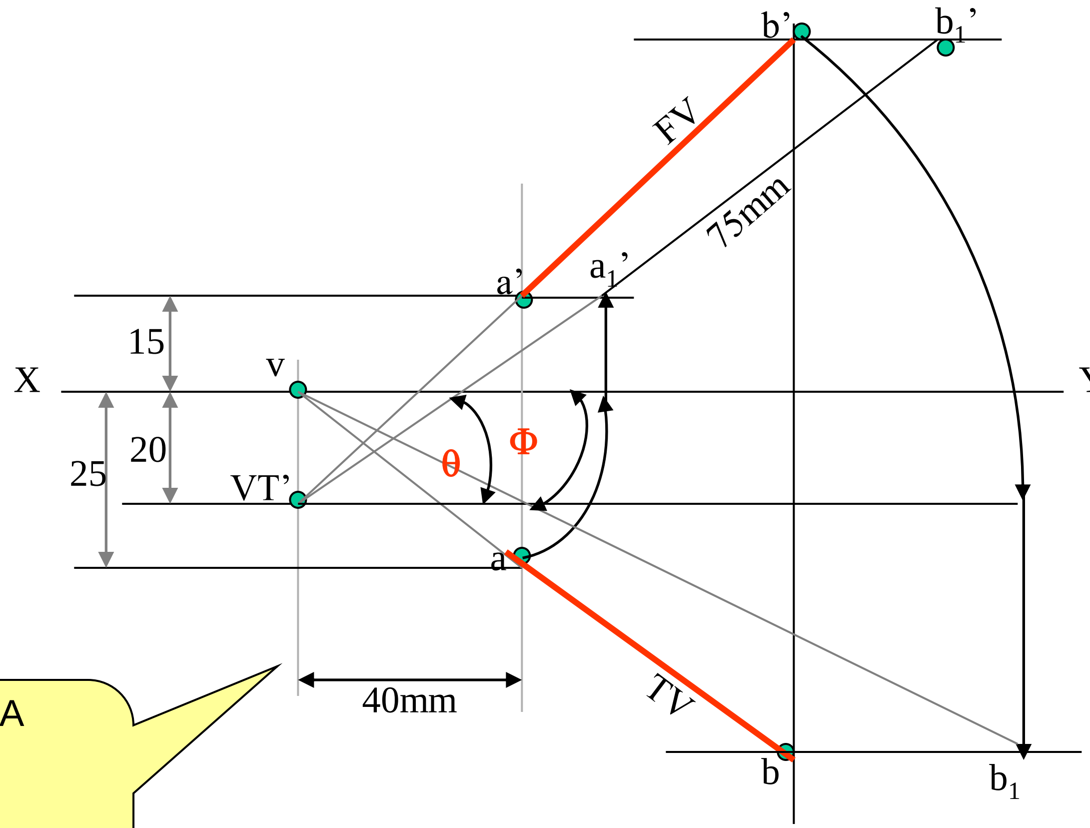
A line AB is 75 mm long. It's Fv & Tv make 45^0 and 60^0 inclinations with X-Y line resp
End A is 15 mm above Hp and VT is 20 mm below Xy line. Line is in first quadrant.
Draw projections, find inclinations with Hp & Vp. Also locate HT.



SOLUTION STEPS:-

Similar to the previous only change
is instead of line's inclinations,
views inclinations are given.
So first take those angles from VT & v
Properly, construct Fv & Tv of extension,
then determine it's TL(V-a_1)
and on it's extension mark TL of line
and proceed and complete it.

PROBLEM 11 :- The projectors drawn from VT & end A of line AB are 40mm apart. End A is 15mm above Hp and 25 mm in front of Vp. VT of line is 20 mm below Hp. If line is 75mm long, draw it's projections, find inclinations with HP & Vp



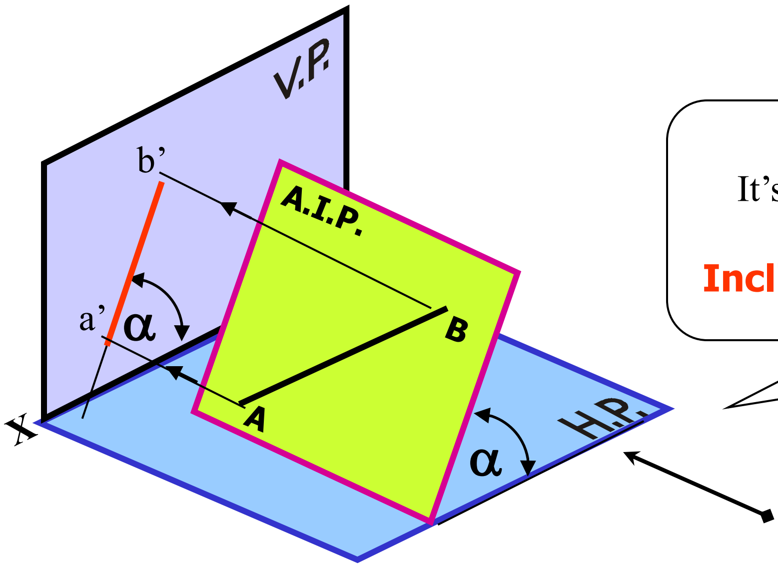
Draw two projectors for VT & end A
Locate these points and then

YES !

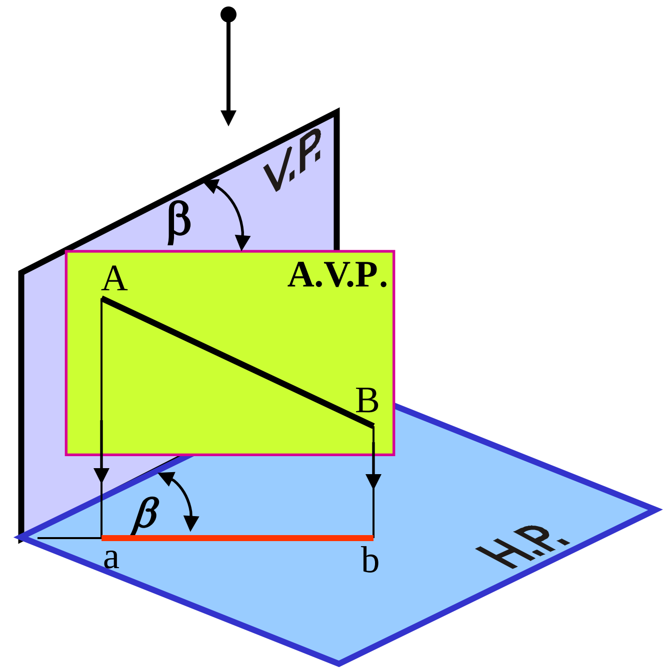
YOU CAN COMPLETE IT.

GROUP (C)

CASES OF THE LINES IN A.V.P., A.I.P. & PROFILE PLANE.

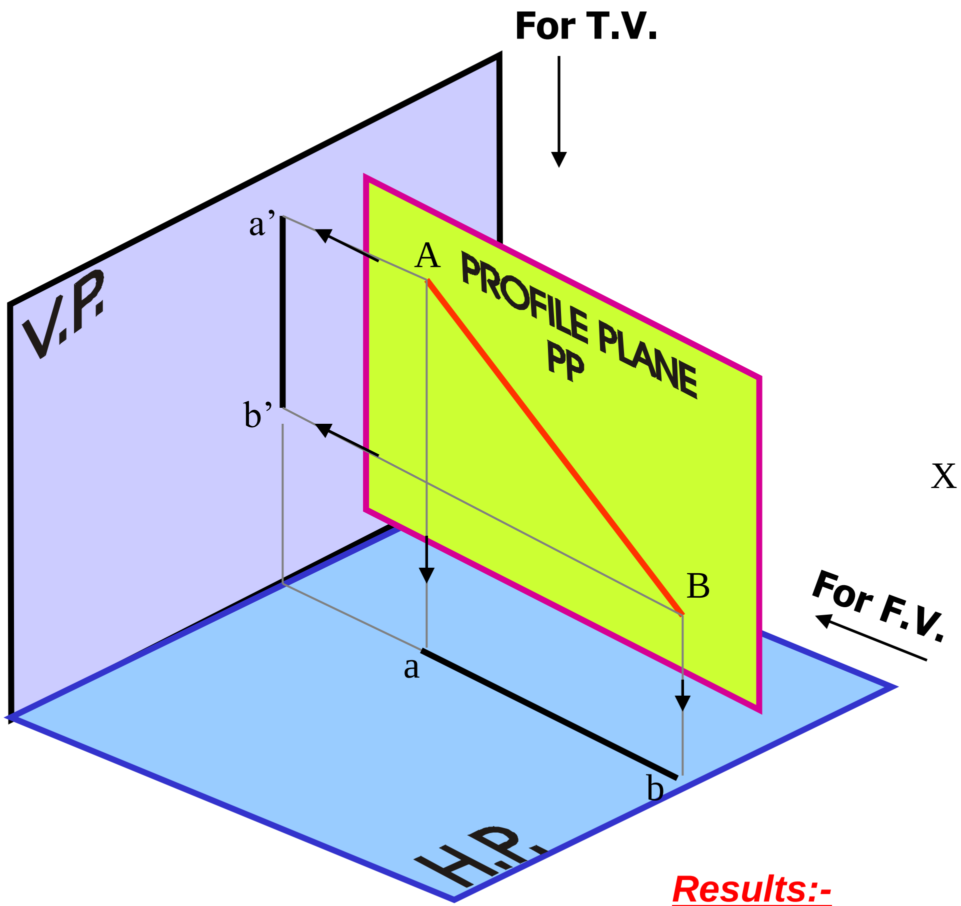


Line AB is in AIP as shown in above figure no 1.
It’s FV (a’b’) is shown projected on Vp.(Looking in arrow direction)
Here one can clearly see that the
Inclination of AIP with HP = Inclination of FV with XY line

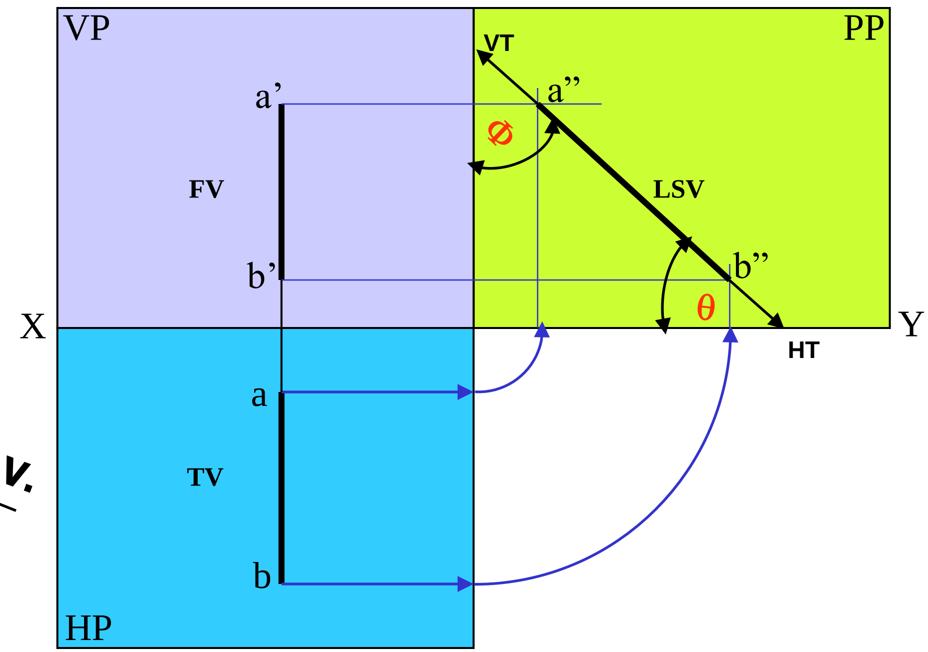


Line AB is in AVP as shown in above figure no 2..
It’s TV (a b) is shown projected on Hp.(Looking in arrow direction)
Here one can clearly see that the
Inclination of AVP with VP = Inclination of TV with XY line

LINE IN A PROFILE PLANE (MEANS IN A PLANE PERPENDICULAR TO BOTH HP & VP)



ORTHOGRAPHIC PATTERN OF LINE IN PROFILE PLANE

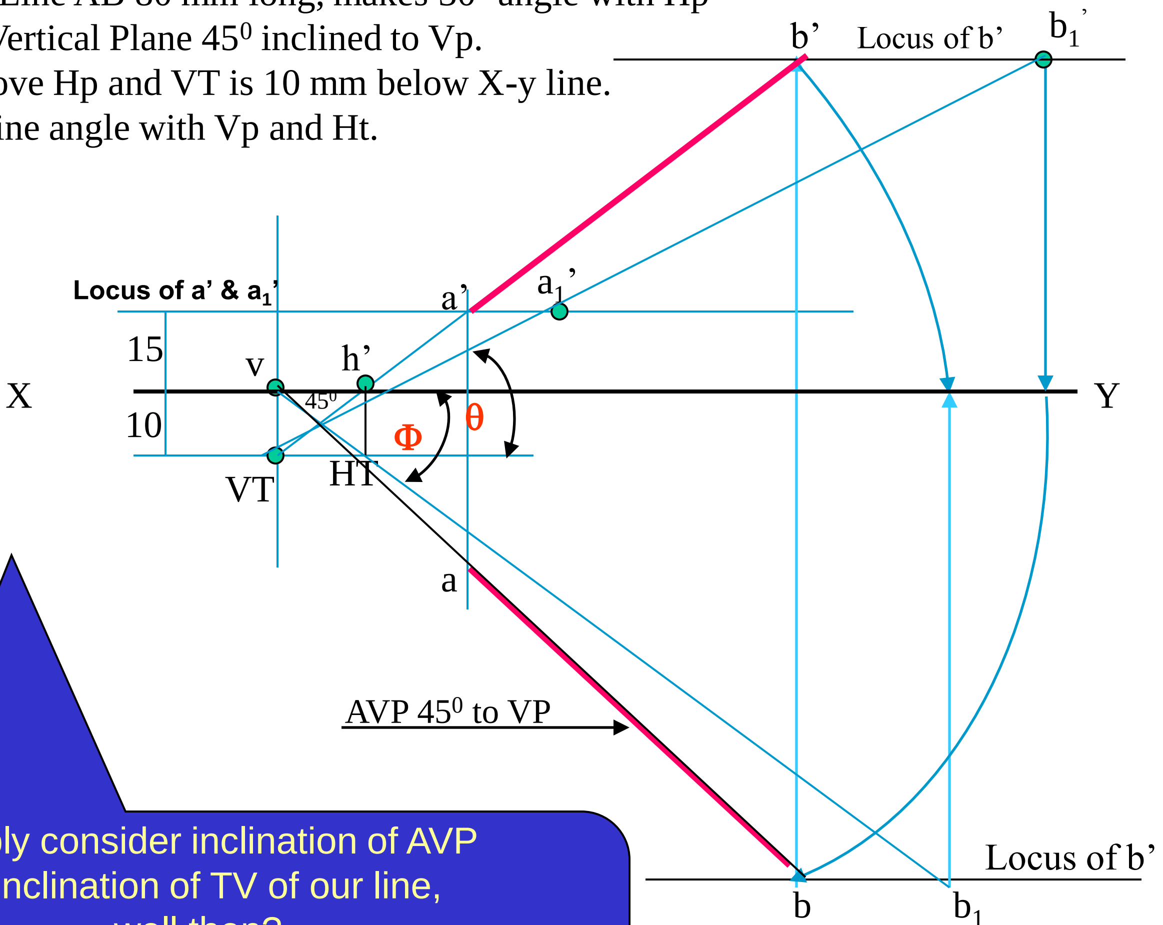


Results:-

1. TV & FV both are vertical, hence arrive on one single projector.
2. It’s Side View shows True Length (TL)
3. Sum of it’s inclinations with HP & VP equals to 90^0 ($\theta + \Phi = 90^0$)
4. It’s HT & VT arrive on same projector and can be easily located From Side View.

OBSERVE CAREFULLY ABOVE GIVEN ILLUSTRATION AND 2nd SOLVED PROBLEM.

PROBLEM 12 :- Line AB 80 mm long, makes 30^0 angle with Hp and lies in an Aux.Vertical Plane 45^0 inclined to Vp. End A is 15 mm above Hp and VT is 10 mm below X-y line. Draw projections, fine angle with Vp and Ht.

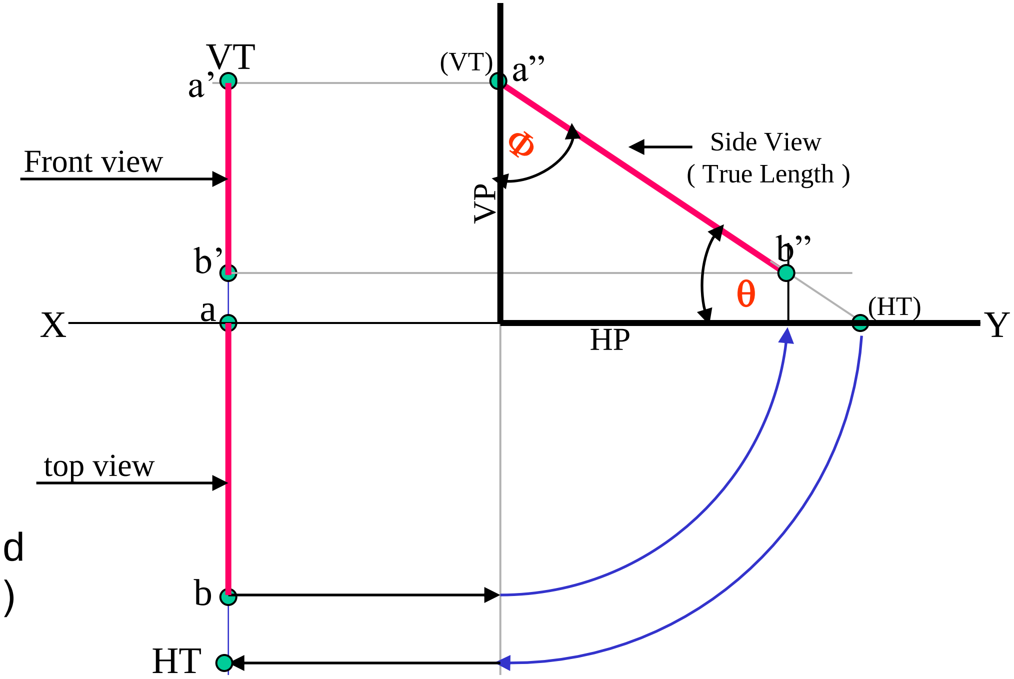


Simply consider inclination of AVP
as inclination of TV of our line,
well then?
You sure can complete it
as previous problems!
Go ahead!!

PROBLEM 13 :- A line AB, 75mm long, has one end A in Vp. Other end B is 15 mm above Hp and 50 mm in front of Vp.Draw the projections of the line when sum of it's Inclinations with HP & Vp is 90^0, means it is lying in a profile plane. Find true angles with ref.planes and it's traces.

SOLUTION STEPS:-

After drawing xy line and one projector
Locate top view of A I.e point a on xy as
It is in Vp,
Locate Fv of B i.e.b'15 mm above xy as
it is above Hp.and Tv of B i.e. b, 50 mm
below xy asit is 50 mm in front of Vp
Draw side view structure of Vp and Hp
and locate S.V. of point B i.e. b''
From this point cut 75 mm distance on Vp and
Mark a'' as A is in Vp. (This is also VT of line.)
From this point draw locus to left & get a'
Extend SV up to Hp. It will be HT. As it is a Tv
Rotate it and bring it on projector of b.
Now as discussed earlier SV gives TL of line
and at the same time on extension up to Hp & Vp
gives inclinations with those panes.



APPLICATIONS OF PRINCIPLES OF PROJECTIONS OF LINES
IN SOLVING CASES OF DIFFERENT PRACTICAL SITUATIONS.

In these types of problems some situation in the field
or
some object will be described .
It's relation with Ground (HP)
And
a Wall or some vertical object (VP) will be given.

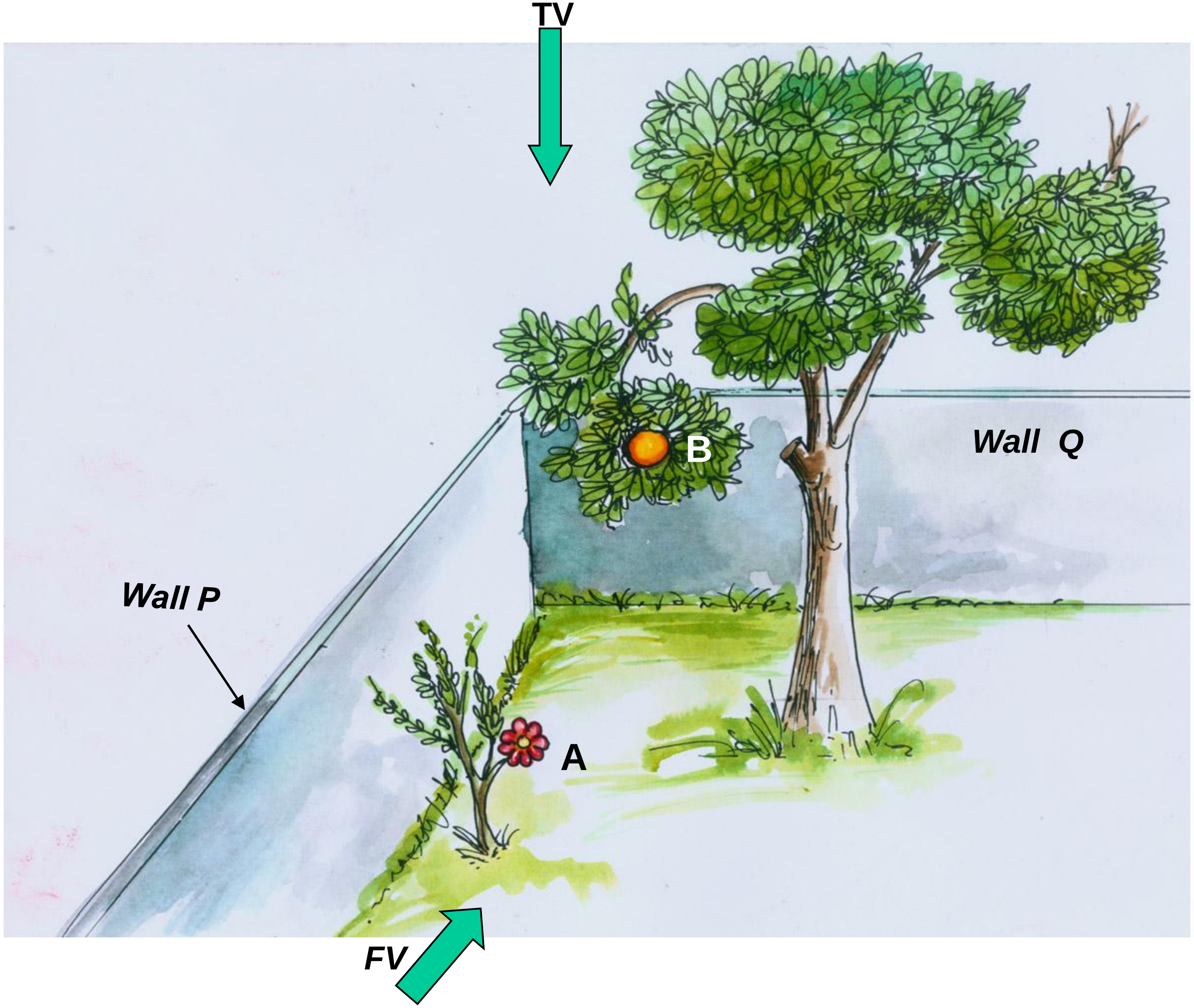
Indirectly information regarding Fv & Tv of some line or lines,
inclined to both reference Planes will be given
and
you are supposed to draw it's projections
and
further to determine it's true Length and it's inclinations with ground.

Here various problems along with
actual pictures of those situations are given
for you to understand those clearly.
Now looking for views in given ARROW directions,
YOU are supposed to draw projections & find answers,
Off course you must visualize the situation properly.

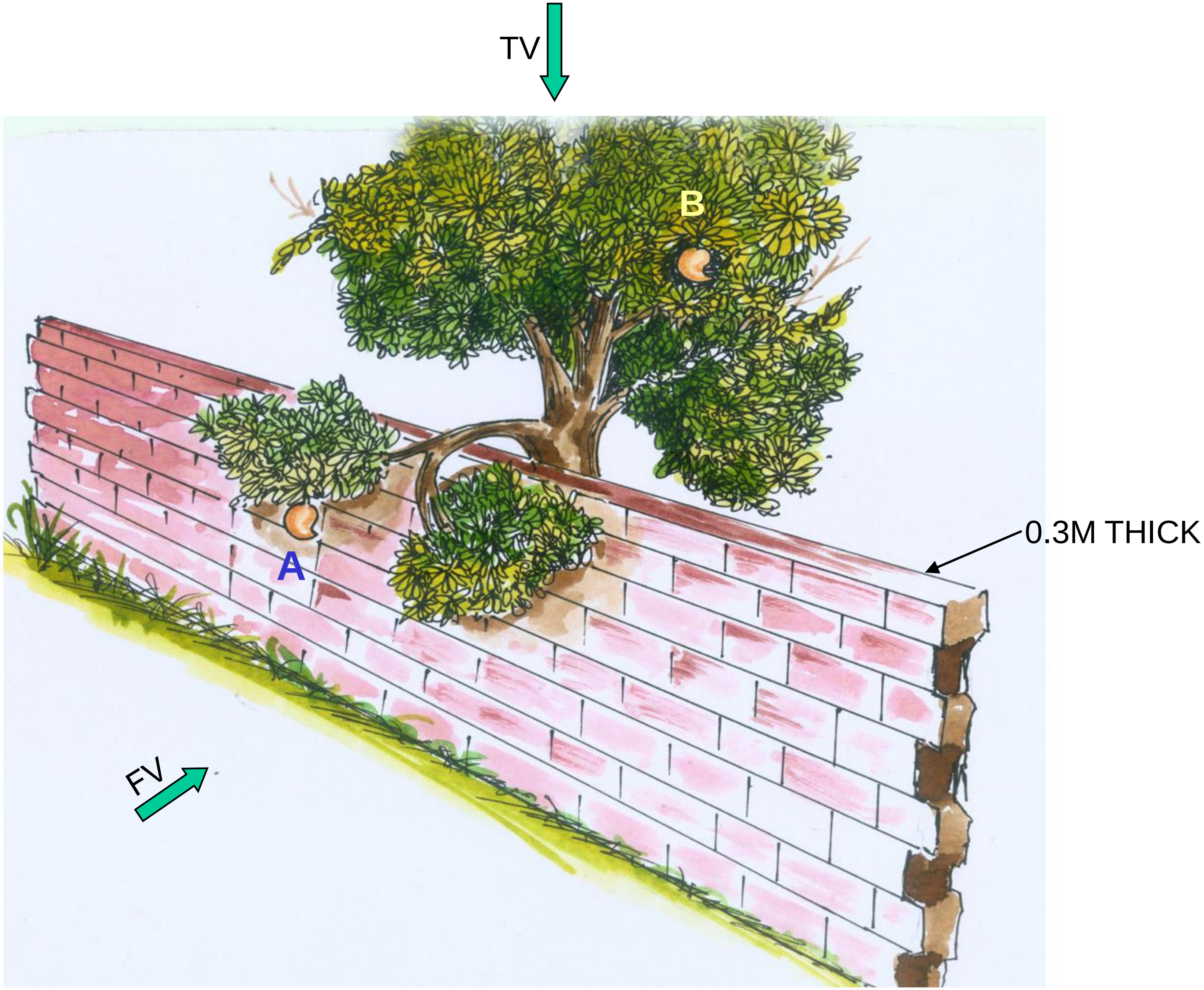
CHECK YOUR ANSWERS
WITH THE SOLUTIONS
GIVEN IN THE END.

ALL THE BEST !!

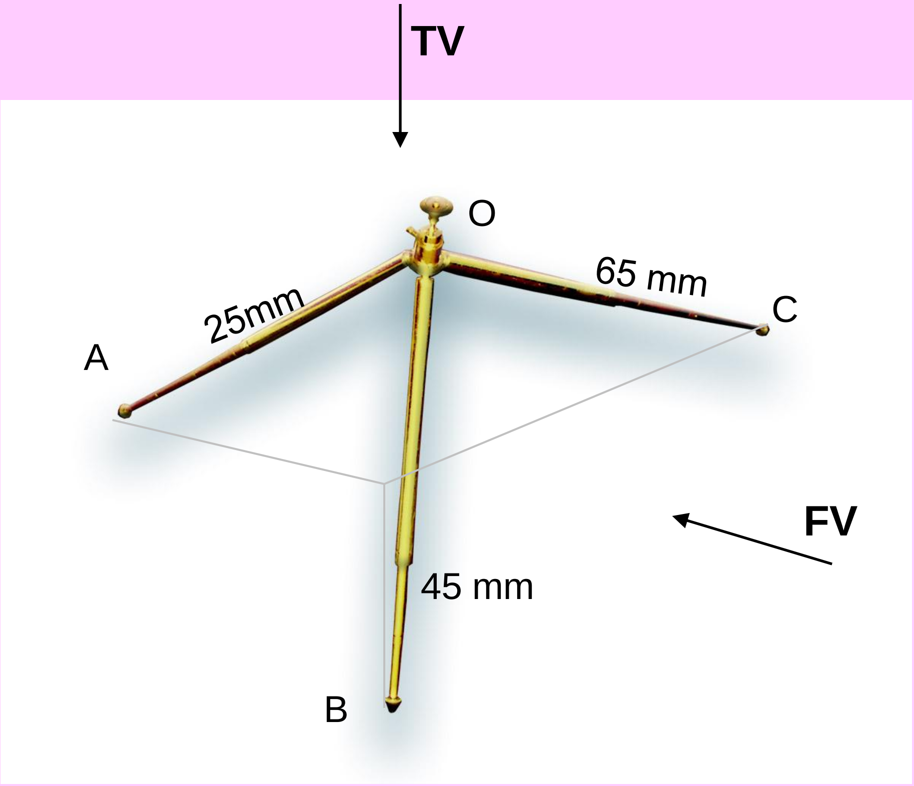
PROBLEM 14:-Two objects, a flower (A) and an orange (B) are within a rectangular compound wall, whose P & Q are walls meeting at 90^0. Flower A is 1M & 5.5 M from walls P & Q respectively. Orange B is 4M & 1.5M from walls P & Q respectively. Drawing projection, find distance between them If flower is 1.5 M and orange is 3.5 M above the ground. Consider suitable scale..



PROBLEM 15 :- Two mangos on a tree A & B are 1.5 m and 3.00 m above ground and those are 1.2 m & 1.5 m from a 0.3 m thick wall but on opposite sides of it. If the distance measured between them along the ground and parallel to wall is 2.6 m, Then find real distance between them by drawing their projections.

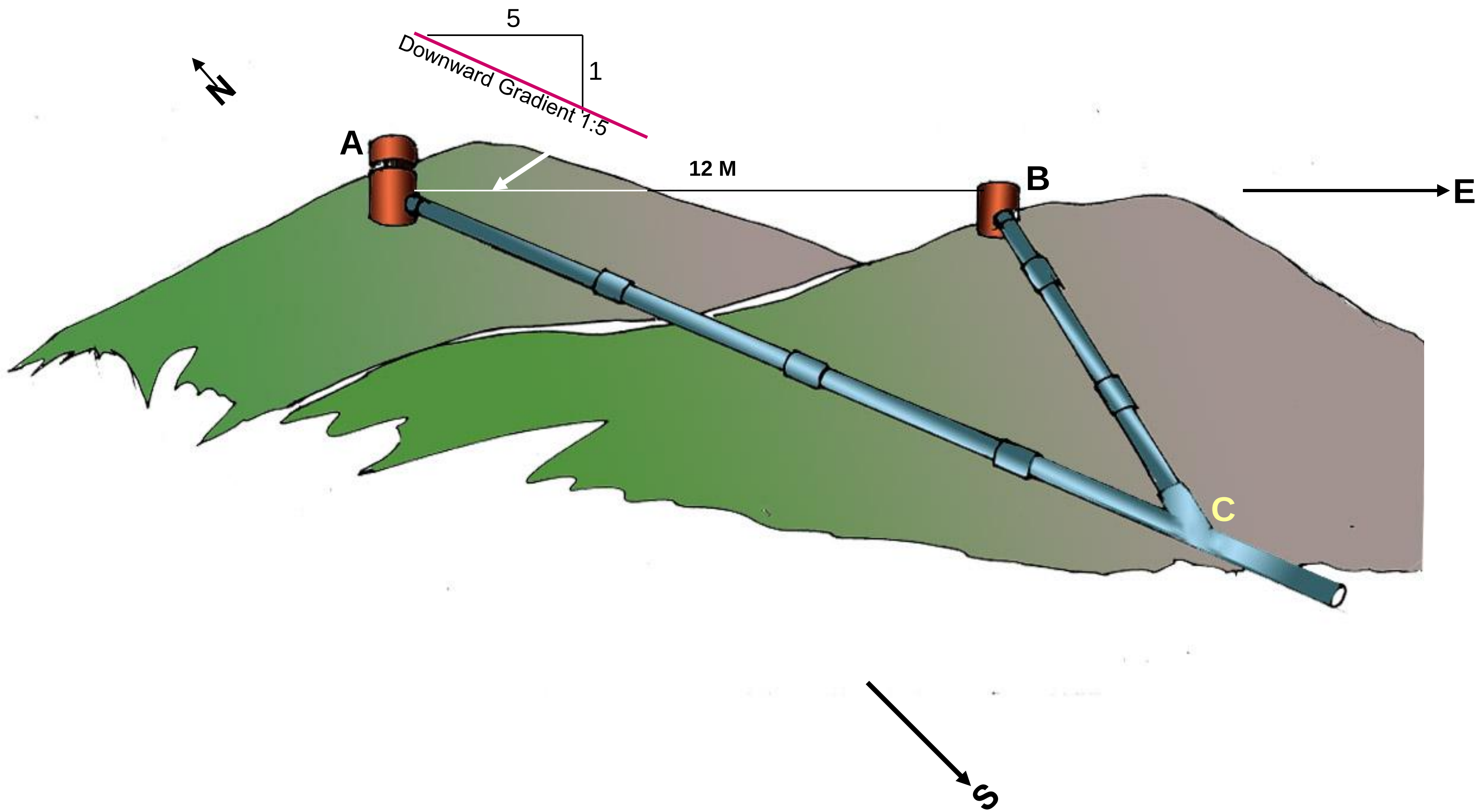


PROBLEM 16 :- oa, ob & oc are three lines, 25mm, 45mm and 65mm long respectively.All equally inclined and the shortest is vertical.This fig. is TV of three rods OA, OB and OC whose ends A,B & C are on ground and end O is 100mm above ground. Draw their projections and find length of each along with their angles with ground.

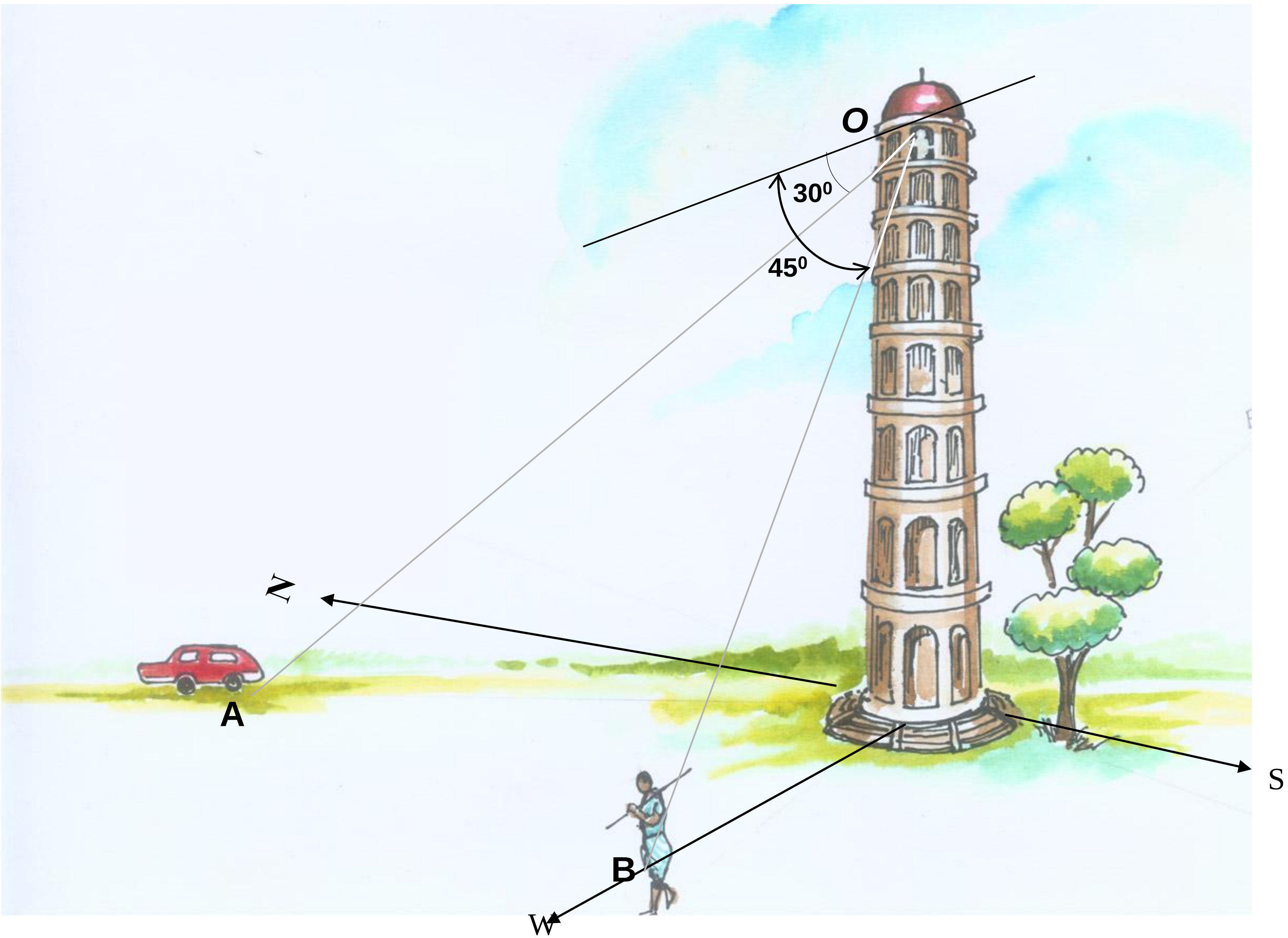


PROBLEM 17:- A pipe line from point **A** has a downward gradient 1:5 and it runs due East-South. Another Point B is 12 M from **A** and due East of **A** and in same level of **A.** Pipe line from **B** runs 20^0 Due East of South and meets pipe line from **A** at point **C.**

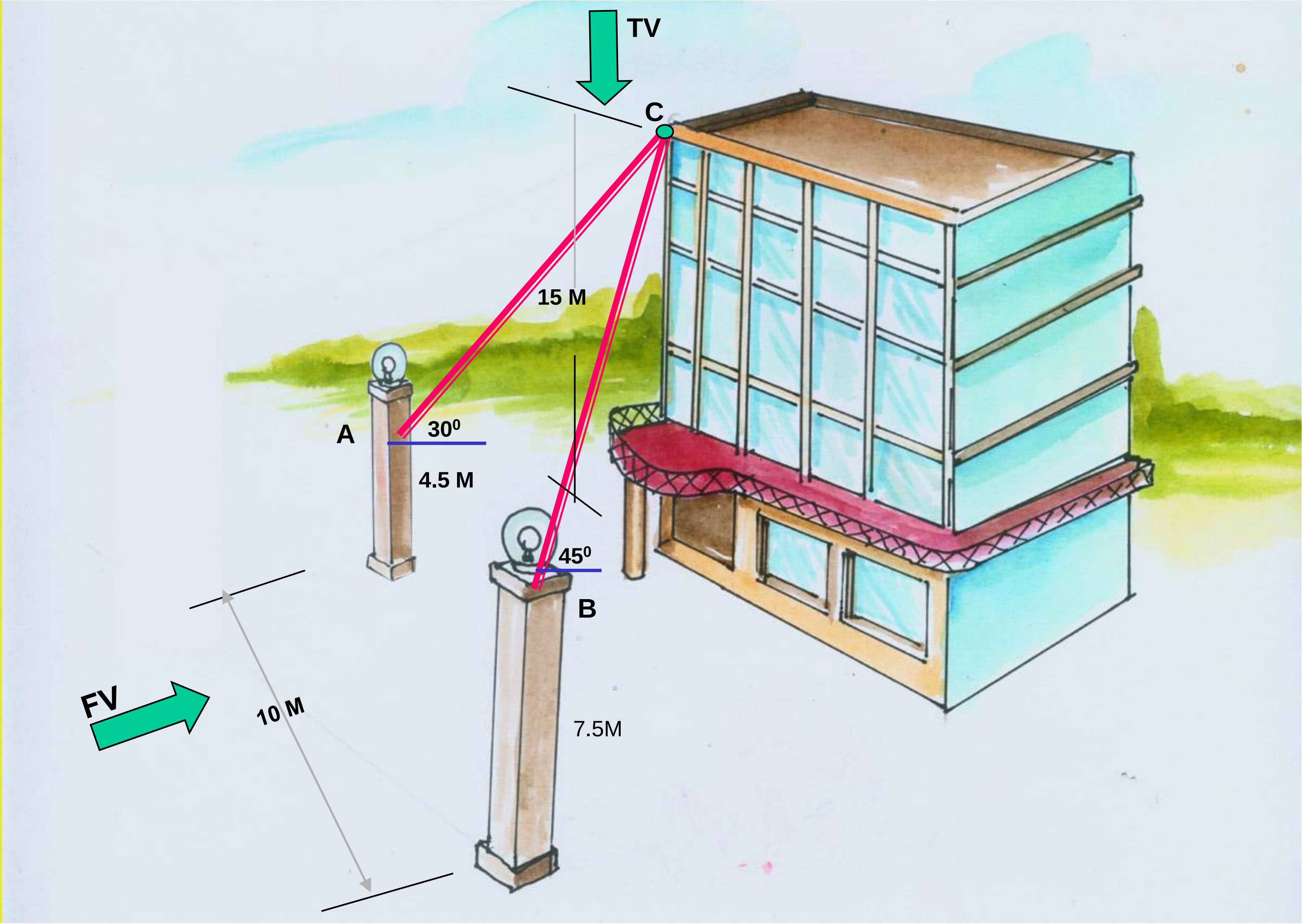
Draw projections and find length of pipe line from B and it's inclination with ground.



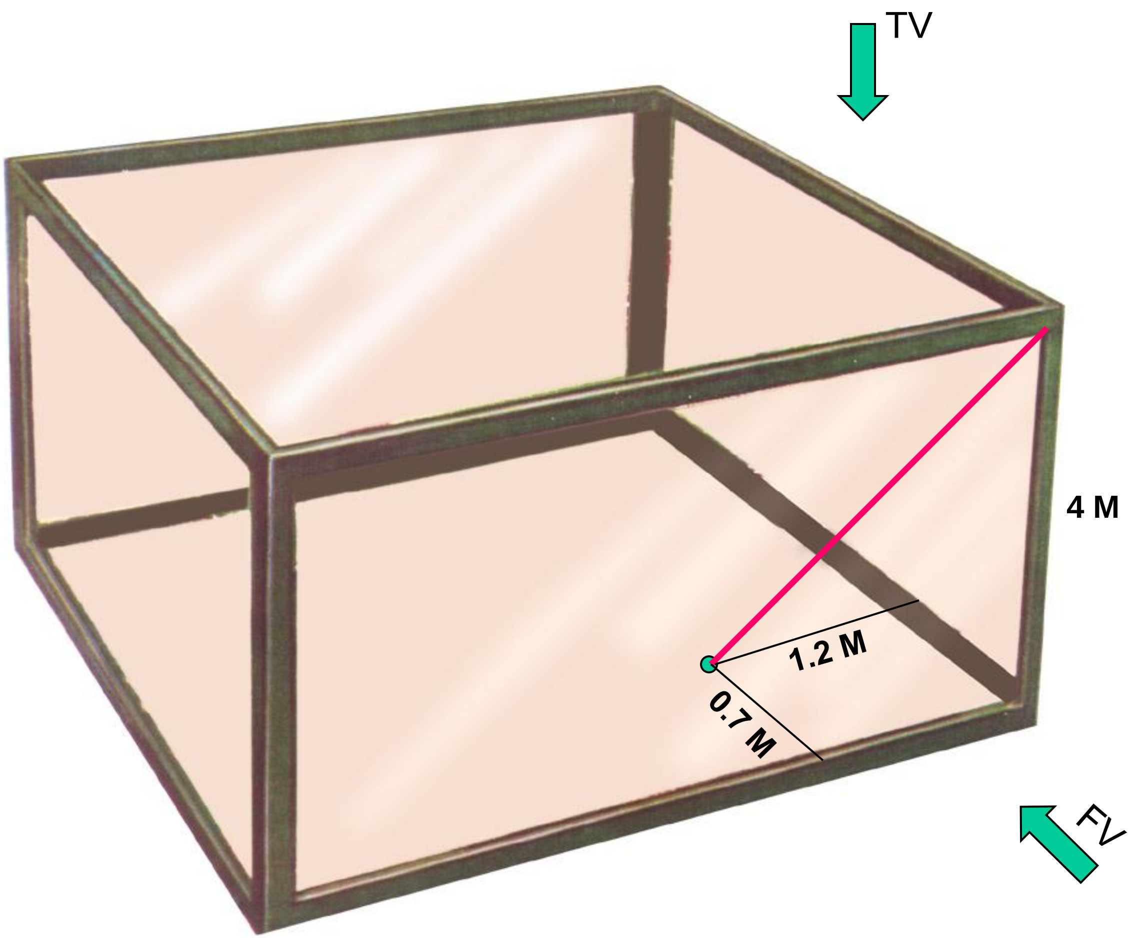
PROBLEM 18: A person observes two objects, A & B, on the ground, from a tower, 15 M high, At the angles of depression 30^0 & 45^0. Object A is is due North-West direction of observer and object B is due West direction. Draw projections of situation and find distance of objects from observer and from tower also.



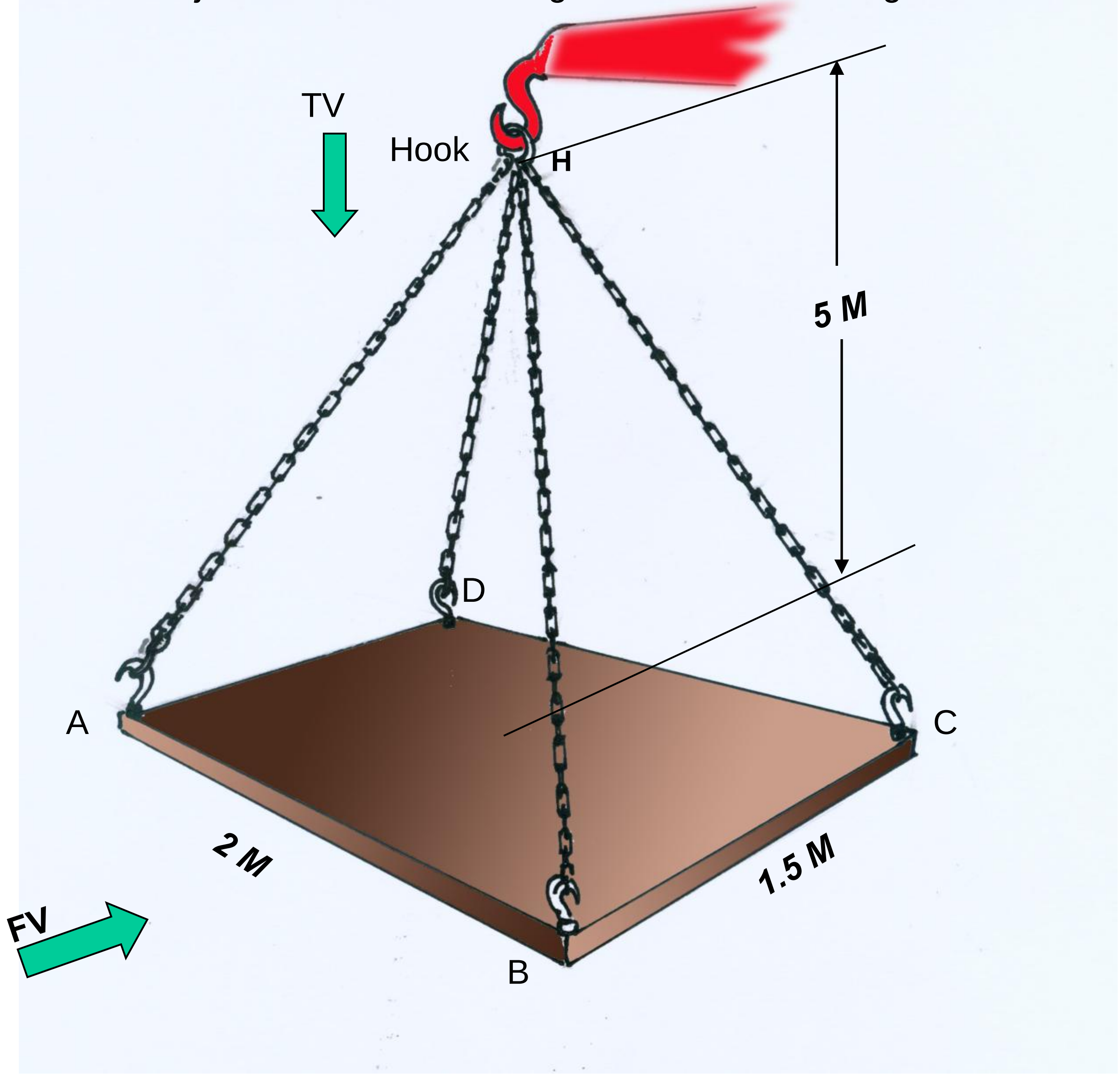
PROBLEM 19:-Guy ropes of two poles fixed at 4.5m and 7.5 m above ground, are attached to a corner of a building 15 M high, make 300 and 450 inclinations with ground respectively.The poles are 10 M apart. Determine by drawing their projections,Length of each rope and distance of poles from building.



PROBLEM 20:- A tank of 4 M height is to be strengthened by four stay rods from each corner by fixing their other ends to the flooring, at a point 1.2 M and 0.7 M from two adjacent walls respectively, as shown. Determine graphically length and angle of each rod with flooring.

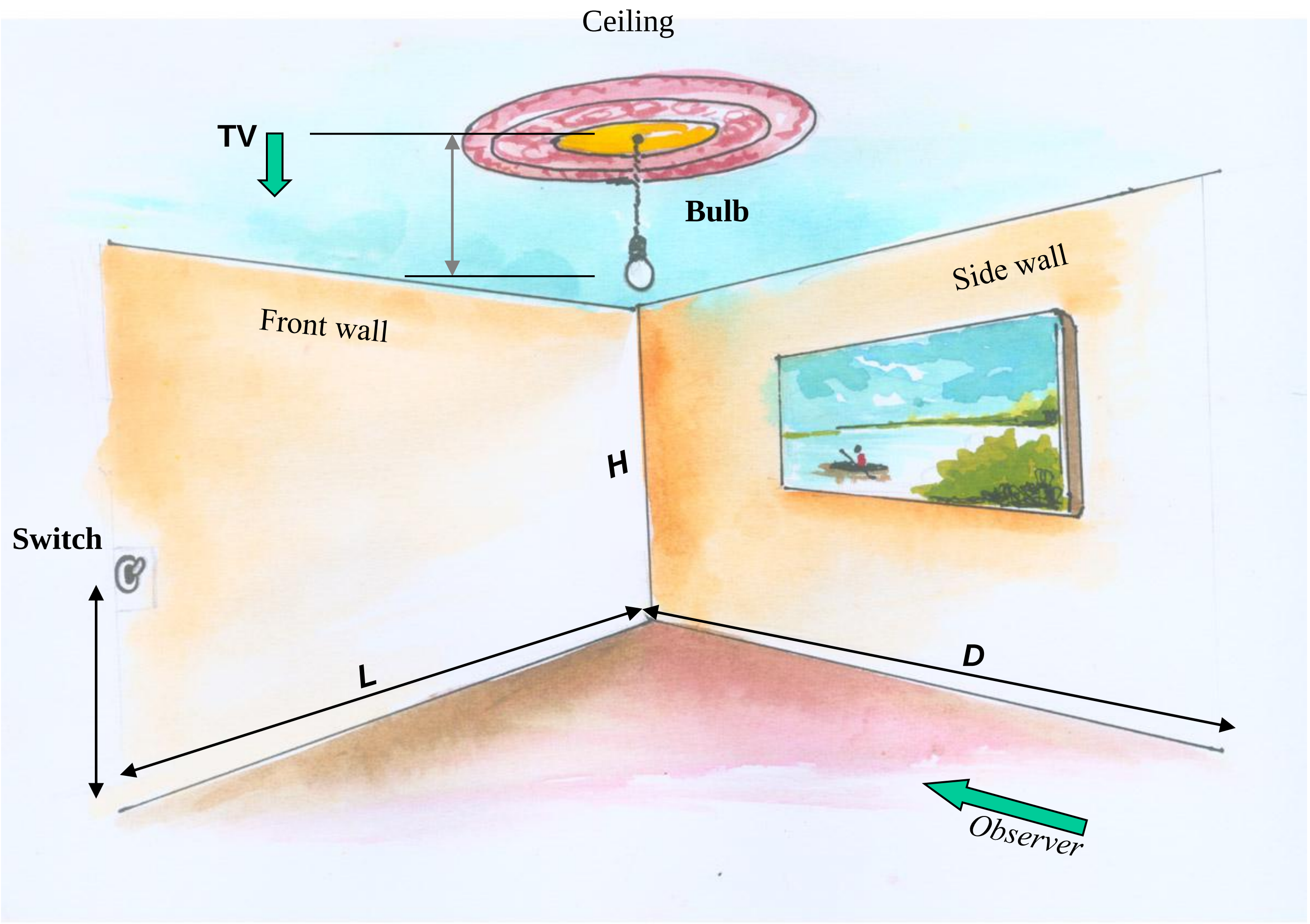


PROBLEM 21:- A horizontal wooden platform 2 M long and 1.5 M wide is supported by four chains from it's corners and chains are attached to a hook 5 M above the center of the platform. Draw projections of the objects and determine length of each chain along with it's inclination with ground.



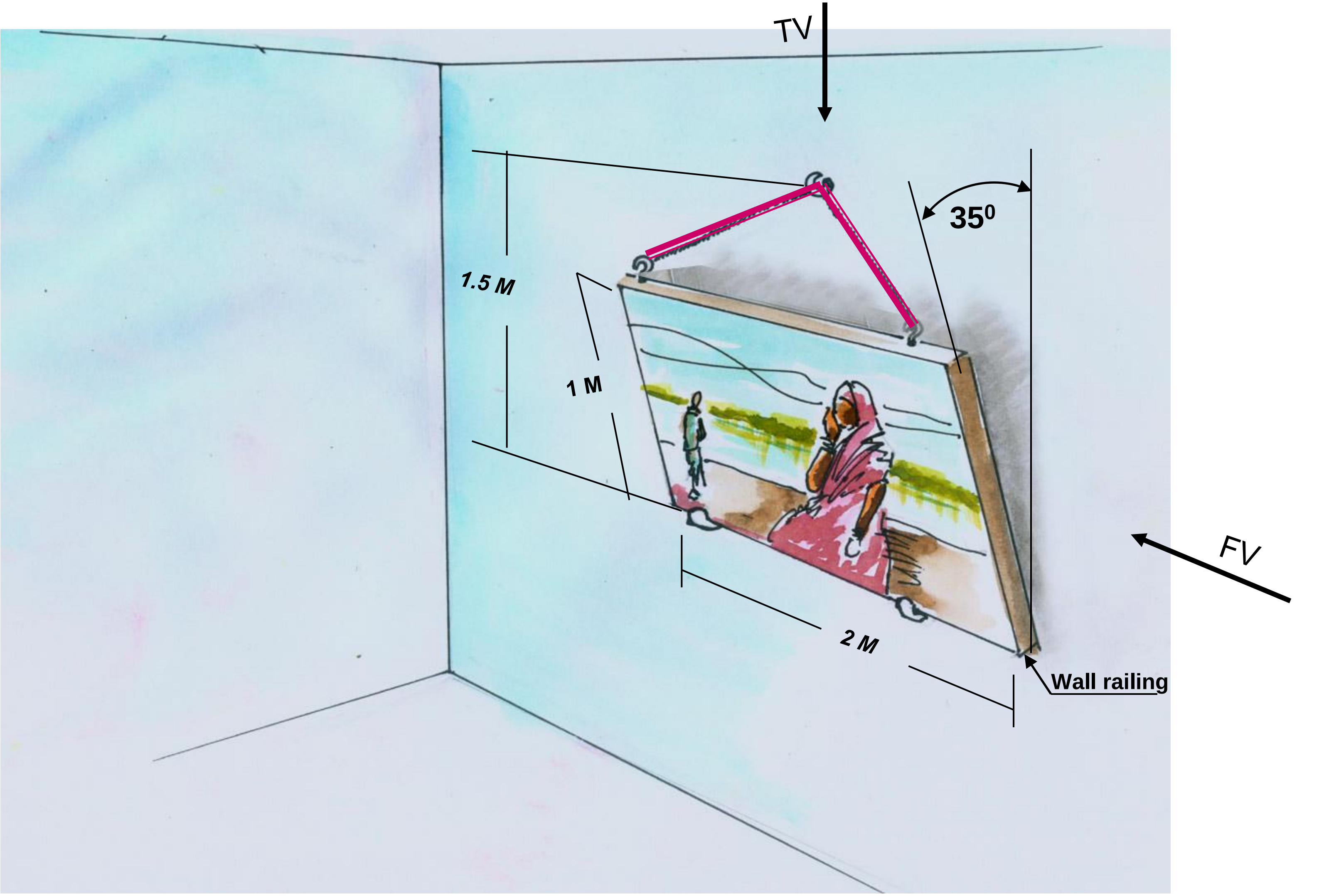
PROBLEM 22.

A room is of size 6.5m L ,5m D,3.5m high.
An electric bulb hangs 1m below the center of ceiling.
A switch is placed in one of the corners of the room, 1.5m above the flooring.
Draw the projections an determine real distance between the bulb and switch.



PROBLEM 23:-

A PICTURE FRAME 2 M WIDE AND 1 M TALL IS RESTING ON HORIZONTAL WALL RAILING MAKES 35^0 INCLINATION WITH WALL. IT IS ATTAACHED TO A HOOK IN THE WALL BY TWO STRINGS. THE HOOK IS 1.5 M ABOVE WALL RAILING. DETERMINE LENGTH OF EACH CHAIN AND TRUE ANGLE BETWEEN THEM



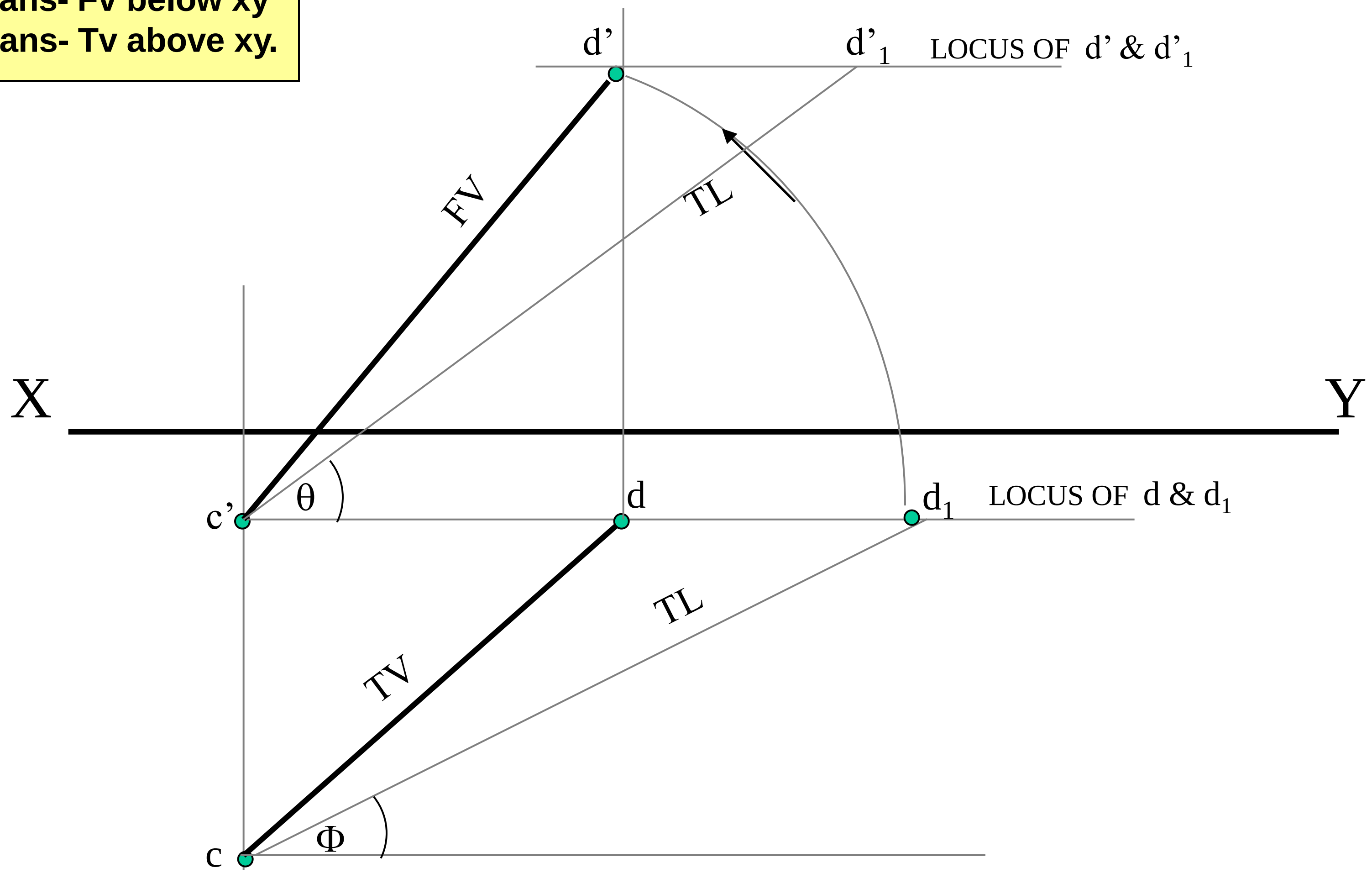
SOME CASES OF THE LINE IN DIFFERENT QUADRANTS.

REMEMBER:

BELOW HP- Means- Fv below xy
BEHIND V p- Means- Tv above xy.

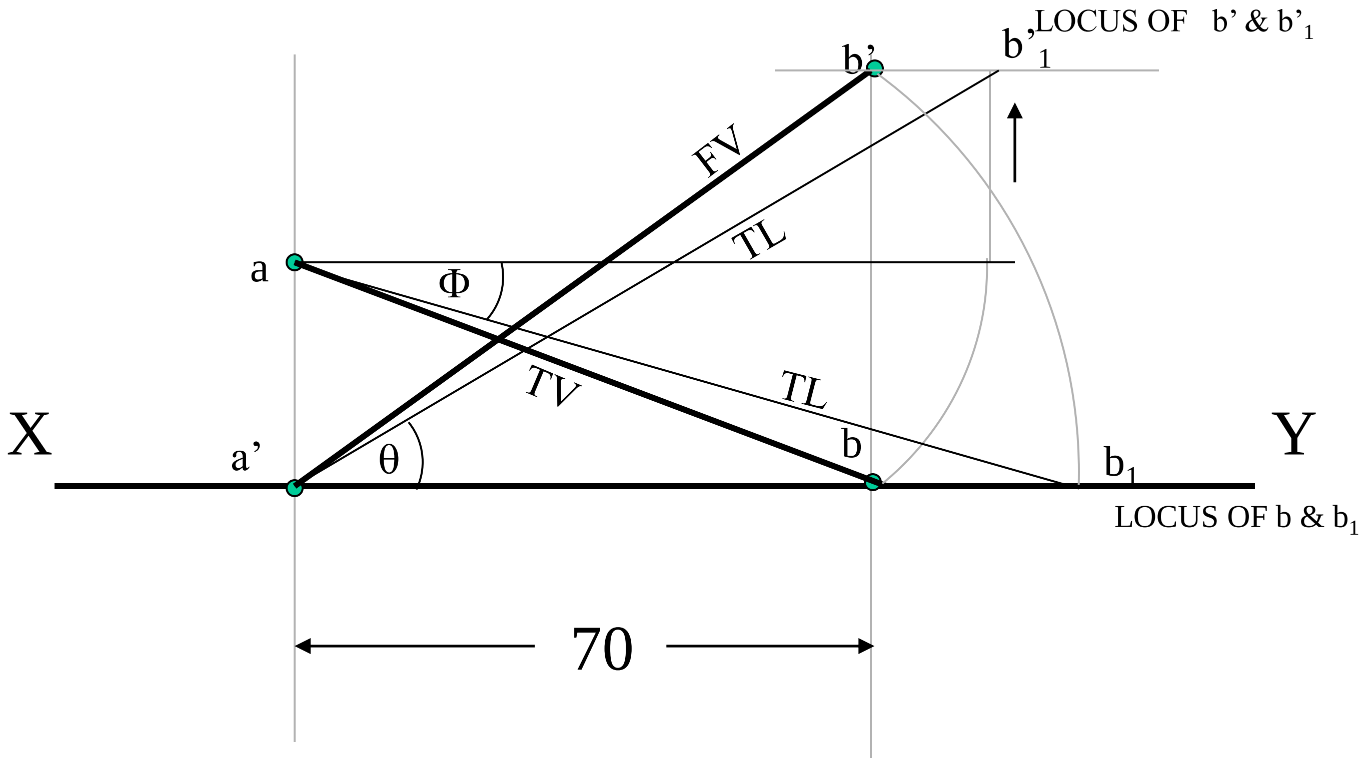
PROBLEM NO.24

T.V. of a 75 mm long Line CD, measures 50 mm.
End C is 15 mm below Hp and 50 mm in front of Vp.
End D is 15 mm in front of Vp and it is above Hp.
Draw projections of CD and find angles with Hp and Vp.



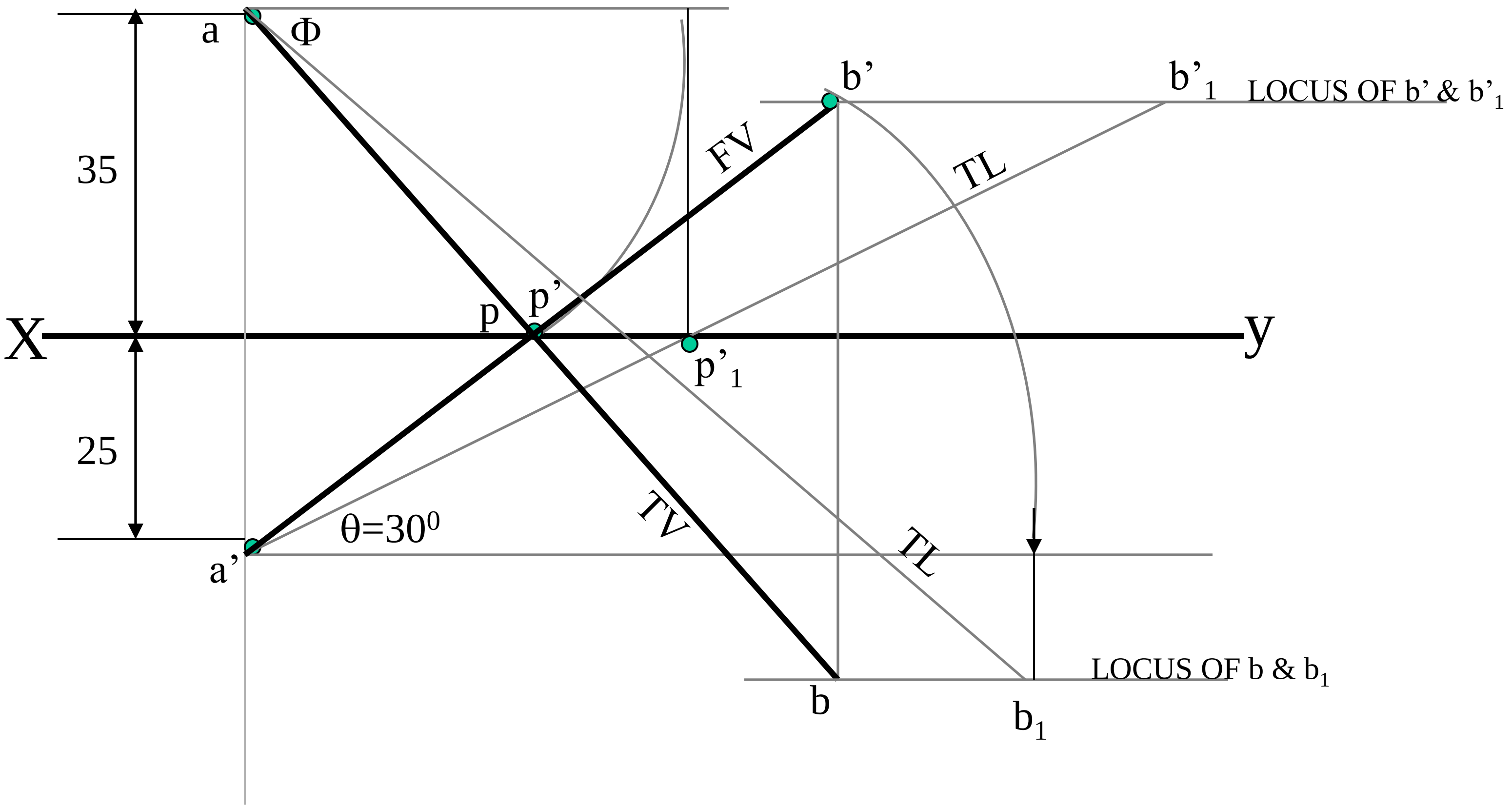
PROBLEM NO.25

End A of line AB is in Hp and 25 mm behind Vp.
End B in Vp.and 50mm above Hp.
Distance between projectors is 70mm.
Draw projections and find it’s inclinations with Ht, Vt.



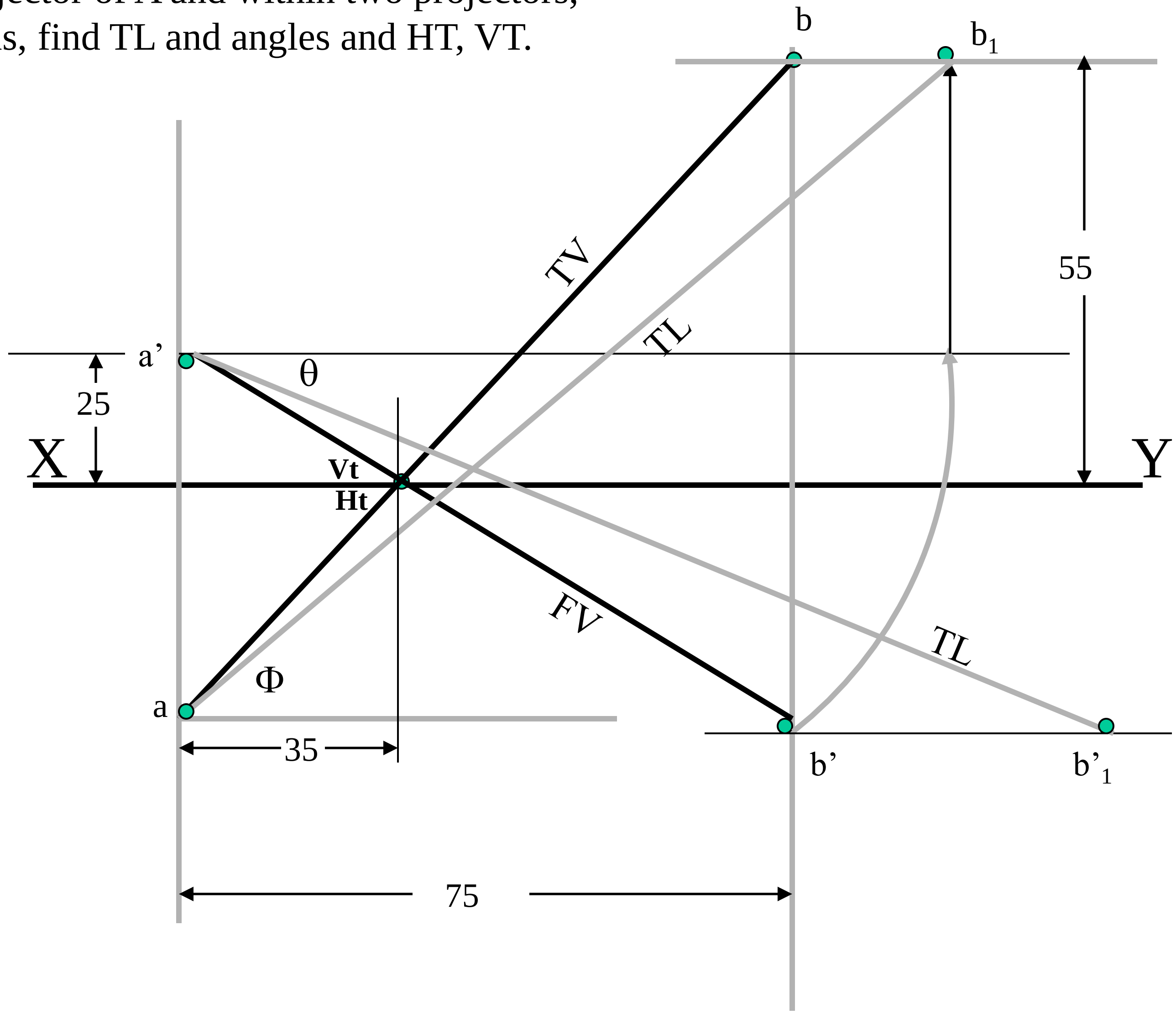
PROBLEM NO.26

End A of a line AB is 25mm below Hp and 35mm behind Vp.
Line is 300 inclined to Hp.
There is a point P on AB contained by both HP & VP.
Draw projections, find inclination with Vp and traces.



PROBLEM NO.27

End A of a line AB is 25mm above Hp and end B is 55mm behind Vp.
The distance between end projectors is 75mm.
If both it's HT & VT coincide on xy in a point,
35mm from projector of A and within two projectors,
Draw projections, find TL and angles and HT, VT.



PROJECTIONS OF PLANES

In this topic various plane figures are the objects.

What is usually asked in the problem?

To draw their projections means F.V, T.V. & S.V.

What will be given in the problem?

1. Description of the plane figure.
2. It's position with HP and VP.

In which manner it's position with HP & VP will be described?

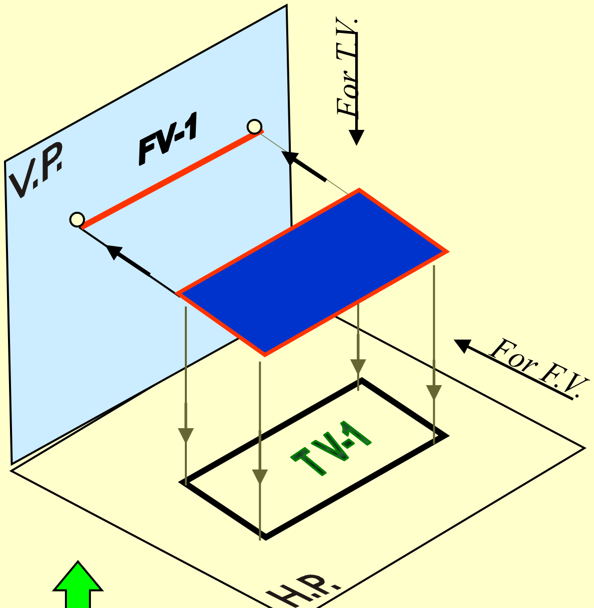
1. **Inclination of it's SURFACE with one of the reference planes will be given.**
2. Inclination of one of it's EDGES with other reference plane will be given

   (Hence this will be a case of an object inclined to both reference Planes.)

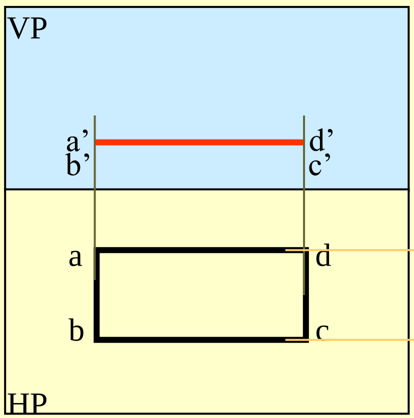
Study the illustration showing surface & side inclination given on next page.

CASE OF A RECTANGLE – OBSERVE AND NOTE ALL STEPS.

SURFACE **PARALLEL** TO HP
PICTORIAL PRESENTATION

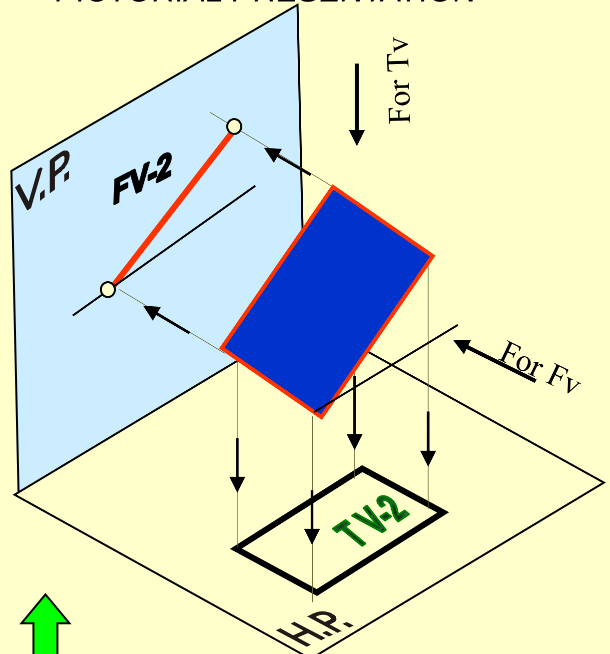


ORTHOGRAPHIC
TV-True Shape
FV- Line // to xy

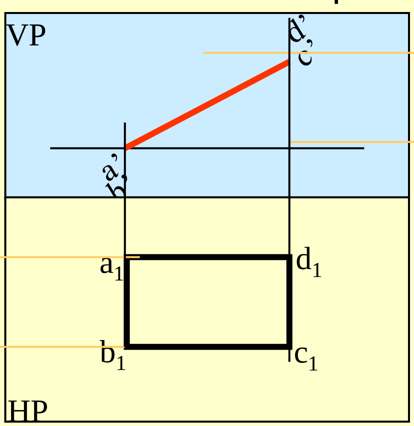


A

SURFACE **INCLINED** TO HP
PICTORIAL PRESENTATION

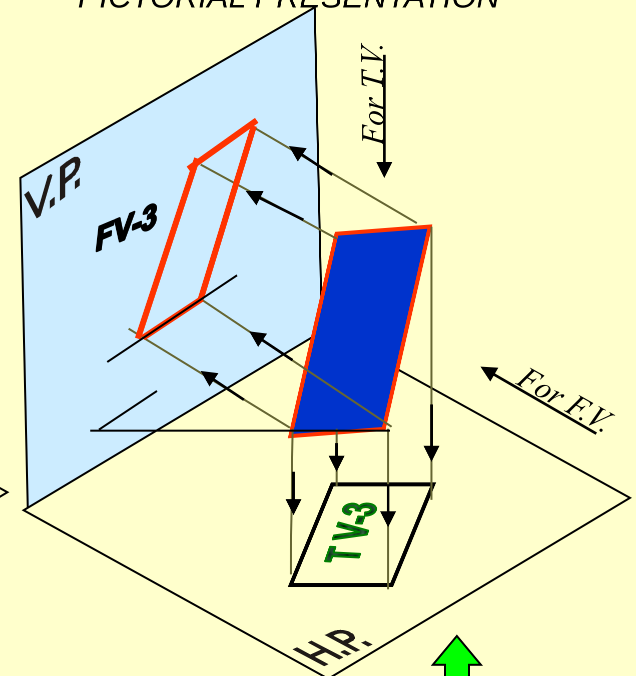


ORTHOGRAPHIC
FV- Inclined to XY
TV- Reduced Shape

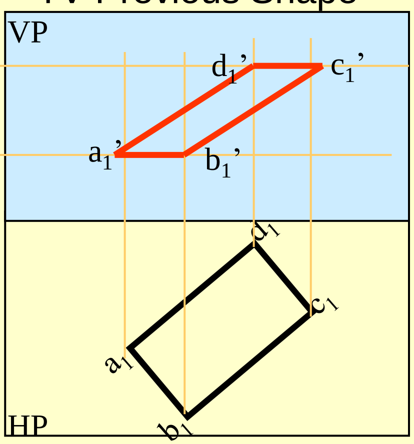


B

ONE SMALL SIDE INCLINED TO VP
PICTORIAL PRESENTATION



ORTHOGRAPHIC
FV- Apparent Shape
TV-Previous Shape



C

PROCEDURE OF SOLVING THE PROBLEM:

IN THREE STEPS EACH PROBLEM CAN BE SOLVED: **(As Shown In Previous Illustration)**

STEP 1. Assume suitable conditions & draw Fv & Tv of initial position.

STEP 2. Now consider surface inclination & draw 2nd Fv & Tv.

STEP 3. After this,consider side/edge inclination and draw 3rd (final) Fv & Tv.

ASSUMPTIONS FOR INITIAL POSITION:

(Initial Position means assuming surface // to HP or VP)

1.If in problem surface is inclined to HP – assume it // HP
Or If surface is inclined to VP – assume it // to VP

2. Now if surface is assumed // to HP- It's TV will show True Shape.
And If surface is assumed // to VP – It's FV will show True Shape.

3. Hence begin with drawing TV or FV as True Shape.

4. While drawing this True Shape –
keep one side/edge (which is making inclination) perpendicular to xy line
(similar to pair no. A on previous page illustration).

Now Complete STEP 2. By making surface inclined to the resp plane & project it's other view.
***(Ref. 2nd pair* B *on previous page illustration*)**

Now Complete STEP 3. By making side inclined to the resp plane & project it's other view.
***(Ref. 3rd pair* C *on previous page illustration*)**

APPLY SAME STEPS TO SOLVE NEXT *ELEVEN* PROBLEMS

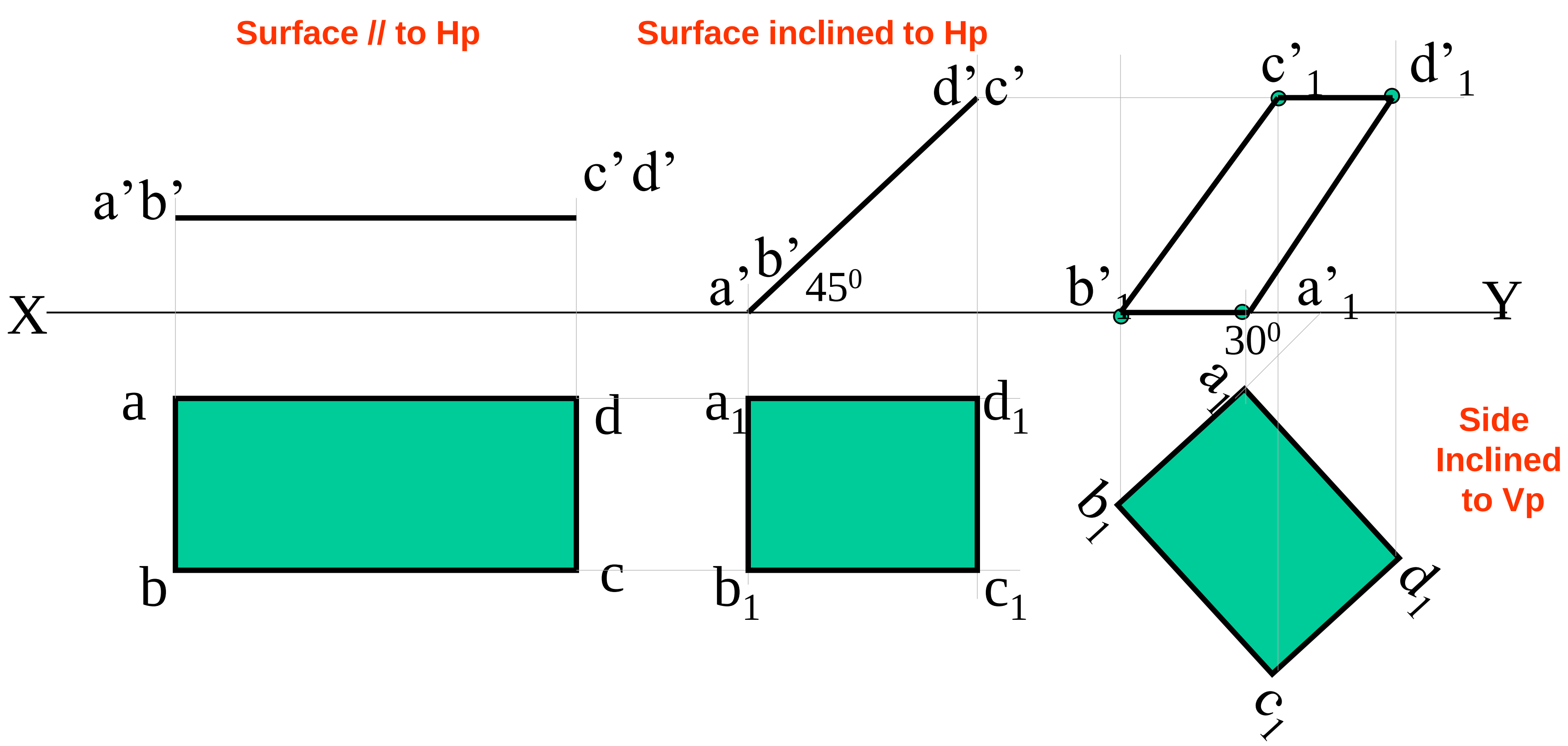
Problem 1:

Rectangle 30mm and 50mm sides is resting on HP on one small side which is 30^0 inclined to VP,while the surface of the plane makes 45^0 inclination with HP. Draw it's projections.

Read problem and answer following questions

1. Surface inclined to which plane? ------- HP
2. Assumption for initial position? ------// to HP
3. So which view will show True shape? --- TV
4. Which side will be vertical? ---One small side.

Hence begin with TV, draw rectangle below X-Y drawing one small side vertical.



Problem 2:

A $30^0 - 60^0$ set square of longest side 100 mm long, is in VP and 30^0 inclined to HP while it's surface is 45^0 inclined to VP.Draw it's projections

(Surface & Side inclinations directly given)

Read problem and answer following questions

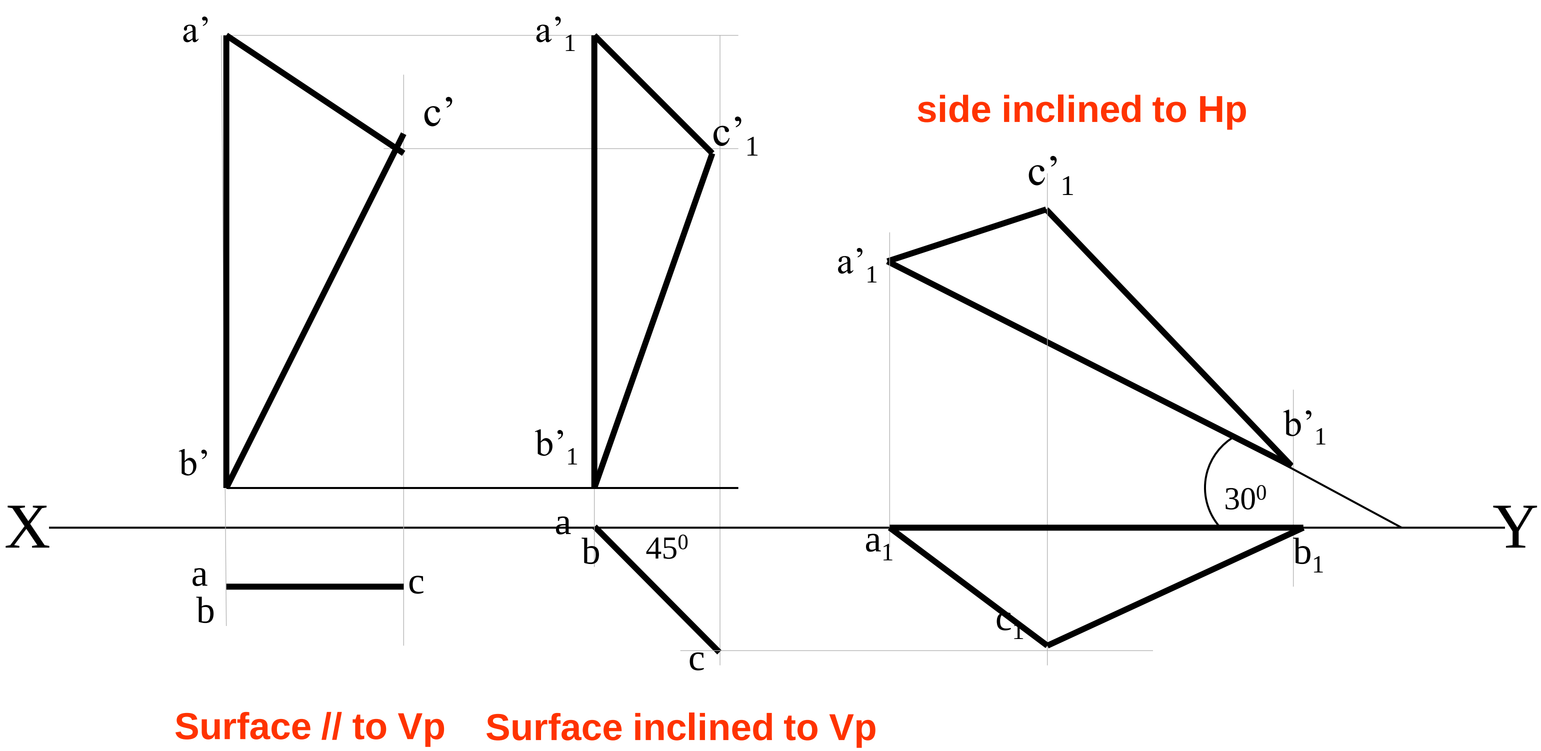
1 .Surface inclined to which plane? ------- VP

2. Assumption for initial position? ------// to VP

3. So which view will show True shape? --- FV

4. Which side will be vertical? ------longest side.

Hence begin with FV, draw triangle above X-Y keeping longest side vertical.



Problem 3:

A 30^0 – 60^0 set square of longest side 100 mm long is in VP and it's surface 45^0 inclined to VP. One end of longest side is 10 mm and other end is 35 mm above HP. Draw it's projections

(Surface inclination directly given. Side inclination indirectly given)

Read problem and answer following questions

1 .Surface inclined to which plane? ------- VP

2. Assumption for initial position? ------// to VP

3. So which view will show True shape? --- FV

4. Which side will be vertical? ------longest side.

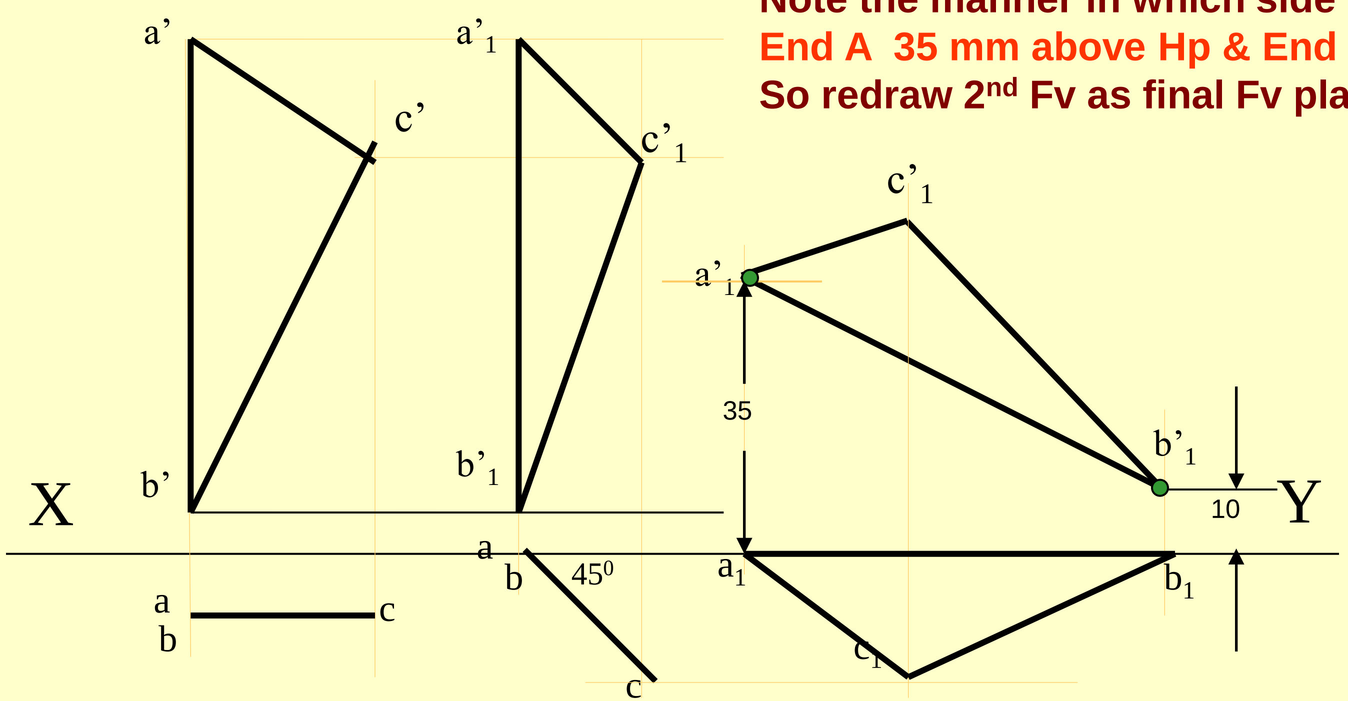
Hence begin with FV, draw triangle above X-Y keeping longest side vertical.

First TWO steps are similar to previous problem.

Note the manner in which side inclination is given.

End A 35 mm above Hp & End B is 10 mm above Hp.

So redraw 2^{nd} Fv as final Fv placing these ends as said.



Problem 4:

A regular pentagon of 30 mm sides is resting on HP on one of it's sides with it's surface 45^0 inclined to HP.

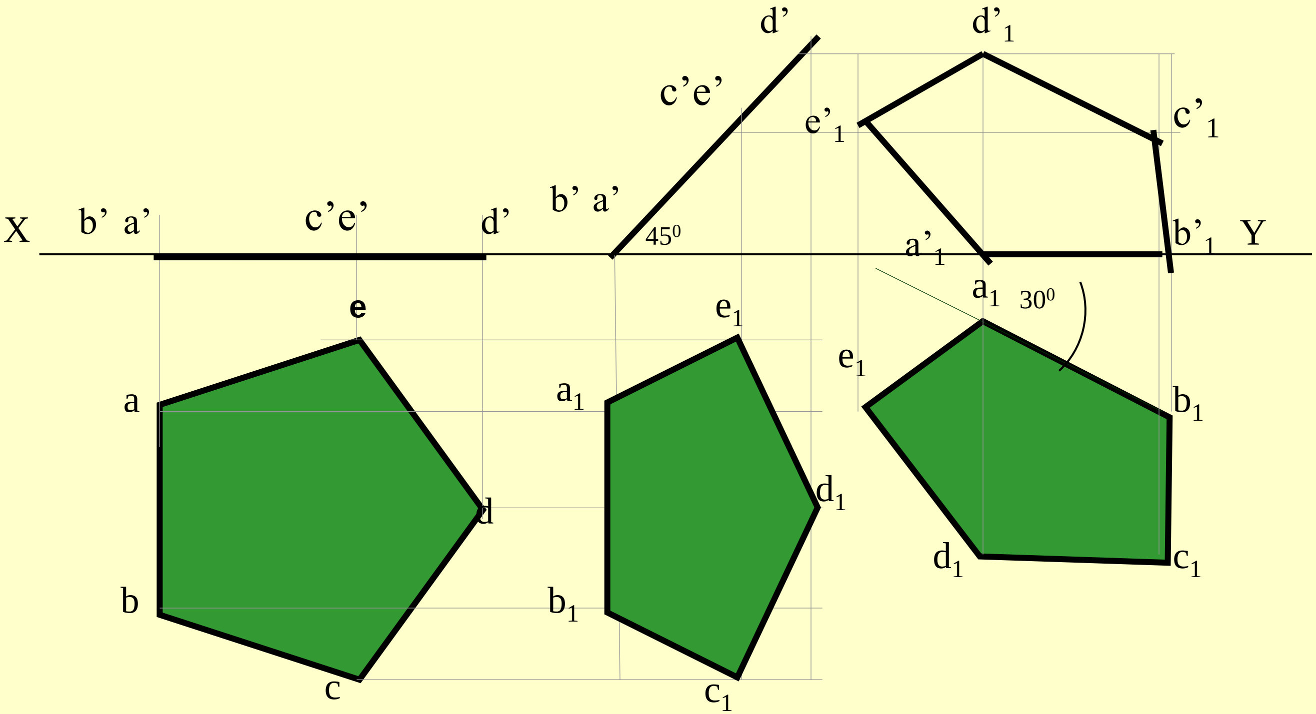
Draw it's projections when the side in HP makes 30^0 angle with VP

SURFACE AND SIDE INCLINATIONS ARE DIRECTLY GIVEN.

Read problem and answer following questions

1. Surface inclined to which plane? ------- ***HP***
2. Assumption for initial position? ------ ***// to HP***
3. So which view will show True shape? --- ***TV***
4. Which side will be vertical? -------- ***any side.***

Hence begin with TV,draw pentagon below X-Y line, taking one side vertical.



Problem 5:

A regular pentagon of 30 mm sides is resting on HP on one of it's sides while it's opposite vertex (corner) is 30 mm above HP.

Draw projections when side in HP is 30^0 inclined to VP.

SURFACE INCLINATION INDIRECTLY GIVEN

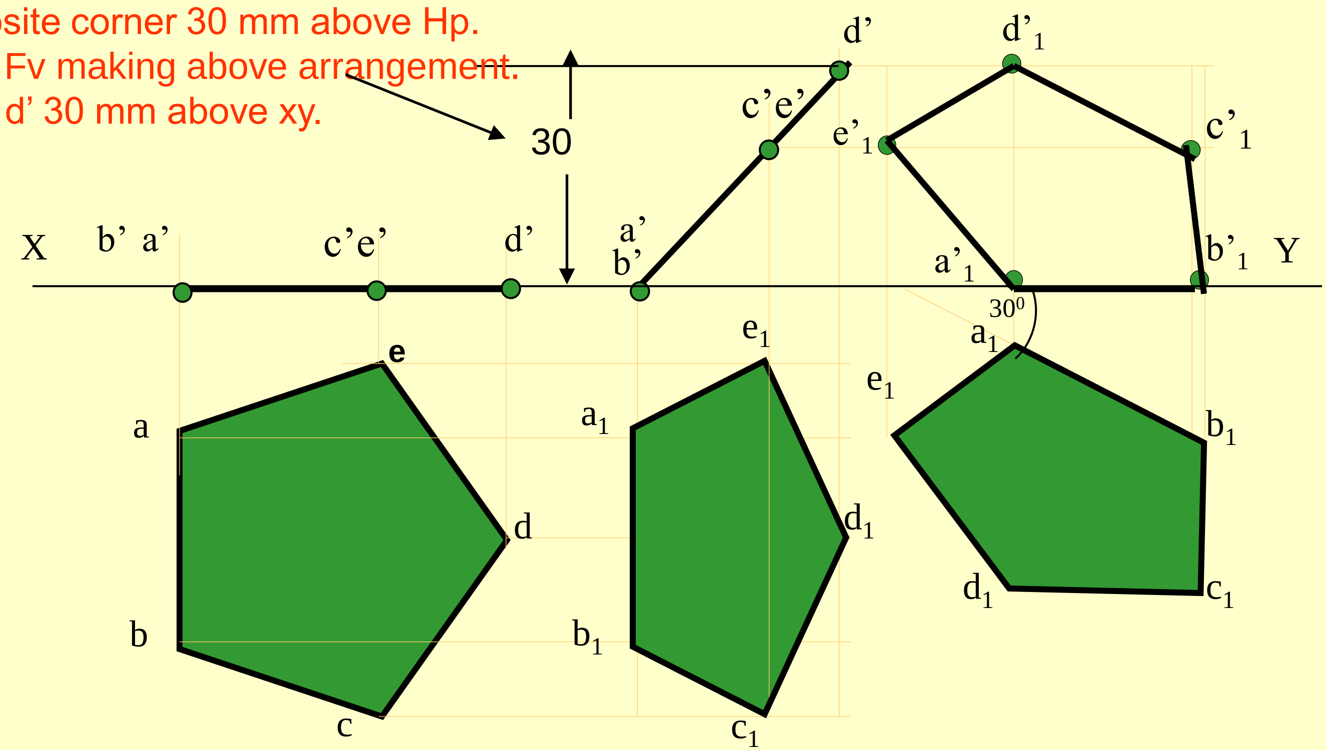
SIDE INCLINATION DIRECTLY GIVEN:

Read problem and answer following questions

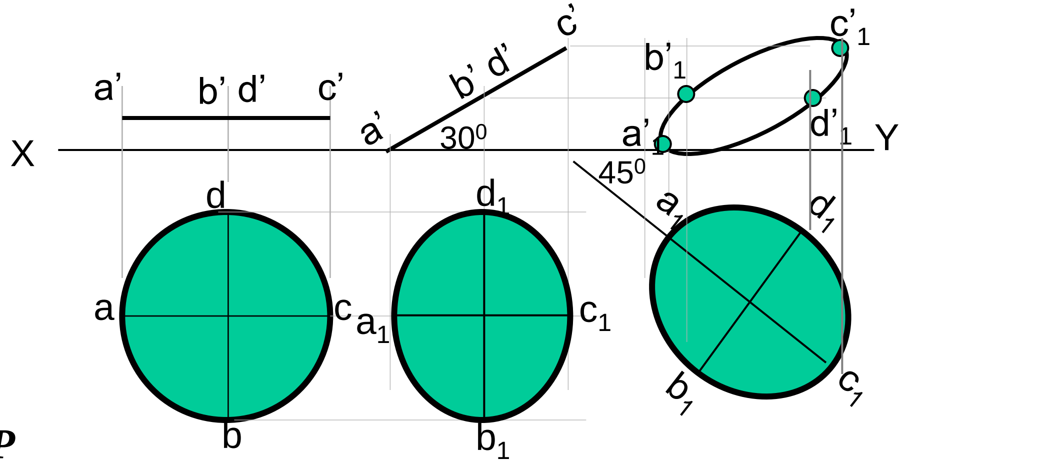
1. Surface inclined to which plane? ------- ***HP***
2. Assumption for initial position? ------ ***// to HP***
3. So which view will show True shape? --- ***TV***
4. Which side will be vertical? --------***any side.***

Hence begin with TV, draw pentagon below X-Y line, taking one side vertical.

ONLY CHANGE is
the manner in which surface inclination is described:
One side on Hp & it's opposite corner 30 mm above Hp.
Hence redraw 1st Fv as a 2nd Fv making above arrangement.
Keep a'b' on xy & d' 30 mm above xy.



Problem 8: A circle of 50 mm diameter is resting on Hp on end A of it's diameter AC which is 30^0 inclined to Hp while it's Tv is 45^0 inclined to Vp.Draw it's projections.



Read problem and answer following questions

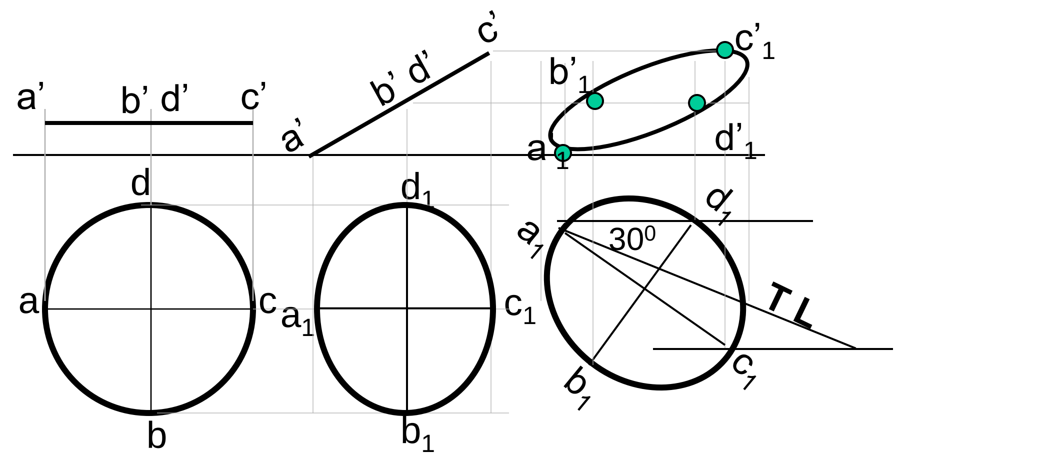
1. Surface inclined to which plane? ------- ***HP***
2. Assumption for initial position? ------ ***// to HP***
3. So which view will show True shape? --- ***TV***
4. Which diameter horizontal? ---------- ***AC***

Hence begin with TV,draw rhombus below X-Y line, taking longer diagonal // to X-Y

The difference in these two problems is in step 3 only.
In problem no.8 inclination of Tv of that AC is given,It could be drawn directly as shown in 3rd step.
While in no.9 angle of AC itself i.e. it's TL, is given. Hence here angle of TL is taken,locus of c_1 Is drawn and then LTV I.e. a_1 c_1 is marked and final TV was completed.Study illustration carefully.

Problem 9: A circle of 50 mm diameter is resting on Hp on end A of it's diameter AC which is 30^0 inclined to Hp while it makes 45^0 inclined to Vp. Draw it's projections.

Note the difference in construction of 3rd step in both solutions.



Problem 10: End A of diameter AB of a circle is in HP A nd end B is in VP.Diameter AB, 50 mm long is 30^0 & 60^0 inclined to HP & VP respectively. Draw projections of circle.

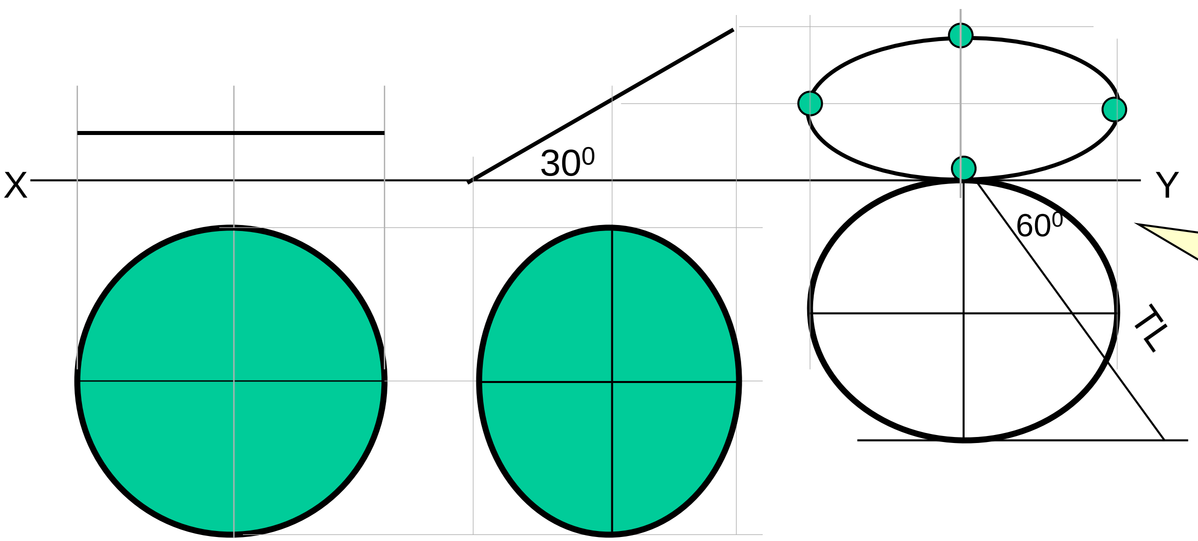
Read problem and answer following questions

1. Surface inclined to which plane? ------- ***HP***
2. Assumption for initial position? ------ ***// to HP***
3. So which view will show True shape? --- ***TV***
4. Which diameter horizontal? ---------- ***AB***

Hence begin with TV,draw CIRCLE below X-Y line, taking DIA. AB // to X-Y

The problem is similar to previous problem of circle – no.9.
But in the 3rd step there is one more change.
Like 9th problem True Length inclination of dia.AB is definitely expected but if you carefully note - the the SUM of it's inclinations with HP & VP is 90^0.
Means Line AB lies in a Profile Plane.
Hence it's both Tv & Fv must arrive on one single projector.

So do the construction accordingly AND ***note the case carefully***..



SOLVE SEPARATELY
ON DRAWING SHEET
GIVING NAMES TO VARIOUS
POINTS AS USUAL,
AS THE CASE IS IMPORTANT

Problem 11:

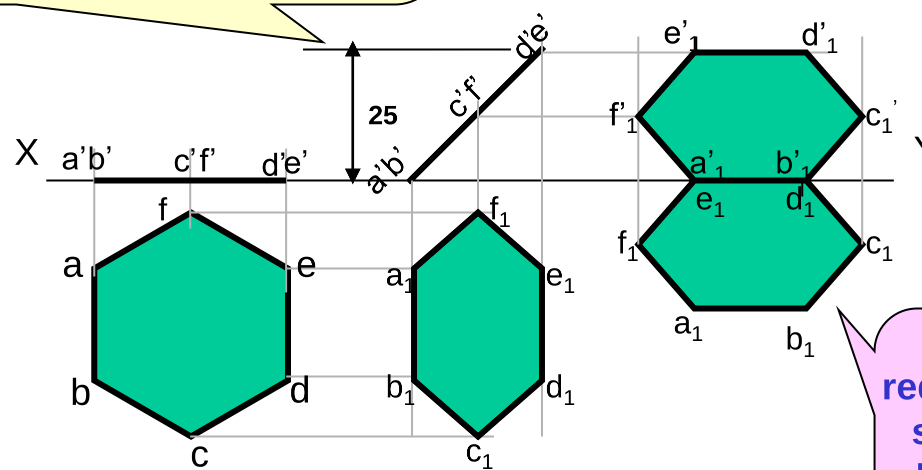
A hexagonal lamina has its one side in HP and
Its apposite parallel side is 25mm above Hp and
In Vp. Draw it's projections.
Take side of hexagon 30 mm long.

Read problem and answer following questions

1. Surface inclined to which plane? ------- ***HP***
2. Assumption for initial position? ------ ***// to HP***
3. So which view will show True shape? --- ***TV***
4. Which diameter horizontal? ---------- ***AC***

Hence begin with TV,draw rhombus below X-Y line, taking longer diagonal // to X-Y

ONLY CHANGE is the manner in which surface inclination is described:
One side on Hp & it's opposite side 25 mm above Hp.
Hence redraw 1st Fv as a 2nd Fv making above arrangement.
Keep a'b' on xy & d'e' 25 mm above xy.



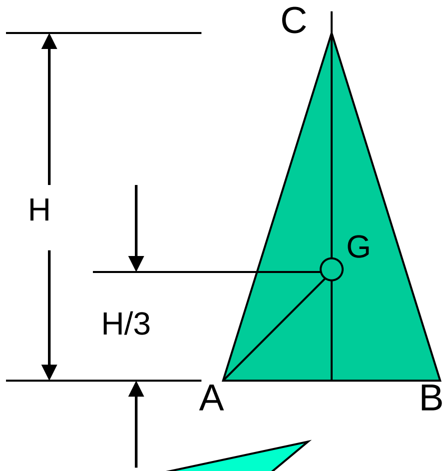
As 3rd step redraw 2nd Tv keeping side DE on xy line. Because it is in VP as said in problem.

FREELY SUSPENDED CASES.

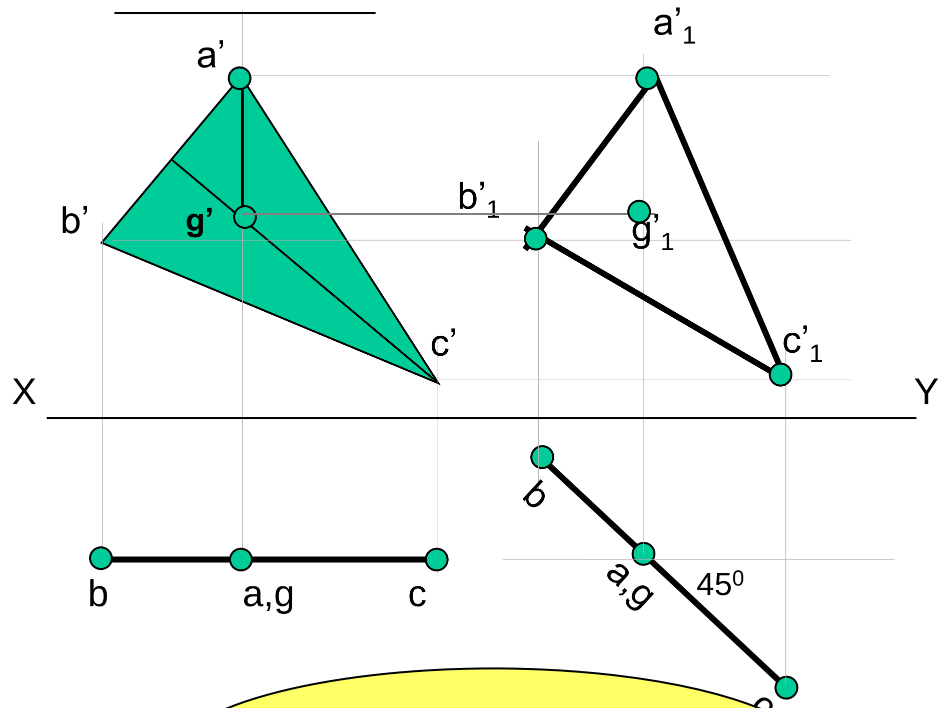
IMPORTANT POINTS

1.In this case the plane of the figure always remains ***perpendicular to Hp***.
2.It may remain parallel or inclined to Vp.
3.Hence ***TV*** in this case will be always a ***LINE view.***
4.Assuming surface // to Vp, draw true shape in suspended position as FV.
(Here keep *line joining* ***point of contact & centroid of fig. vertical***)
5.Always begin with FV as a True Shape but in a suspended position.
AS shown in 1st FV.

Problem 12:
An isosceles triangle of 40 mm long base side, 60 mm long altitude Is freely suspended from one corner of Base side.It's plane is 45^0 inclined to Vp. Draw it's projections.



First draw a given triangle
With given dimensions,
Locate it's centroid position
And
join it with point of suspension.



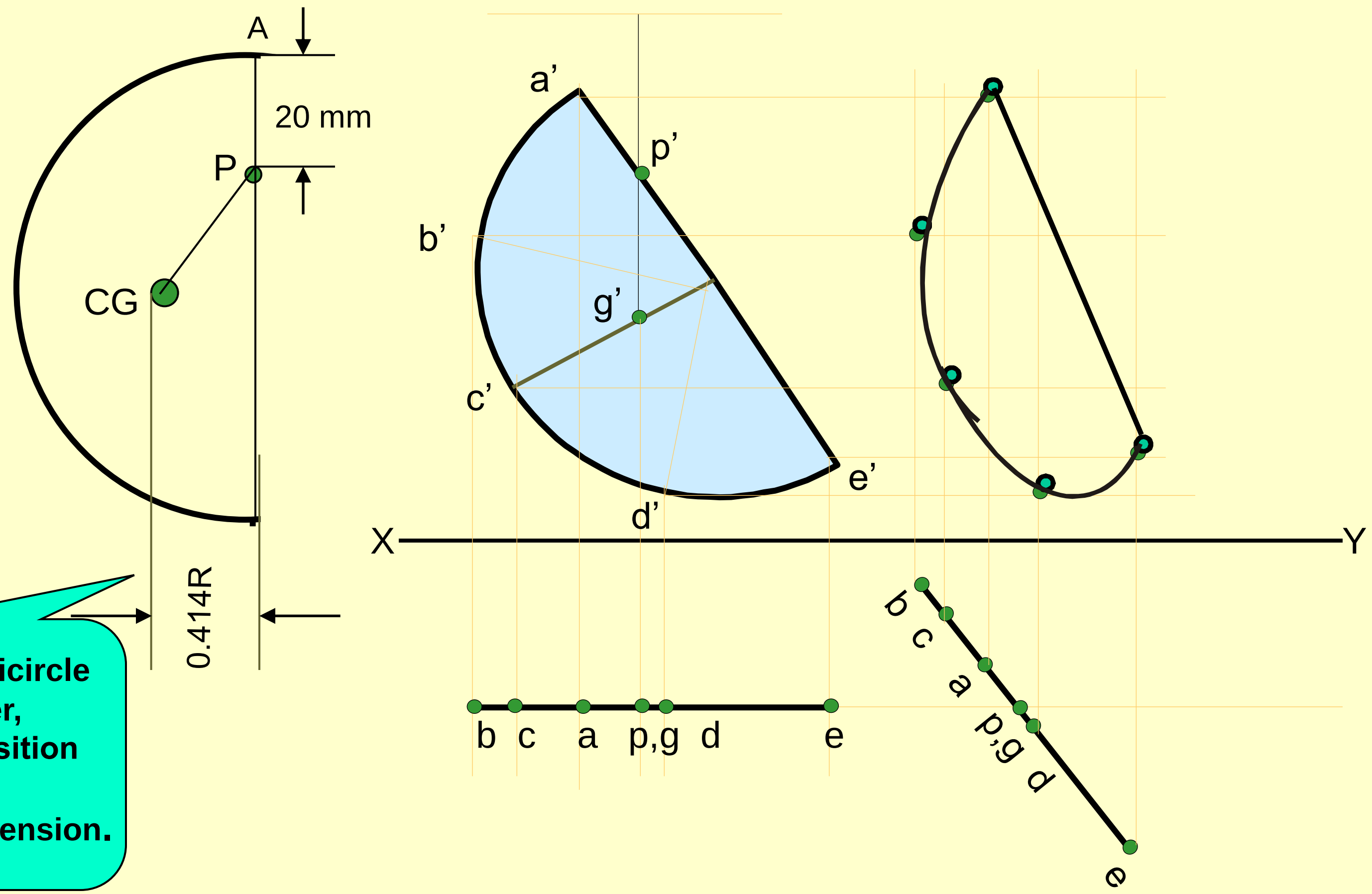
Similarly solve next problem of Semi-circle

IMPORTANT POINTS

Problem 13

:A semicircle of 100 mm diameter is suspended from a point on its straight edge 30 mm from the midpoint of that edge so that the surface makes an angle of 45^0 with VP.
Draw its projections.

1.In this case the plane of the figure always remains ***perpendicular to Hp***.
2.It may remain parallel or inclined to Vp.
3.Hence ***TV*** in this case will be always a ***LINE view.***
4.Assuming surface // to Vp, draw true shape in suspended position as FV.
(Here keep *line joining* ***point of contact & centroid of fig. vertical***)
5.Always begin with FV as a True Shape but in a suspended position.
AS shown in 1st FV.



First draw a given semicircle
With given diameter,
Locate it's centroid position
And
join it with point of suspension.

To determine true shape of plane figure when it's projections are given.
BY USING AUXILIARY PLANE METHOD

WHAT WILL BE THE PROBLEM?
Description of final Fv & Tv will be given.
You are supposed to determine true shape of that plane figure.

Follow the below given steps:

1. Draw the given Fv & Tv as per the given information in problem.
2. Then among all lines of Fv & Tv select a line showing True Length (T.L.) (It's other view must be // to xy)
3. Draw x_1-y_1 perpendicular to this line showing T.L.
4. Project view on x_1-y_1 (it must be a line view)
5. Draw x_2-y_2 // to this line view & project new view on it.

It will be the required answer i.e. True Shape.

The facts you must know:-
If you carefully study and observe the solutions of all previous problems,
You will find
IF ONE VIEW IS A LINE VIEW & THAT TOO PARALLEL TO XY LINE,
THEN AND THEN IT'S OTHER VIEW WILL SHOW TRUE SHAPE:

NOW FINAL VIEWS ARE ALWAYS SOME SHAPE, NOT LINE VIEWS:
SO APPLYING ABOVE METHOD:
WE FIRST CONVERT ONE VIEW IN INCLINED LINE VIEW .(By using x1y1 aux.plane)
THEN BY MAKING IT // TO X2-Y2 WE GET TRUE SHAPE.

Study Next Four Cases

Problem 14 **Tv is a triangle abc. Ab is 50 mm long, angle cab is 300 and angle cba is 650. a’b’c’ is a Fv. a’ is 25 mm, b’ is 40 mm and c’ is 10 mm above Hp respectively. Draw projections of that figure and find it’s true shape.**

As per the procedure-

1.First draw Fv & Tv as per the data.

2.In Tv line ab is // to xy hence it’s other view a’b’ is TL. So draw x_1y_1 perpendicular to it.

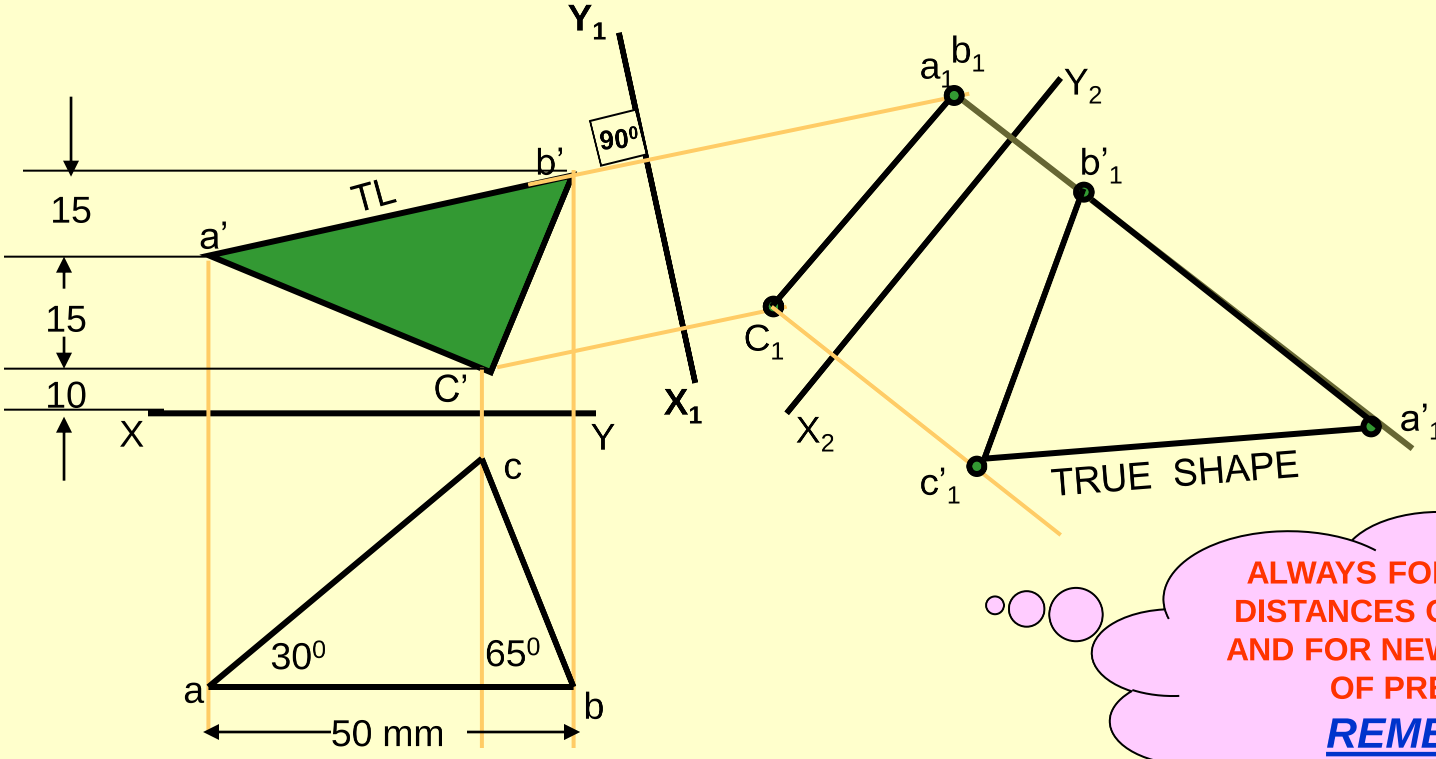
3.Project view on x1y1.

a) First draw projectors from a’b’ & c’ on x_1y_1.

b) from xy take distances of a,b & c(Tv) mark on these projectors from x_1y_1. Name points a1b1 & c1.

c) This line view is an Aux.Tv. Draw x_2y_2 // to this line view and project Aux. Fv on it. for that from x_1y_1 take distances of a’b’ & c’ and mark from x_2y= on new projectors.

4.Name points a'_1 b'_1 & c'_1 and join them. This will be the required true shape.



ALWAYS FOR NEW FV TAKE DISTANCES OF PREVIOUS FV AND FOR NEW TV, DISTANCES OF PREVIOUS TV

REMEMBER!!

Problem 15: Fv & Tv of a triangular plate are shown. Determine it's true shape.

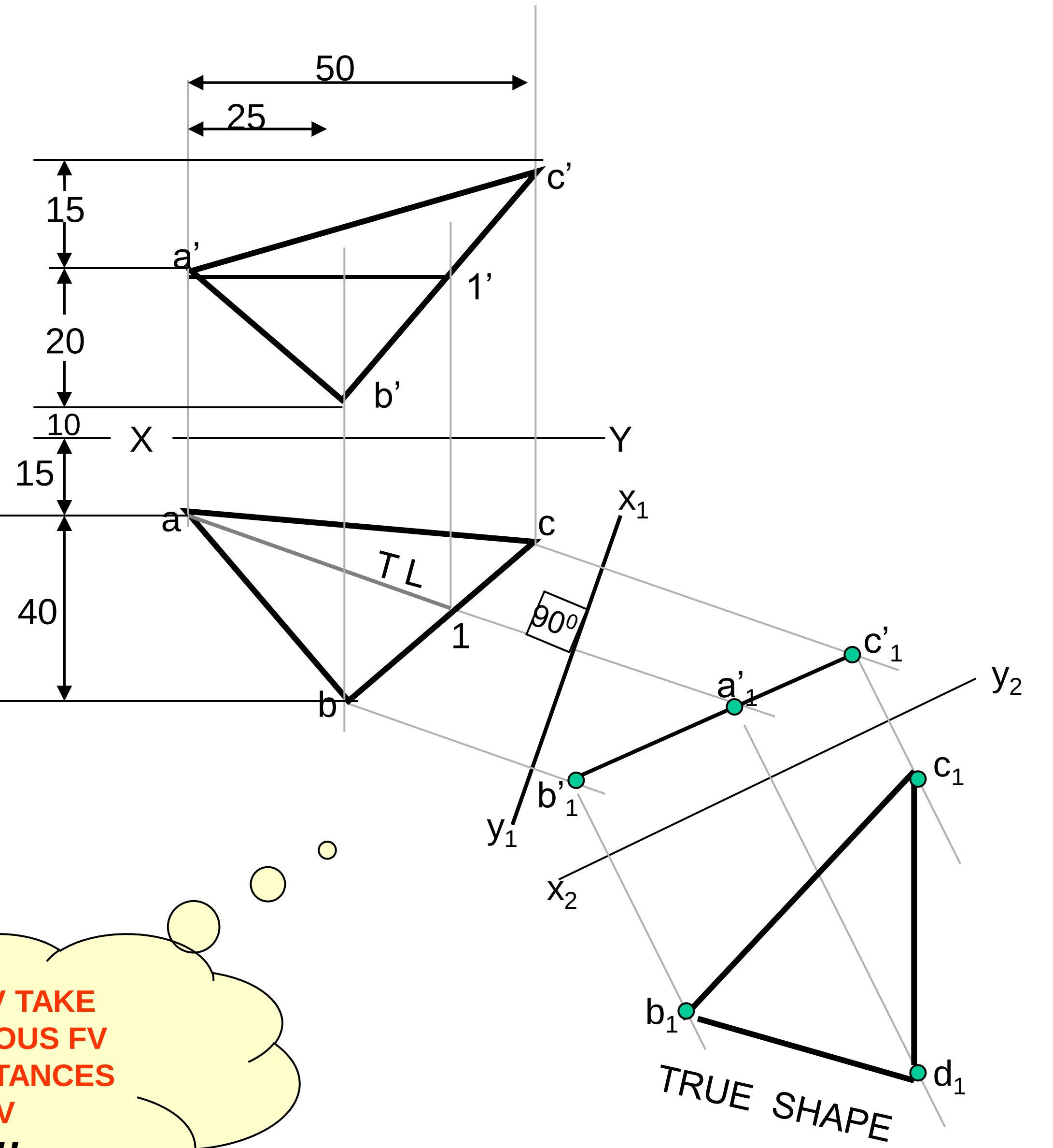
USE SAME PROCEDURE STEPS OF PREVIOUS PROBLEM:
BUT THERE IS ONE DIFFICULTY:

NO LINE IS // TO XY IN ANY VIEW.
MEANS NO TL IS AVAILABLE.

IN SUCH CASES DRAW ONE LINE // TO XY IN ANY VIEW & IT'S OTHER VIEW CAN BE CONSIDERED AS TL FOR THE PURPOSE.

HERE a' 1' line in Fv is drawn // to xy.
HENCE it's Tv a-1 becomes TL.

THEN FOLLOW SAME STEPS AND DETERMINE TRUE SHAPE.
(STUDY THE ILLUSTRATION)



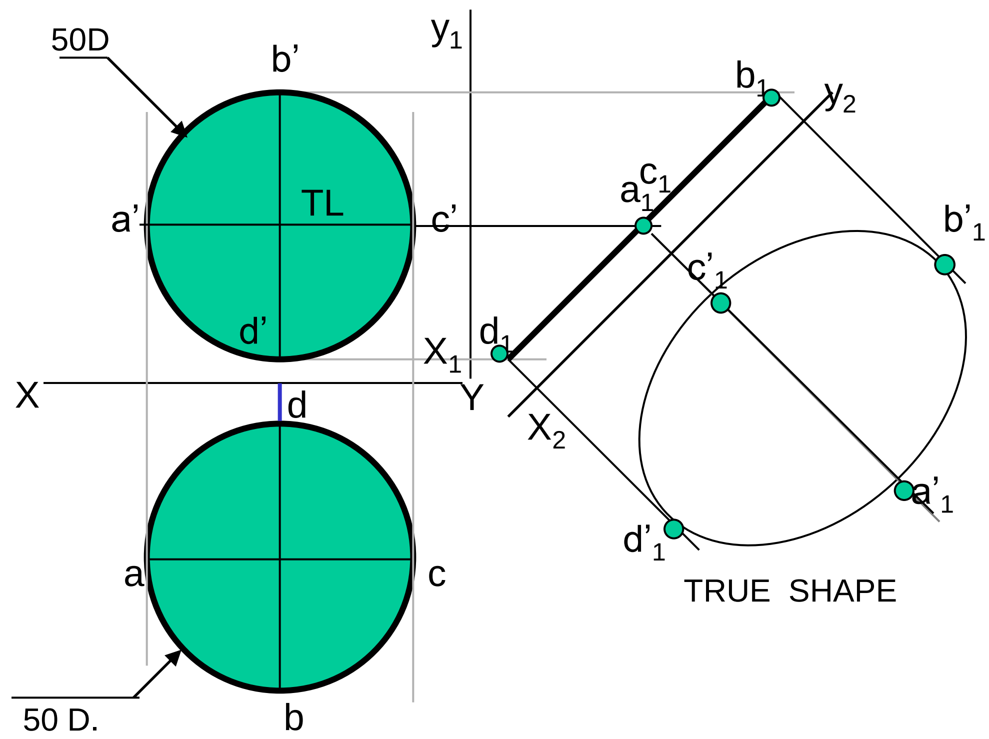
ALWAYS FOR NEW FV TAKE DISTANCES OF PREVIOUS FV AND FOR NEW TV, DISTANCES OF PREVIOUS TV

REMEMBER!!

PROBLEM 16: **Fv & Tv both are circles of 50 mm diameter. Determine true shape of an elliptical plate.**

ADOPT SAME PROCEDURE.
a c is considered as line // to xy.
Then a'c' becomes TL for the purpose.
Using steps properly true shape can be Easily determined.

Study the illustration.



ALWAYS, FOR NEW FV TAKE DISTANCES OF PREVIOUS FV AND FOR NEW TV, DISTANCES OF PREVIOUS TV

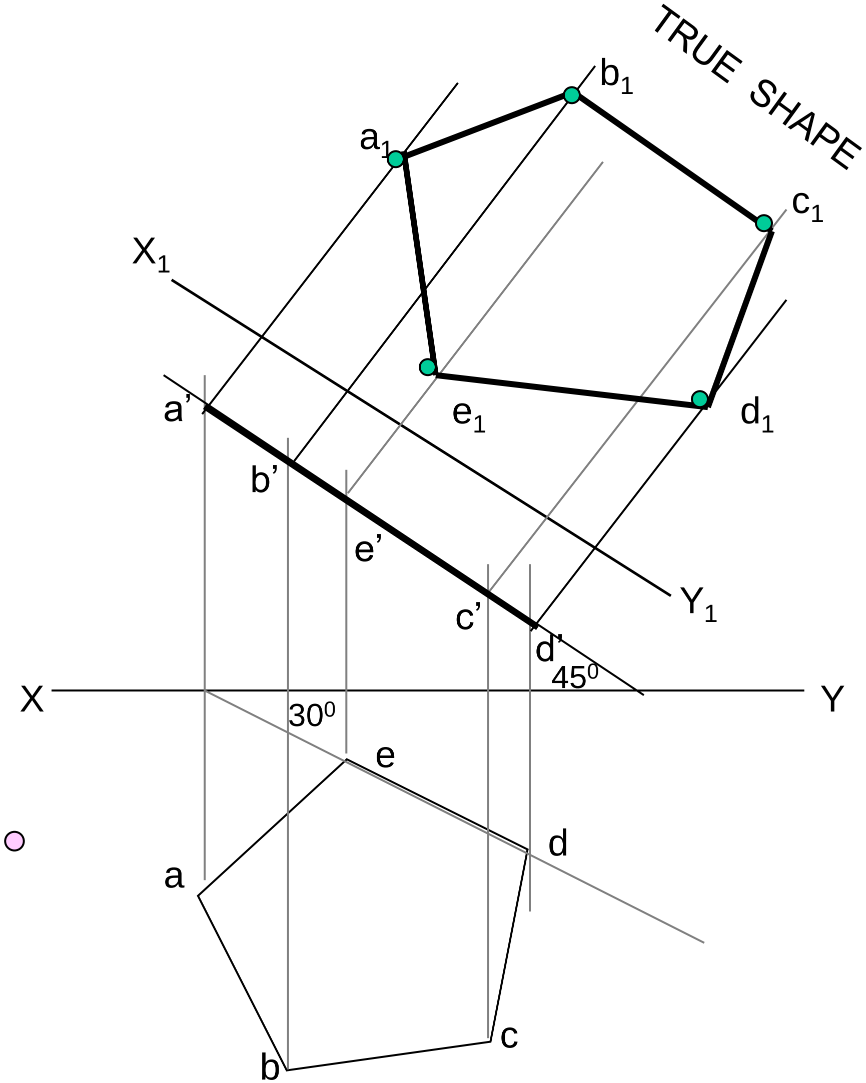
REMEMBER!!

Problem 17 : Draw a regular pentagon of 30 mm sides with one side 30^0 inclined to xy. This figure is Tv of some plane whose Fv is A line 45^0 inclined to xy. Determine it's true shape.

IN THIS CASE ALSO TRUE LENGTH IS NOT AVAILABLE IN ANY VIEW.

BUT ACTUALLY WE DONOT REQUIRE TL TO FIND IT'S TRUE SHAPE, AS ONE VIEW (FV) IS ALREADY A LINE VIEW. SO JUST BY DRAWING X1Y1 // TO THIS VIEW WE CAN PROJECT VIEW ON IT AND GET TRUE SHAPE:

STUDY THE ILLUSTRATION..



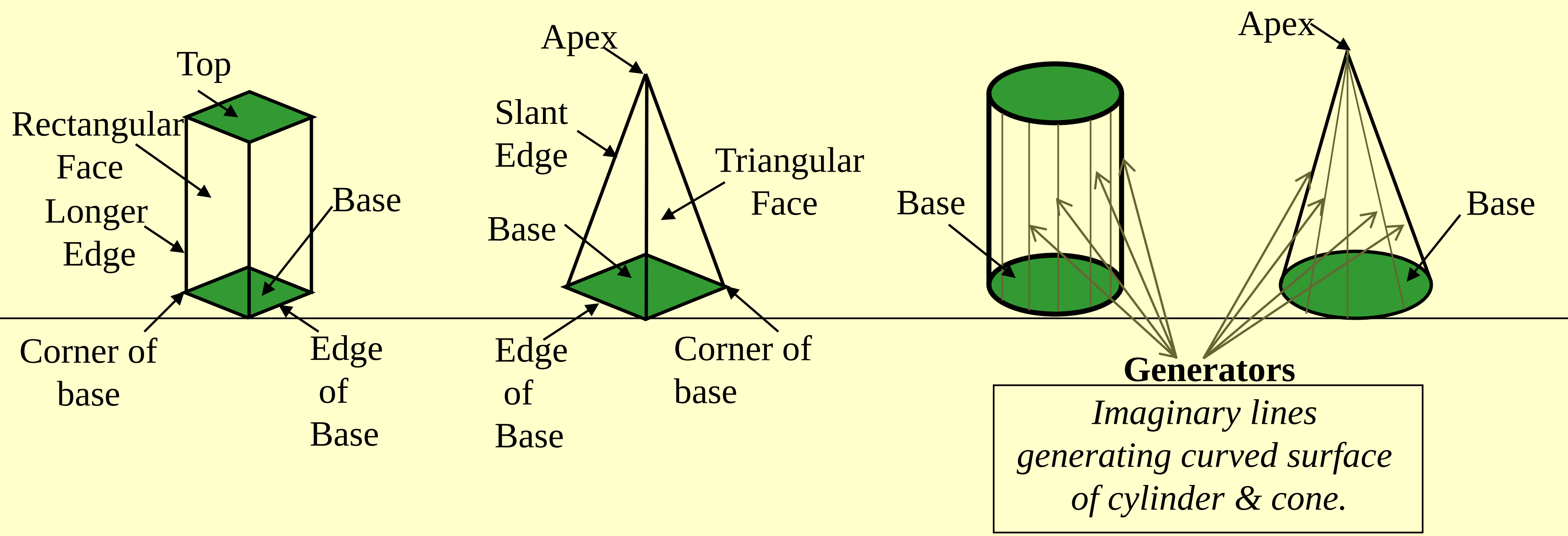
ALWAYS FOR NEW FV TAKE DISTANCES OF PREVIOUS FV AND FOR NEW TV, DISTANCES OF PREVIOUS TV

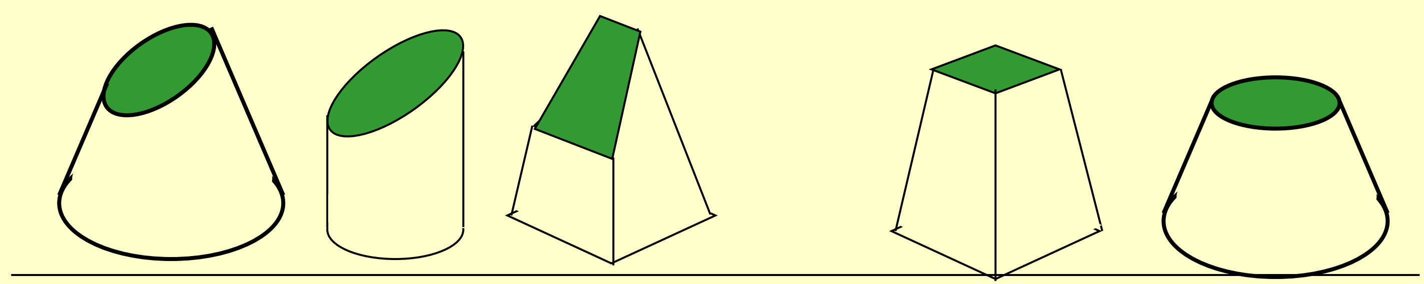
REMEMBER!!

SOLIDS

Dimensional parameters of different solids.

Square Prism **Square Pyramid** **Cylinder** **Cone**





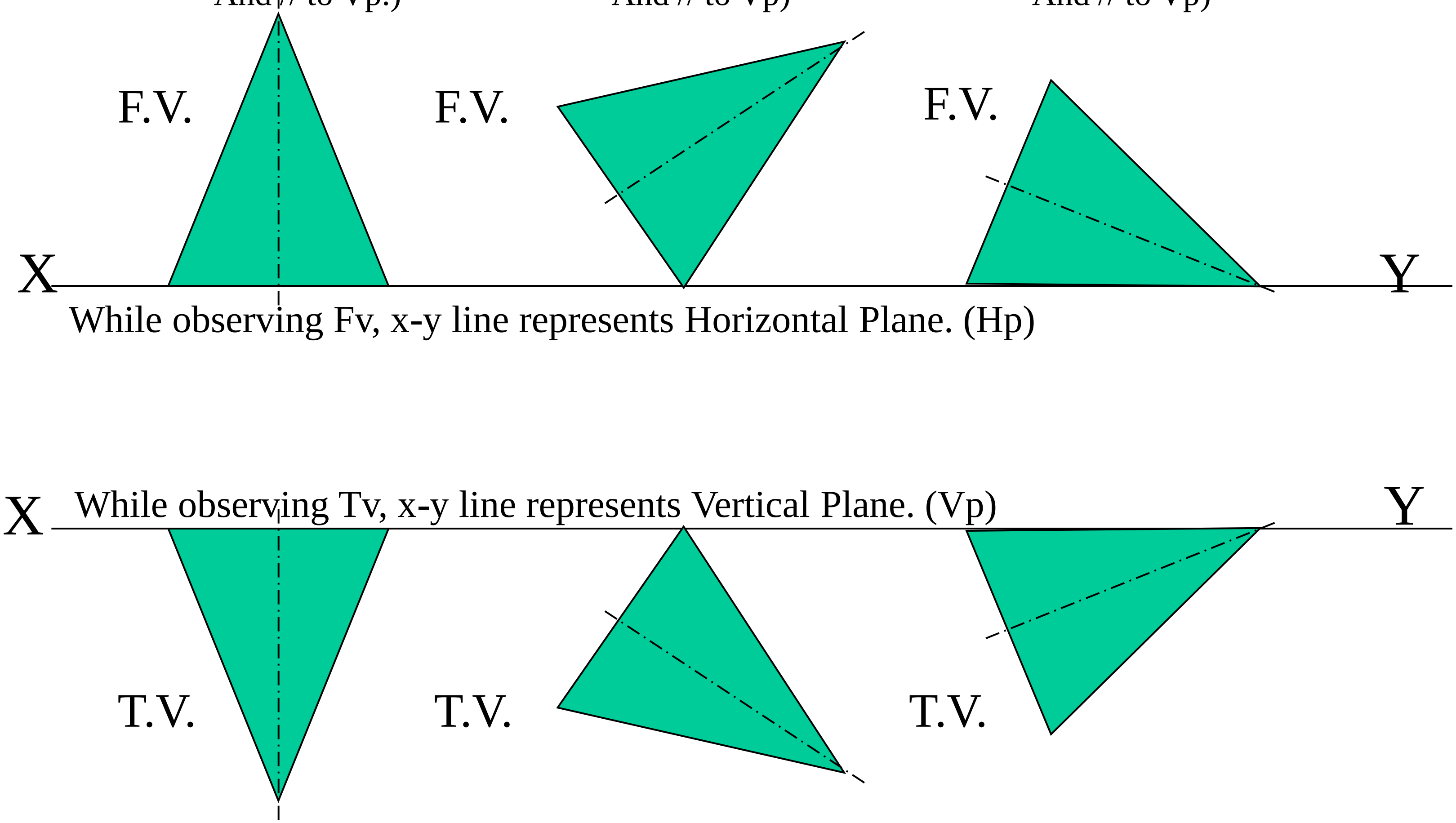
Sections of solids(top & base not parallel)

Frustum of cone & pyramids.
(top & base parallel to each other)

STANDING ON H.P
On it's base.
(Axis perpendicular to Hp
And // to Vp.)

RESTING ON H.P
On one point of base circle.
(Axis inclined to Hp
And // to Vp)

LYING ON H.P
On one generator.
(Axis inclined to Hp
And // to Vp)



STANDING ON V.P
On it's base.
Axis perpendicular to Vp
And // to Hp

RESTING ON V.P
On one point of base circle.
Axis inclined to Vp
And // to Hp

LYING ON V.P
On one generator.
Axis inclined to Vp
And // to Hp

STEPS TO SOLVE PROBLEMS IN SOLIDS

Problem is solved in three steps:

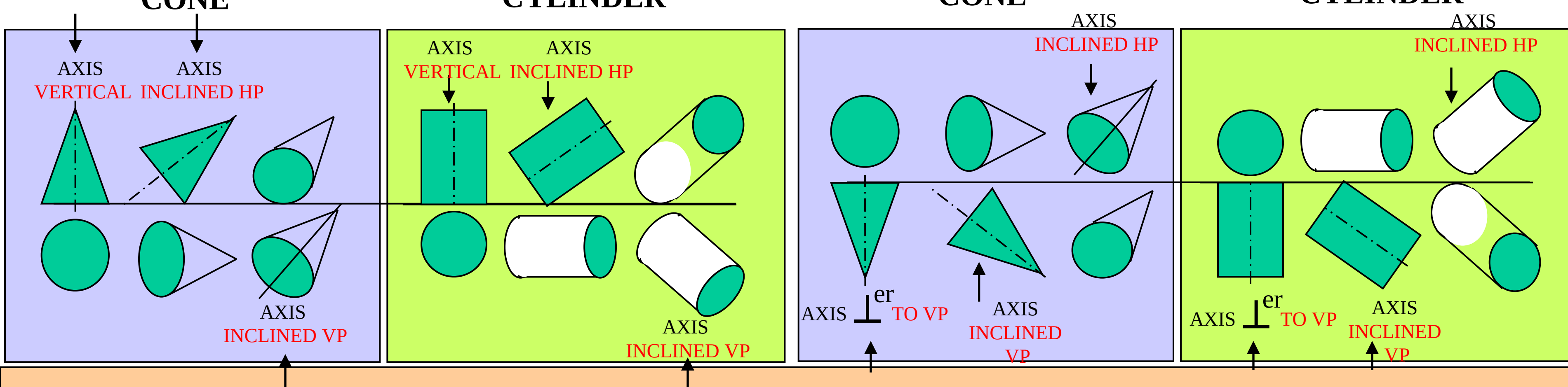
STEP 1: ASSUME SOLID STANDING ON THE PLANE WITH WHICH IT IS MAKING INCLINATION.
(IF IT IS INCLINED TO HP, ASSUME IT STANDING ON HP)
(IF IT IS INCLINED TO VP, ASSUME IT STANDING ON VP)
IF STANDING ON HP - IT'S TV WILL BE TRUE SHAPE OF IT'S BASE OR TOP:
IF STANDING ON VP - IT'S FV WILL BE TRUE SHAPE OF IT'S BASE OR TOP.
BEGIN WITH THIS VIEW:
IT'S OTHER VIEW WILL BE A RECTANGLE (IF SOLID IS ***CYLINDER OR ONE OF THE PRISMS)***:
IT'S OTHER VIEW WILL BE A TRIANGLE (IF SOLID IS ***CONE OR ONE OF THE PYRAMIDS):***
DRAW FV & TV OF THAT SOLID IN STANDING POSITION:

STEP 2: CONSIDERING SOLID'S INCLINATION (AXIS POSITION) DRAW IT'S FV & TV.

STEP 3: IN LAST STEP, CONSIDERING REMAINING INCLINATION, DRAW IT'S FINAL FV & TV.

GENERAL PATTERN (THREE STEPS) OF SOLUTION:

GROUP B SOLID. CONE	GROUP A SOLID. CYLINDER	GROUP B SOLID. CONE	GROUP A SOLID. CYLINDER



Three steps If solid is inclined to Hp	Three steps If solid is inclined to Hp	Three steps If solid is inclined to Vp	Three steps If solid is inclined to Vp

Study Next *Twelve* Problems and Practice them separately !!

CATEGORIES OF ILLUSTRATED PROBLEMS!

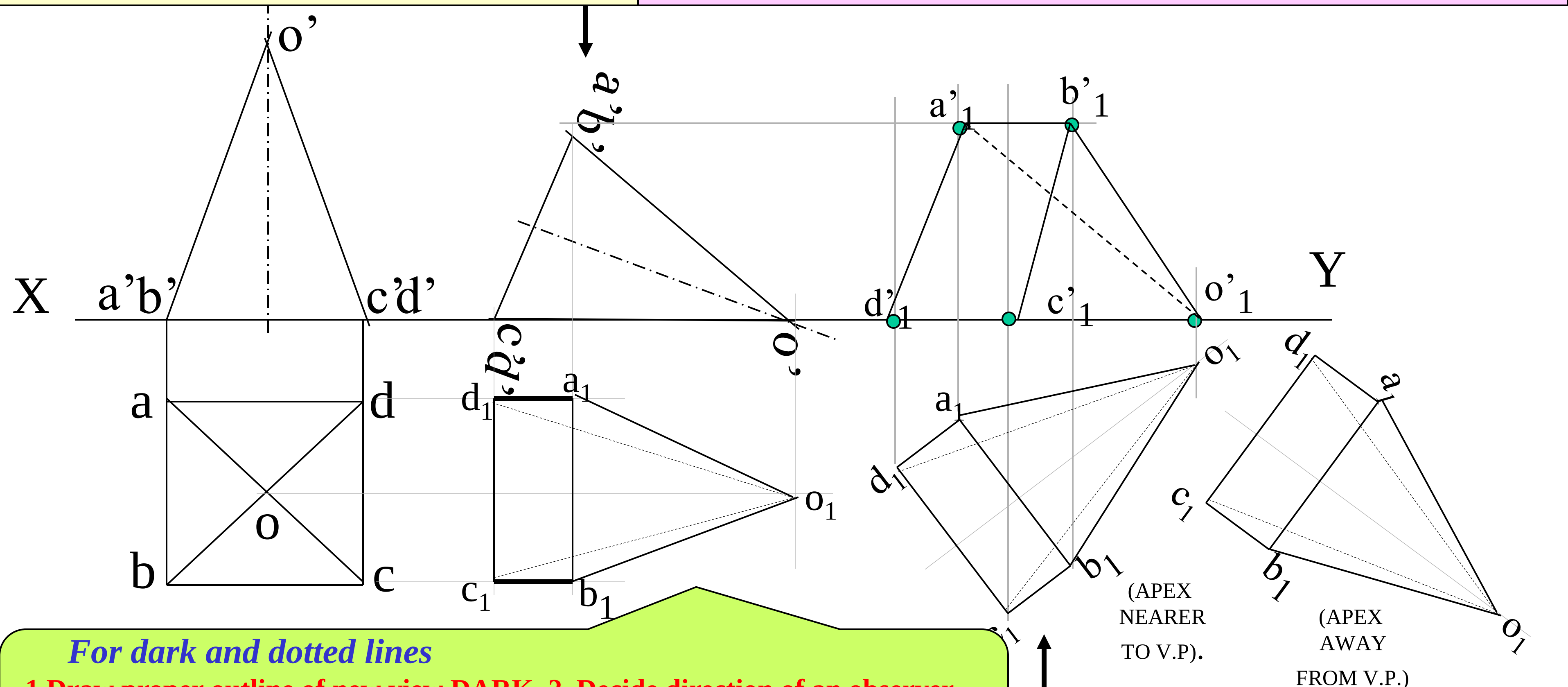
PROBLEM NO.1, 2, 3, 4	GENERAL CASES OF SOLIDS INCLINED TO HP & VP
PROBLEM NO. 5 & 6	CASES OF CUBE & TETRAHEDRON
PROBLEM NO. 7	CASE OF FREELY SUSPENDED SOLID WITH SIDE VIEW.
PROBLEM NO. 8	CASE OF CUBE (WITH SIDE VIEW)
PROBLEM NO. 9	CASE OF TRUE LENGTH INCLINATION WITH HP & VP.
PROBLEM NO. 10 & 11	CASES OF COMPOSITE SOLIDS. (AUXILIARY PLANE)
PROBLEM NO. 12	CASE OF A FRUSTUM (AUXILIARY PLANE)

Problem 1. A square pyramid, 40 mm base sides and axis 60 mm long, has a triangular face on the ground and the vertical plane containing the axis makes an angle of 45^0 with the VP. Draw its projections. Take apex nearer to VP

Solution Steps :

Triangular face on Hp , means it is lying on Hp:

1.Assume it standing on Hp.
2.It's Tv will show True Shape of base(square)
3.Draw square of 40mm sides with one side vertical Tv & taking 50 mm axis project Fv. (a triangle)
4.Name all points as shown in illustration.
5.Draw 2nd Fv in lying position I.e.o'c'd' face on xy. And project it's Tv.
6.Make visible lines dark and hidden dotted, as per the procedure.
7.Then construct remaining inclination with Vp (Vp containing axis ic the center line of 2nd Tv.Make it 45^0 to xy as shown take apex near to xy, as it is nearer to Vp) & project final Fv.



For dark and dotted lines

1.Draw proper outline of new view DARK. 2. Decide direction of an observer.
3. Select nearest point to observer and draw all lines starting from it-dark.
4. Select farthest point to observer and draw all lines (remaining)from it- dotted.

Problem 2:

A cone 40 mm diameter and 50 mm axis is resting on one generator on Hp which makes 30^0 inclination with Vp Draw it's projections.

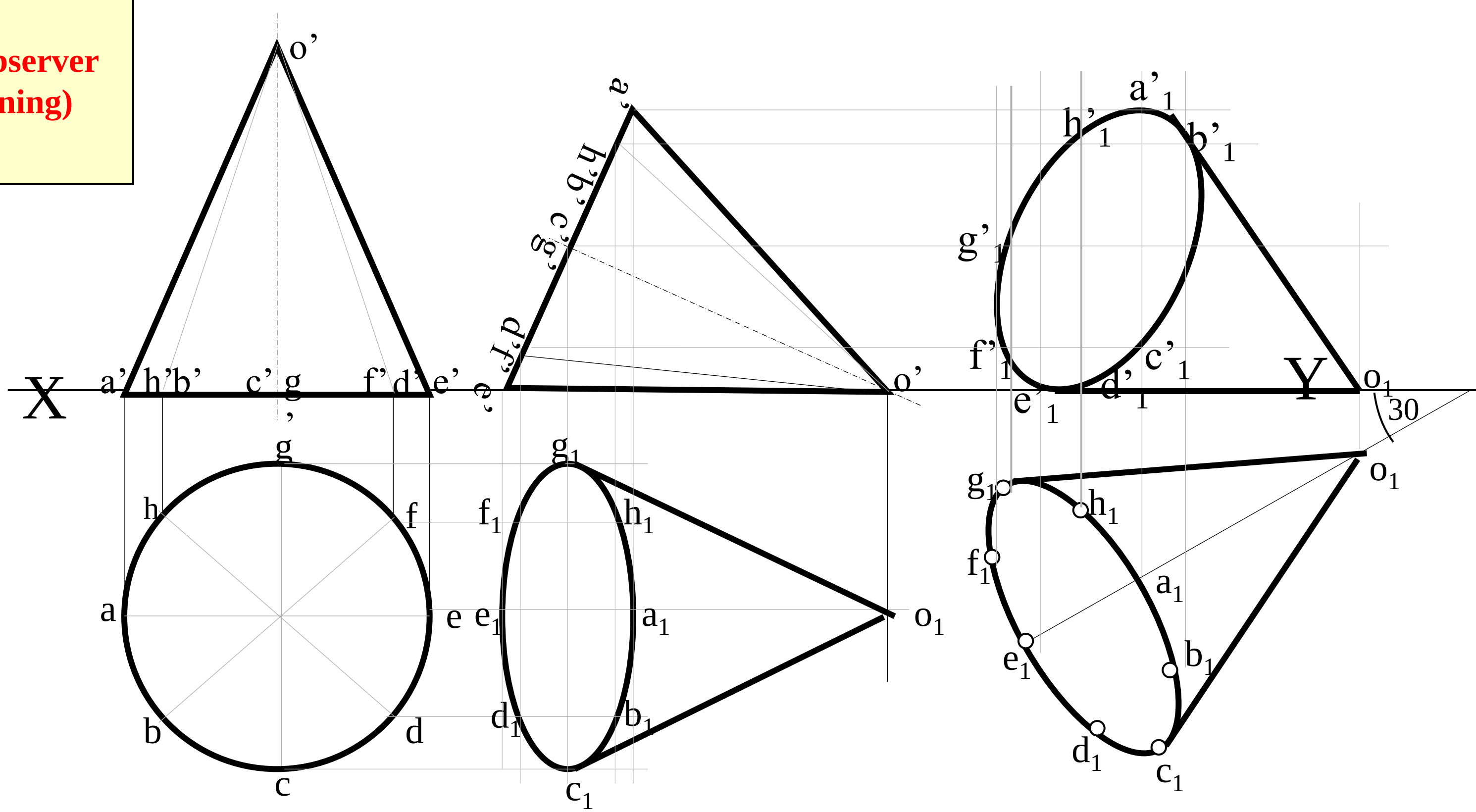
For dark and dotted lines

1.Draw proper outline of new vie DARK.
2. Decide direction of an observer.
3. Select nearest point to observer and draw all lines starting from it-dark.
4. Select farthest point to observer and draw all lines (remaining) from it- dotted.

Solution Steps:

Resting on Hp on one generator, means lying on Hp:

1.Assume it standing on Hp.
2.It's Tv will show True Shape of base(circle)
3.Draw 40mm dia. Circle as Tv & taking 50 mm axis project Fv. (a triangle)
4.Name all points as shown in illustration.
5.Draw 2^{nd} Fv in lying position I.e.o'e' on xy. And project it's Tv below xy.
6.Make visible lines dark and hidden dotted, as per the procedure.
7.Then construct remaining inclination with Vp (generator o_1e_1 30^0 to xy as shown) & project final Fv.



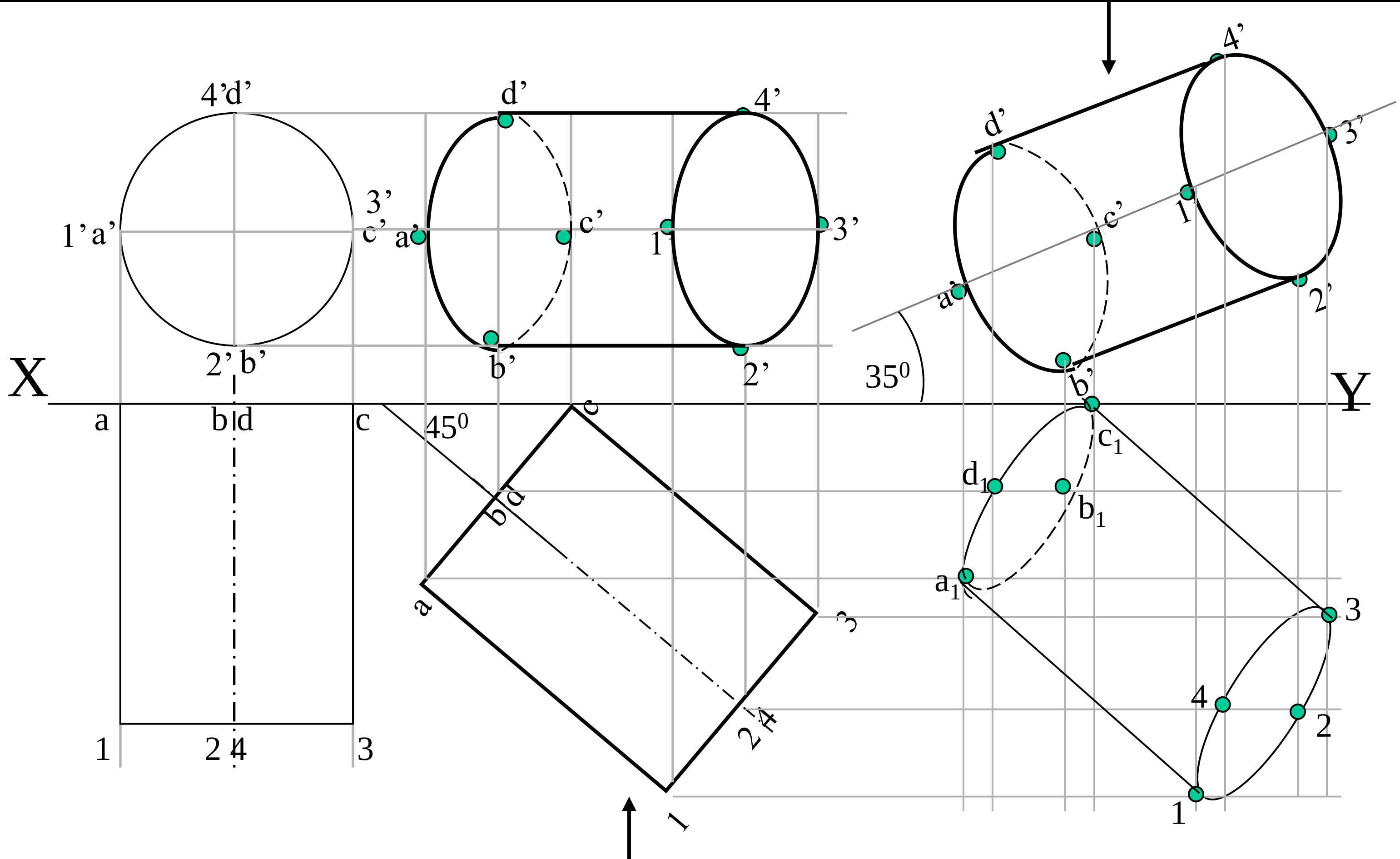
Problem 3:

A cylinder 40 mm diameter and 50 mm axis is resting on one point of a base circle on Vp while it's axis makes 45^0 with Vp and Fv of the axis 35^0 with Hp. Draw projections..

Solution Steps:

Resting on Vp on one point of base, means inclined to Vp:

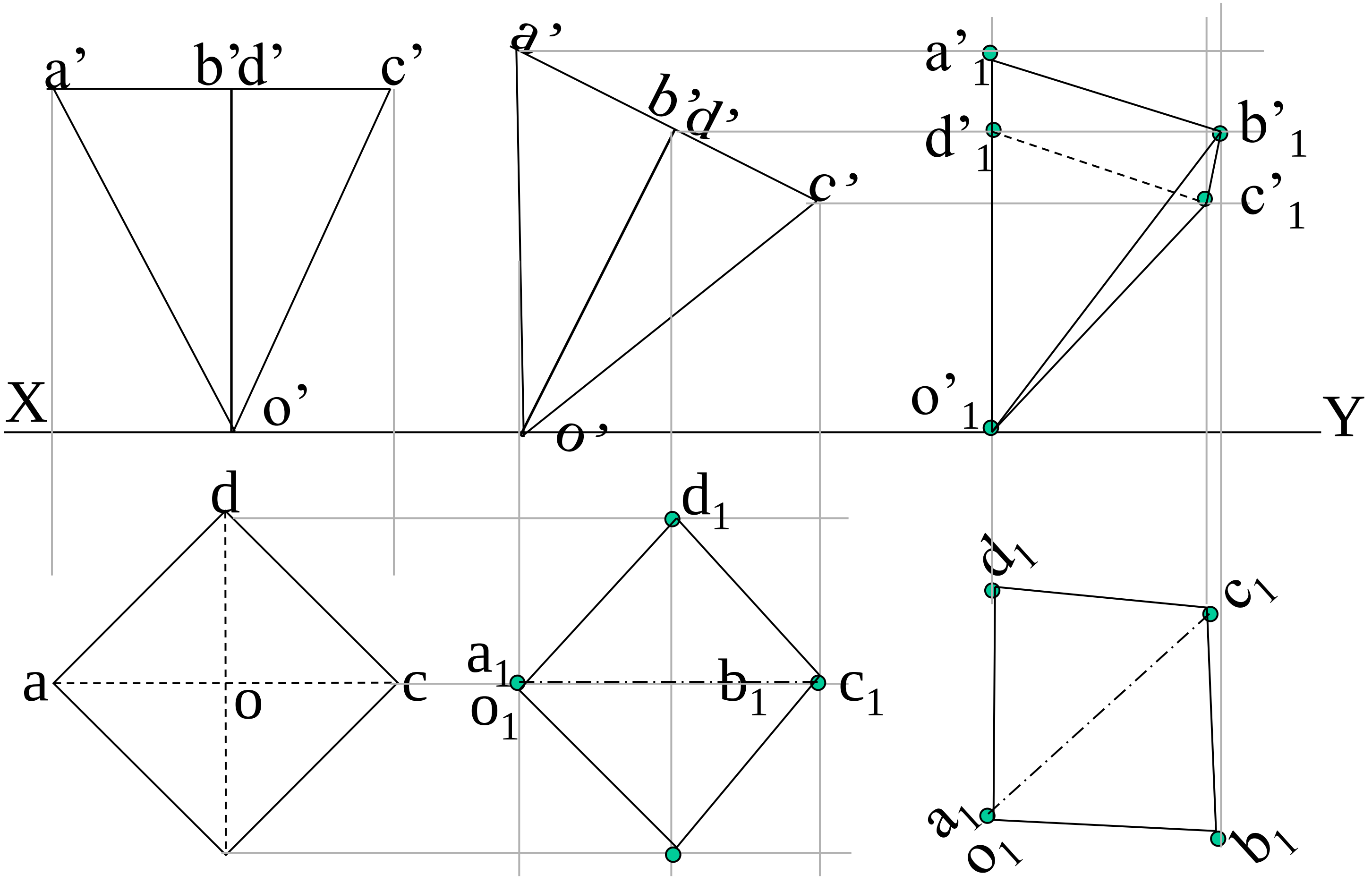
1. Assume it standing on Vp
2. It's Fv will show True Shape of base & top(circle)
3. Draw 40mm dia. Circle as Fv & taking 50 mm axis project Tv. (a Rectangle)
4. Name all points as shown in illustration.
5. Draw 2nd Tv making axis 45^0 to xy And project it's Fv above xy.
6. Make visible lines dark and hidden dotted, as per the procedure.
7. Then construct remaining inclination with Hp (Fv of axis I.e. center line of view to xy as shown) & project final Tv.



Problem 4: A square pyramid 30 mm base side and 50 mm long axis is resting on it's apex on Hp, such that it's one slant edge is vertical and a triangular face through it is perpendicular to Vp. Draw it's projections.

Solution Steps :

1. Assume it standing on Hp but as said on apex.(inverted).
2. It's Tv will show True Shape of base(square)
3. Draw a corner case square of 30 mm sides as Tv(as shown) Showing all slant edges dotted, as those will not be visible from top.
4. taking 50 mm axis project Fv. (a triangle)
5. Name all points as shown in illustration.
6. Draw 2nd Fv keeping o'a' slant edge vertical & project it's Tv
7. Make visible lines dark and hidden dotted, as per the procedure.
8. Then redrew 2nd Tv as final Tv keeping $a_1o_1d_1$ triangular face perpendicular to Vp I.e.xy. Then as usual project final Fv.



Problem 5: A cube of 50 mm long edges is so placed on Hp on one corner that a body diagonal is parallel to Hp and perpendicular to Vp Draw it's projections.

Solution Steps:

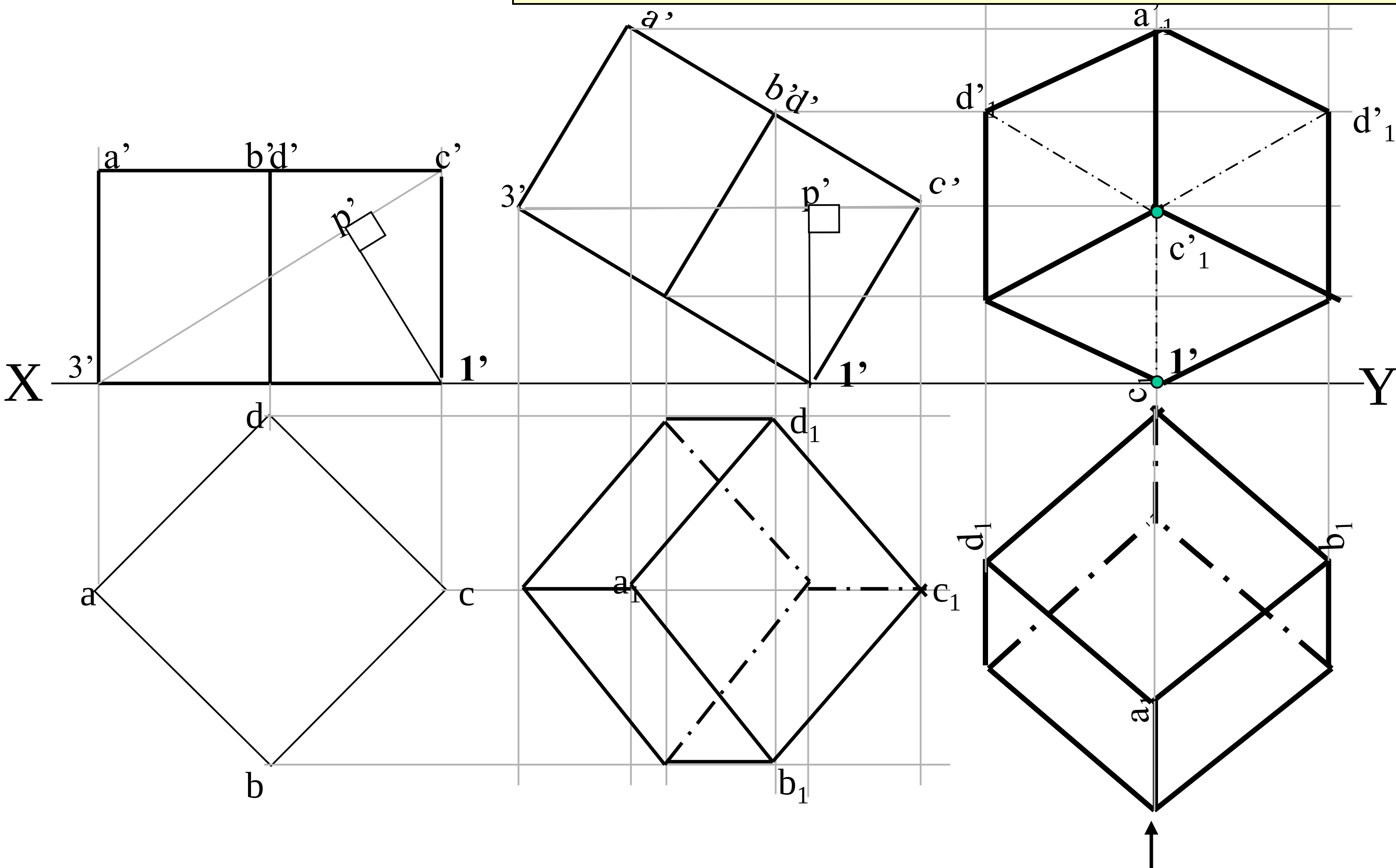
1.Assuming standing on Hp, begin with Tv,a square with all sides equally inclined to xy.Project Fv and name all points of FV & TV.

2.Draw a body-diagonal joining c' with 3'(This can become // to xy)

3.From 1' drop a perpendicular on this and name it p'

4.Draw 2nd Fv in which 1'-p' line is vertical ***means*** c'-3' diagonal must be horizontal. .Now as usual project Tv..

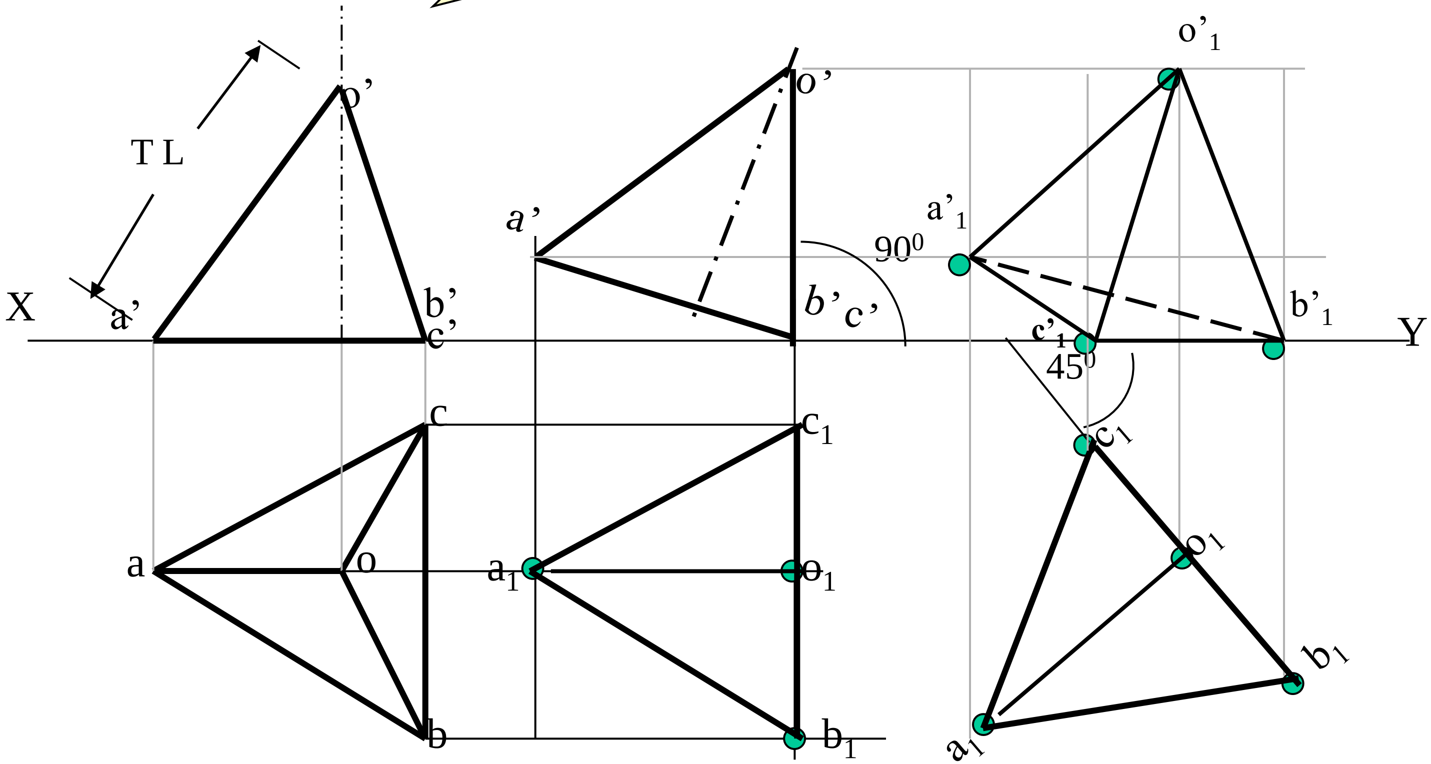
6.In final Tv draw same diagonal is perpendicular to Vp as said in problem. Then as usual project final FV.



Problem 6: A tetrahedron of 50 mm long edges is resting on one edge on Hp while one triangular face containing this edge is vertical and 45^0 inclined to Vp. Draw projections.

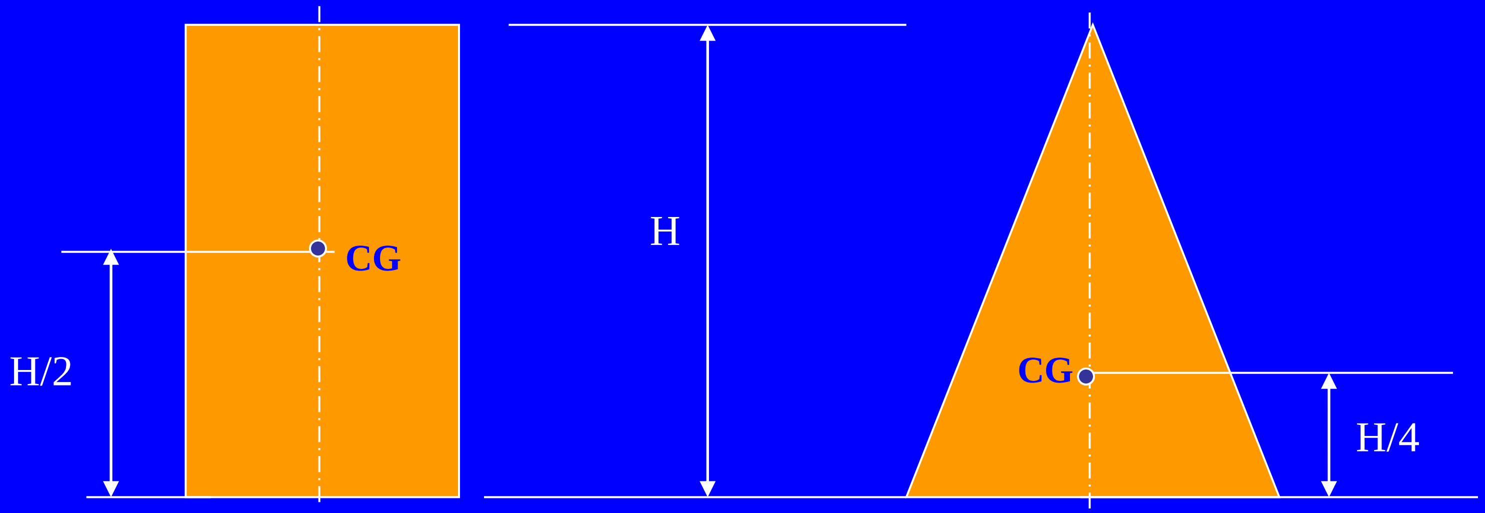
IMPORTANT:
Tetrahedron is a special type of triangular pyramid in which base sides & slant edges are equal in length. Solid of four faces. Like cube it is also described by One dimension only.. Axis length generally not given.

Solution Steps
As it is resting assume it standing on Hp.
Begin with Tv , an equilateral triangle as side case as shown:
First project base points of Fv on xy, name those & axis line.
From a' with TL of edge, 50 mm, cut on axis line & mark o'
(as axis is not known, o' is finalized by slant edge length)
Then complete Fv.
In 2^{nd} Fv make face o'b'c' vertical as said in problem.
And like all previous problems solve completely.



FREELY SUSPENDED SOLIDS:

Positions of CG, on axis, from base, for different solids are shown below.



GROUP A SOLIDS
(Cylinder & Prisms)

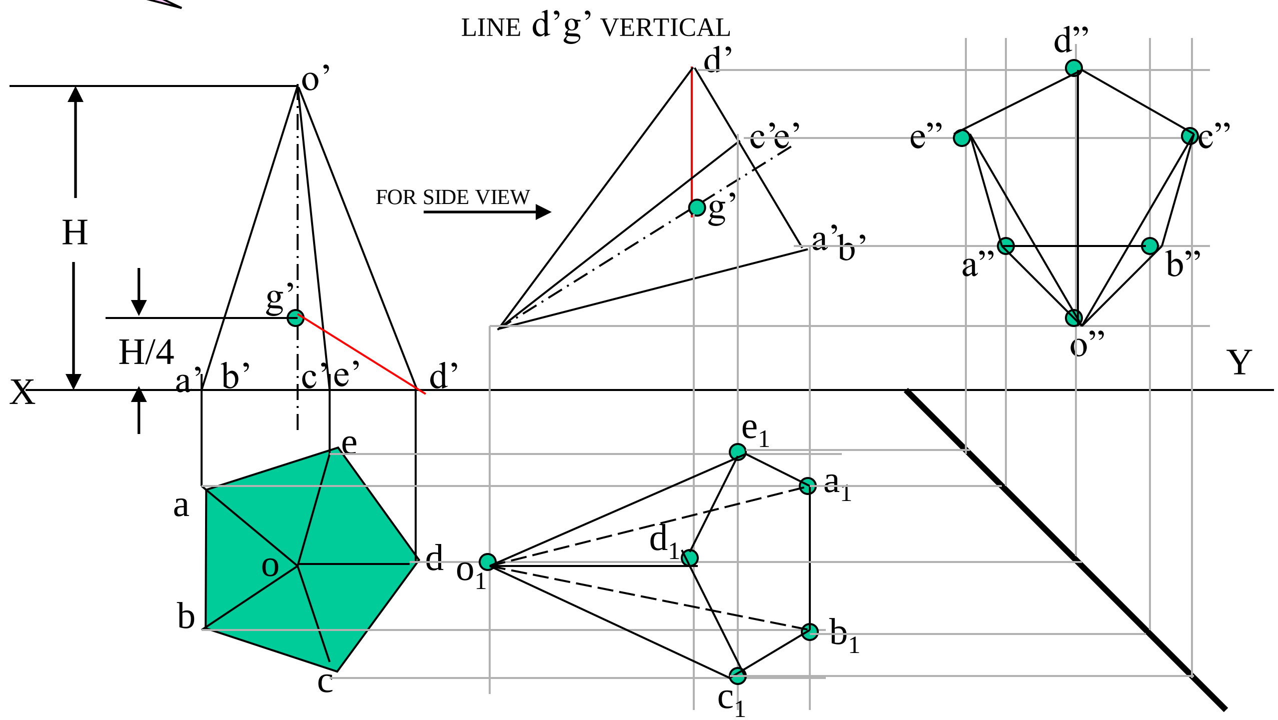
GROUP B SOLIDS
(Cone & Pyramids)

Problem 7: A pentagonal pyramid 30 mm base sides & 60 mm long axis, is freely suspended from one corner of base so that a plane containing it's axis remains parallel to Vp.
Draw it's three views.

Solution Steps:

In all suspended cases axis shows inclination with Hp.

1. Hence assuming it standing on Hp, drew Tv - a regular pentagon,corner case.
2. Project Fv & locate CG position on axis – (¼ H from base.) and name g' and Join it with corner d'
3. As 2nd Fv, redraw first keeping line g'd' vertical.
4. As usual project corresponding Tv and then Side View looking from.



IMPORTANT:
When a solid is freely suspended from a corner, then line joining point of contact & C.G. remains vertical.
(Here axis shows inclination with Hp.)
So in all such cases, assume solid standing on Hp initially.)

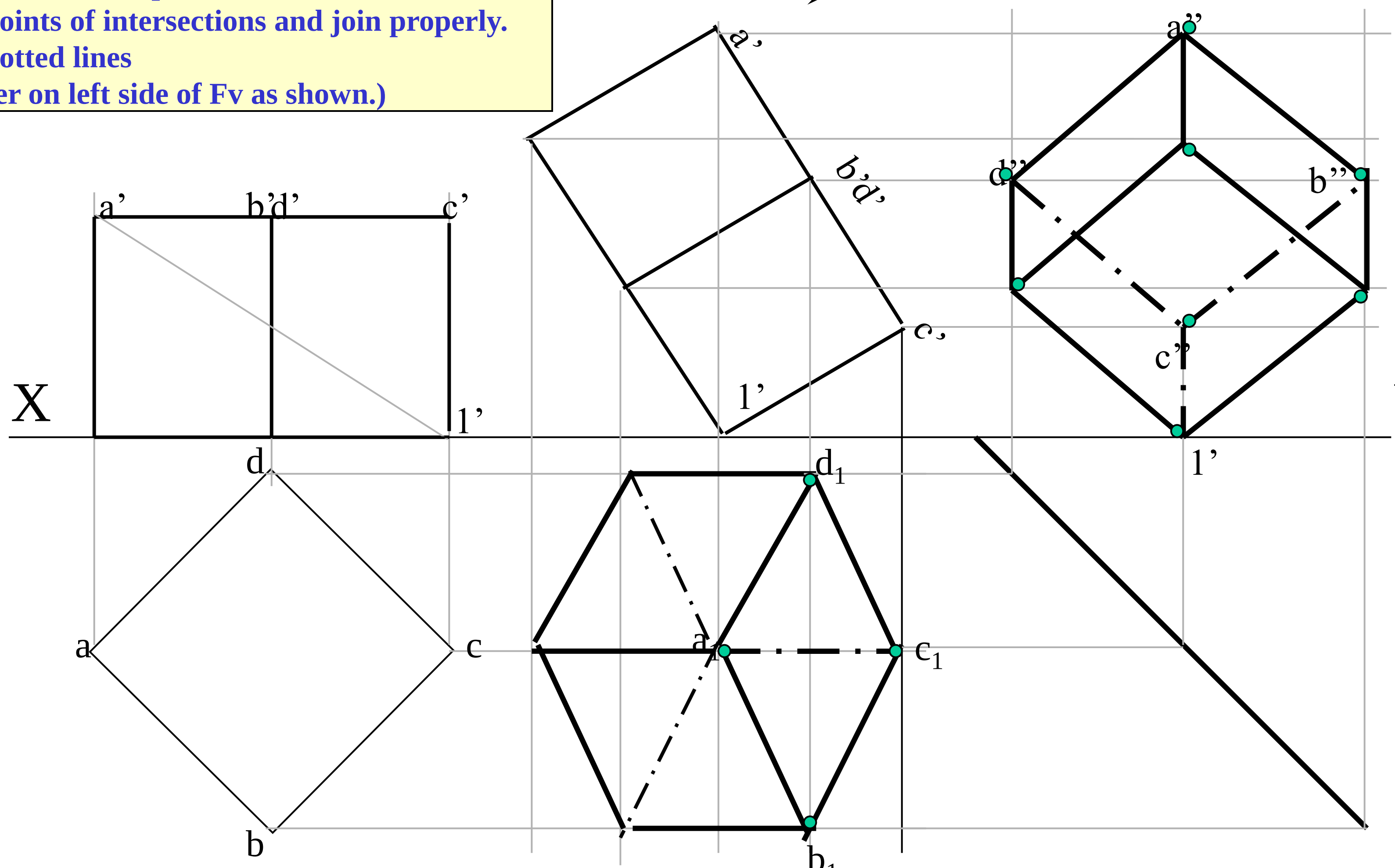
Problem 8:

A cube of 50 mm long edges is so placed on Hp on one corner that a body diagonal through this corner is perpendicular to Hp and parallel to Vp Draw it's three views.

Solution Steps:

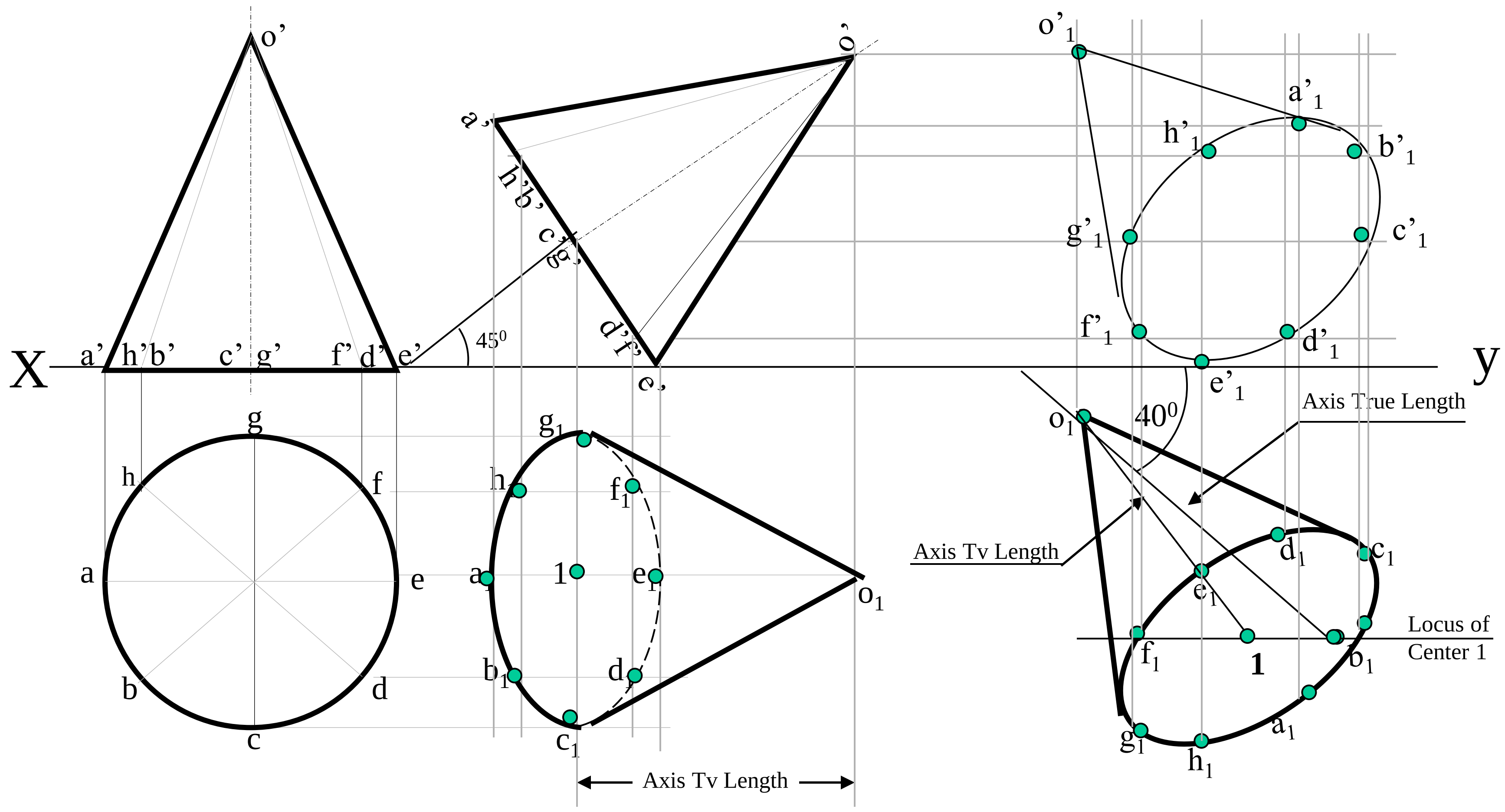
1. Assuming it standing on Hp begin with Tv, a square of corner case.
2. Project corresponding Fv.& name all points as usual in both views.
3. Join a'1' as body diagonal and draw 2nd Fv making it vertical (I' on xy)
4. Project it's Tv drawing dark and dotted lines as per the procedure.
5. With standard method construct Left-hand side view.

(Draw a 45° inclined Line in Tv region (below xy). Project horizontally all points of Tv on this line and reflect vertically upward, above xy.After this, draw horizontal lines, from all points of Fv, to meet these lines. Name points of intersections and join properly. For dark & dotted lines locate observer on left side of Fv as shown.)



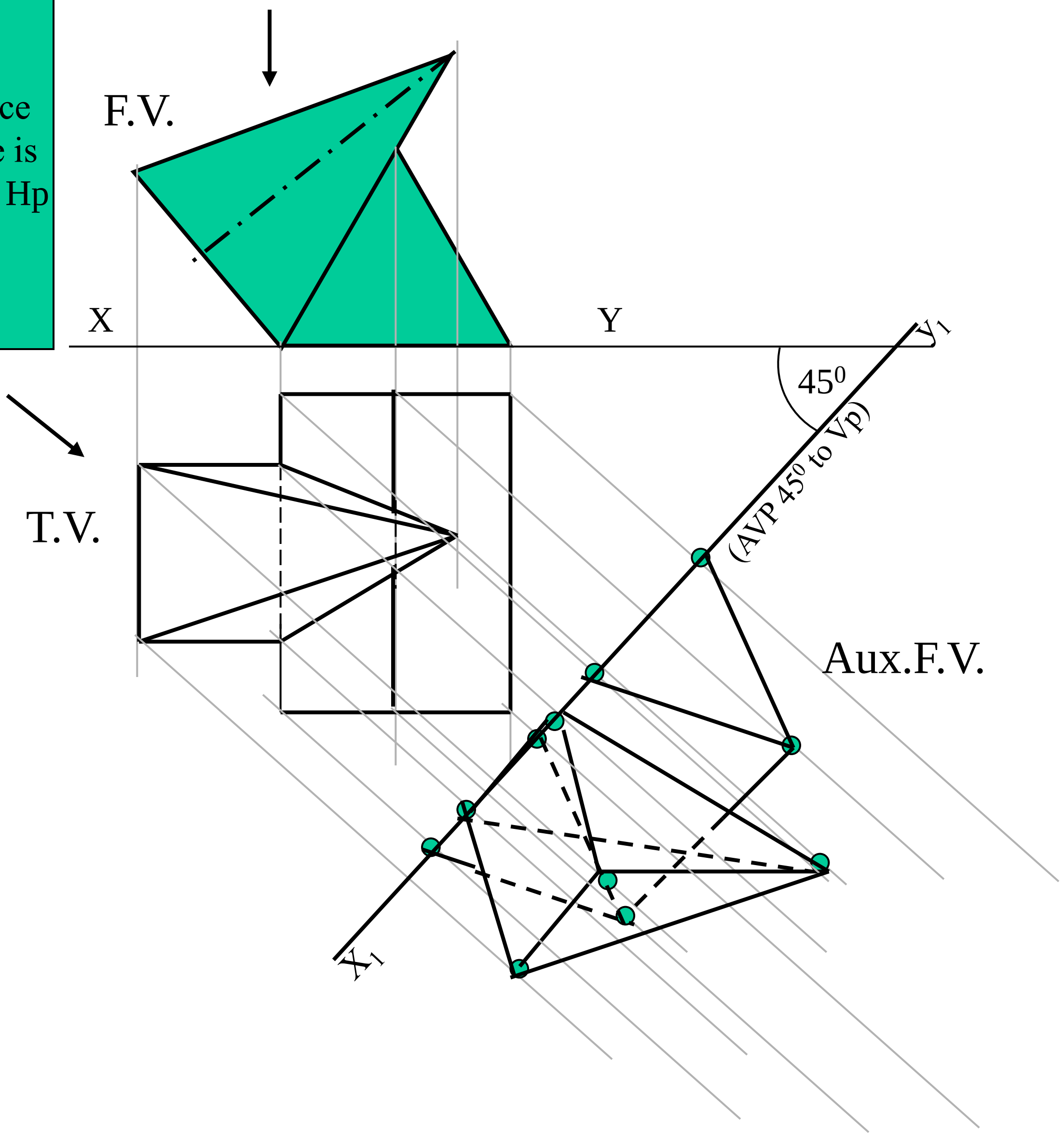
Problem 9: A right circular cone, 40 mm base diameter and 60 mm long axis is resting on Hp on one point of base circle such that it's axis makes 45^0 inclination with Hp and 40^0 inclination with Vp. Draw it's projections.

This case resembles to **problem no.7 & 9 from projections of planes** topic.
In previous all cases 2nd inclination was done by a parameter not showing TL.Like Tv of axis is inclined to Vp etc. But here it is clearly said that the axis is 40^0 inclined to Vp. Means here TL inclination is expected. So the same construction done in those Problems is done here also. See carefully the final Tv and inclination taken there.
So assuming it standing on HP begin as usual.



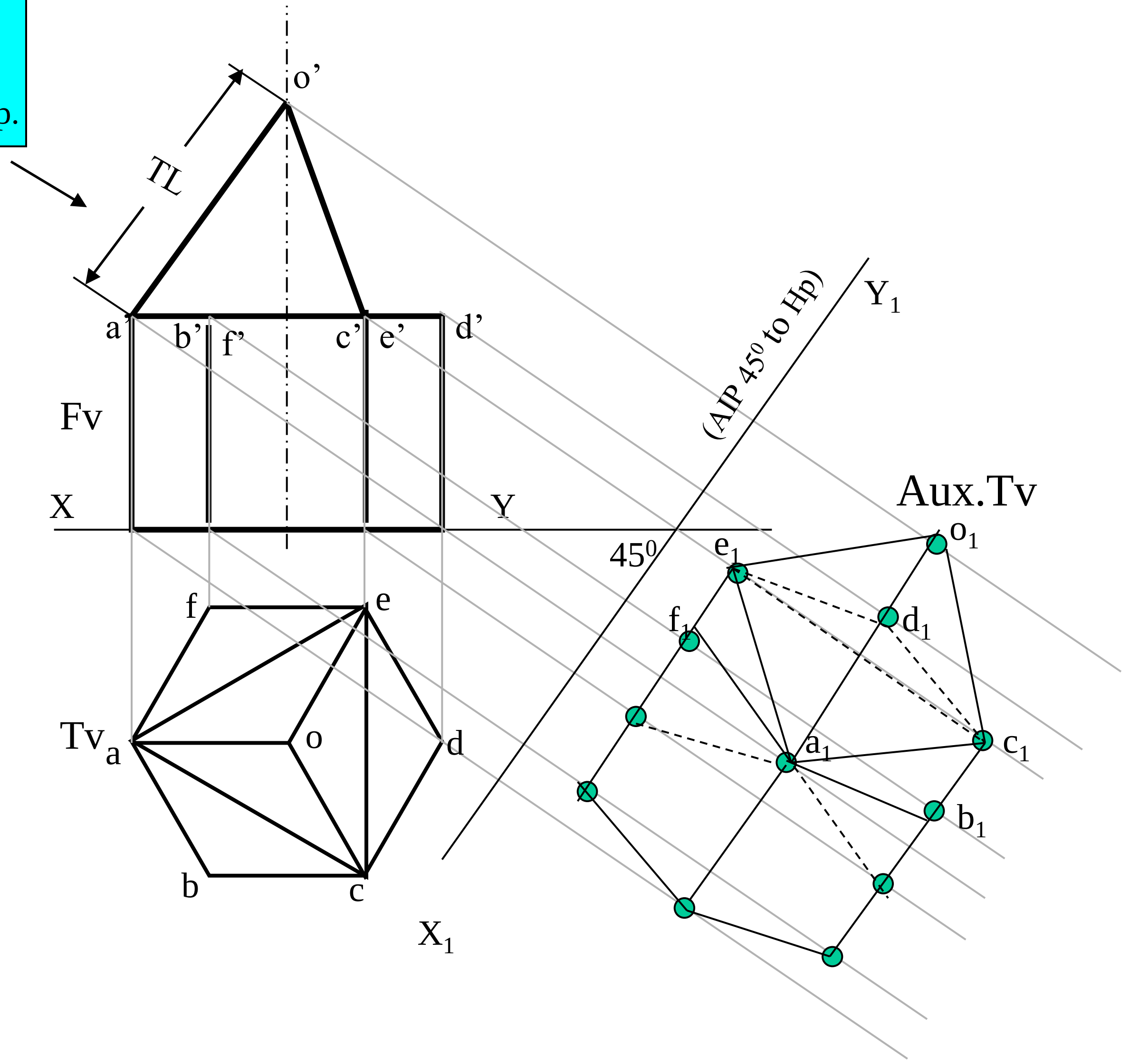
Problem 10: A triangular prism,
40 mm base side 60 mm axis
is lying on Hp on one rectangular face
with axis perpendicular to Vp.
One square pyramid is leaning on it's face
centrally with axis // to vp. It's base side is
30 mm & axis is 60 mm long resting on Hp
on one edge of base.Draw FV & TV of
both solids.Project another FV
on an AVP 45^0 inclined to VP.

Steps :
Draw Fv of lying prism
(an equilateral Triangle)
And Fv of a leaning pyramid.
Project Tv of both solids.
Draw x_1y_1 45^0 inclined to xy
and project aux.Fv on it.
Mark the distances of first FV
from first xy for the distances
of aux. Fv from x_1y_1 line.
Note the observer's directions
Shown by arrows and further
steps carefully.

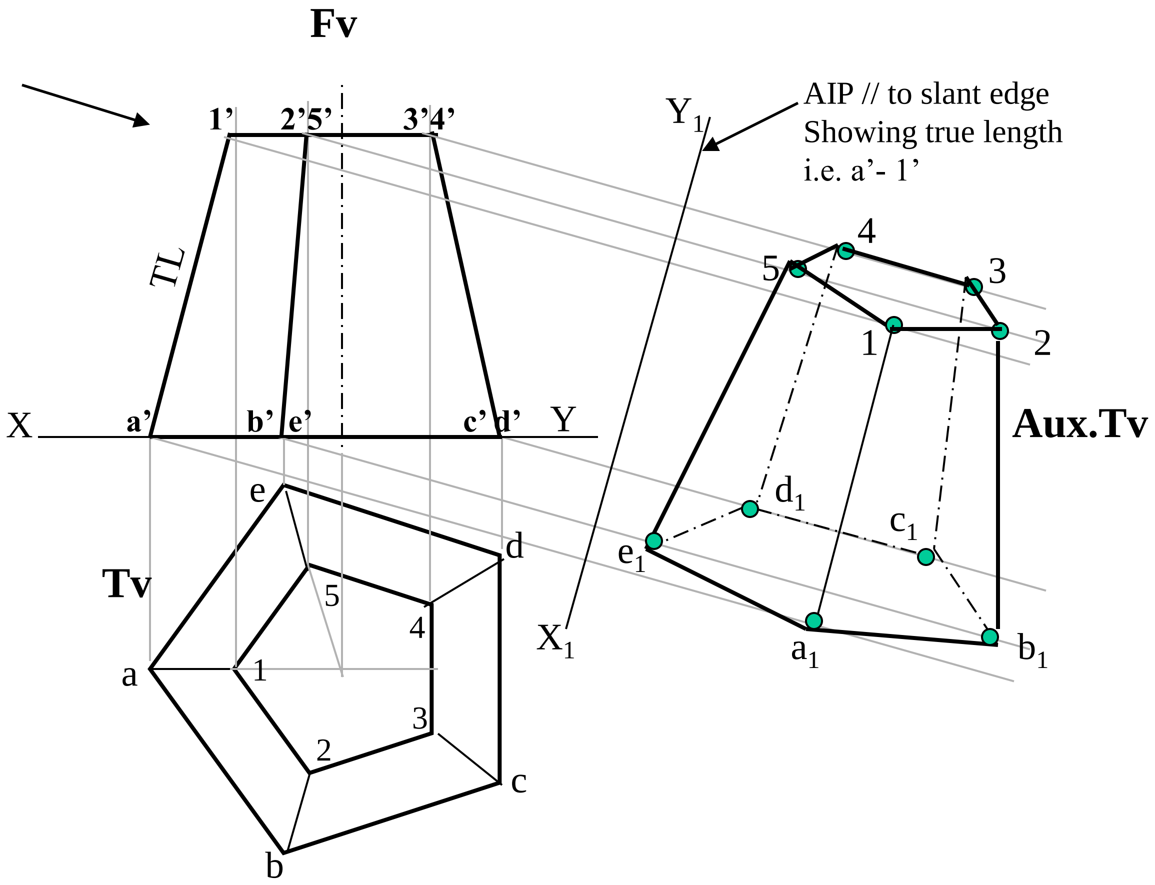


Problem 11: A hexagonal prism of base side 30 mm longand axis 40 mm long, is standing on Hp on it's base with one base edge // to Vp. A tetrahedron is placed centrally on the top of it.The base of tetrahedron is a triangle formed by joining alternate corners of top of prism..Draw projections of both solids. Project an auxiliary Tv on AIP 45^0 inclined to Hp.

STEPS:
Draw a regular hexagon as Tv of standing prism With one side // to xy and name the top points.Project it's Fv – a rectangle and name it's top.
Now join it's alternate corners a-c-e and the triangle formed is base of a tetrahedron as said.
Locate center of this triangle & locate apex o
Extending it's axis line upward mark apex o'
By cutting TL of edge of tetrahedron equal to a-c. and complete Fv of tetrahedron.
Draw an AIP (x1y1) 45^0 inclined to xy And project Aux.Tv on it by using similar Steps like previous problem.



Problem 12: A frustum of regular hexagonal pyrami is standing on it's larger base On Hp with one base side perpendicular to Vp.Draw it's Fv & Tv.
Project it's Aux.Tv on an AIP parallel to one of the slant edges showing TL.
Base side is 50 mm long , top side is 30 mm long and 50 mm is height of frustum.



DRAWINGS:

(A Graphical Representation)

The Fact about:

If compared with Verbal or Written Description,
Drawings offer far better idea about the Shape, Size & Appearance of any object or situation or location, that too in quite a less time.

Hence it has become the Best Media of Communication not only in Engineering but in almost all Fields.

Drawings
(Some Types)

- **Nature Drawings**
  (landscape, scenery etc.)
- **Geographical** Drawings
  (maps etc.)
- **Botanical Drawings**
  (plants, flowers etc.)
- **Zoological Drawings**
  (creatures, animals etc.)
- Portraits
  (human faces, expressions etc.)
- **Engineering Drawings,** ***(projections.)***
  - Building Related Drawings.
  - Machine component Drawings

Orthographic Projections
(Fv,Tv & Sv.-Mech.Engg terms)
(Plan, Elevation- Civil Engg.terms)
(Working Drawings 2-D type)

Isometric (Mech.Engg.Term.)
or Perspective(Civil Engg.Term)
(Actual Object Drawing 3-D)

ORTHOGRAPHIC PROJECTIONS:

IT IS A TECHNICAL DRAWING IN WHICH DIFFERENT VIEWS OF AN OBJECT ARE PROJECTED ON DIFFERENT REFERENCE PLANES OBSERVING PERPENDICULAR TO RESPECTIVE REFERENCE PLANE

Different Reference planes are

Horizontal Plane (HP),
Vertical Frontal Plane (VP)
Side Or Profile Plane (PP)

And

Different Views are Front View (FV), Top View (TV) and Side View (SV)

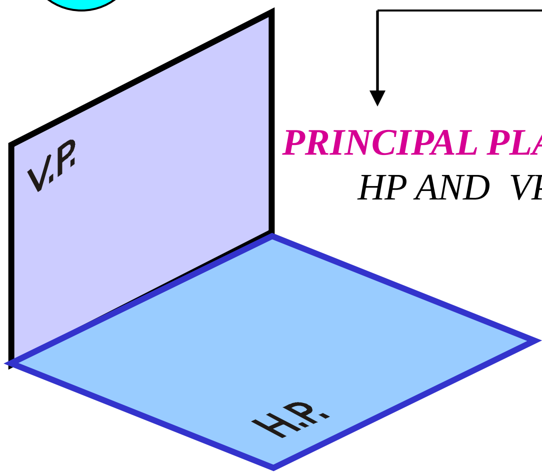
FV is a view projected on VP.
TV is a view projected on HP.
SV is a view projected on PP.

IMPORTANT TERMS OF ORTHOGRAPHIC PROJECTIONS:

1. **Planes.**
2. **Pattern of planes & Pattern of views**
3. **Methods of drawing Orthographic Projections**

1

PLANES

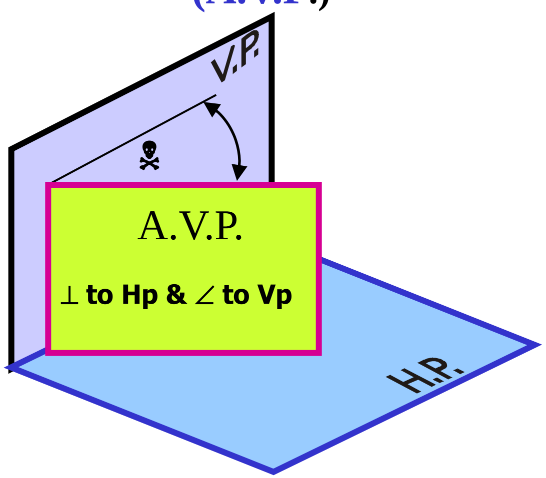


PRINCIPAL PLANES

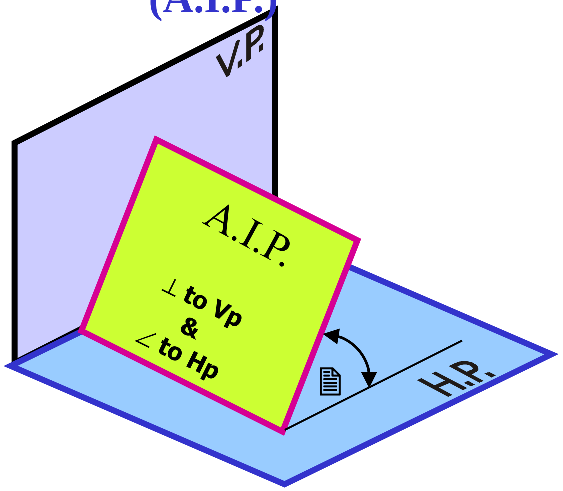
HP AND VP

AUXILIARY PLANES

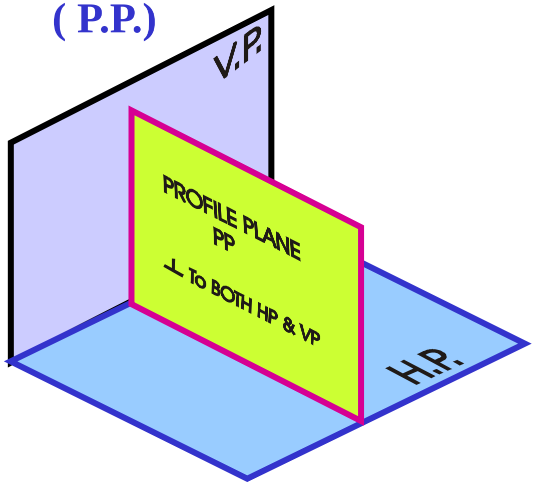
Auxiliary Vertical Plane (A.V.P.)



Auxiliary Inclined Plane (A.I.P.)

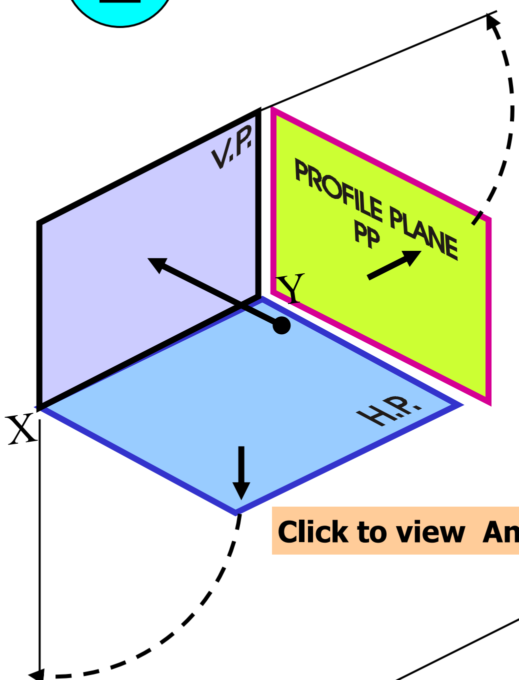


Profile Plane (P.P.)



2

PATTERN OF PLANES & VIEWS (First Angle Method)



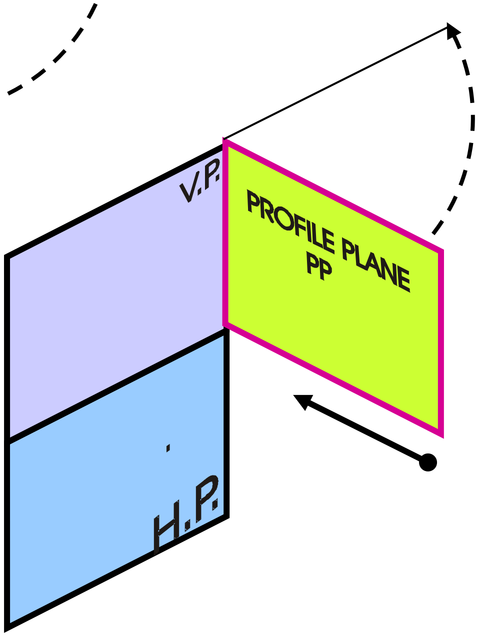
THIS IS A PICTORIAL SET-UP OF ALL THREE PLANES.
ARROW DIRECTION IS A NORMAL WAY OF OBSERVING THE OBJECT.
BUT IN THIS DIRECTION ONLY VP AND A VIEW ON IT (FV) CAN BE SEEN.
THE OTHER PLANES AND VIEWS ON THOSE CAN NOT BE SEEN.

PROCEDURE TO SOLVE ABOVE PROBLEM:-

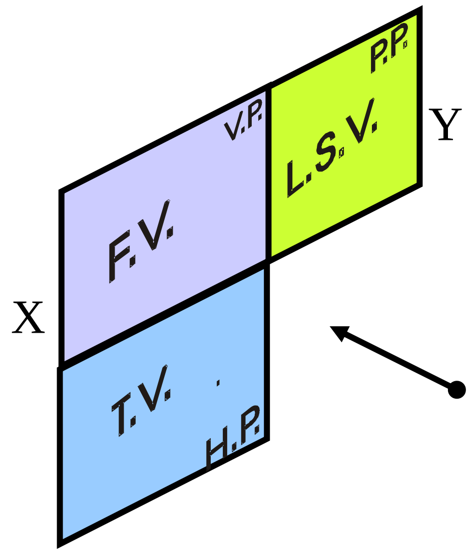
TO MAKE THOSE PLANES ALSO VISIBLE FROM THE ARROW DIRECTION,
A) HP IS ROTATED 90^0 DOUNWARD
B) PP, 90^0 IN RIGHT SIDE DIRECTION.
THIS WAY BOTH PLANES ARE BROUGHT IN THE SAME PLANE CONTAINING VP.

Click to view Animation

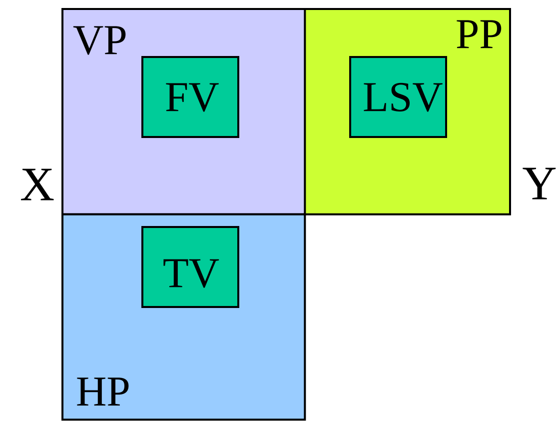
On clicking the button if a warning comes please click YES to continue, this program is safe for your pc.



HP IS ROTATED DOWNWARD 90^0
AND
BROUGHT IN THE PLANE OF VP.



PP IS ROTATED IN RIGHT SIDE 90^0
AND
BROUGHT IN THE PLANE OF VP.



ACTUAL PATTERN OF PLANES & VIEWS
OF ORTHOGRAPHIC PROJECTIONS
DRAWN IN
FIRST ANGLE METHOD OF PROJECTIONS

3

Methods of Drawing Orthographic Projections

First Angle Projections Method

Here views are drawn
by placing object
in 1st Quadrant

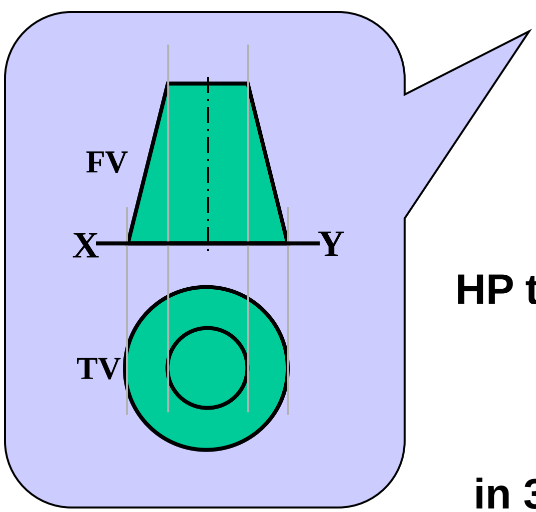
(Fv above X-y, Tv below X-y)

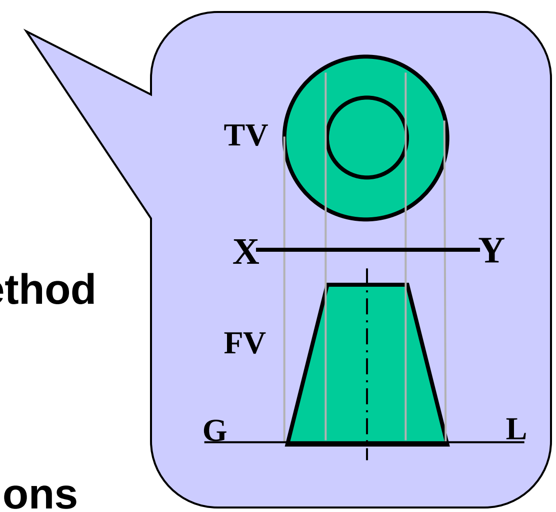
Third Angle Projections Method

Here views are drawn
by placing object
in 3rd Quadrant.

(Tv above X-y, Fv below X-y)

SYMBOLIC PRESENTATION OF BOTH METHODS WITH AN OBJECT STANDING ON HP (GROUND) ON IT'S BASE.



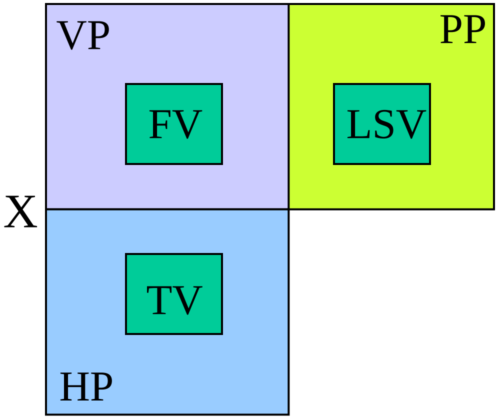


NOTE:-
HP term is used in 1st Angle method
&
For the same
Ground term is used
in 3rd Angle method of projections

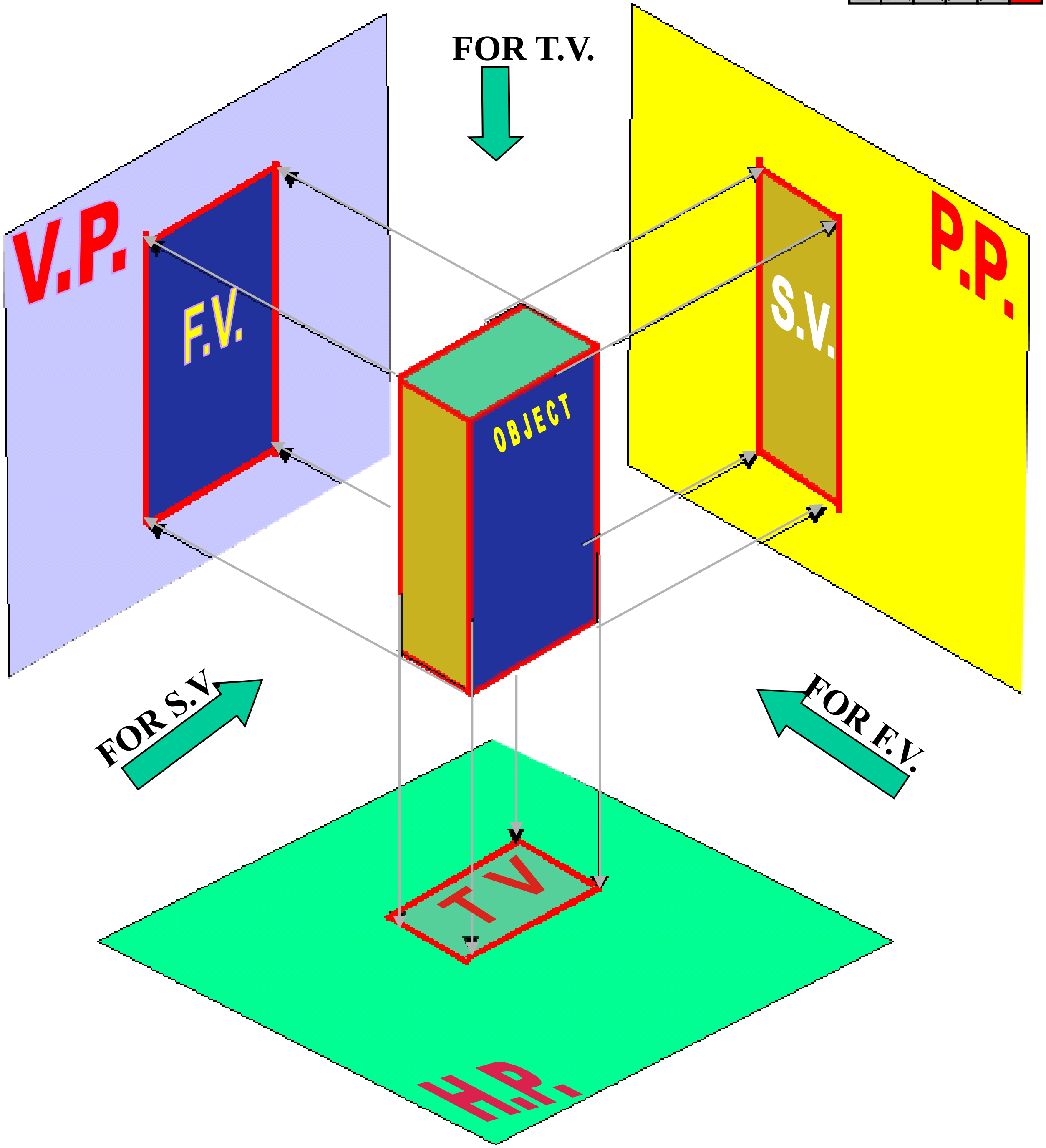
FIRST ANGLE PROJECTION

IN THIS METHOD,
THE OBJECT IS ASSUMED TO BE SITUATED IN FIRST QUADRANT
MEANS
ABOVE HP & INFRONT OF VP.

OBJECT IS INBETWEEN OBSERVER & PLANE.



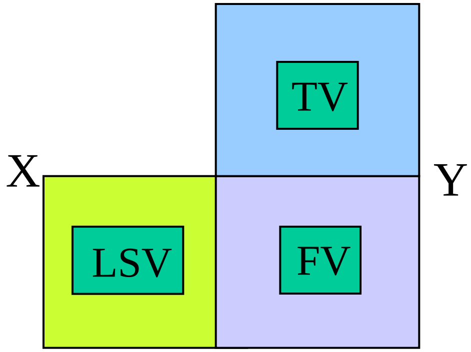
ACTUAL PATTERN OF PLANES & VIEWS IN FIRST ANGLE METHOD OF PROJECTIONS



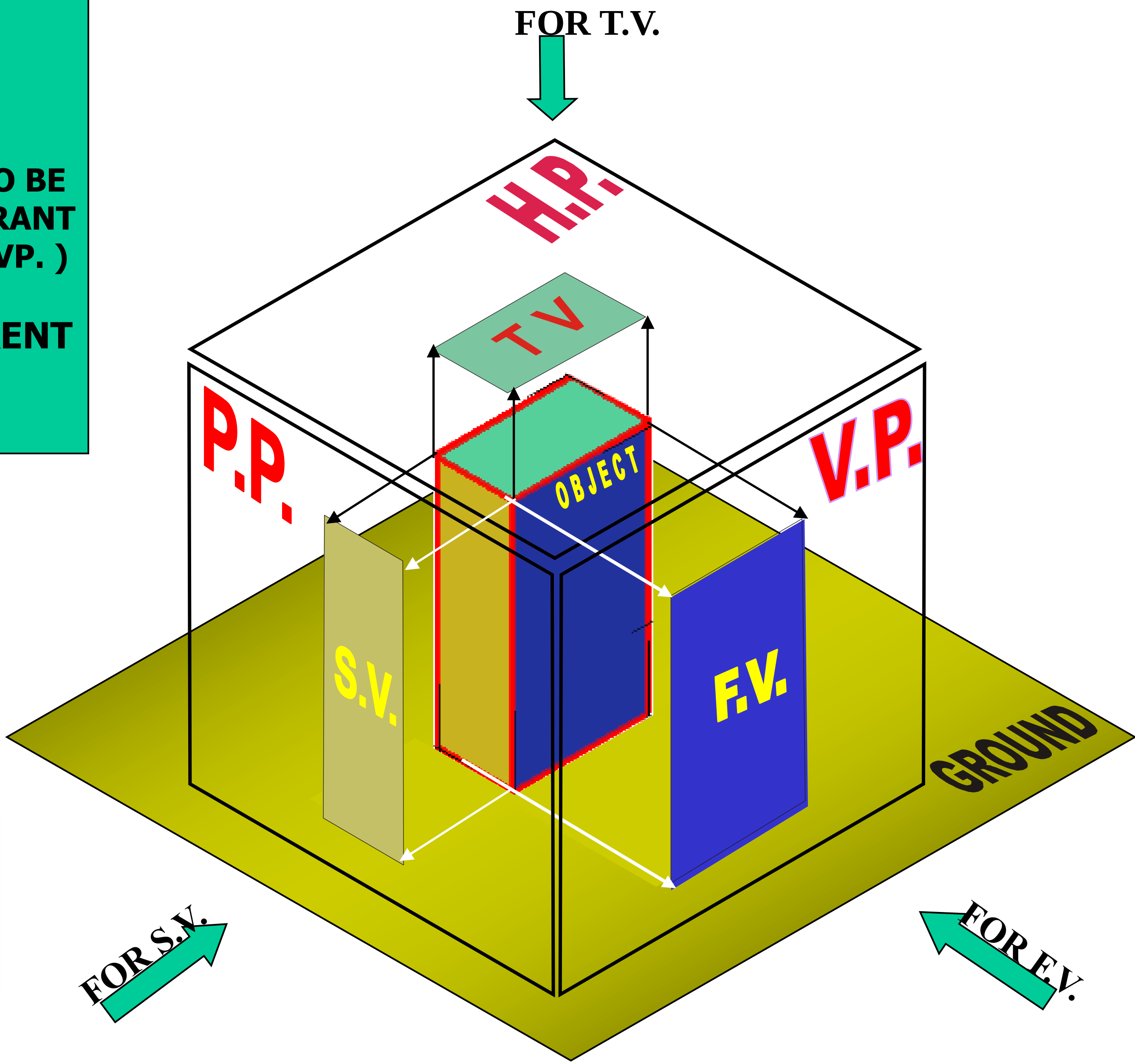
THIRD ANGLE PROJECTION

IN THIS METHOD,
THE OBJECT IS ASSUMED TO BE SITUATED IN THIRD QUADRANT (BELOW HP & BEHIND OF VP.)

PLANES BEING TRANSPERENT AND INBETWEEN OBSERVER & OBJECT.



ACTUAL PATTERN OF PLANES & VIEWS OF THIRD ANGLE PROJECTIONS



ORTHOGRAPHIC PROJECTIONS
{ MACHINE ELEMENTS }

OBJECT IS OBSERVED IN THREE DIRECTIONS.
THE DIRECTIONS SHOULD BE NORMAL
TO THE RESPECTIVE PLANES.
AND NOW PROJECT THREE DIFFERENT VIEWS ON THOSE PLANES.
THESE VEWS ARE FRONT VIEW , TOP VIEW AND SIDE VIEW.

FRONT VIEW IS A VIEW PROJECTED ON VERTICAL PLANE (VP)
TOP VIEW IS A VIEW PROJECTED ON HORIZONTAL PLANE (HP)
SIDE VIEW IS A VIEW PROJECTED ON PROFILE PLANE (PP)

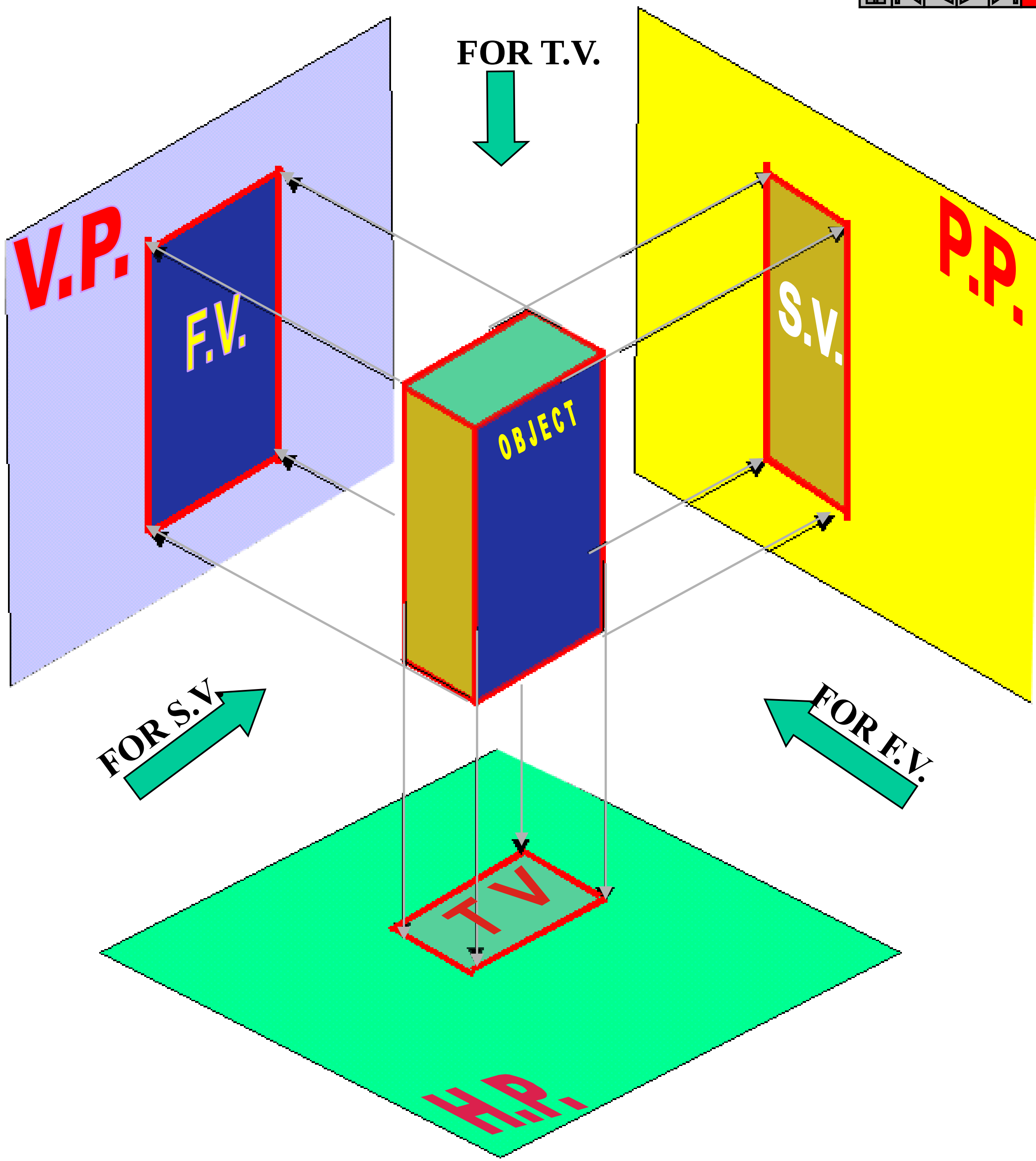
FIRST STUDY THE CONCEPT OF 1ST AND 3RD ANGLE PROJECTION METHODS

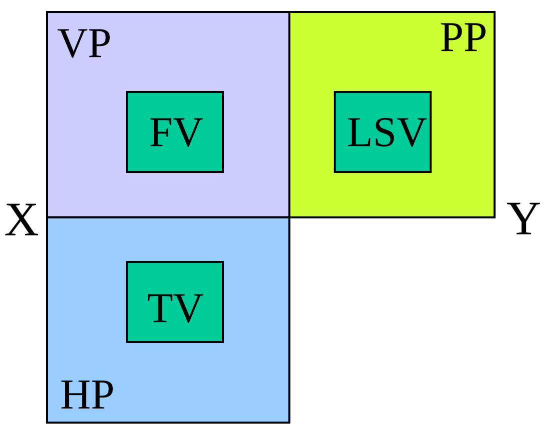
AND THEN STUDY NEXT 26 ILLUSTRATED CASES CAREFULLY.
TRY TO RECOGNIZE SURFACES
PERPENDICULAR TO THE ARROW DIRECTIONS

FIRST ANGLE PROJECTION

IN THIS METHOD,
THE OBJECT IS ASSUMED TO BE SITUATED IN FIRST QUADRANT MEANS ABOVE HP & INFRONT OF VP.

OBJECT IS INBETWEEN OBSERVER & PLANE.



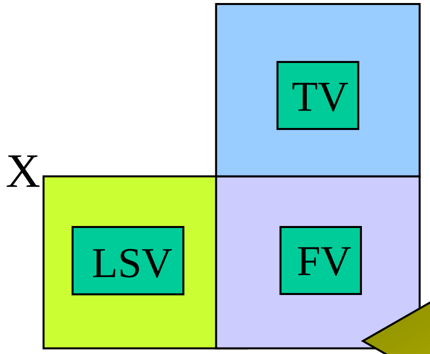


ACTUAL PATTERN OF PLANES & VIEWS IN FIRST ANGLE METHOD OF PROJECTIONS

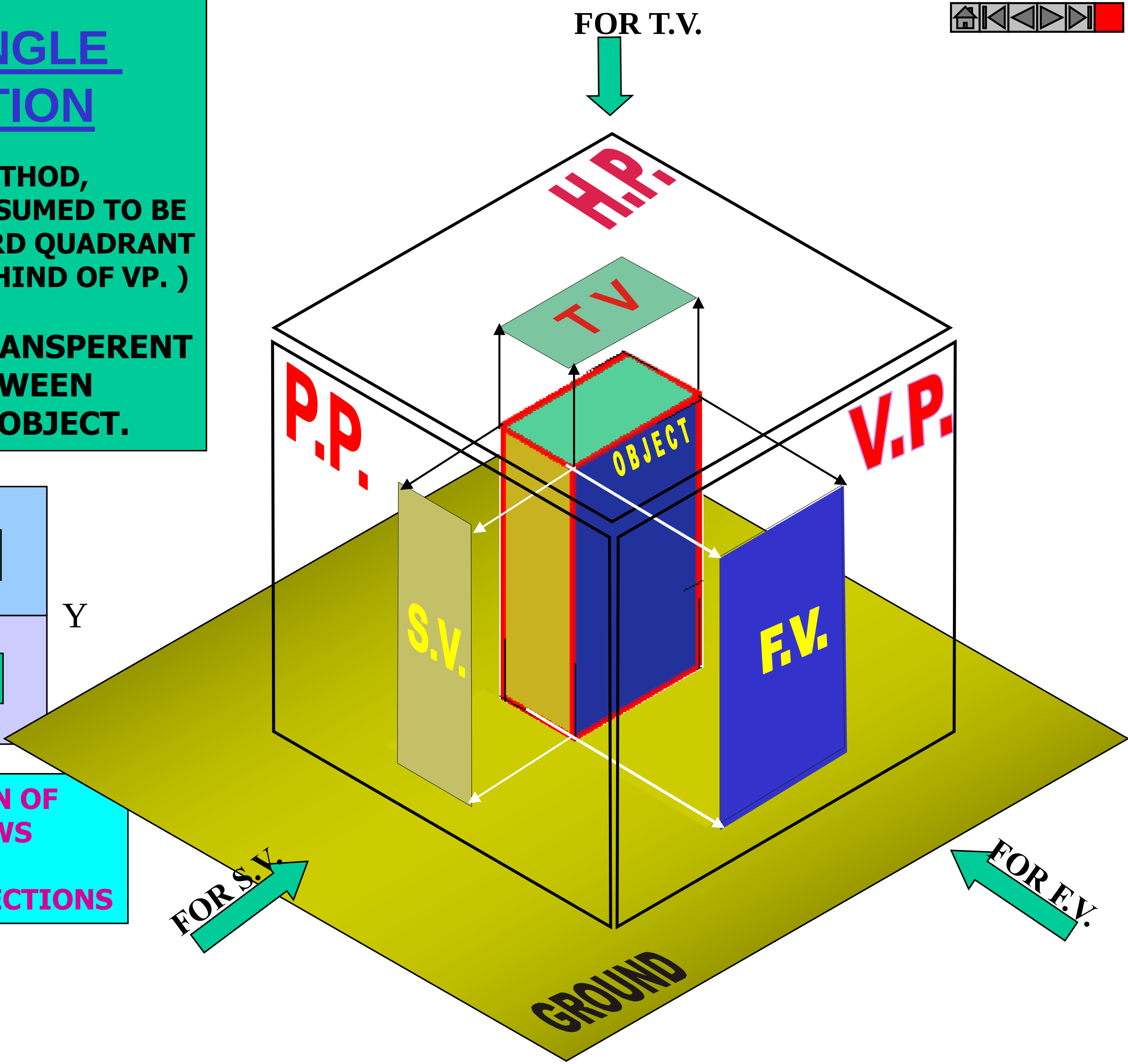
THIRD ANGLE PROJECTION

**IN THIS METHOD,
THE OBJECT IS ASSUMED TO BE SITUATED IN THIRD QUADRANT
(BELOW HP & BEHIND OF VP.)**

PLANES BEING TRANSPERENT AND INBETWEEN OBSERVER & OBJECT.



ACTUAL PATTERN OF PLANES & VIEWS OF THIRD ANGLE PROJECTIONS



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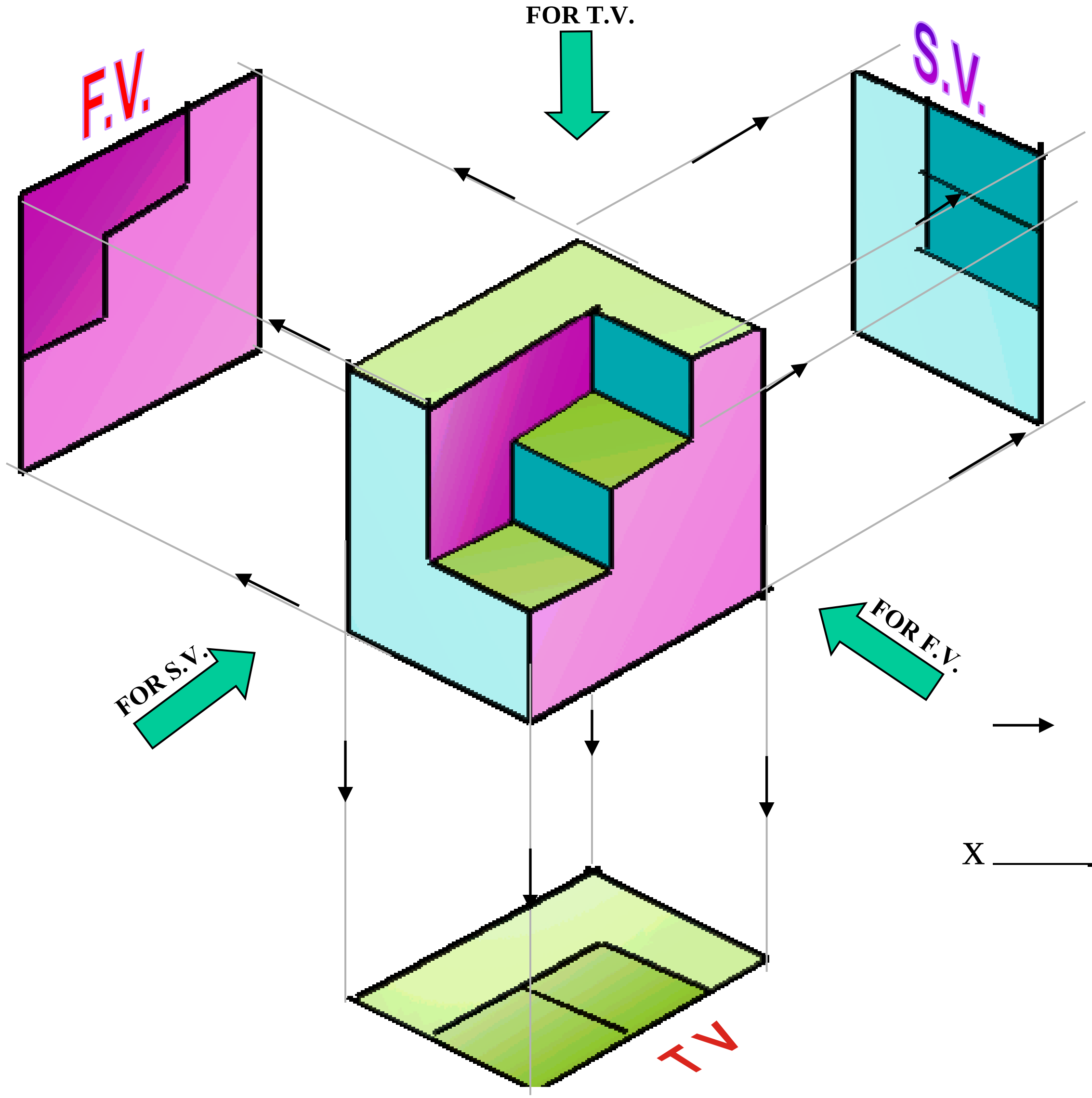
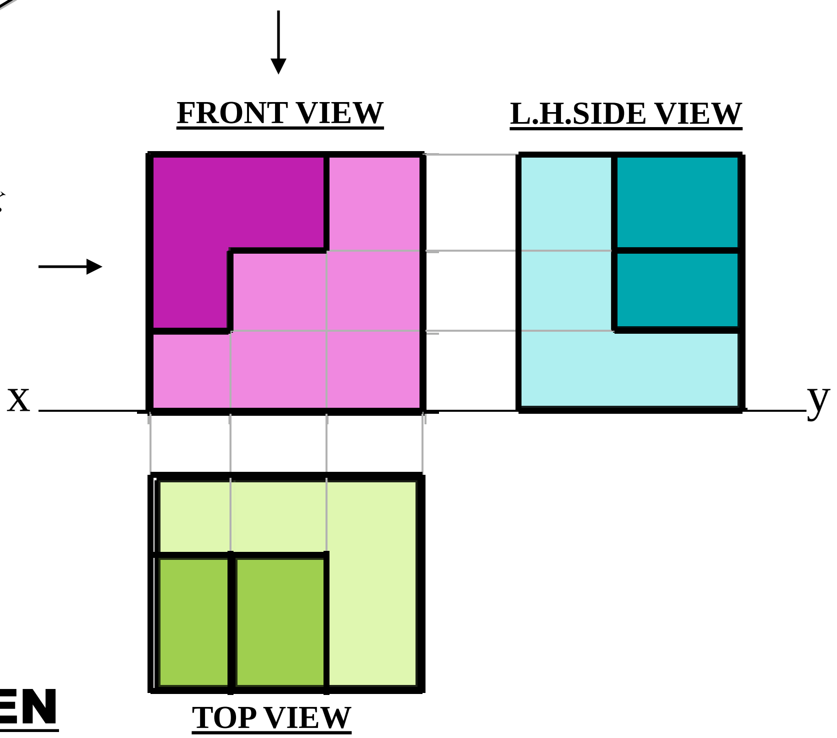
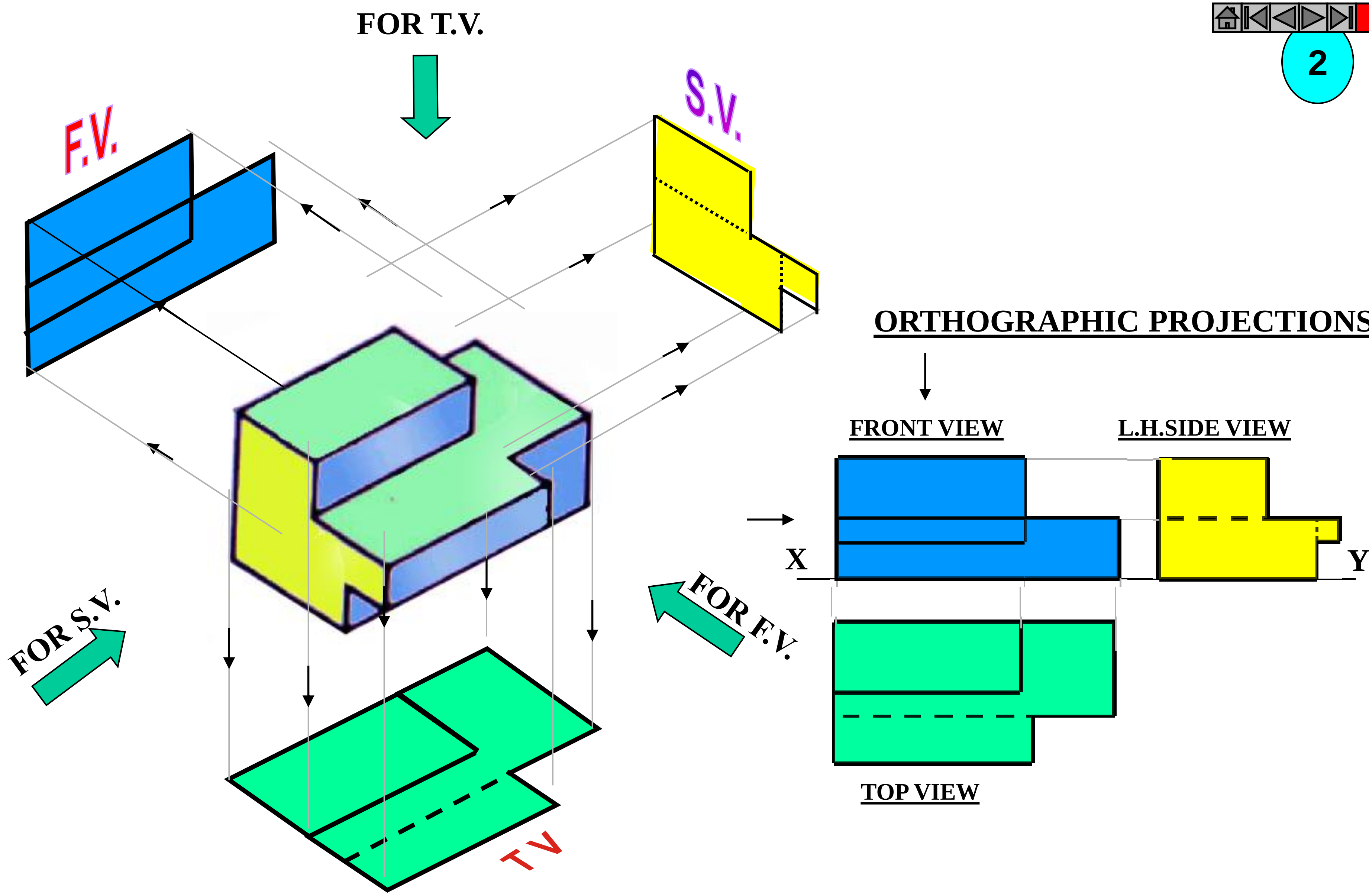


ORTHOGRAPHIC PROJECTIONS



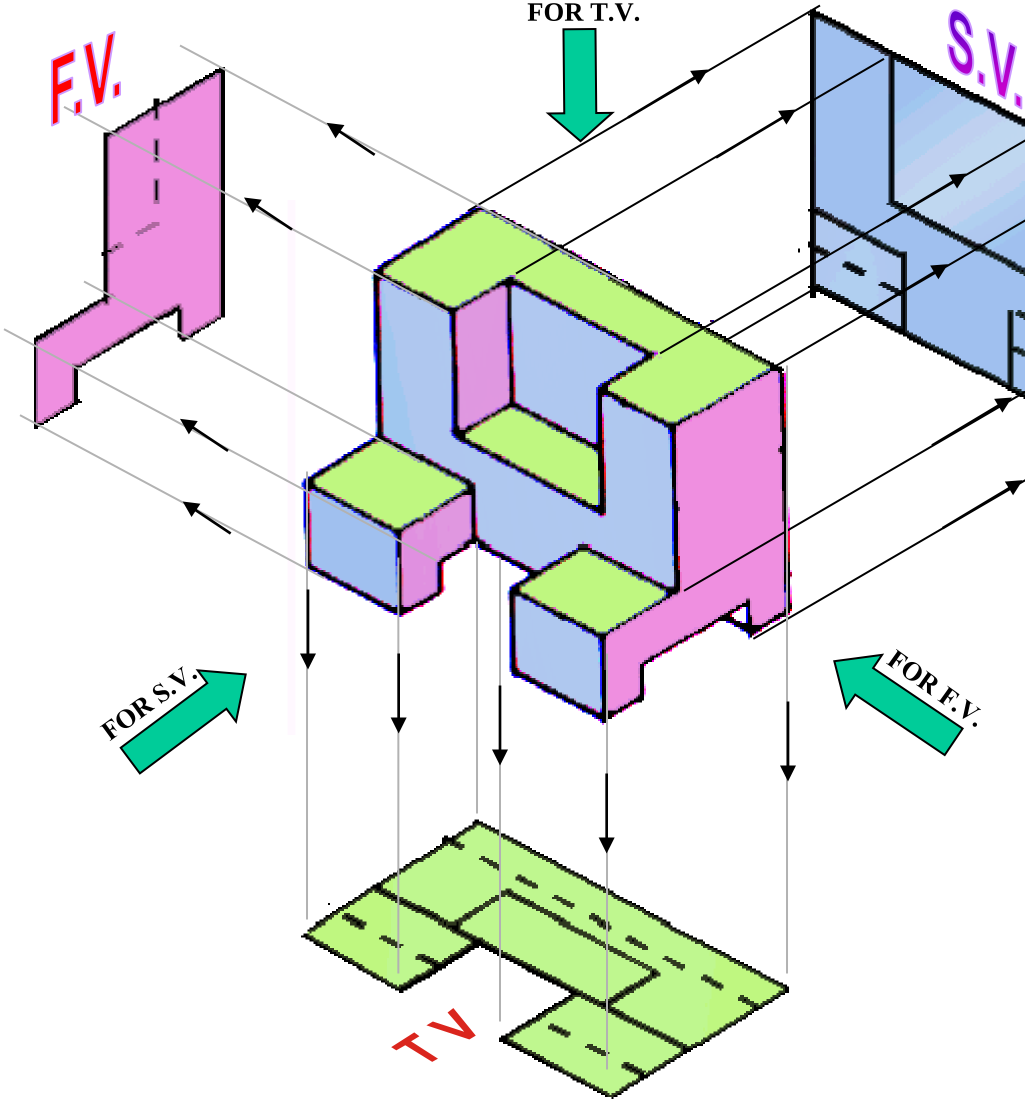
PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

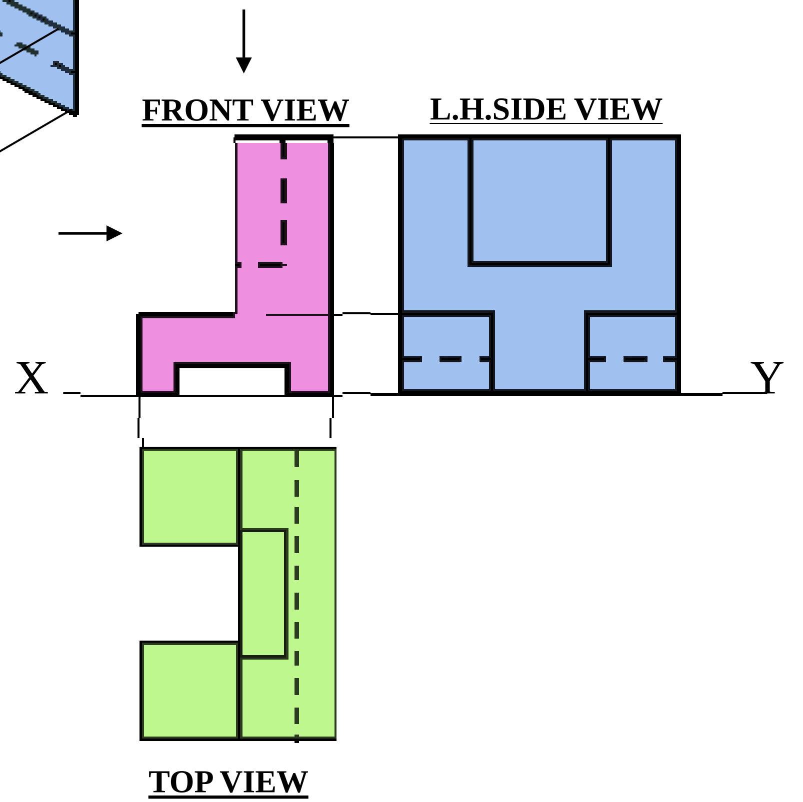


PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD



ORTHOGRAPHIC PROJECTIONS



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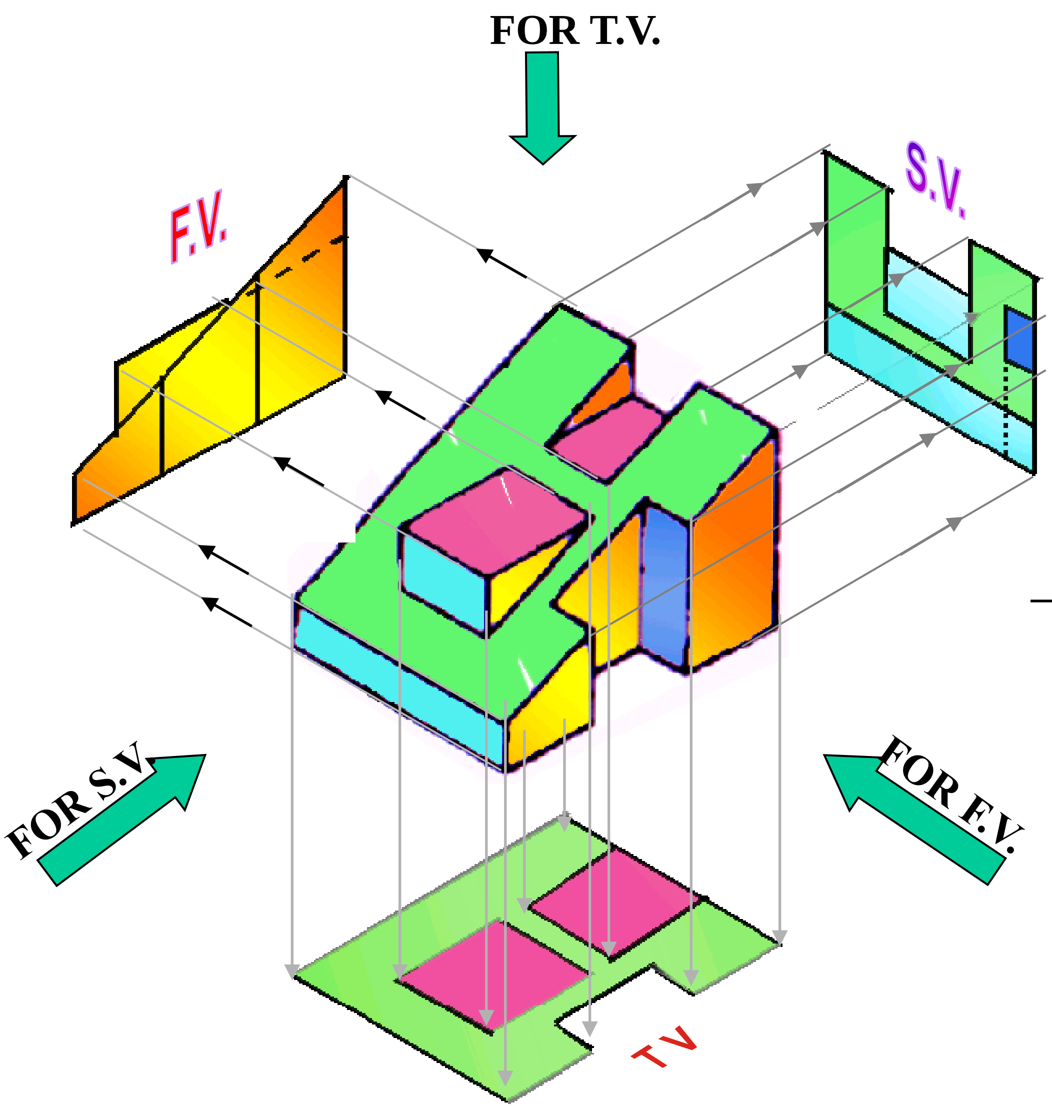

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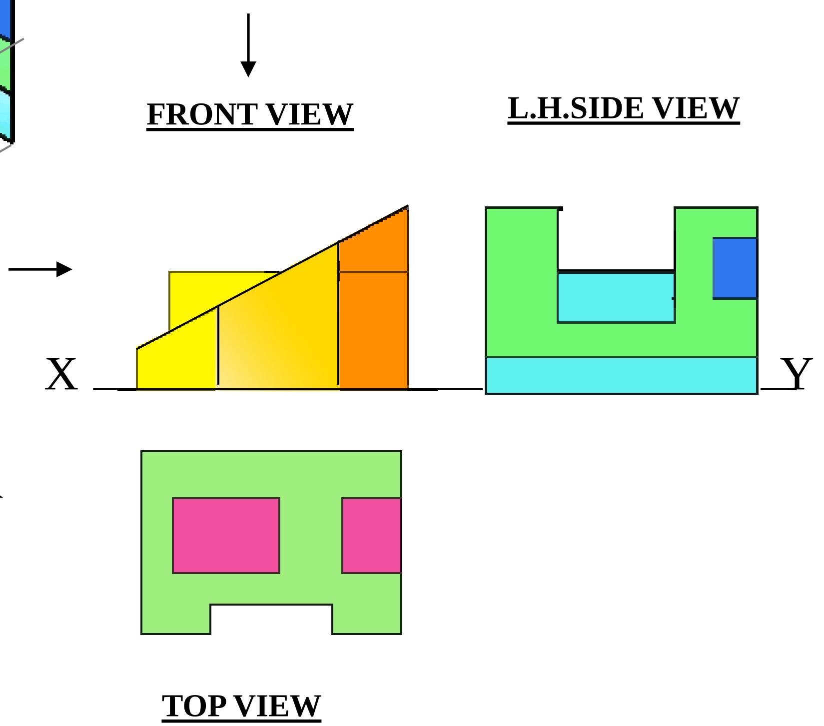

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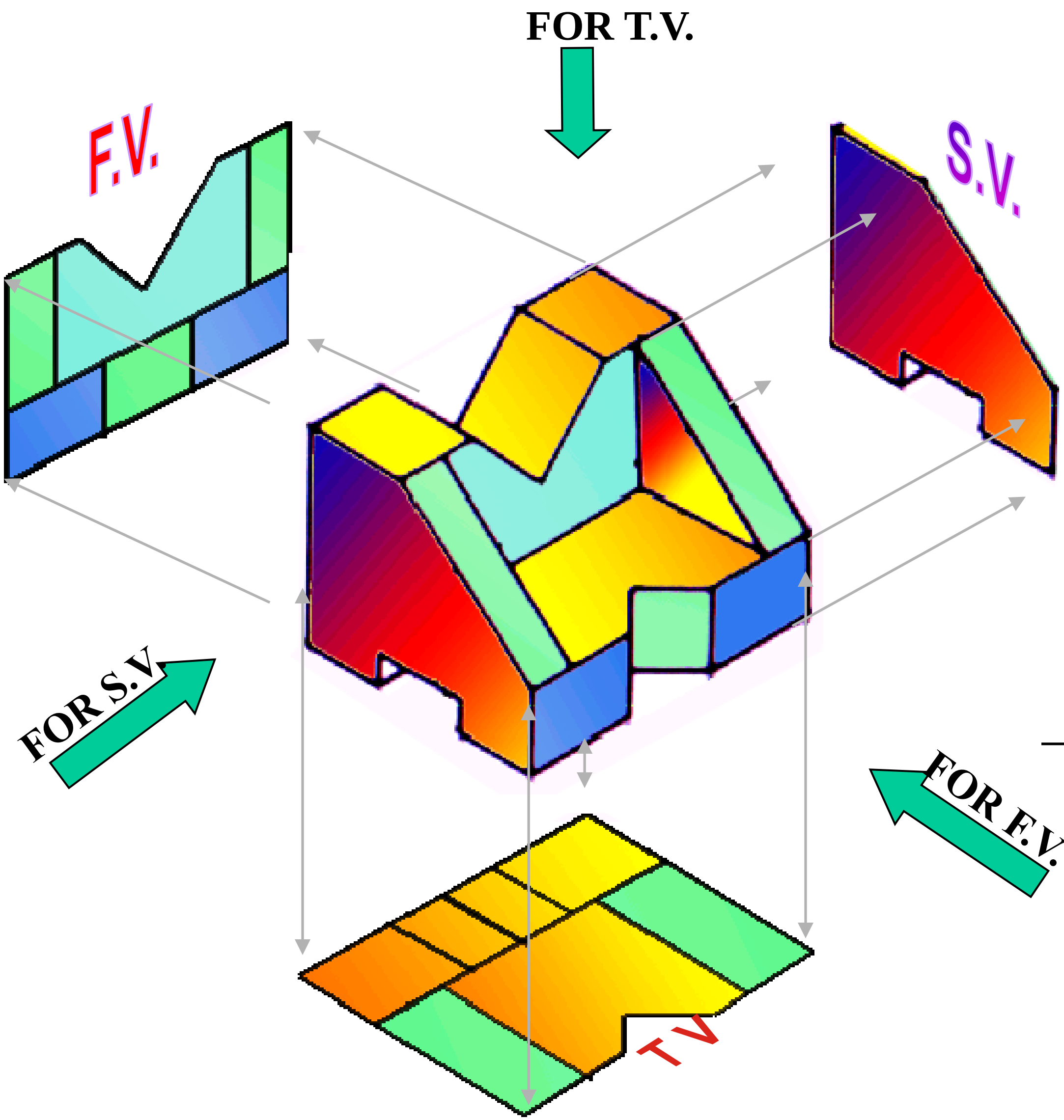

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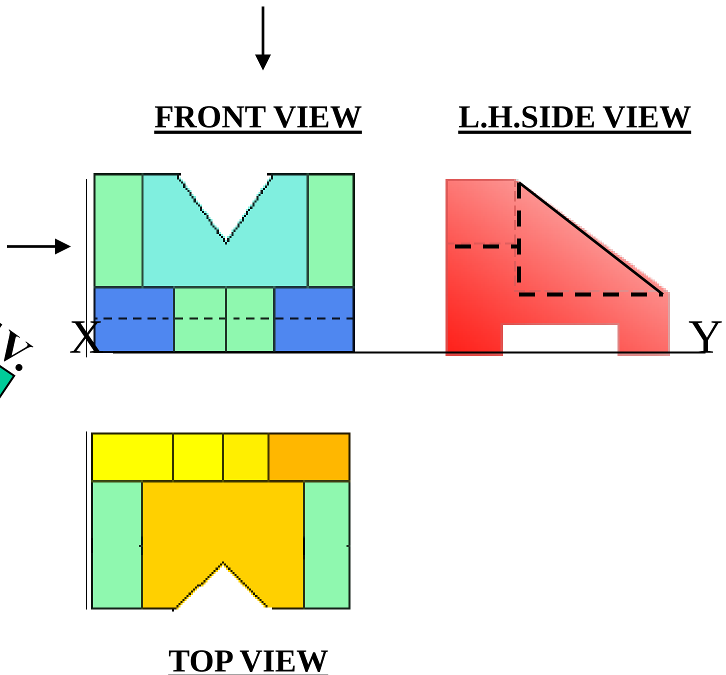

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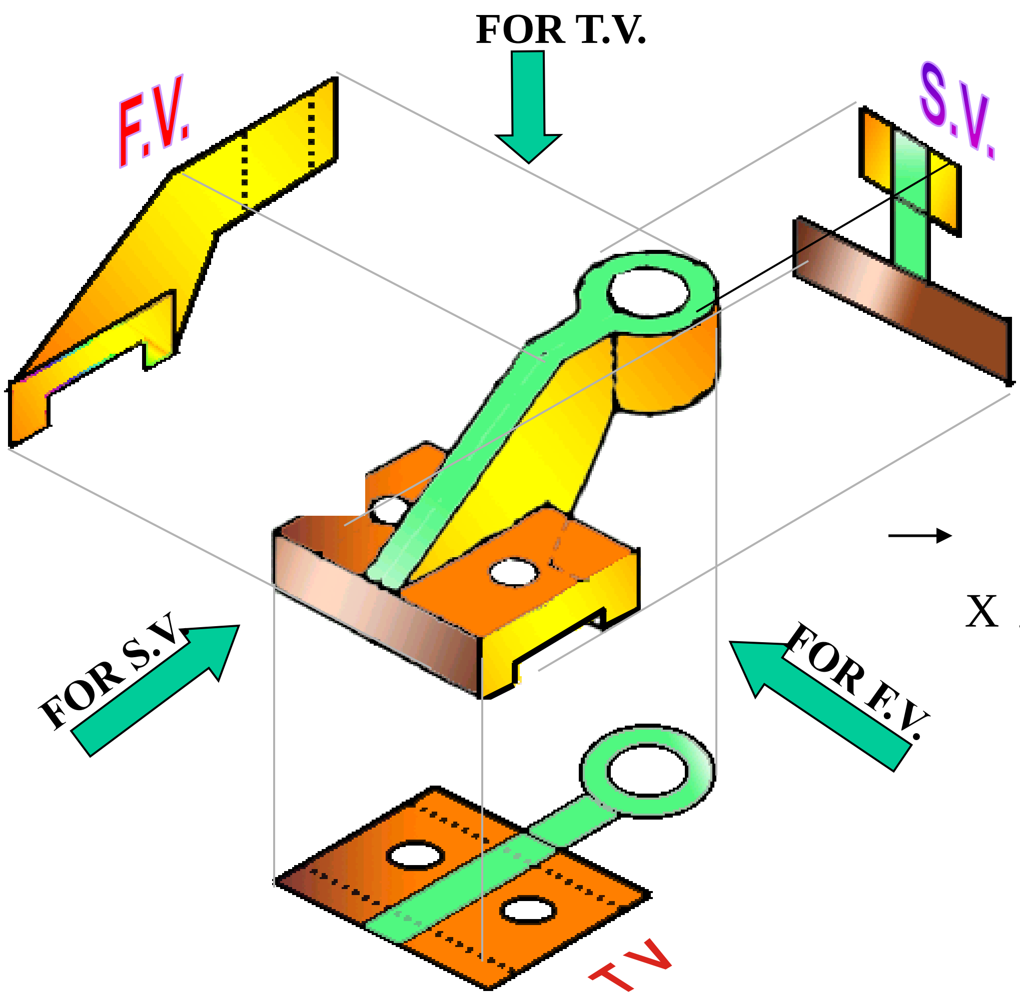

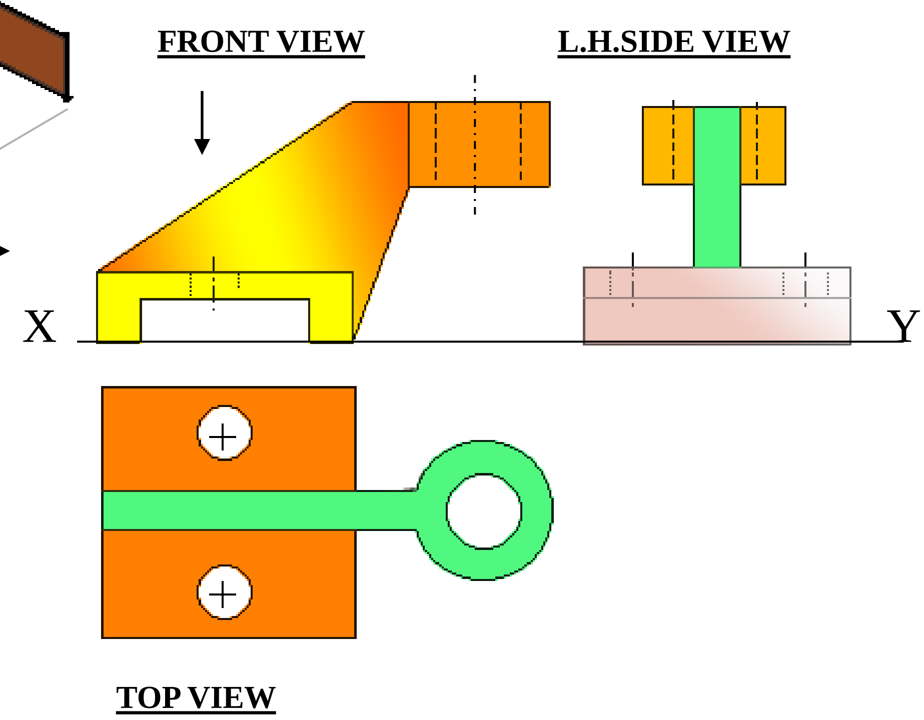

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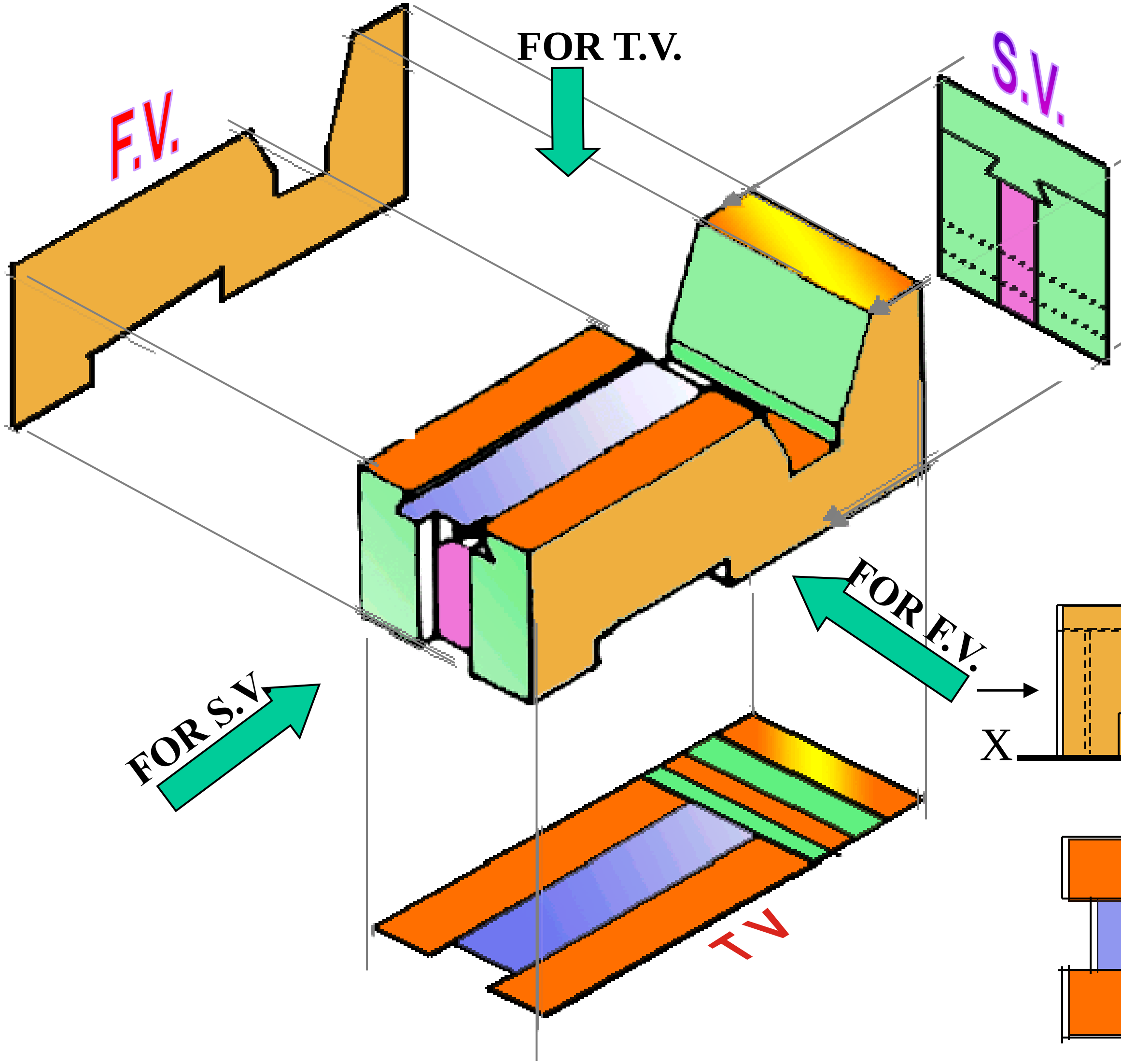

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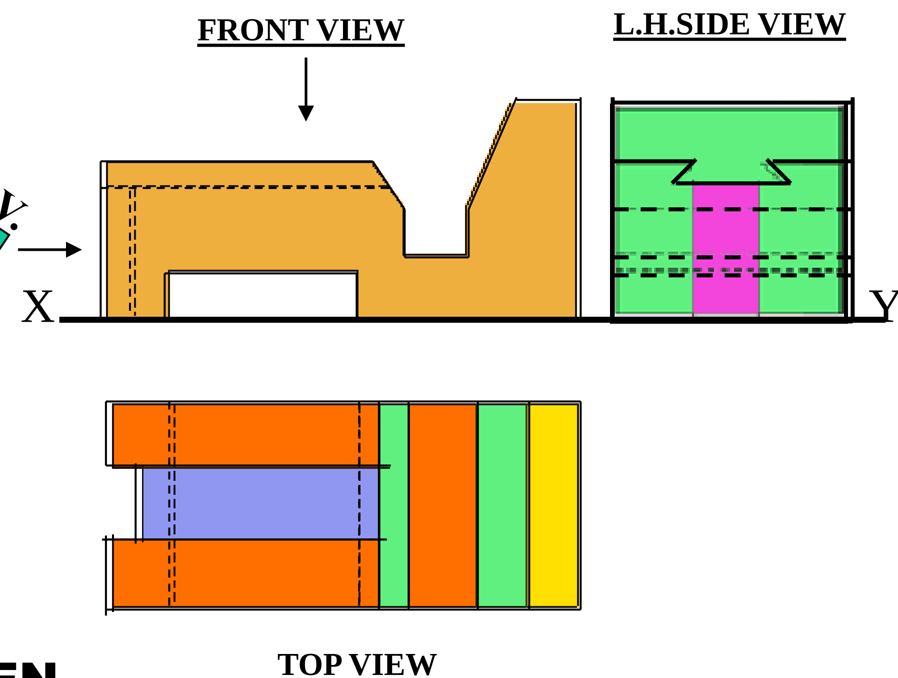
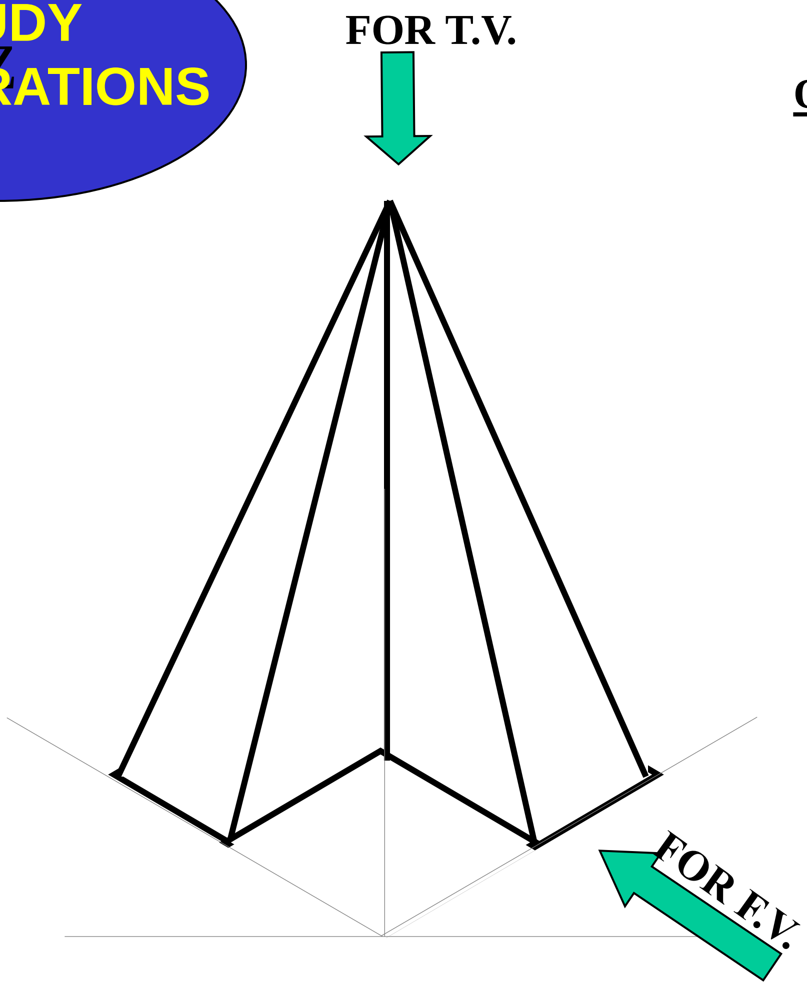


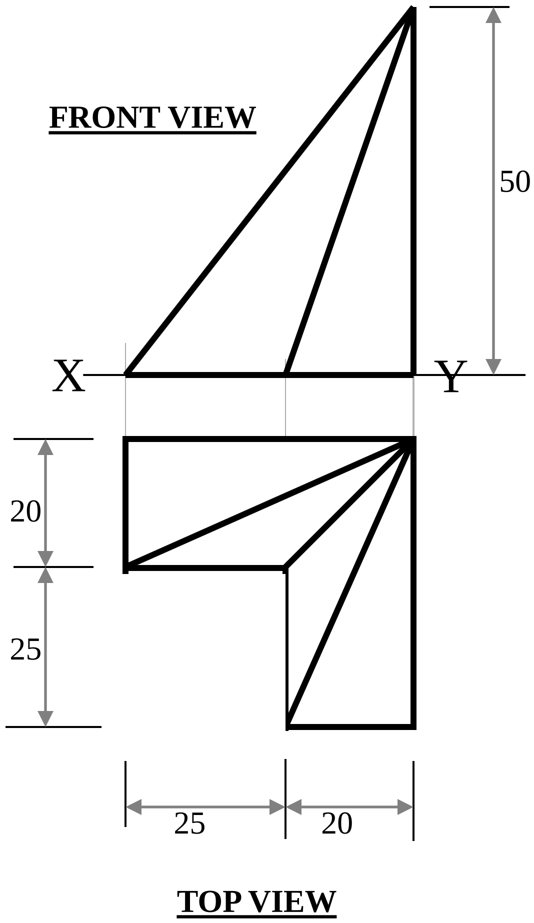
PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

STUDY ILLUSTRATIONS

ORTHOGRAPHIC PROJECTIONS





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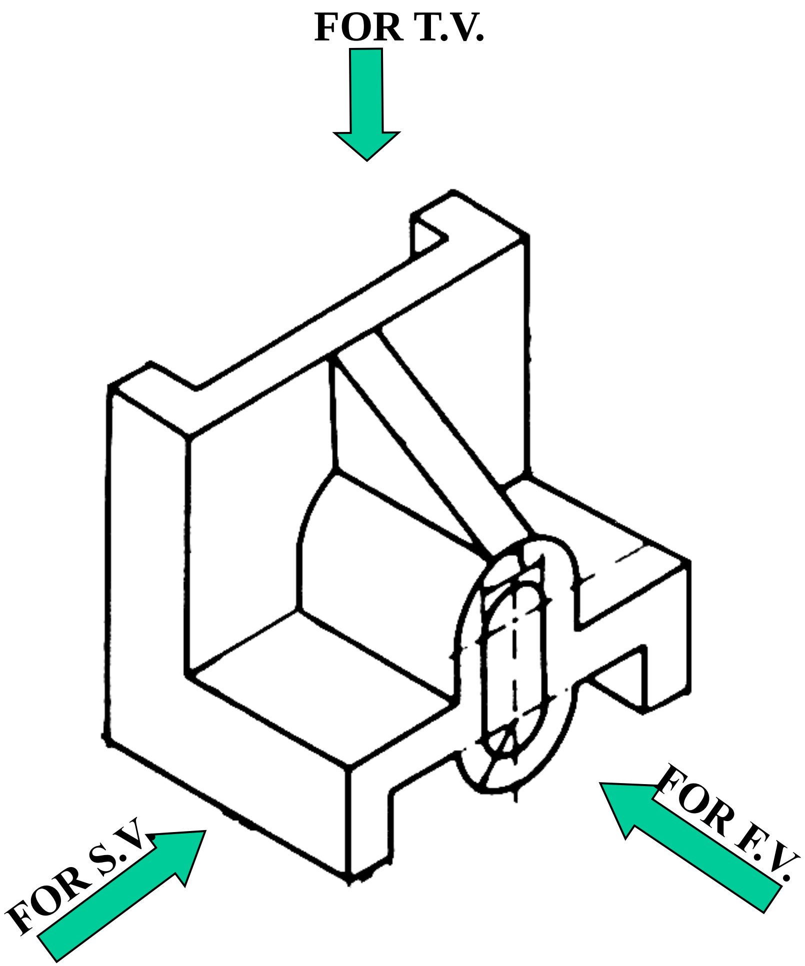

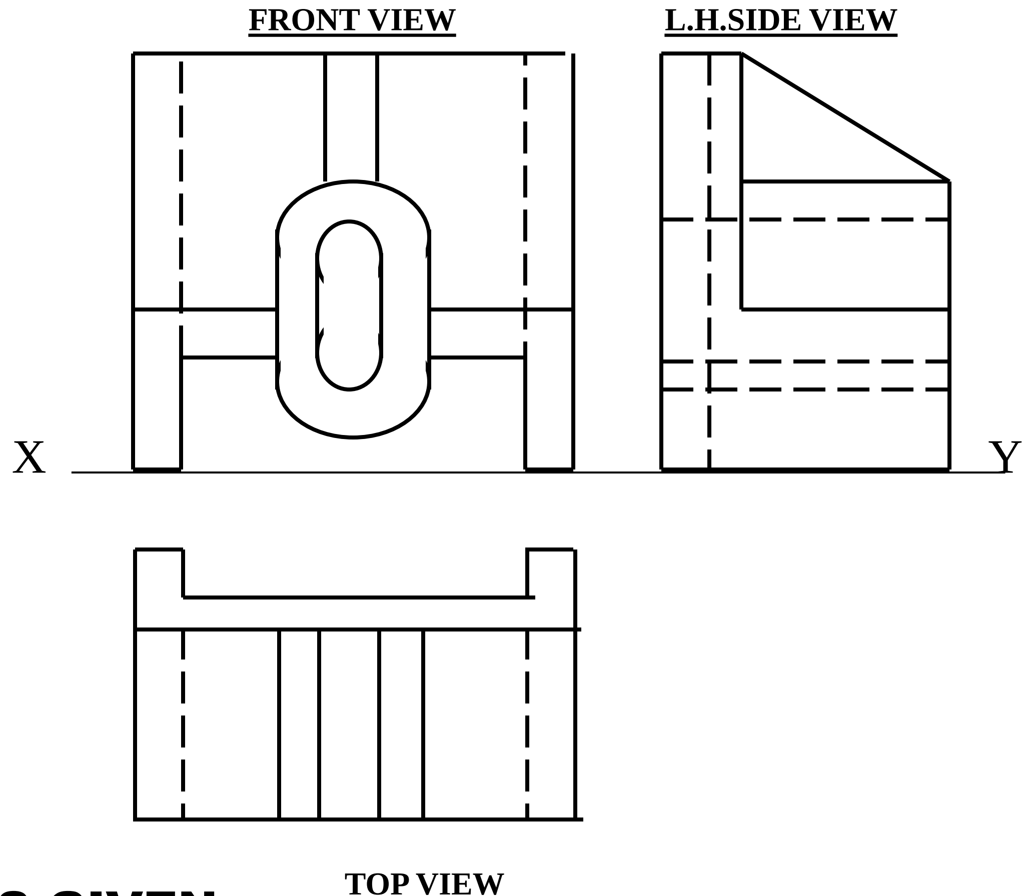

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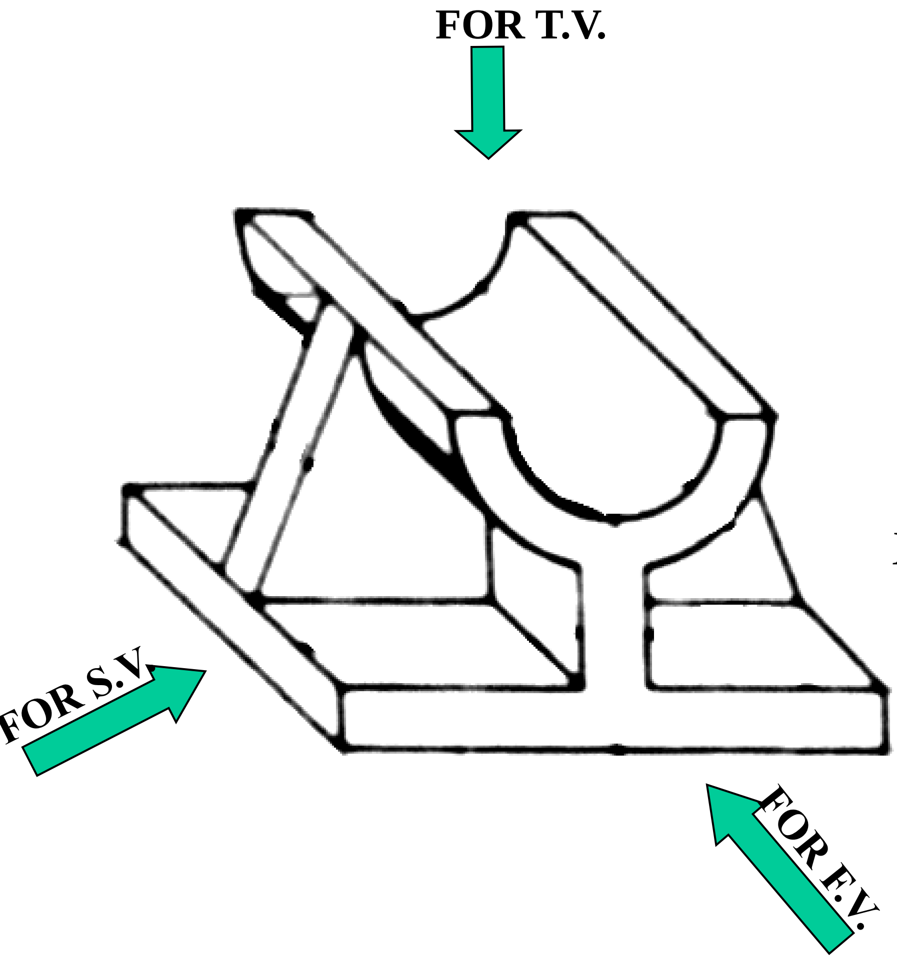

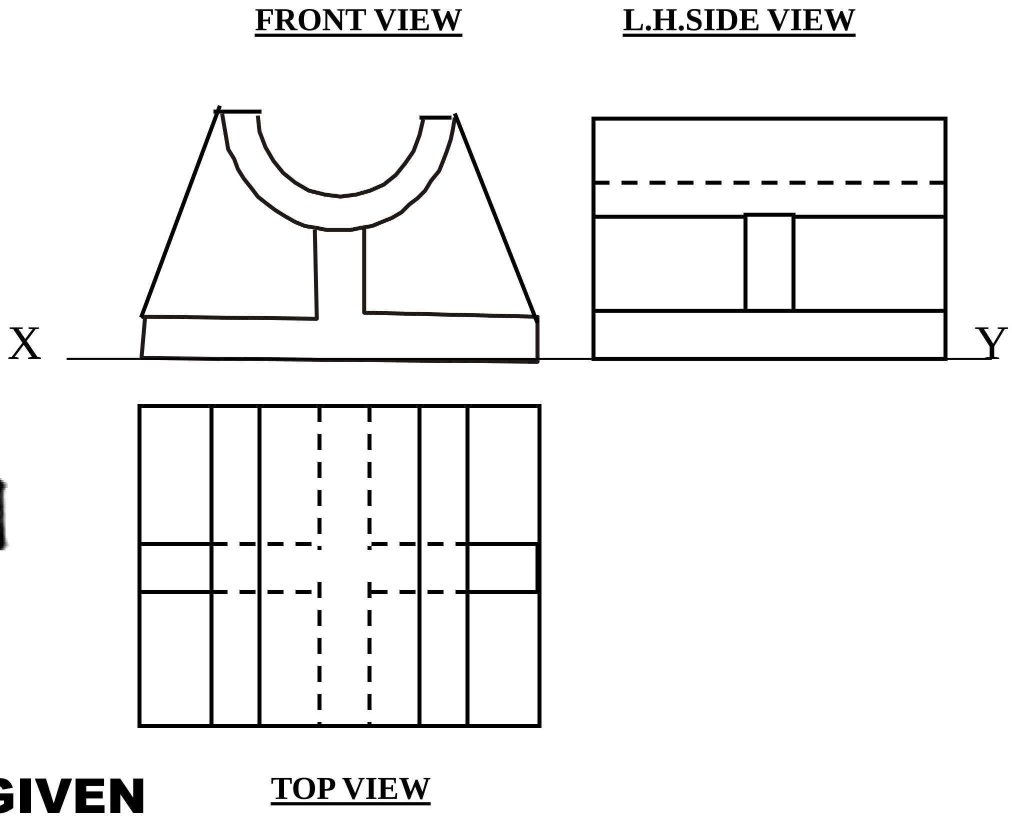

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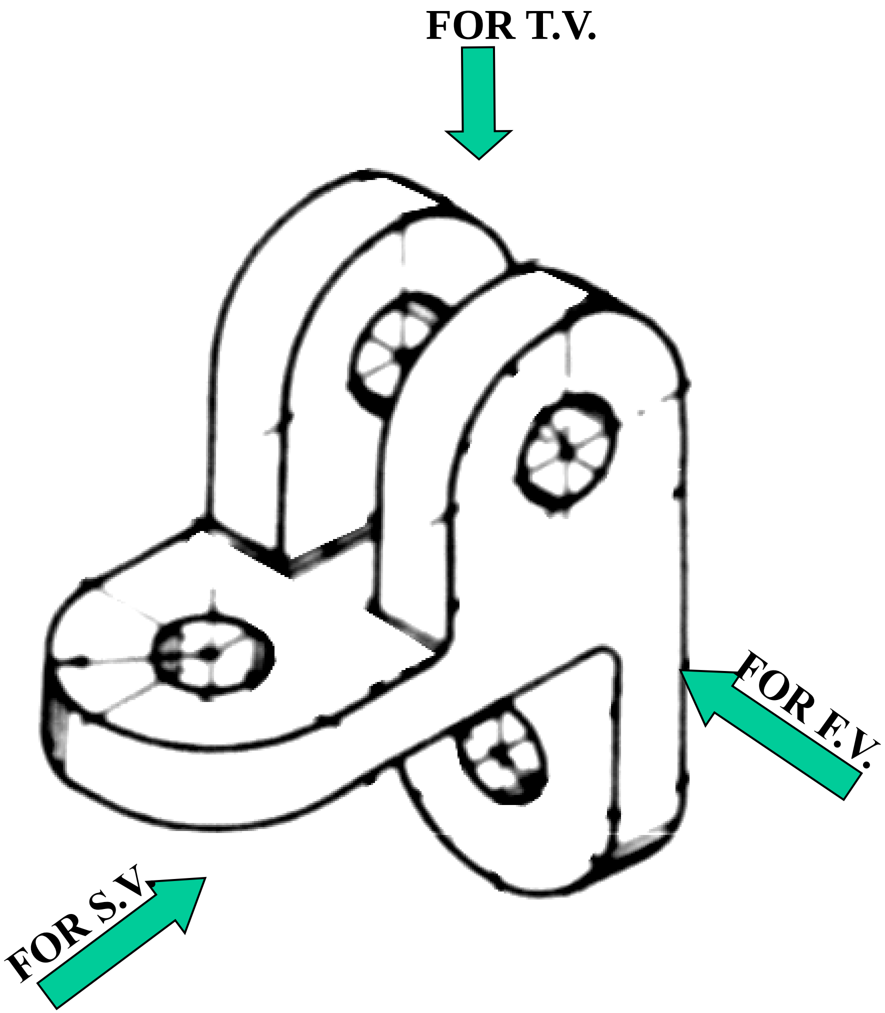

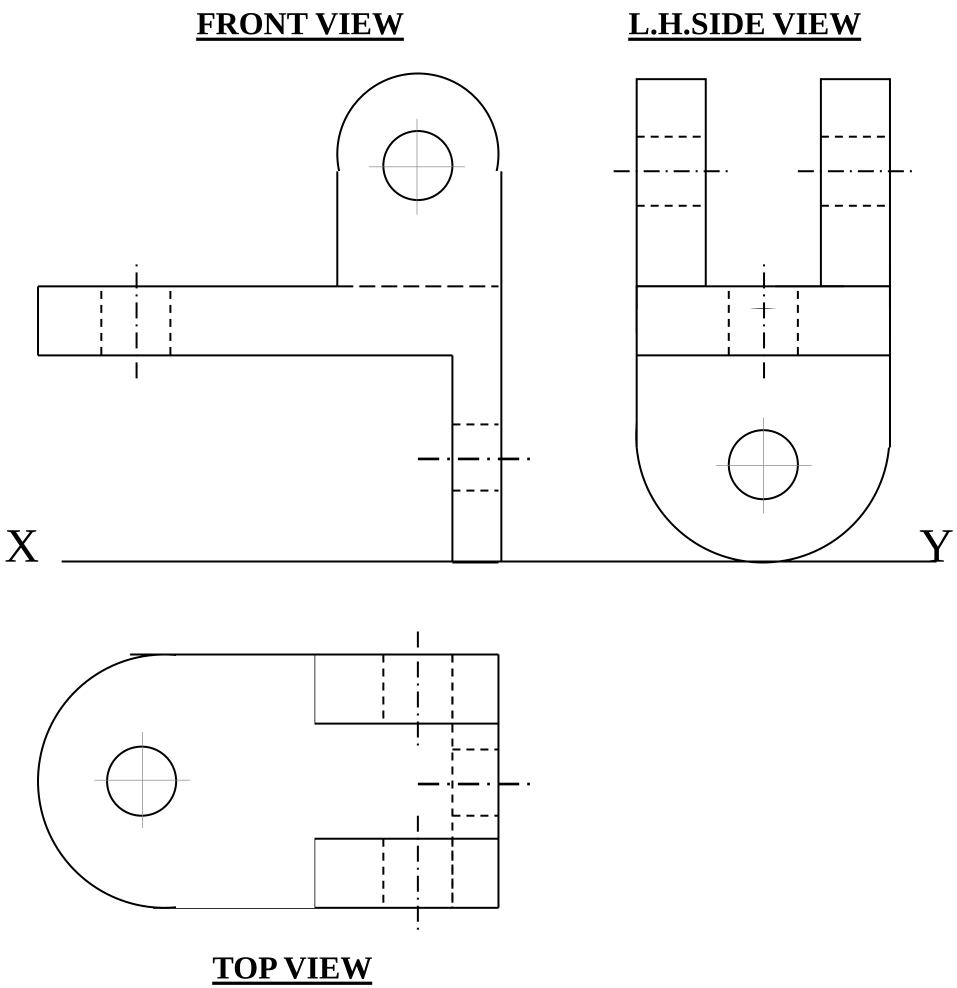

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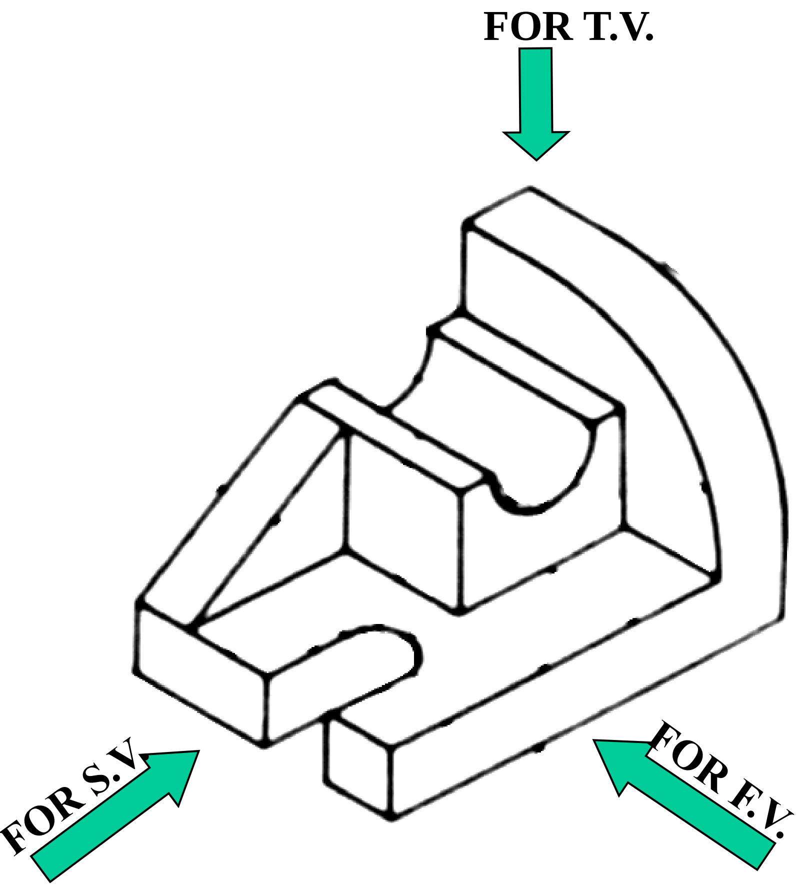
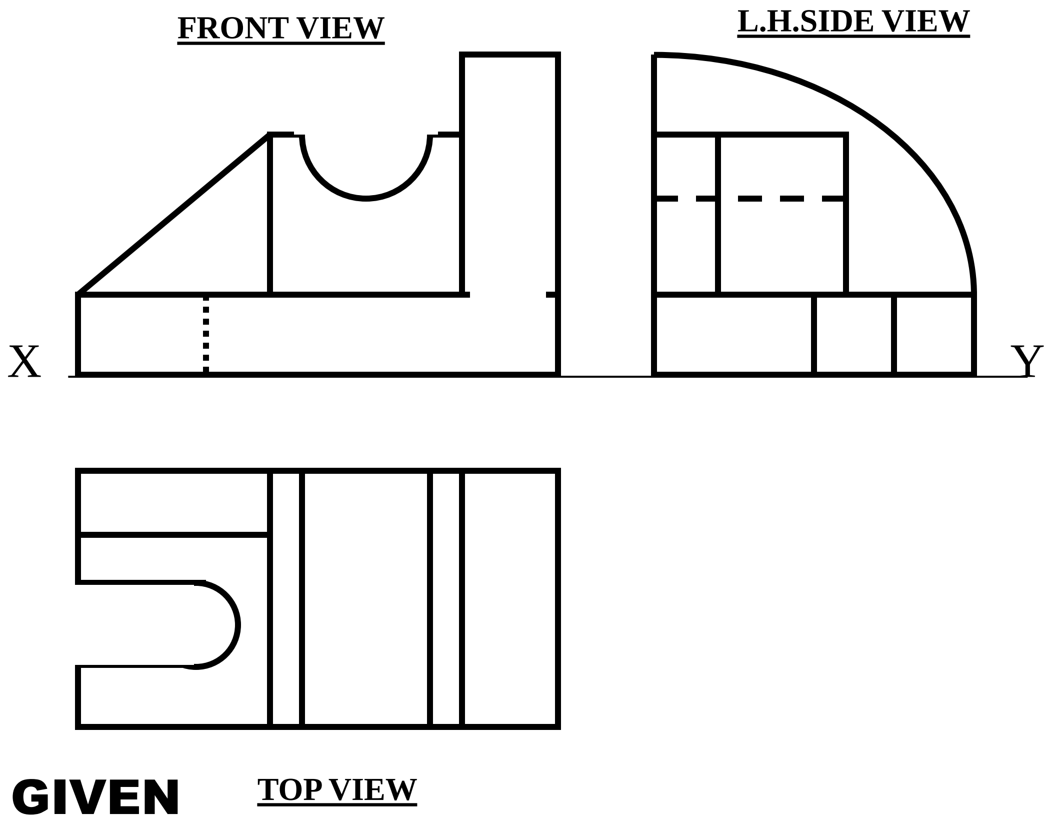


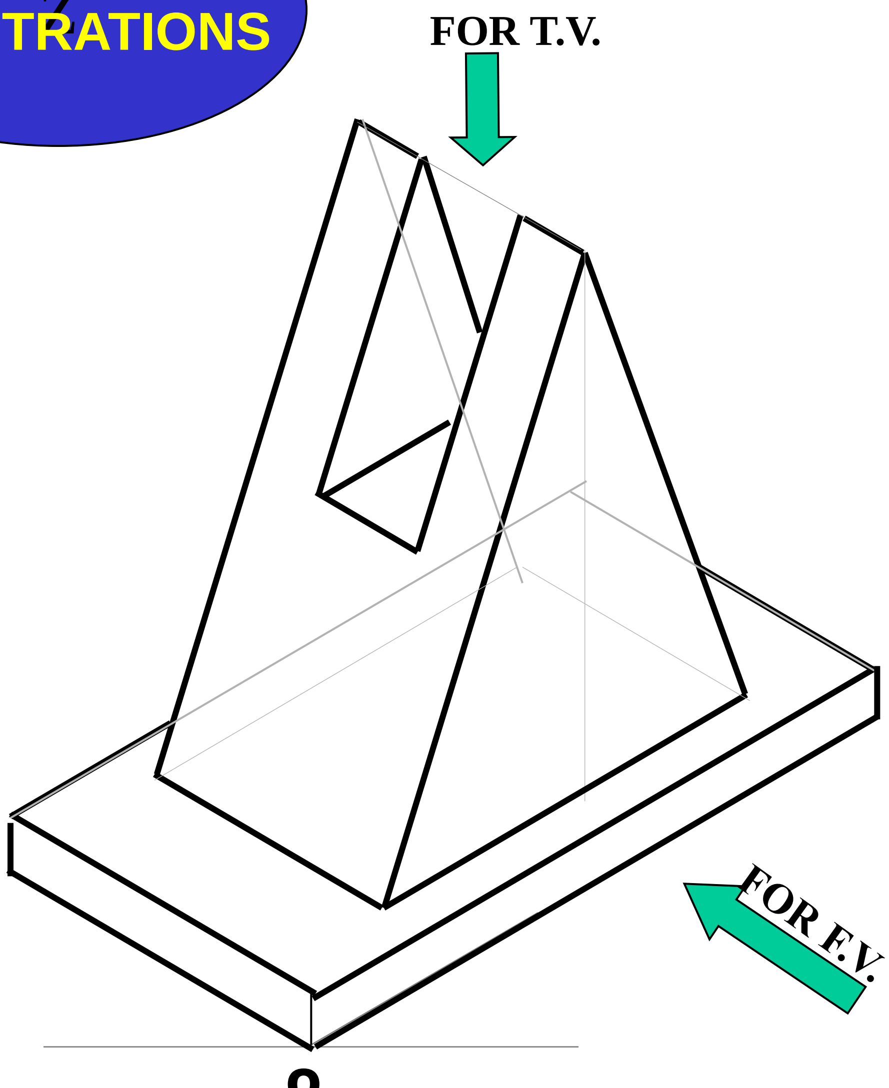
ORTHOGRAPHIC PROJECTIONS



PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

STUDY ILLUSTRATIONS



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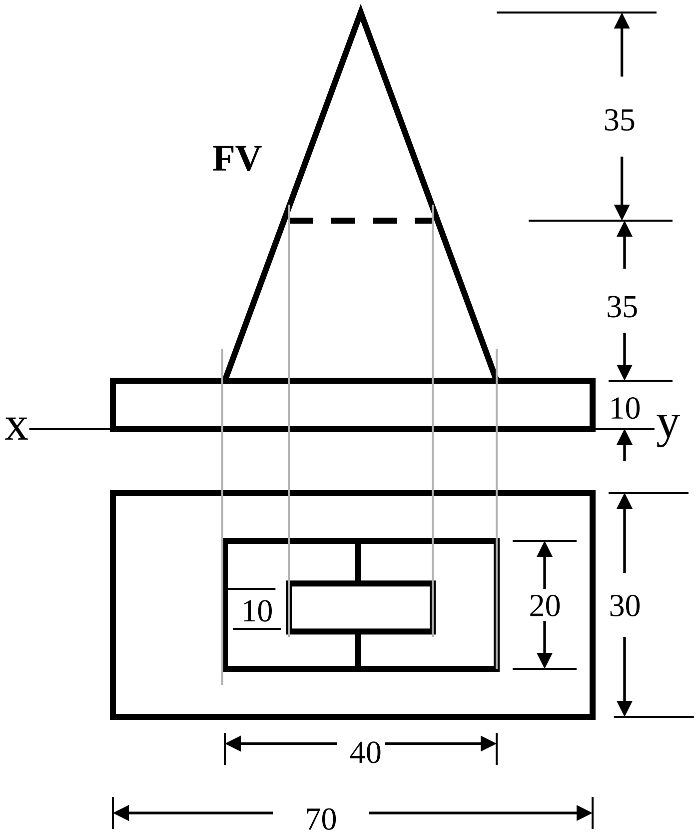
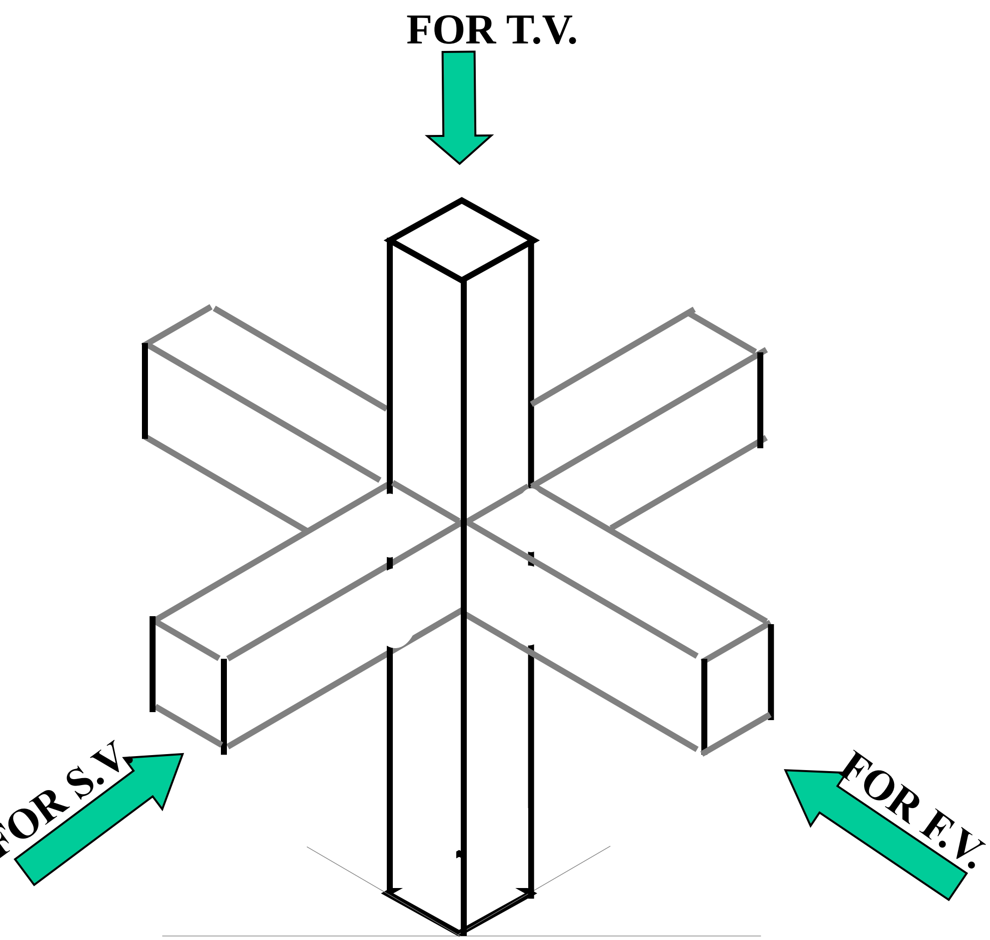


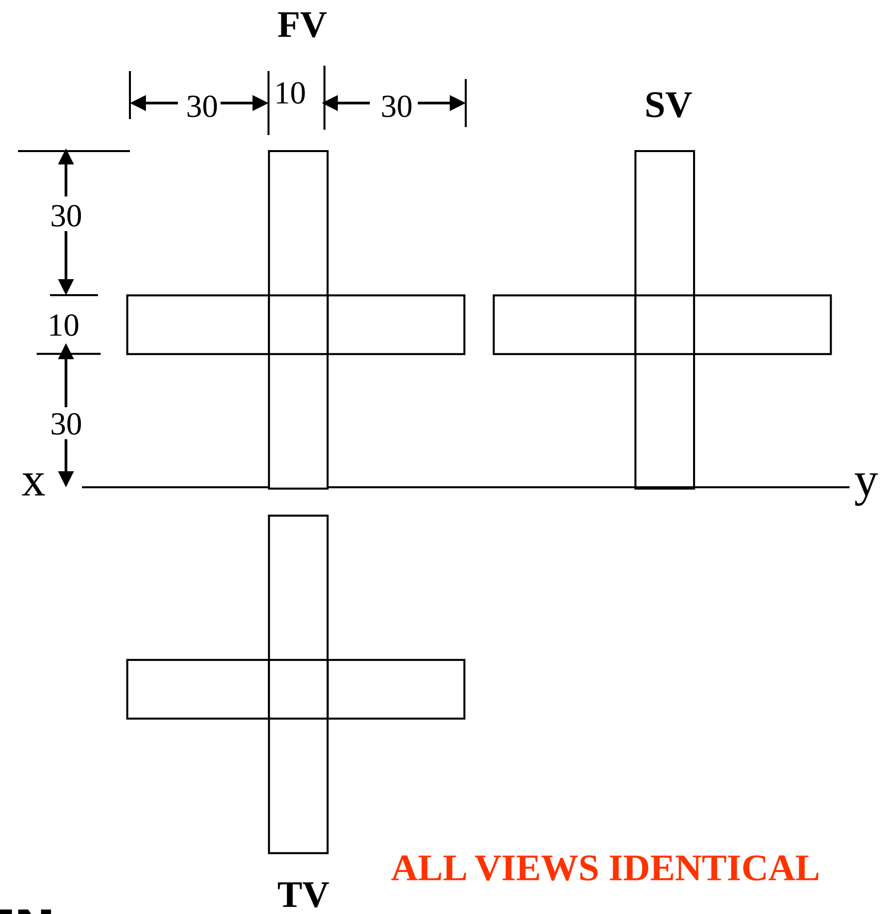
TV

PICTORIAL PRESENTATION IS GIVEN

DRAW FV AND TV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD



ORTHOGRAPHIC PROJECTIONS



ALL VIEWS IDENTICAL

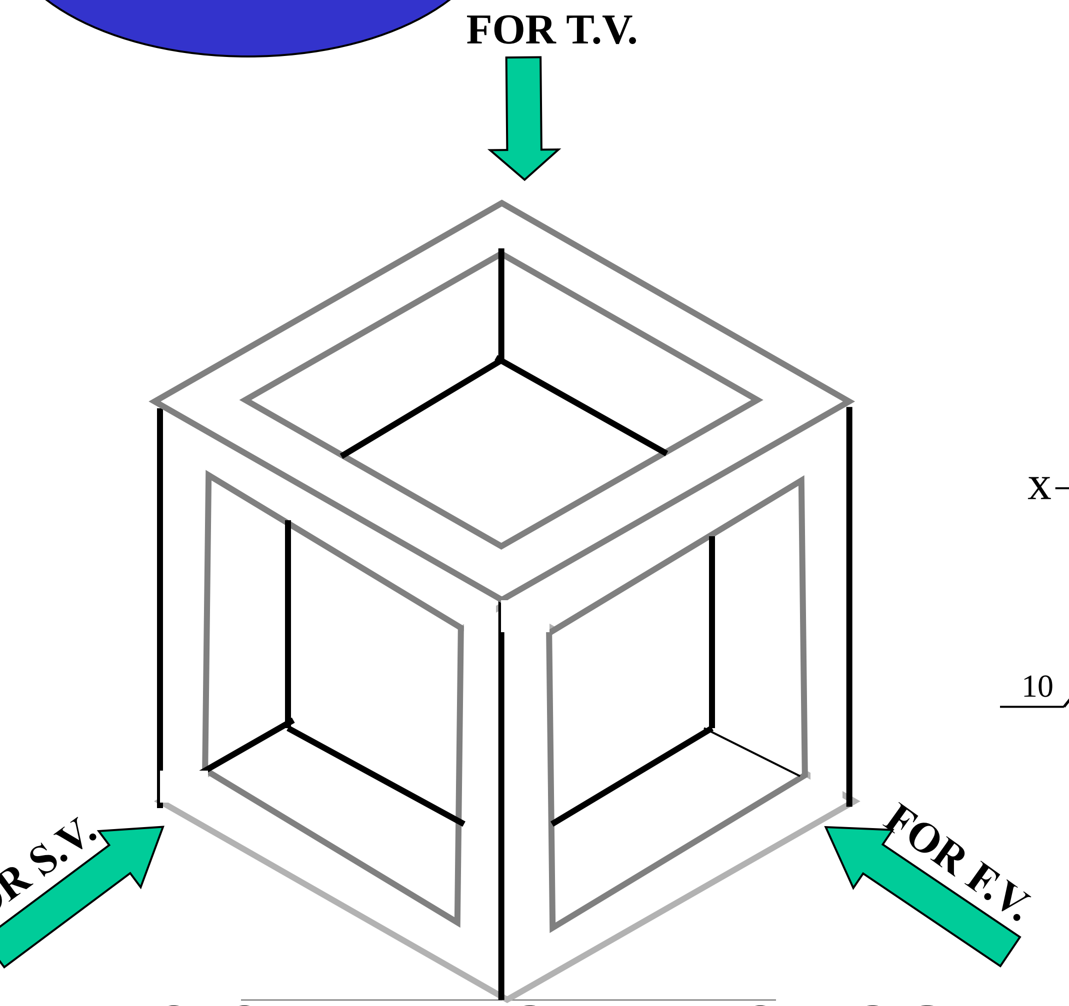
PICTORIAL PRESENTATION IS GIVEN

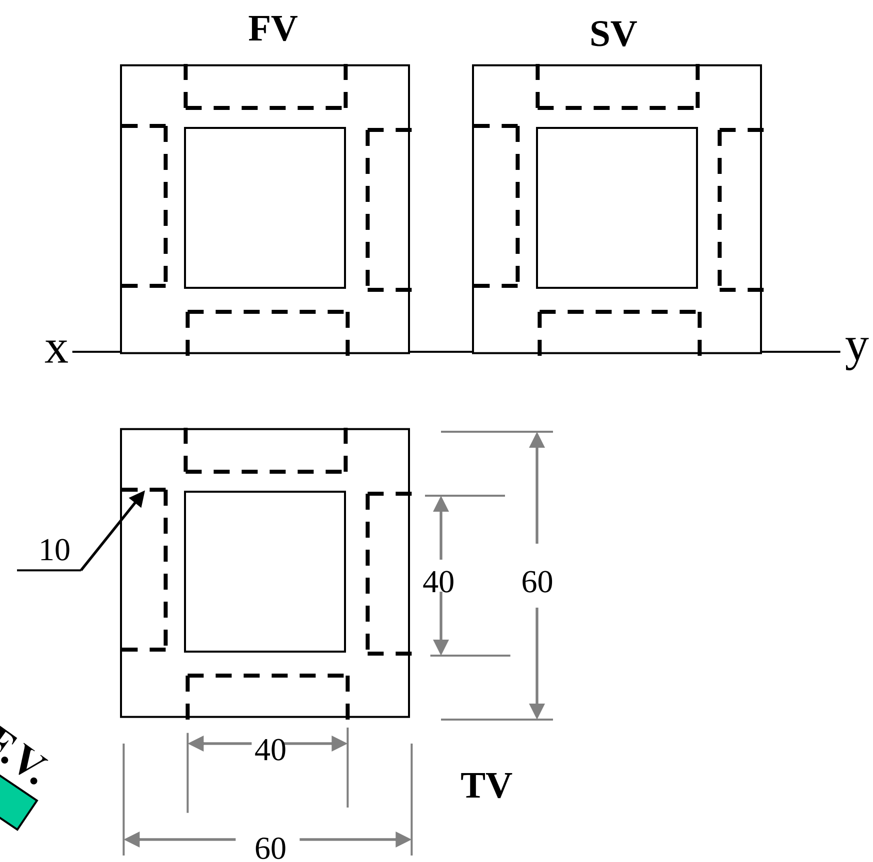
DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

STUDY ILLUSTRATIONS

ORTHOGRAPHIC PROJECTIONS

ALL VIEWS IDENTICAL



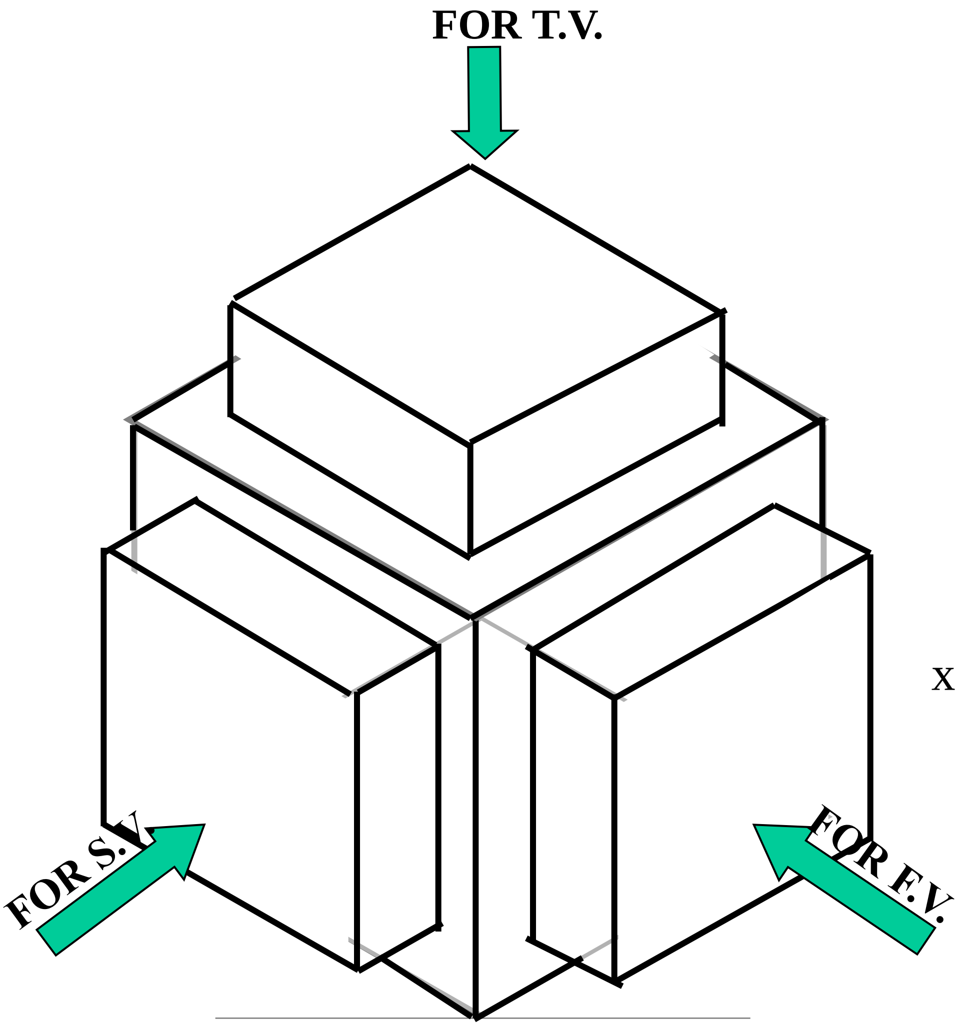


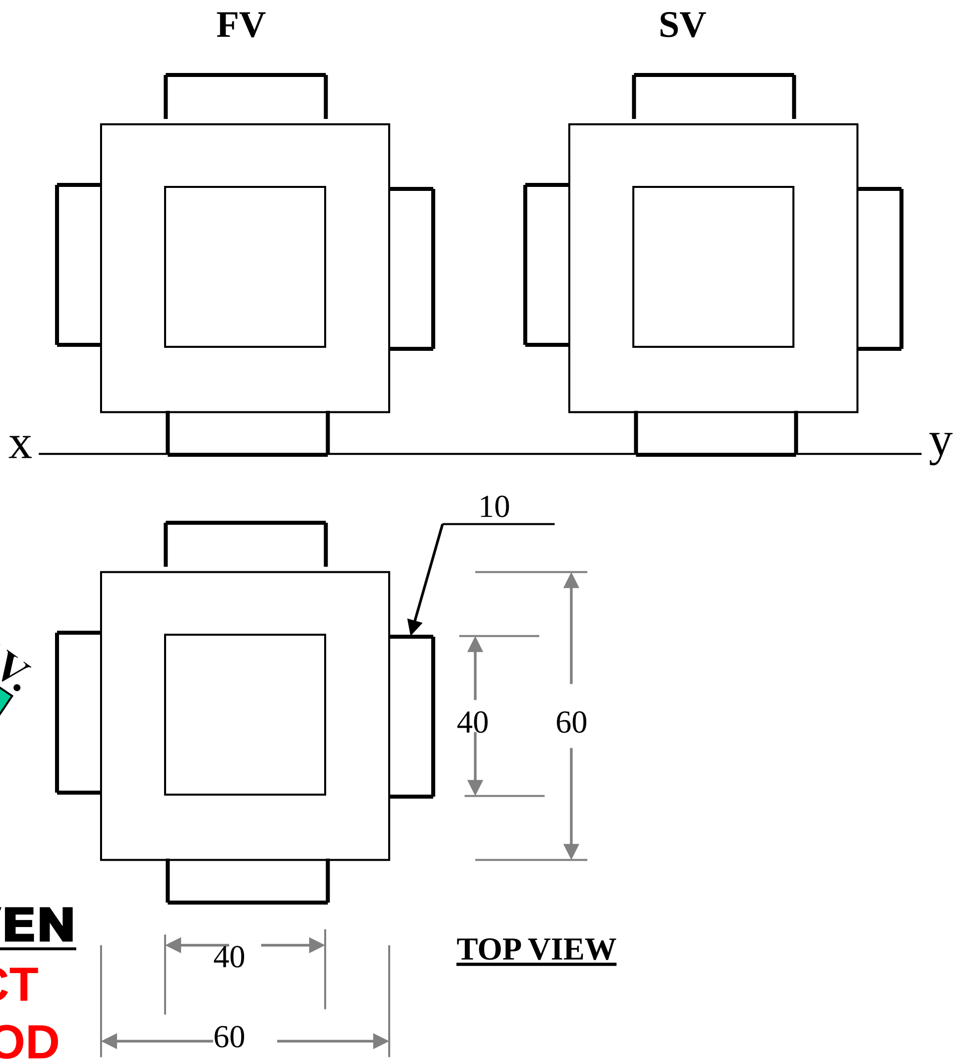
PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

ORTHOGRAPHIC PROJECTIONS

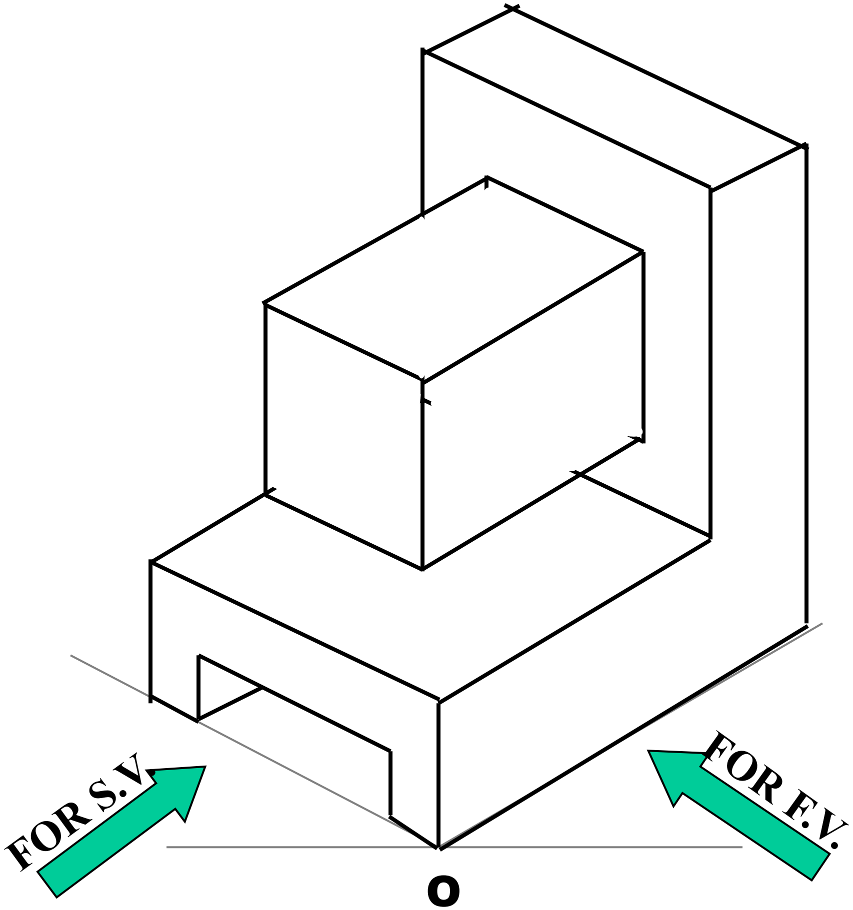
ALL VIEWS IDENTICAL





PICTORIAL PRESENTATION IS GIVEN

DRAW THREE VIEWS OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD



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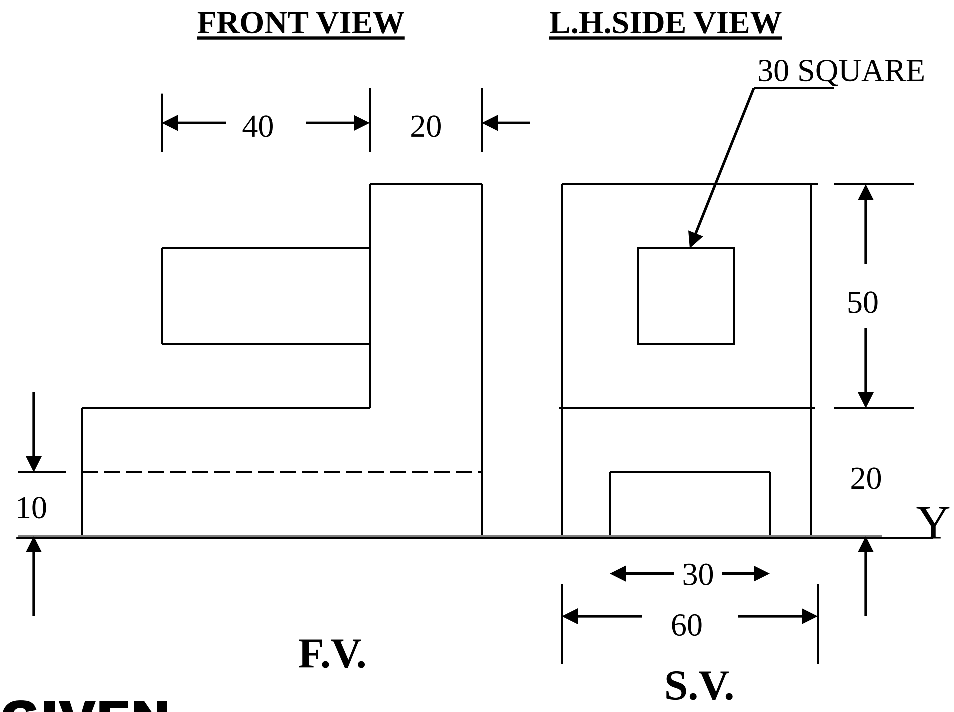
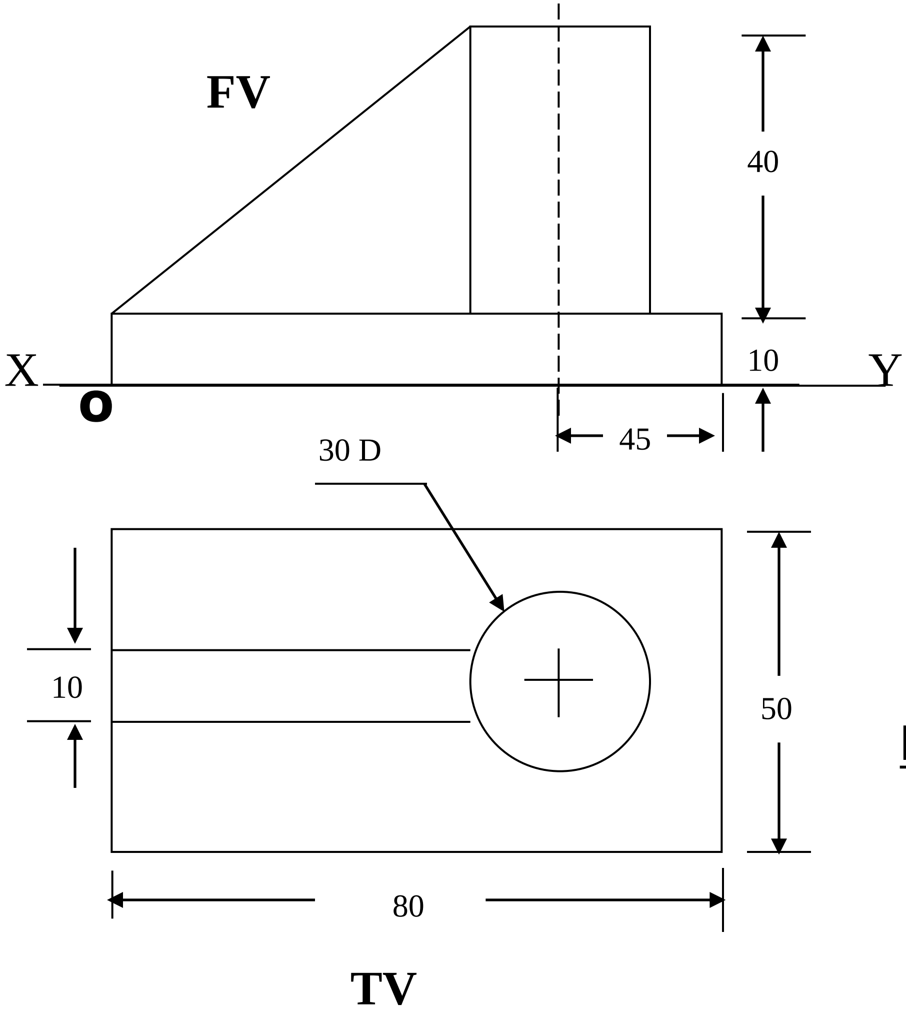
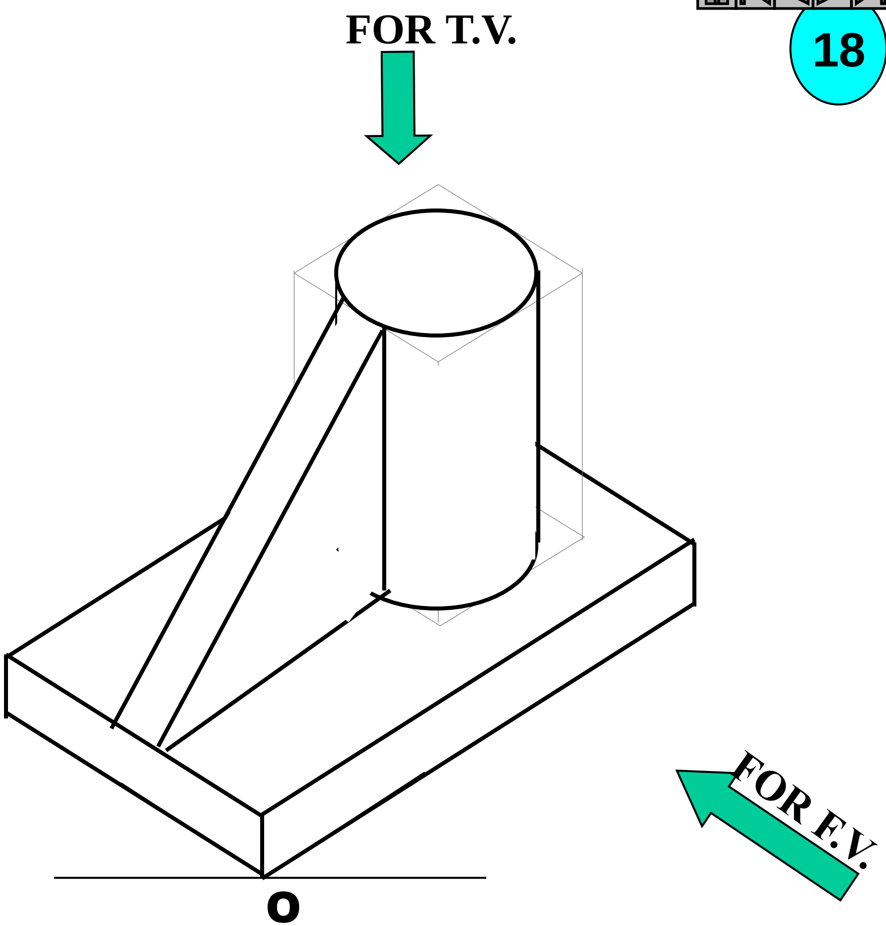


PICTORIAL PRESENTATION IS GIVEN

DRAW FV AND SV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

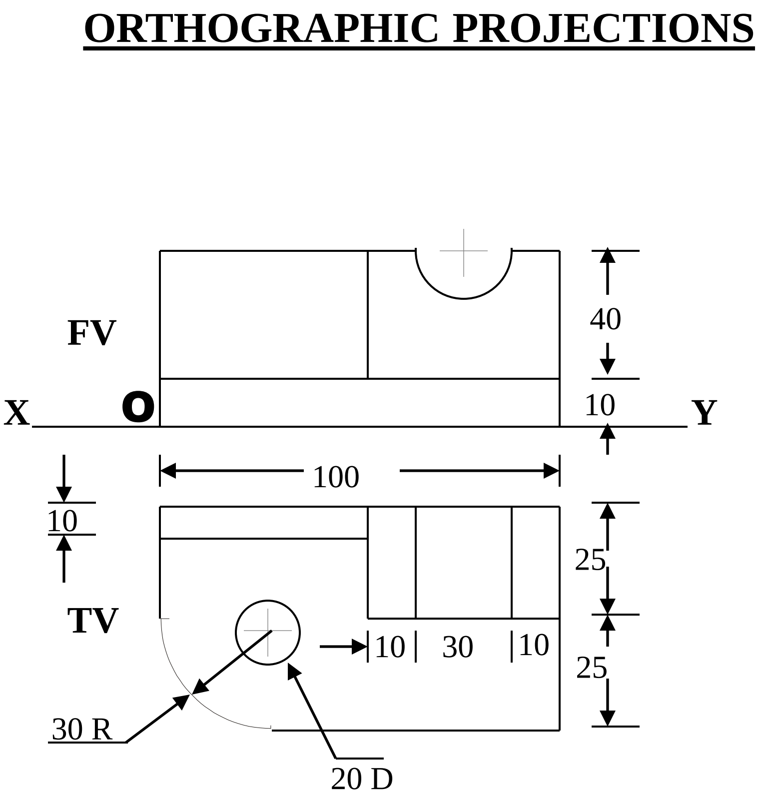
ORTHOGRAPHIC PROJECTIONS

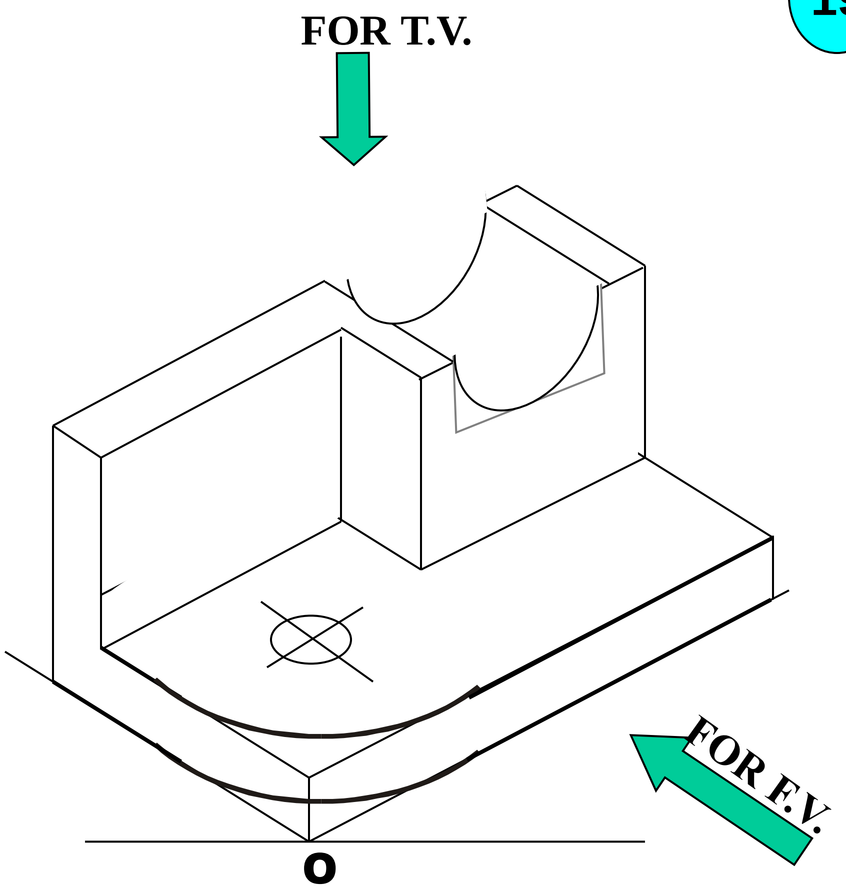




PICTORIAL PRESENTATION IS GIVEN

DRAW FV AND TV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD



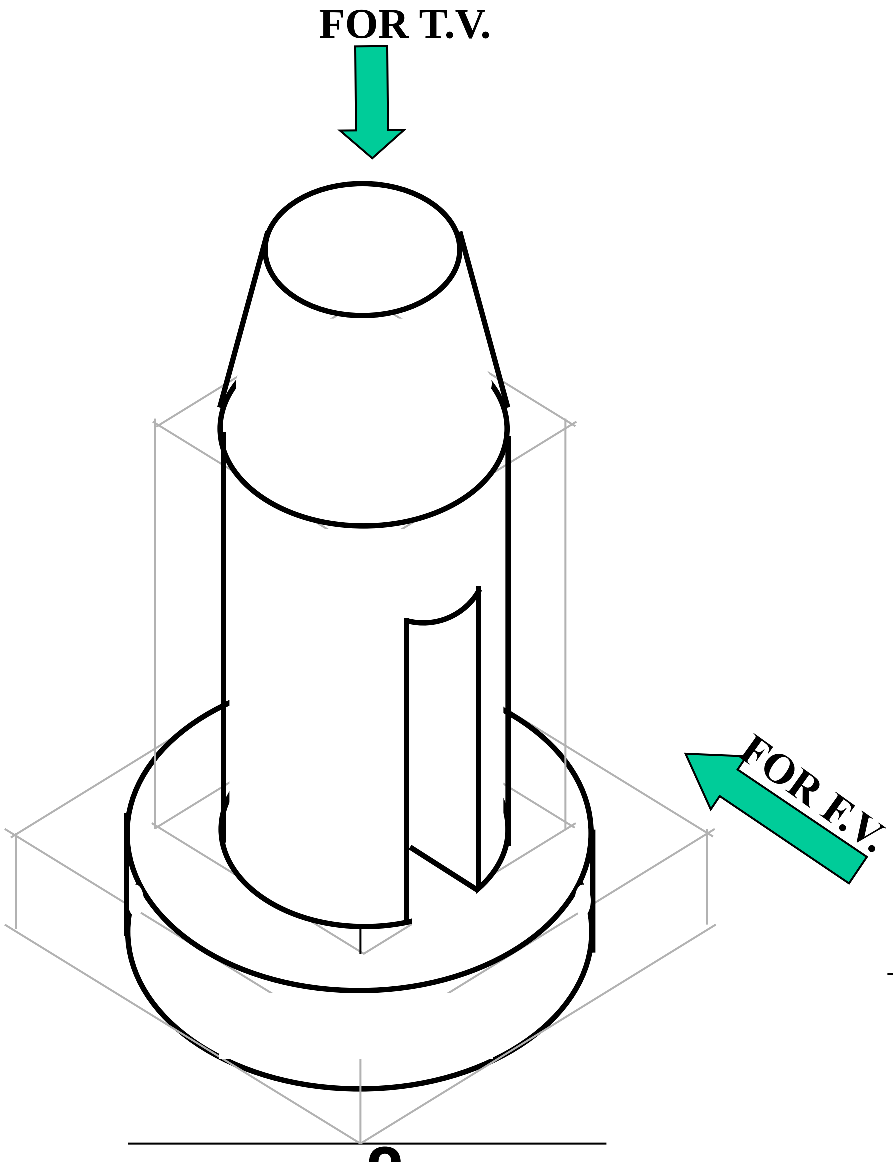


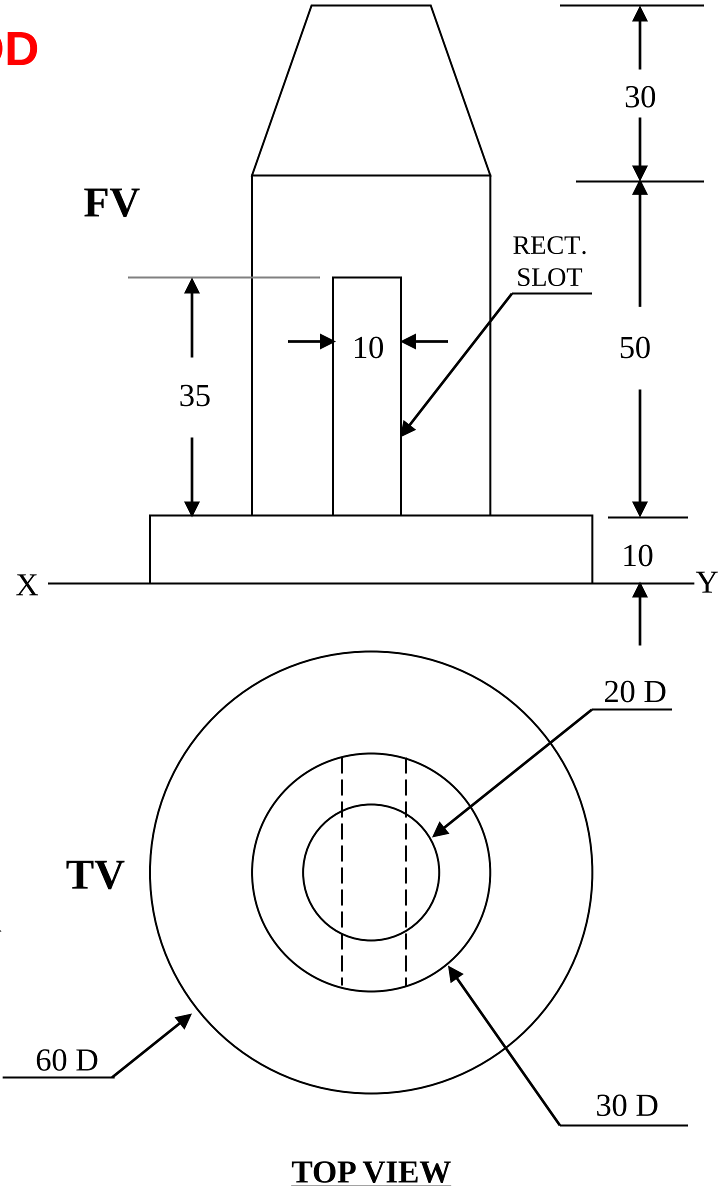
PICTORIAL PRESENTATION IS GIVEN

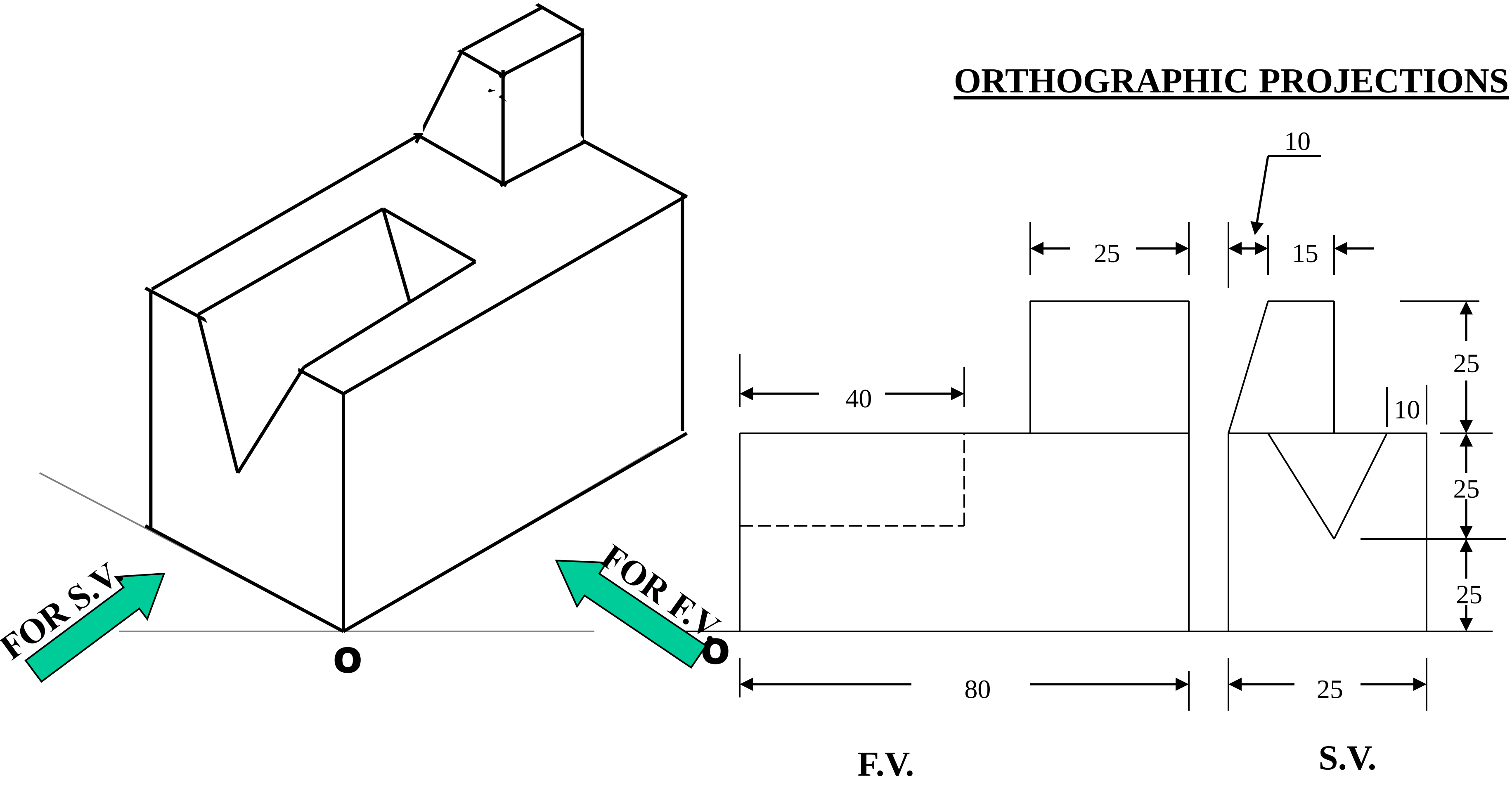
DRAW FV AND TV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

PICTORIAL PRESENTATION IS GIVEN

DRAW FV AND TV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD



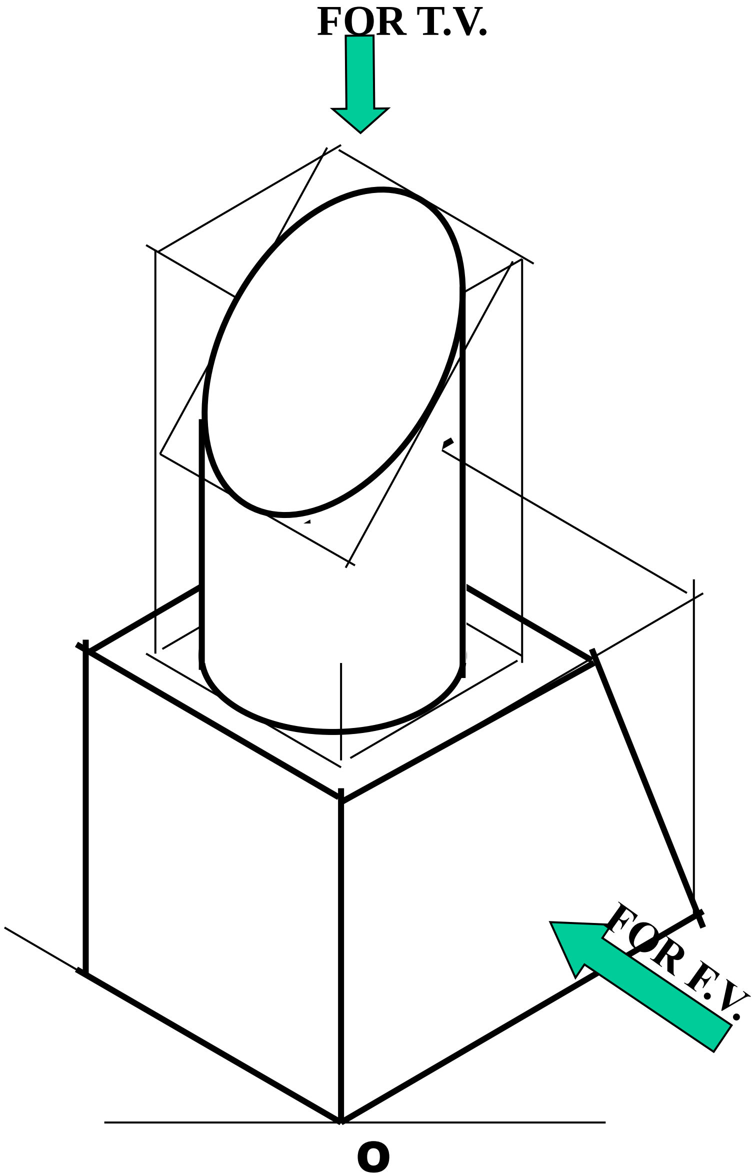


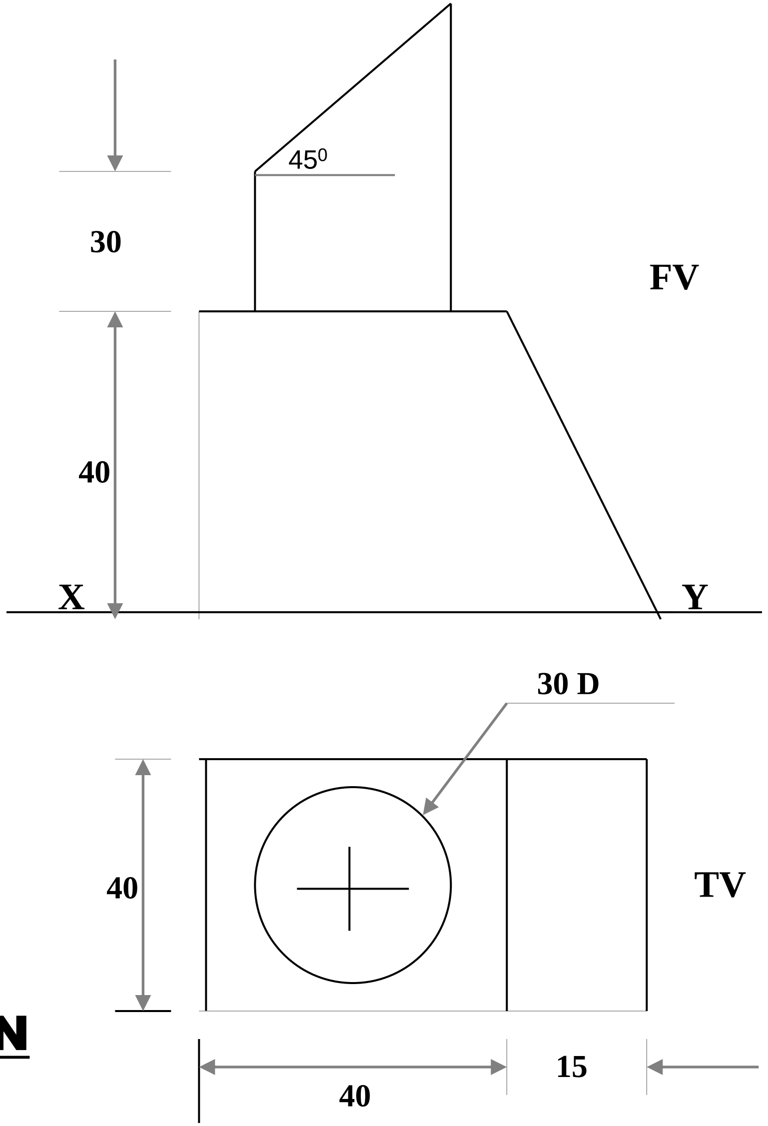


PICTORIAL PRESENTATION IS GIVEN

DRAW FV AND SV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

ORTHOGRAPHIC PROJECTIONS





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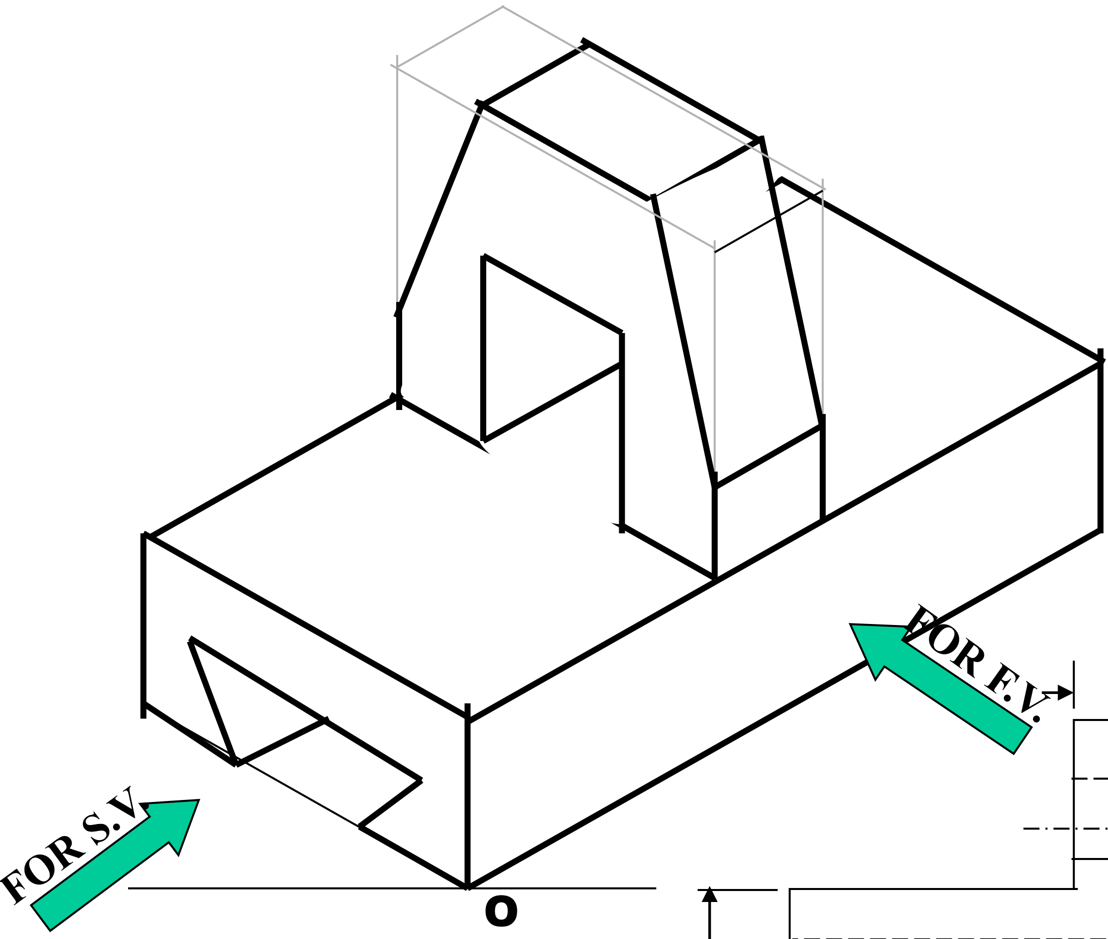

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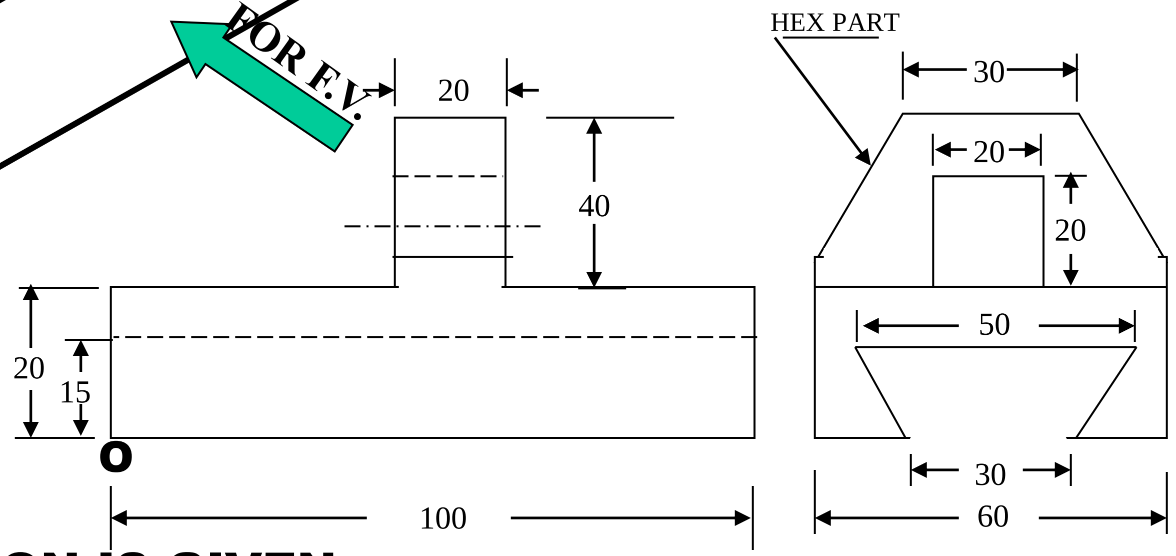


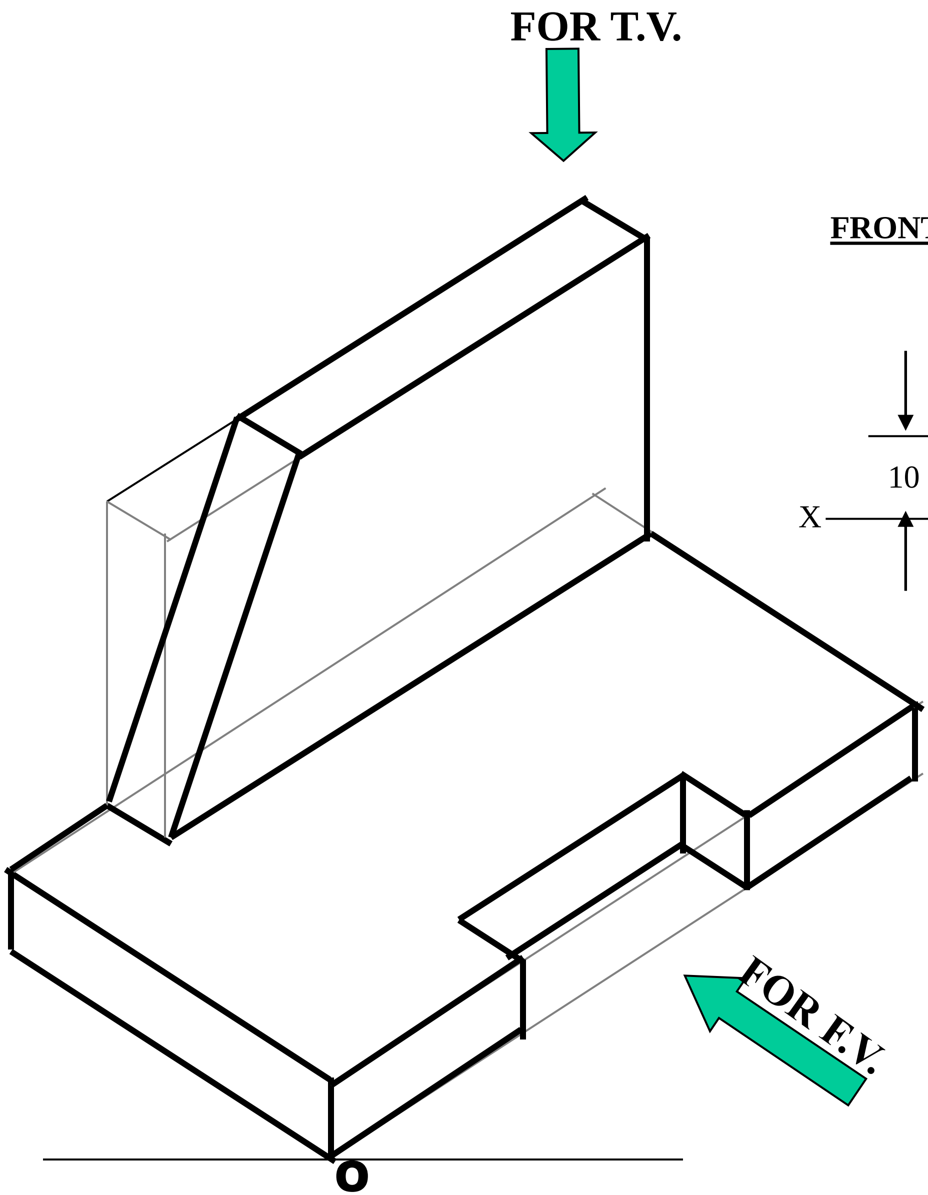
FRONT VIEW

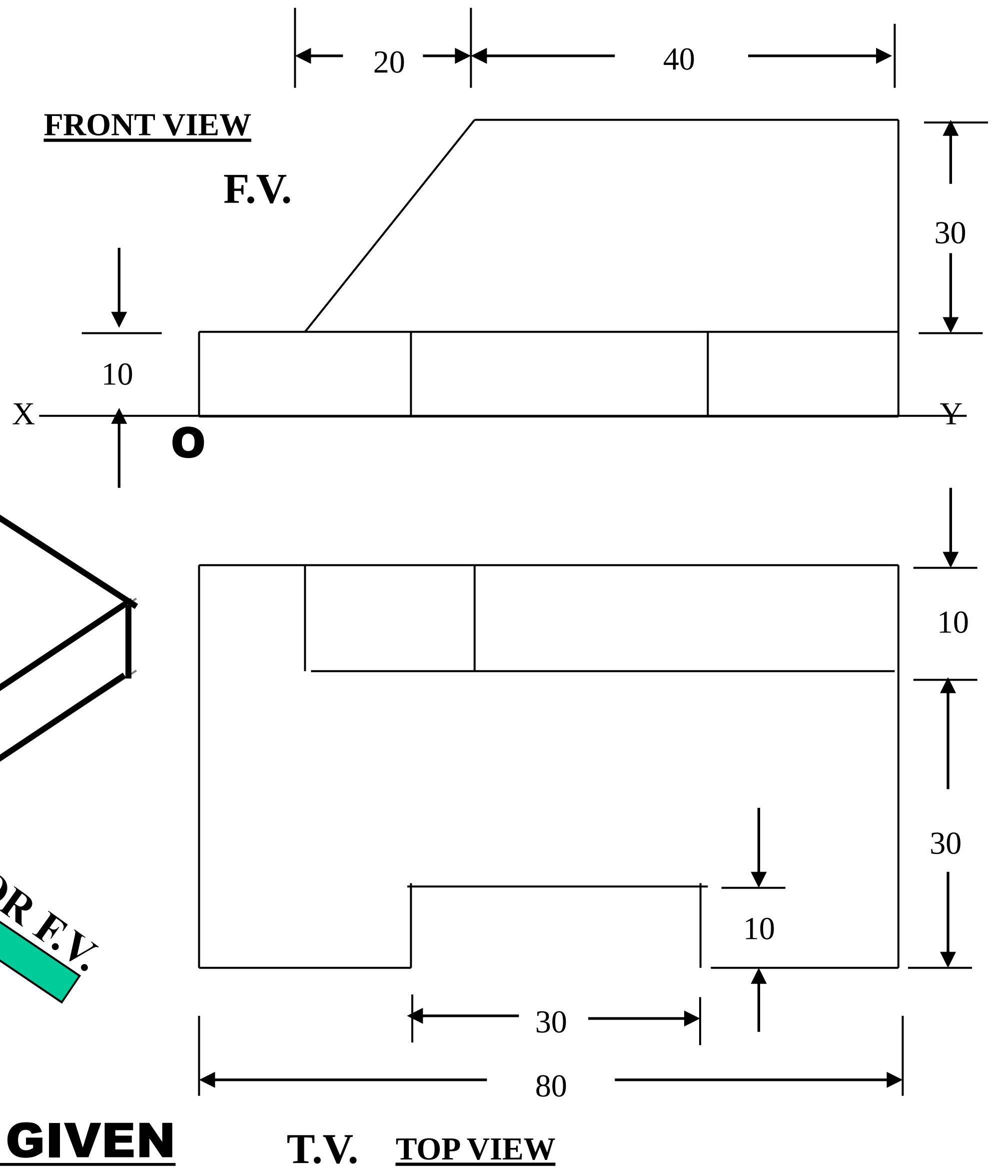
L.H.SIDE VIEW

PICTORIAL PRESENTATION IS GIVEN

DRAW FV ABD SV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

ORTHOGRAPHIC PROJECTIONS



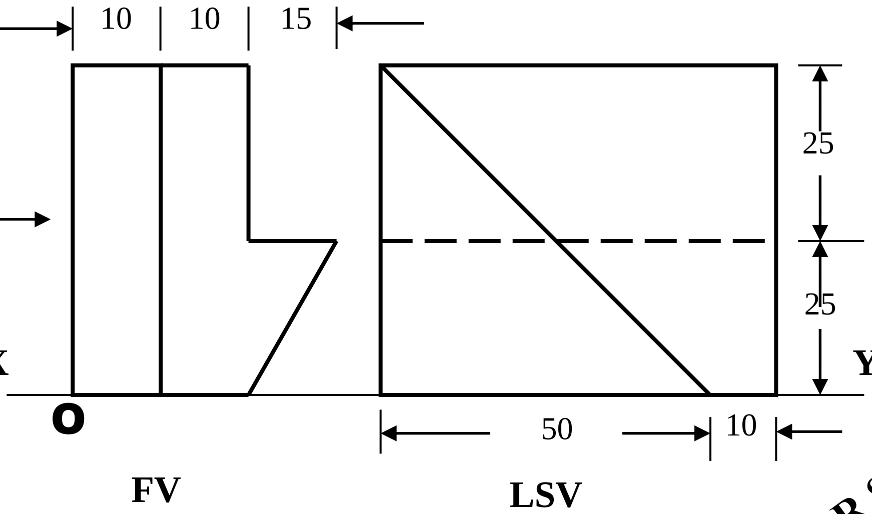


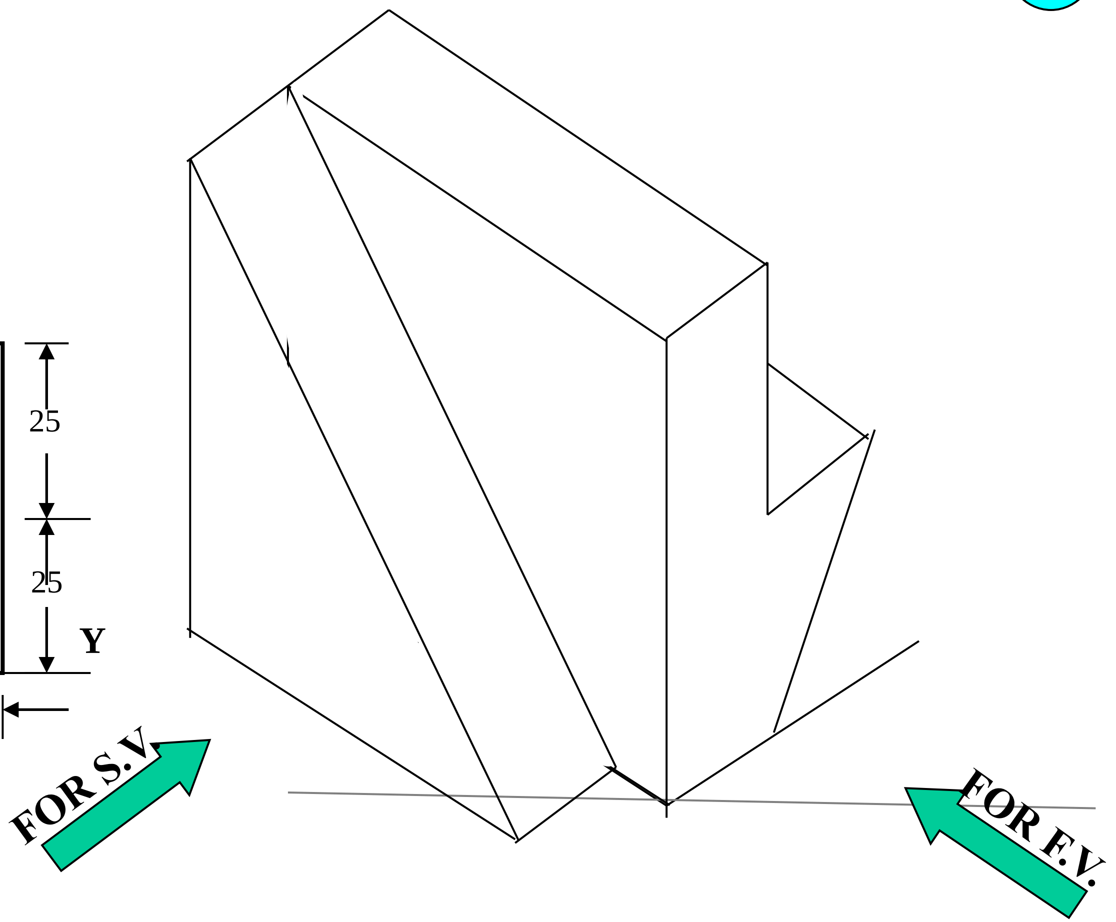
PICTORIAL PRESENTATION IS GIVEN

DRAW FV AND TV OF THIS OBJECT

BY FIRST ANGLE PROJECTION METHOD

ORTHOGRAPHIC PROJECTIONS





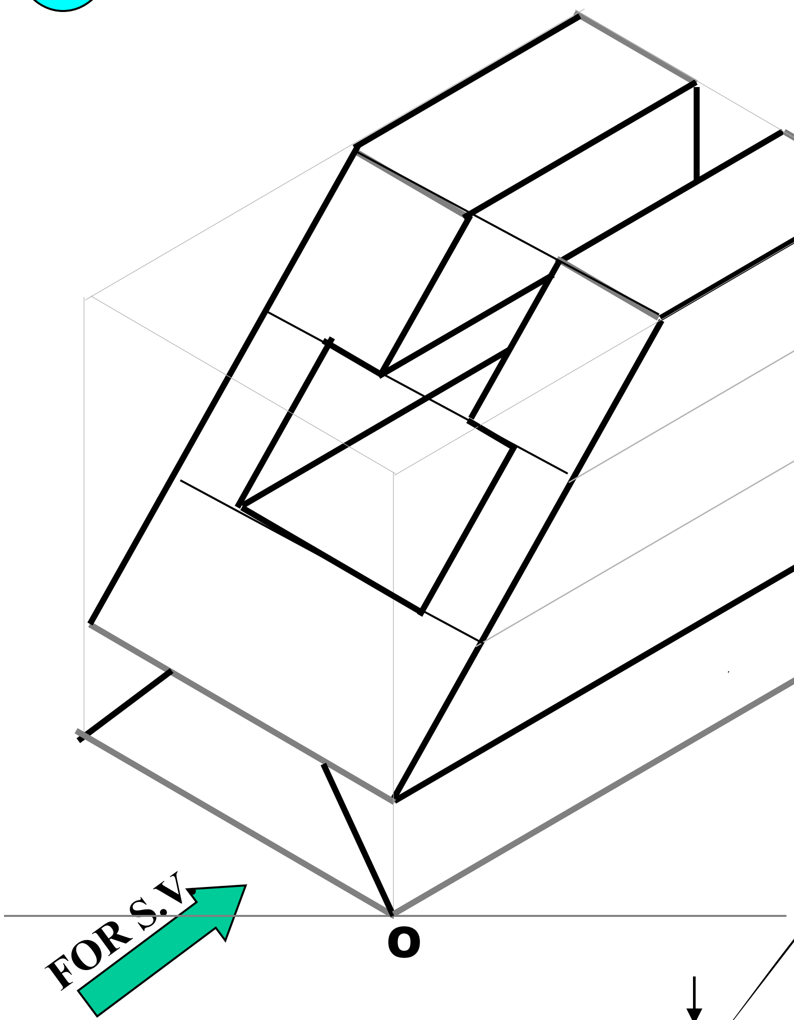
PICTORIAL PRESENTATION IS GIVEN

DRAW FV AND LSV OF THIS OBJECT
BY FIRST ANGLE PROJECTION METHOD

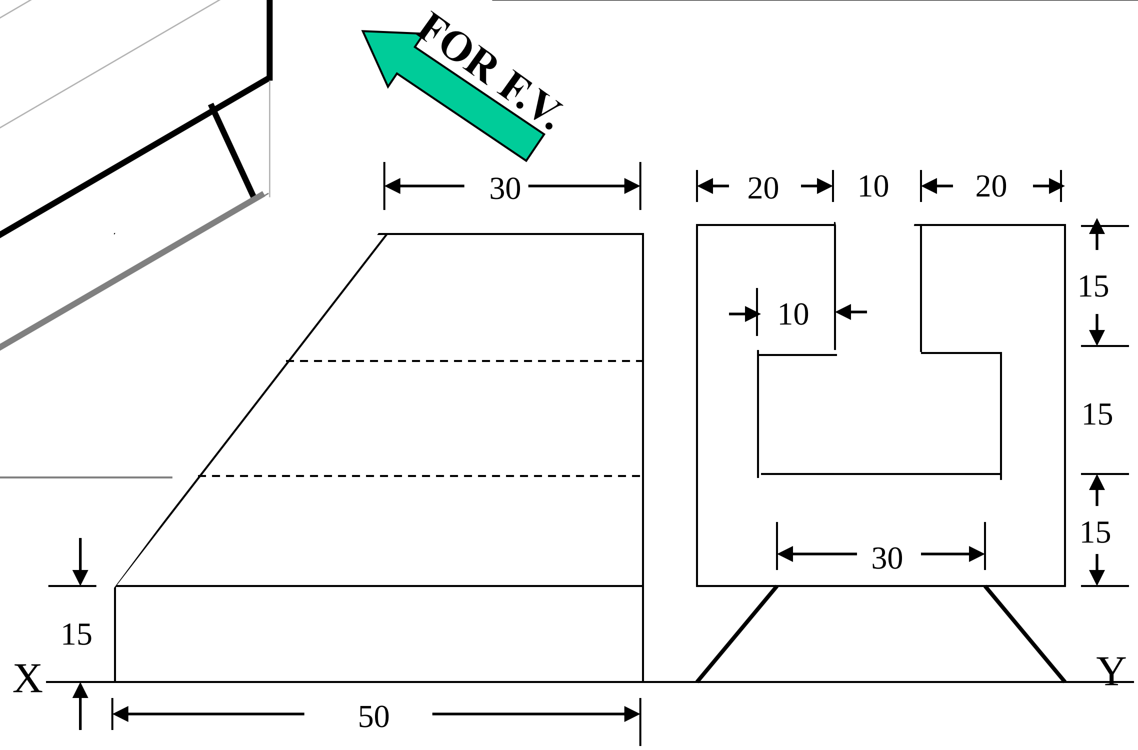
26

PICTORIAL PRESENTATION IS GIVEN

DRAW FV AND SV OF THIS OBJECT BY FIRST ANGLE PROJECTION METHOD



ORTHOGRAPHIC PROJECTIONS



ENGINEERING APPLICATIONS
OF
THE PRINCIPLES
OF
PROJECTIONS OF SOLIDES.

1. SECTIONS OF SOLIDS.
2. DEVELOPMENT.
3. INTERSECTIONS.

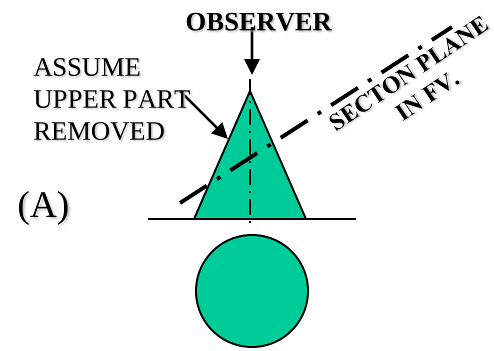
STUDY CAREFULLY
THE ILLUSTRATIONS GIVEN ON
NEXT *SIX* PAGES !

SECTIONING A SOLID.
An object (here a solid) is cut by some imaginary cutting plane to understand internal details of that object.

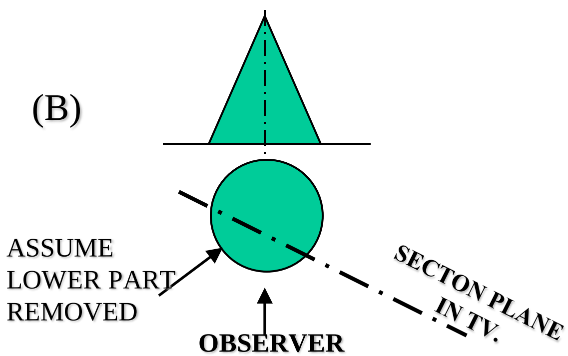
The action of cutting is called SECTIONING a solid & The plane of cutting is called SECTION PLANE.

Two cutting actions means section planes are recommended.

A) Section Plane perpendicular to Vp and inclined to Hp.
(This is a definition of an Aux. Inclined Plane i.e. A.I.P.)
NOTE:- This section plane appears as a straight line in FV.



B) Section Plane perpendicular to Hp and inclined to Vp.
(This is a definition of an Aux. Vertical Plane i.e. A.V.P.)
NOTE:- This section plane appears as a straight line in TV.

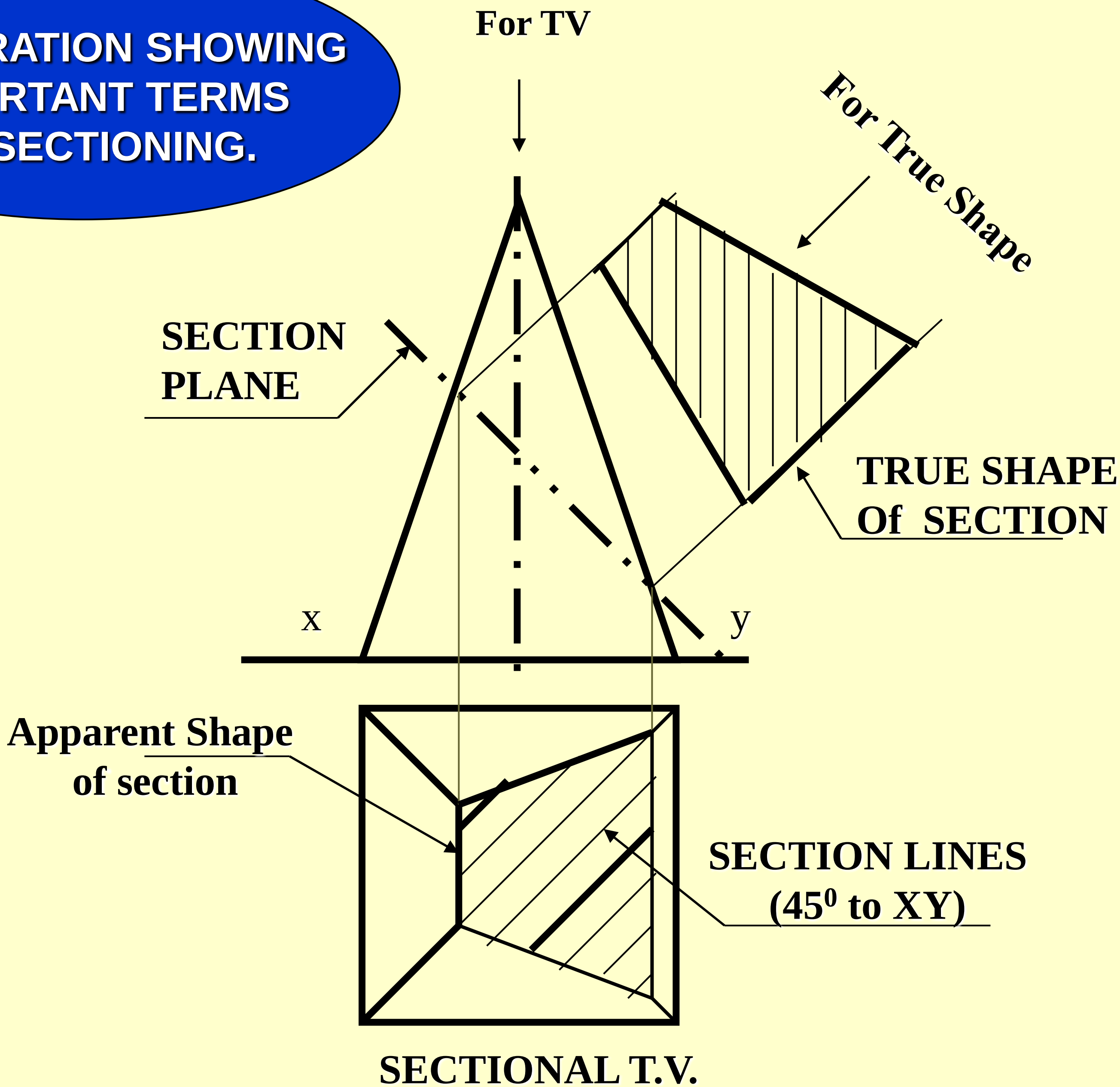


Remember:-

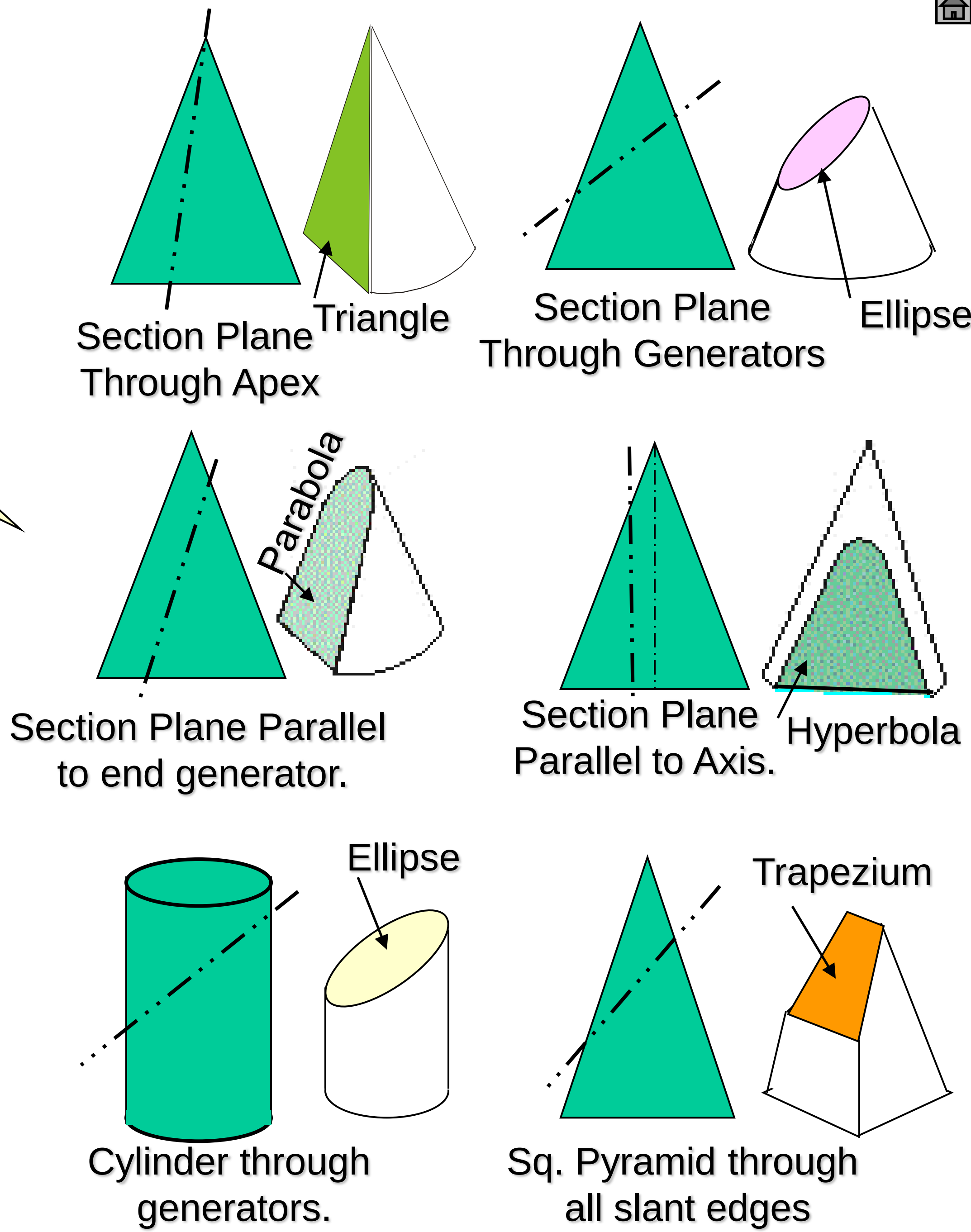
1. After launching a section plane either in FV or TV, the part towards observer is assumed to be removed.

2. As far as possible the smaller part is assumed to be removed.

ILLUSTRATION SHOWING IMPORTANT TERMS IN SECTIONING.



Typical Section Planes & Typical Shapes Of Sections.



DEVELOPMENT OF SURFACES OF SOLIDS.

MEANING:-

ASSUME OBJECT HOLLOW AND MADE-UP OF THIN SHEET. CUT OPEN IT FROM ONE SIDE AND UNFOLD THE SHEET COMPLETELY. THEN THE SHAPE OF THAT UNFOLDED SHEET IS CALLED **DEVELOPMENT OF LATERLAL SUEFACES** OF THAT OBJECT OR SOLID.

LATERLAL SURFACE IS THE SURFACE EXCLUDING SOLID'S TOP & BASE.

ENGINEERING APLICATION:

THERE ARE SO MANY PRODUCTS OR OBJECTS WHICH ARE DIFFICULT TO MANUFACTURE BY CONVENTIONAL MANUFACTURING PROCESSES, BECAUSE OF THEIR SHAPES AND SIZES. THOSE ARE FABRICATED IN SHEET METAL INDUSTRY BY USING DEVELOPMENT TECHNIQUE. THERE IS A VAST RANGE OF SUCH OBJECTS.

EXAMPLES:-

Boiler Shells & chimneys, Pressure Vessels, Shovels, Trays, Boxes & Cartons, Feeding Hoppers, Large Pipe sections, Body & Parts of automotives, Ships, Aeroplanes and many more.

WHAT IS OUR OBJECTIVE IN THIS TOPIC ?

To learn methods of development of surfaces of different solids, their sections and frustums.

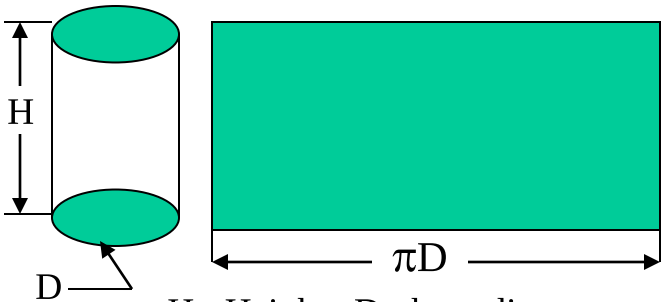
*But before going ahead, note following **Important** points.*

1. Development is different drawing than PROJECTIONS.
2. It is a shape showing AREA, means it's a 2-D plain drawing.
3. Hence all dimensions of it must be TRUE dimensions.
4. As it is representing shape of an un-folded sheet, no edges can remain hidden And hence DOTTED LINES are never shown on development.

Study illustrations given on next page carefully.

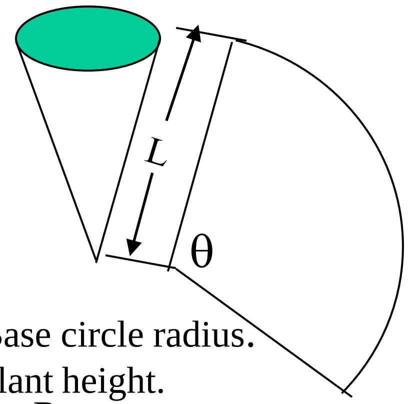
Development of lateral surfaces of different solids.
(Lateral surface is the surface excluding top & base)

Cylinder: A Rectangle



H= Height D= base diameter

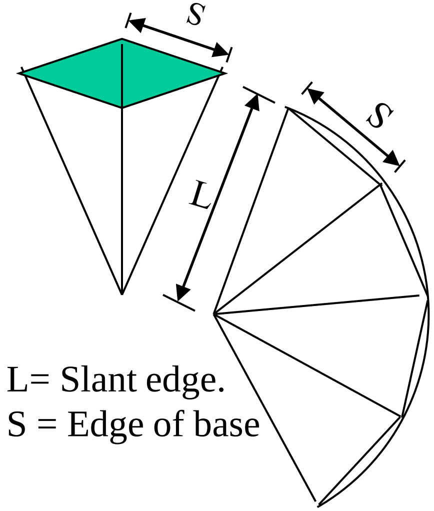
Cone: (Sector of circle)



R=Base circle radius.
L=Slant height.

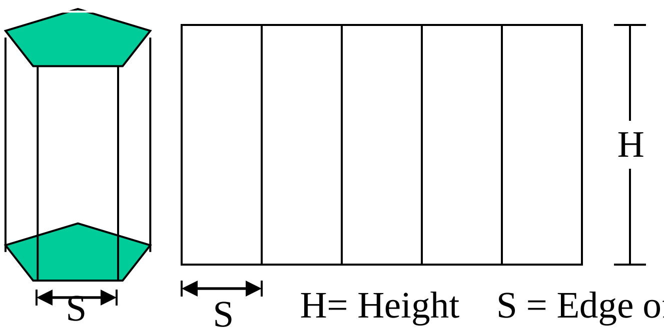
$$\theta = \frac{R}{L} \times 360^0$$

Pyramids: (No.of triangles)



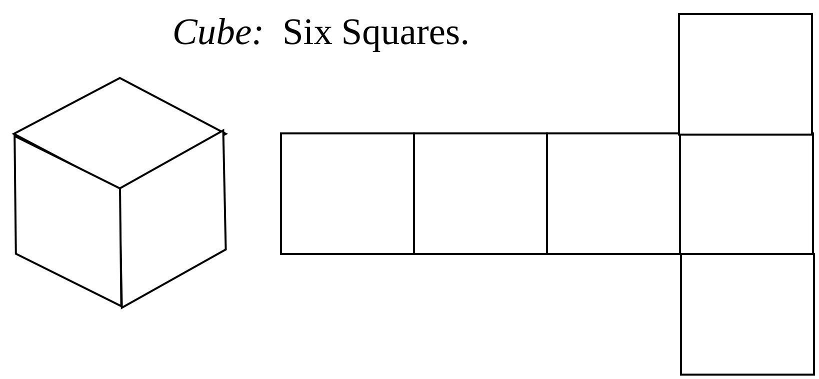
L= Slant edge.
S = Edge of base

Prisms: No.of Rectangles

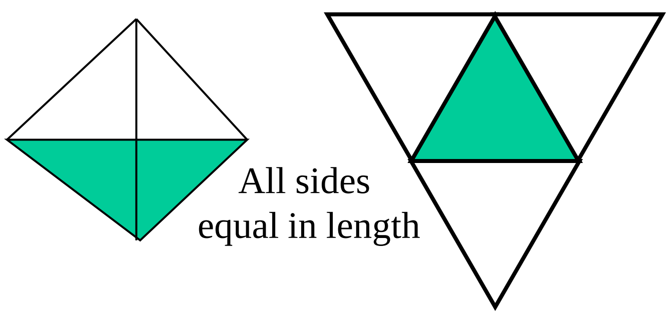


H= Height S = Edge of base

Cube: Six Squares.



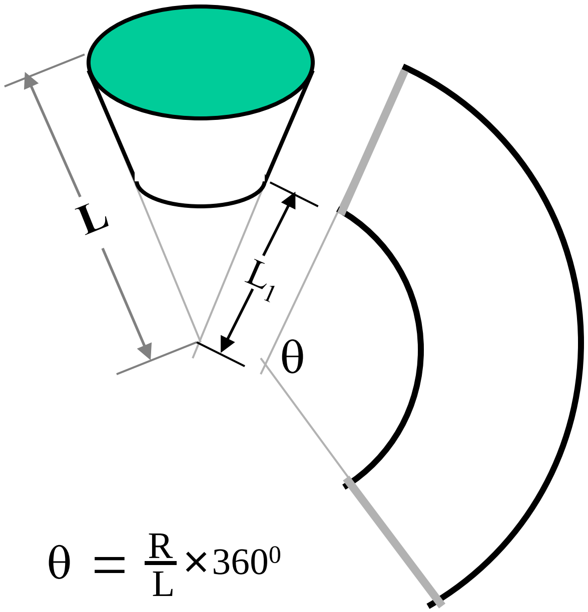
Tetrahedron: Four Equilateral Triangles



All sides equal in length

FRUSTUMS

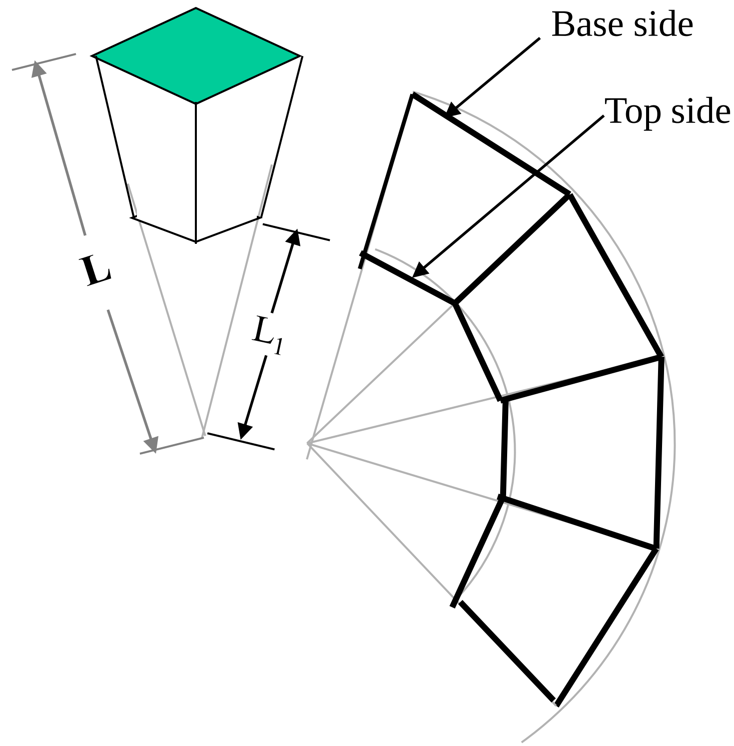
DEVELOPMENT OF
FRUSTUM OF CONE



$$\theta = \frac{R}{L} \times 360^0$$

R= Base circle radius of cone
L= Slant height of cone
L_1 = Slant height of cut part.

DEVELOPMENT OF
FRUSTUM OF SQUARE PYRAMID

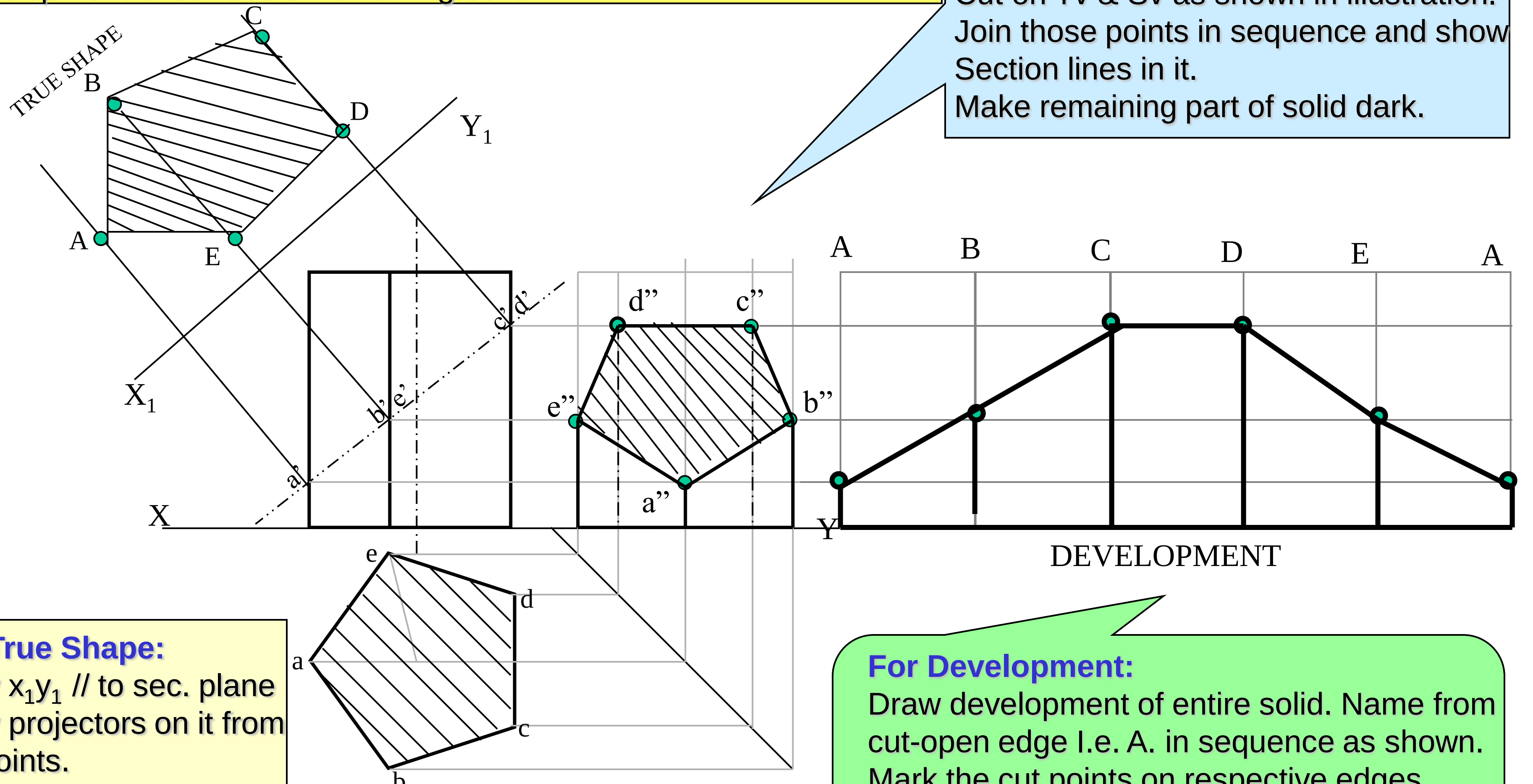


L= Slant edge of pyramid
L_1 = Slant edge of cut part.

STUDY NEXT *NINE* PROBLEMS OF SECTIONS & DEVELOPMENT

Problem 1: A pentagonal prism , 30 mm base side & 50 mm axis is standing on Hp on it's base whose one side is perpendicular to Vp. It is cut by a section plane 45^0 inclined to Hp, through mid point of axis. Draw Fv, sec.Tv & sec. Side view. Also draw true shape of section and Development of surface of remaining solid.

Solution Steps: *for sectional views:*
Draw three views of standing prism.
Locate sec.plane in Fv as described.
Project points where edges are getting
Cut on Tv & Sv as shown in illustration.
Join those points in sequence and show
Section lines in it.
Make remaining part of solid dark.

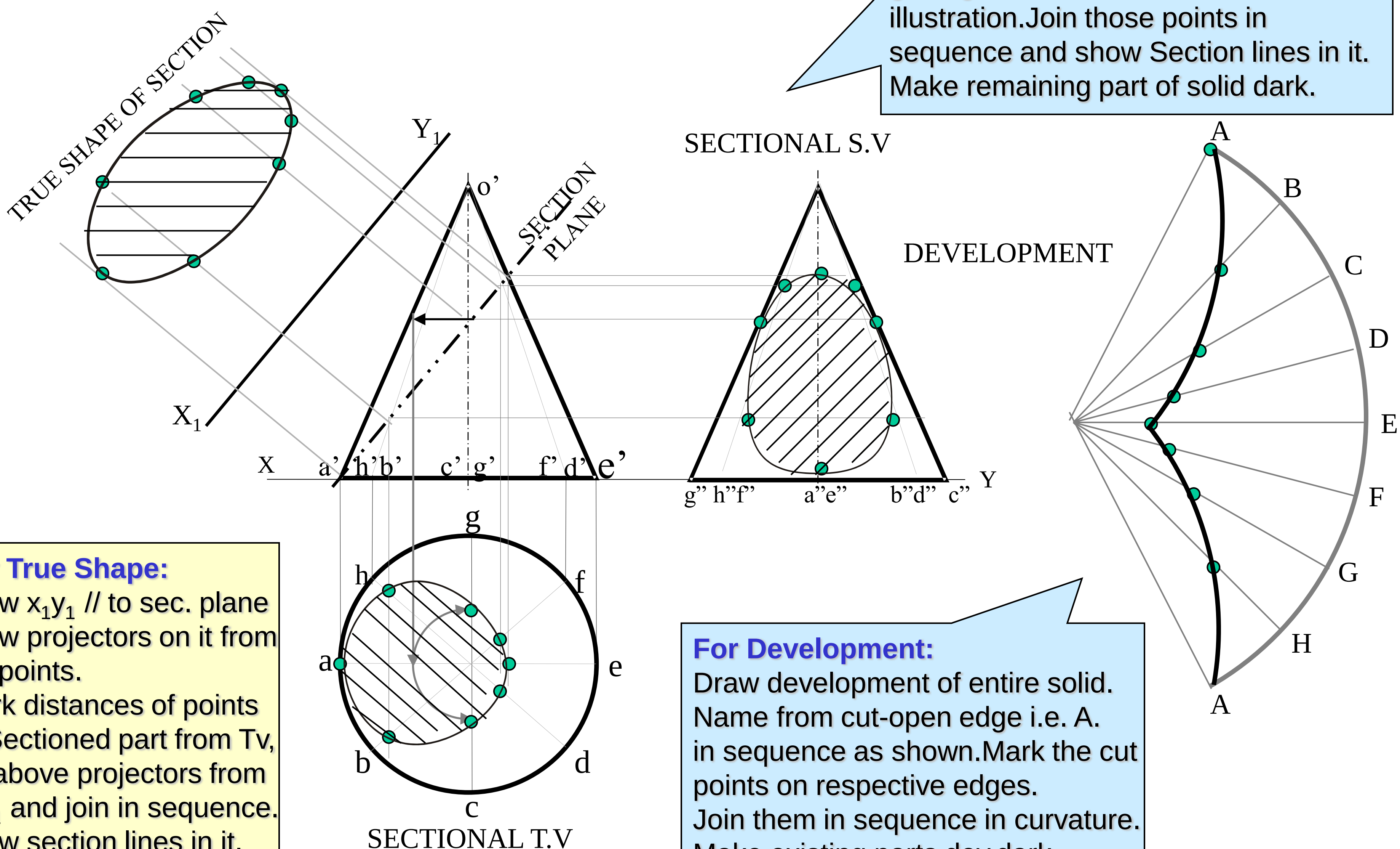


For True Shape:
Draw x_1y_1 // to sec. plane
Draw projectors on it from cut points.
Mark distances of points of Sectioned part from Tv, on above projectors from x_1y_1 and join in sequence.
Draw section lines in it.
It is required true shape.

For Development:
Draw development of entire solid. Name from cut-open edge I.e. A. in sequence as shown.
Mark the cut points on respective edges.
Join them in sequence in st. lines.
Make existing parts dev.dark.

Problem 2: A cone, 50 mm base diameter and 70 mm axis is standing on it's base on Hp. It cut by a section plane 45^0 inclined to Hp through base end of end generator.Draw projections, sectional views, true shape of section and development of surfaces of remaining solid.

Solution Steps: *for sectional views:*
Draw three views of standing cone.
Locate sec.plane in Fv as described.
Project points where generators are getting Cut on Tv & Sv as shown in illustration.Join those points in sequence and show Section lines in it.
Make remaining part of solid dark.

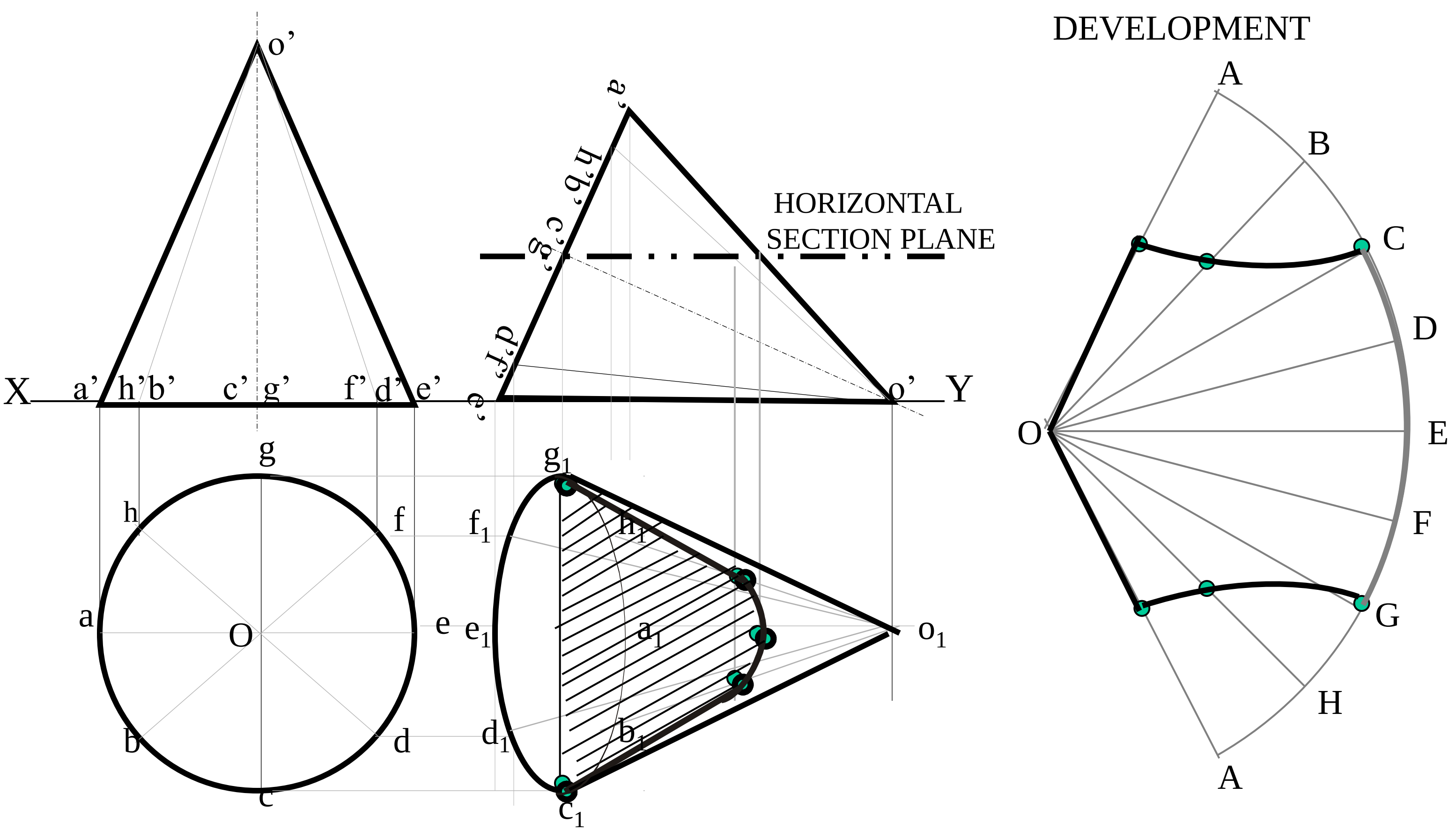


For True Shape:
Draw x_1y_1 // to sec. plane
Draw projectors on it from cut points.
Mark distances of points of Sectioned part from Tv, on above projectors from x_1y_1 and join in sequence.
Draw section lines in it.
It is required true shape.

For Development:
Draw development of entire solid.
Name from cut-open edge i.e. A. in sequence as shown.Mark the cut points on respective edges.
Join them in sequence in curvature.
Make existing parts dev.dark.

Problem 3: **A cone 40mm diameter and 50 mm axis is resting on one generator on Hp(lying on Hp) which is // to Vp.. Draw it's projections.It is cut by a horizontal section plane through it's base center. Draw sectional TV, development of the surface of the remaining part of cone.**

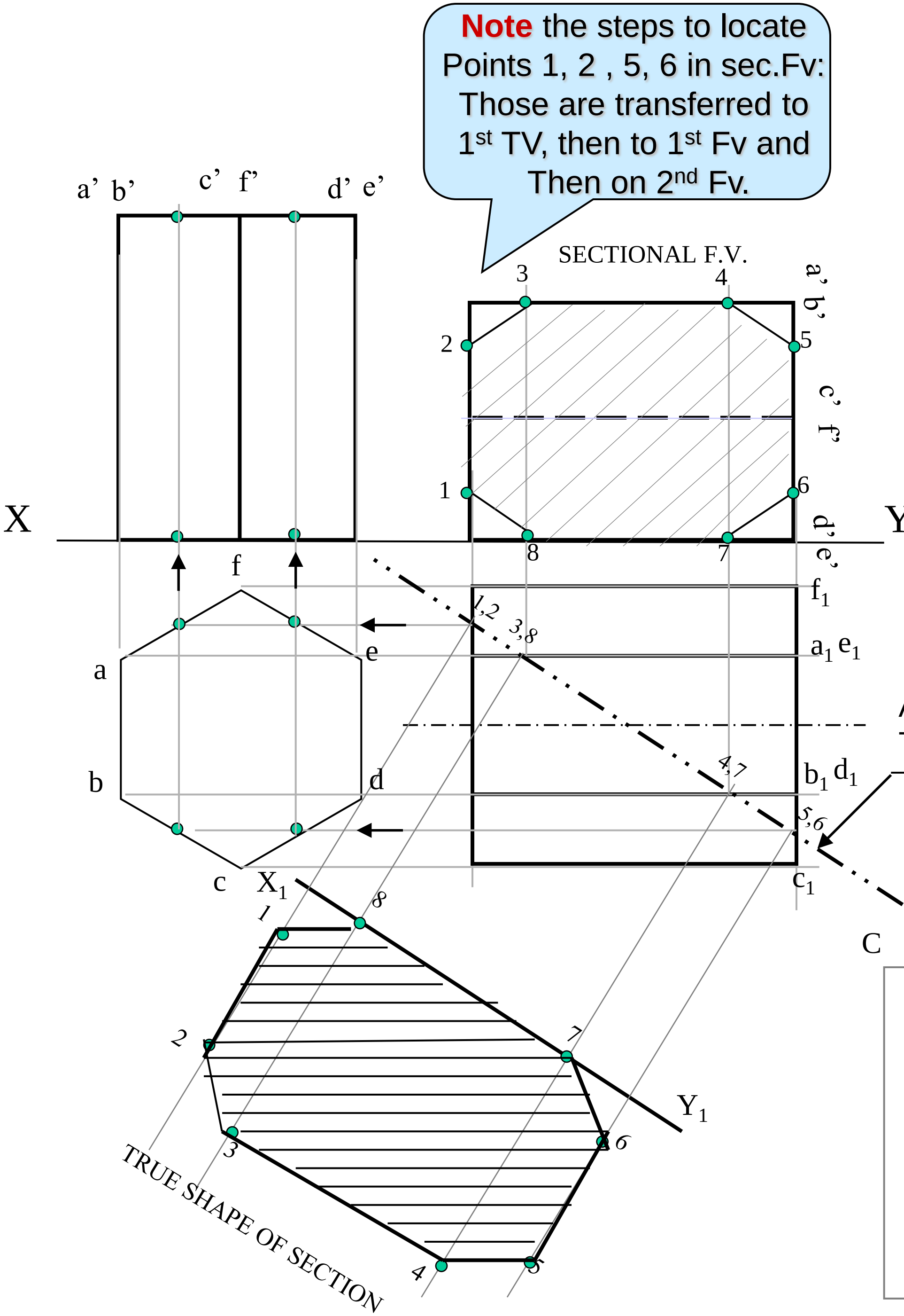
Follow similar solution steps for Sec.views - True shape – Development as per previous problem!



SECTIONAL T.V
(SHOWING TRUE SHAPE OF SECTION)

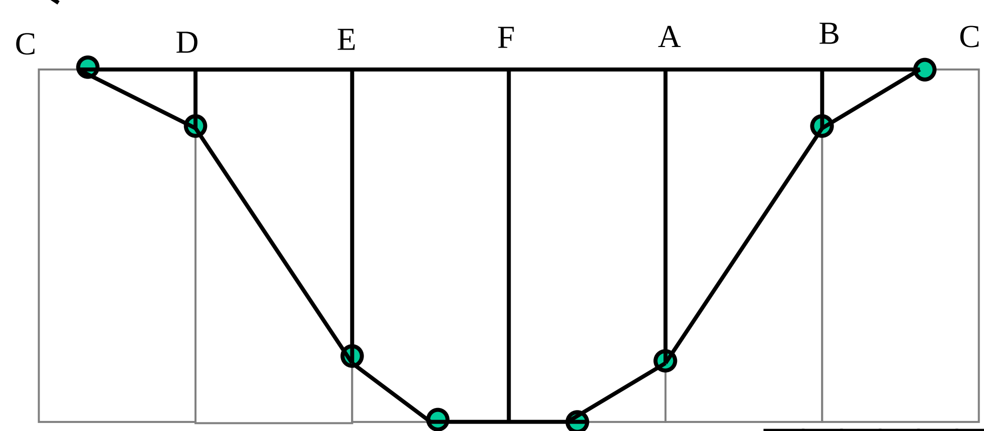
Problem 4: A hexagonal prism. 30 mm base side & 55 mm axis is lying on Hp on it's rect.face with axis // to Vp. It is cut by a section plane normal to Hp and 30^0 inclined to Vp bisecting axis.
Draw sec. Views, true shape & development.

Use similar steps for sec.views & true shape.
NOTE: for development, always cut open object from From an edge in the boundary of the view in which sec.plane appears as a line.
Here it is Tv and in boundary, there is c1 edge.Hence it is opened from c and named C,D,E,F,A,B,C.



A.V.P30^0 inclined to Vp
Through mid-point of axis.

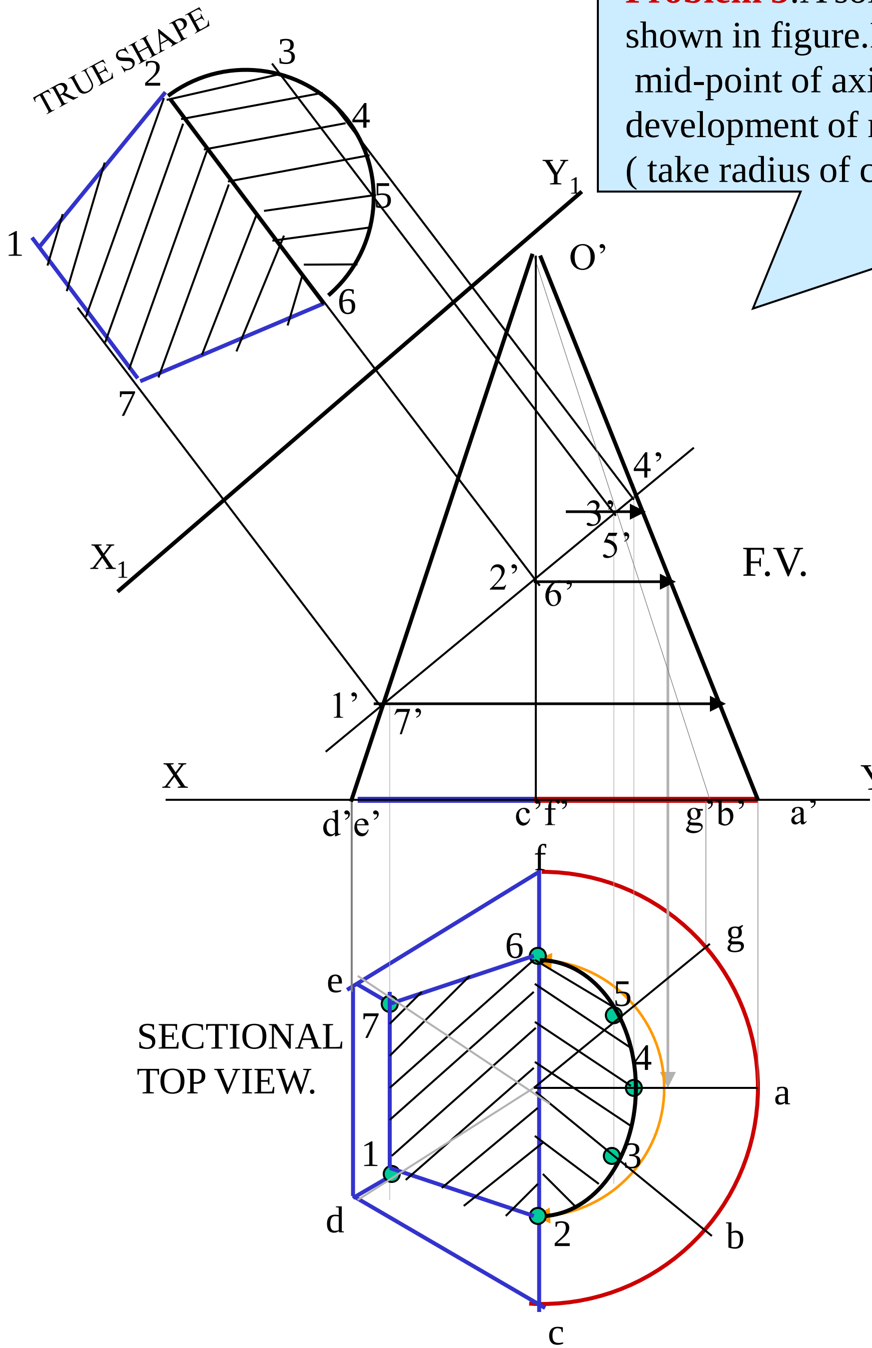
AS SECTION PLANE IS IN T.V.,
CUT OPEN FROM BOUNDRY EDGE ***C_1*** FOR DEVELOPMENT.

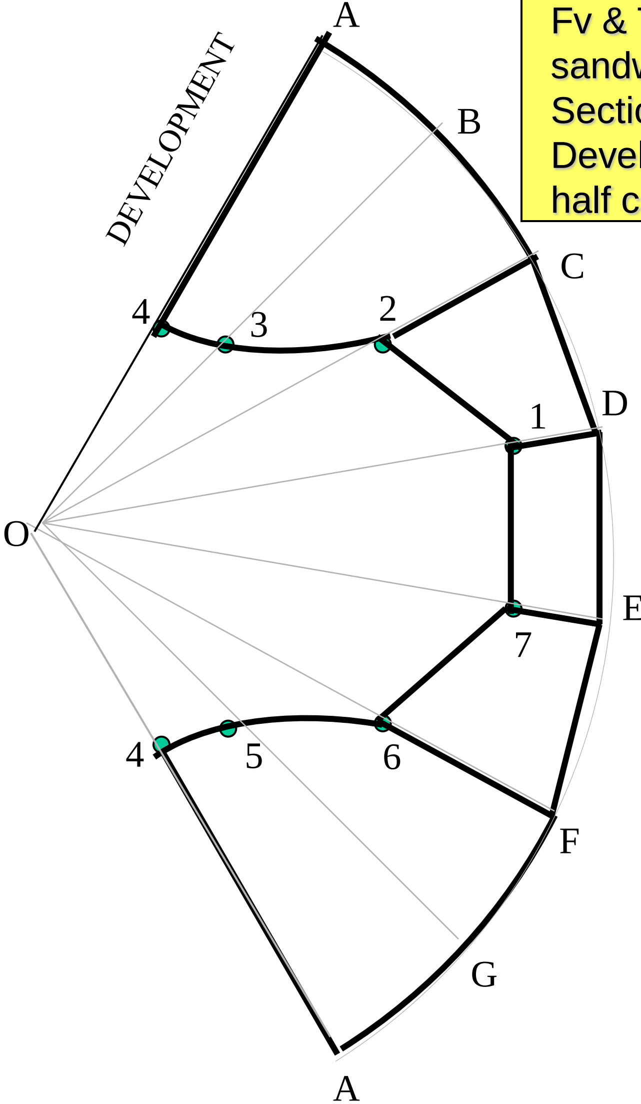


DEVELOPMENT

Problem 5:A solid composed of a half-cone and half- hexagonal pyramid is shown in figure.It is cut by a section plane 45^0 inclined to Hp, passing through mid-point of axis.Draw F.v., sectional T.v.,true shape of section and development of remaining part of the solid.
(take radius of cone and each side of hexagon 30mm long and axis 70mm.)

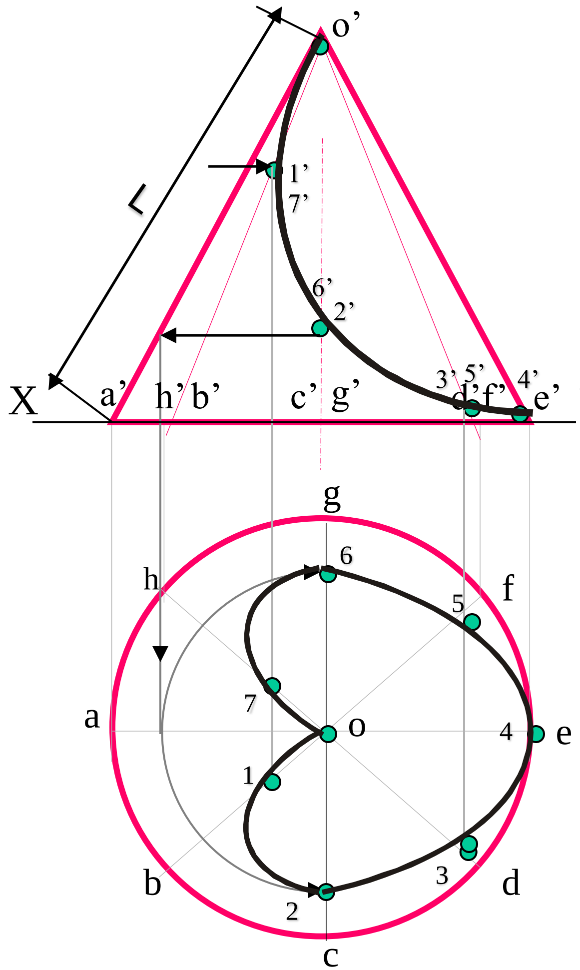
Note:
Fv & TV 8f two solids sandwiched
Section lines style in both:
Development of half cone & half pyramid:





Problem 6: Draw a semicircle 0f 100 mm diameter and inscribe in it a largest circle.If the semicircle is development of a cone and inscribed circle is some curve on it, then draw the projections of cone showing that curve.

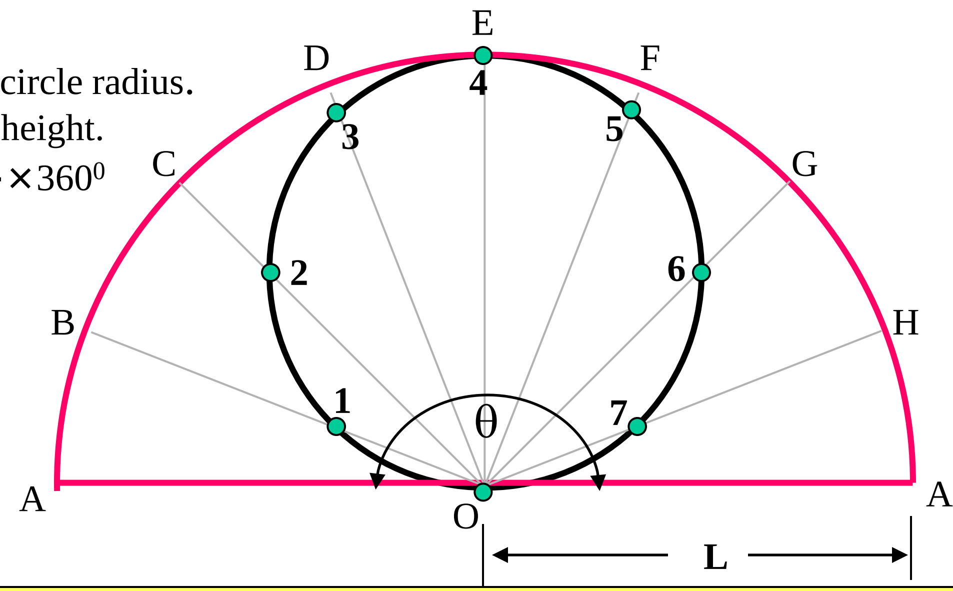
TO DRAW PRINCIPAL VIEWS FROM GIVEN DEVELOPMENT.



R=Base circle radius.

L=Slant height.

$$\theta = \frac{R}{L} \times 360^0$$



Solution Steps:

Draw semicircle of given diameter, divide it in 8 Parts and inscribe in it a largest circle as shown.Name intersecting points 1, 2, 3 etc.

Semicircle being dev.of a cone it's radius is slant height of cone.(L)

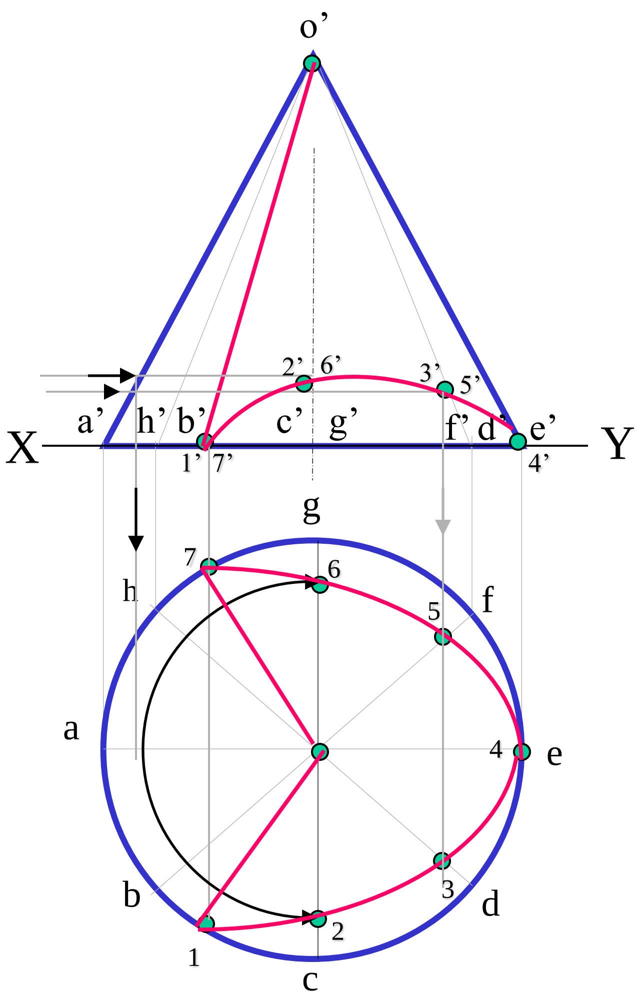
Then using above formula find R of base of cone. Using this data draw Fv & Tv of cone and form 8 generators and name.

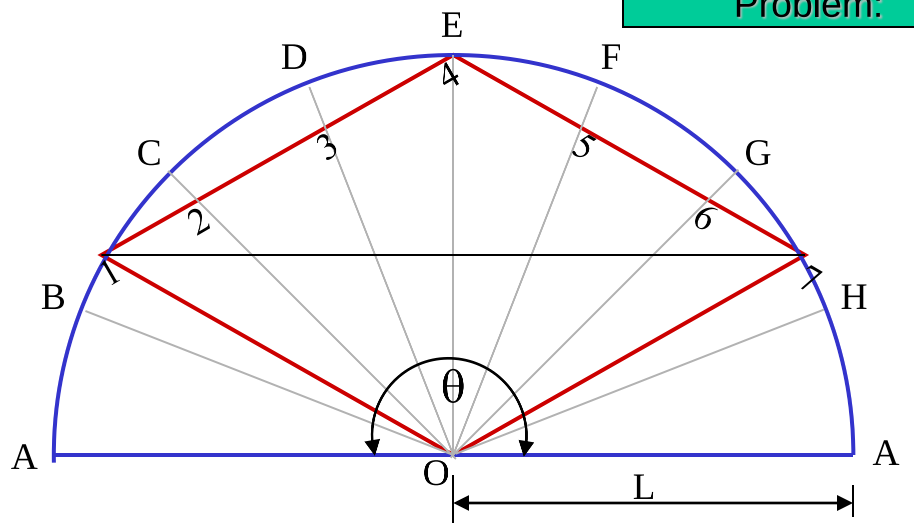
Take o -1 distance from dev.,mark on TL i.e.o'a' on Fv & bring on o'b' and name 1' Similarly locate all points on Fv. Then project all on Tv on respective generators and join by smooth curve.

Problem 7: Draw a semicircle 0f 100 mm diameter and inscribe in it a largest **rhombus**. If the semicircle is development of a cone and rhombus is some curve on it, then draw the projections of cone showing that curve.

TO DRAW PRINCIPAL VIEWS FROM GIVEN DEVELOPMENT.

Solution Steps:
Similar to previous Problem:



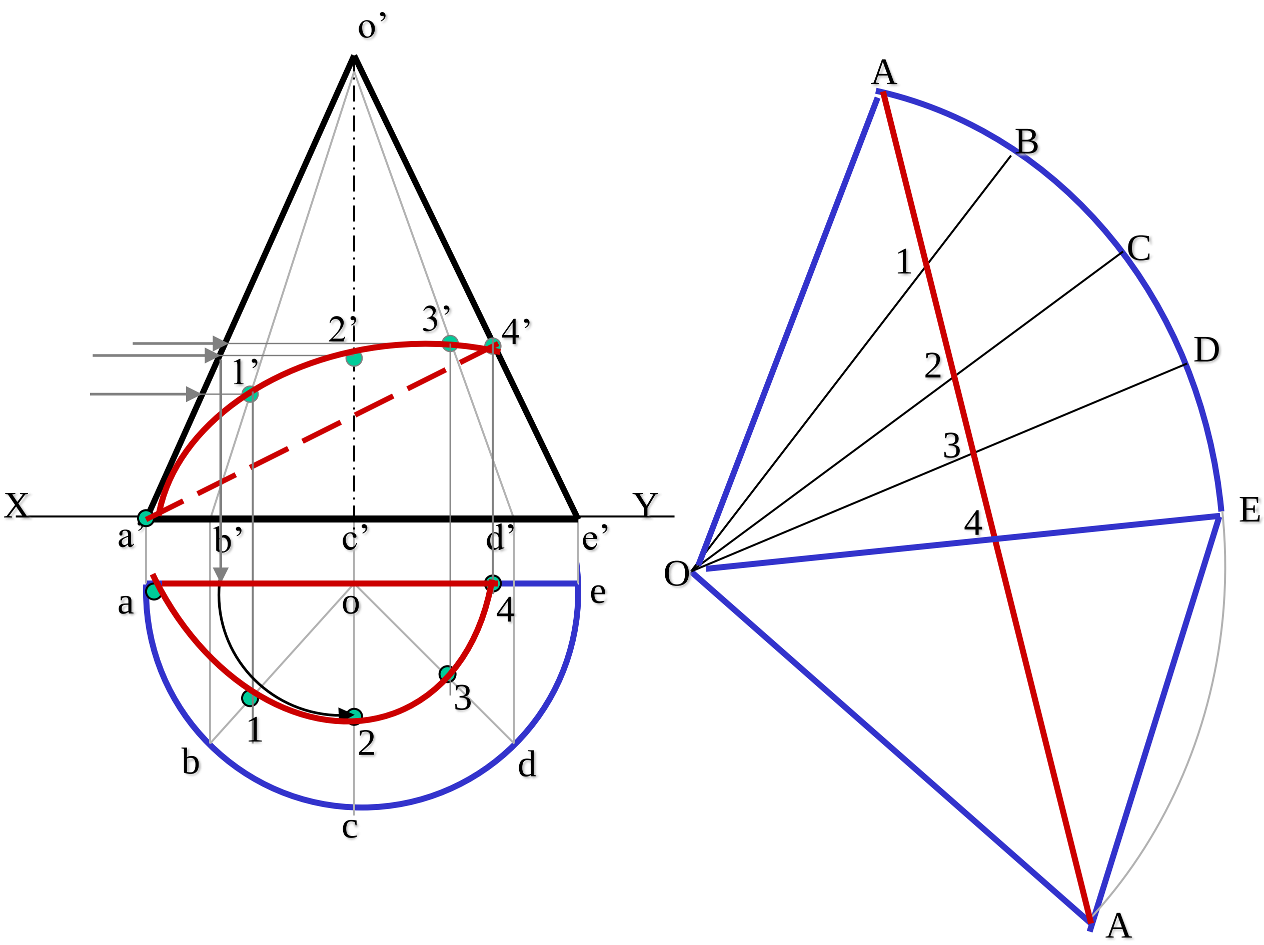


R=Base circle radius.
L=Slant height.

$$\theta = \frac{R}{L} \times 360^0$$

Problem 8: A half cone of 50 mm base diameter, 70 mm axis, is standing on it's half base on HP with it's flat face parallel and nearer to VP.An inextensible string is wound round it's surface from one point of base circle and brought back to the same point.If the string is of ***shortest length***, find it and show it on the projections of the cone.

TO DRAW A CURVE ON PRINCIPAL VIEWS FROM DEVELOPMENT.

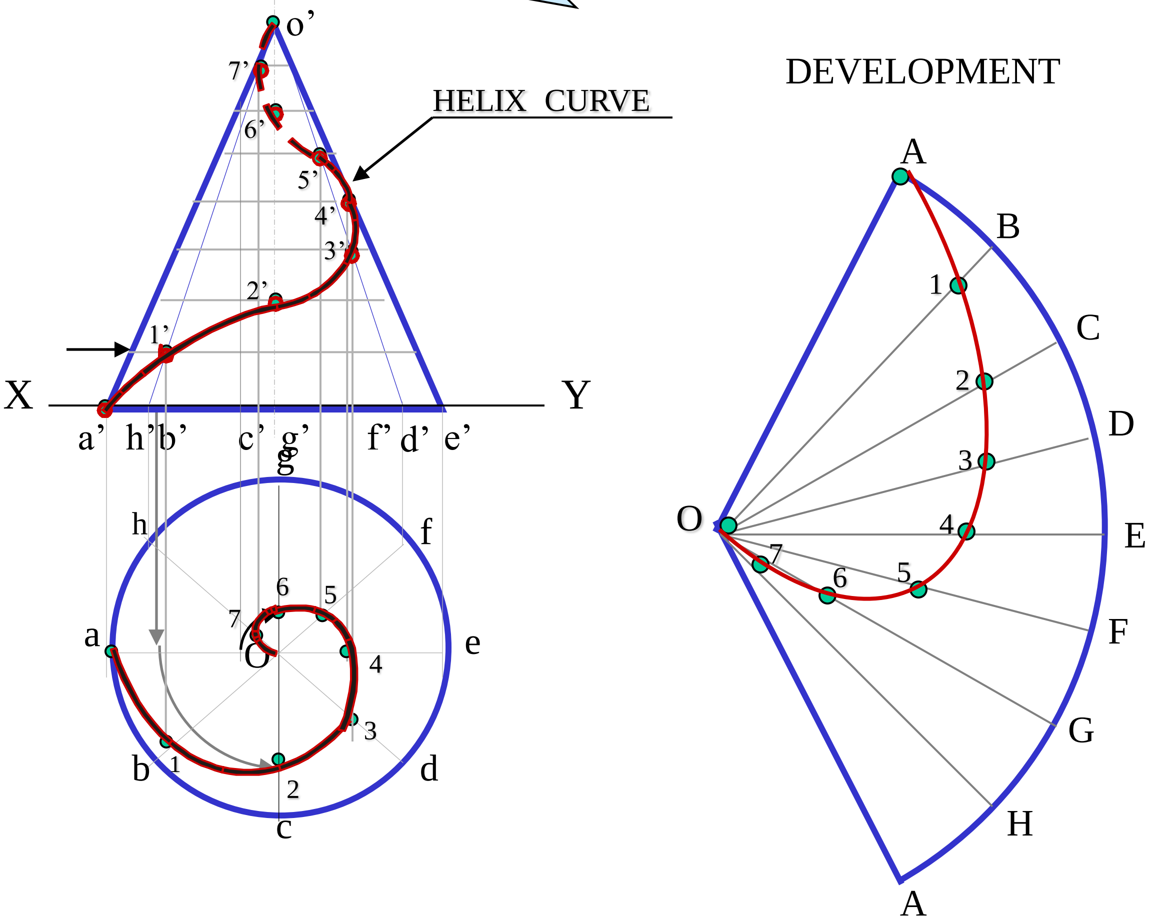


Concept: A string wound from a point up to the same Point, of shortest length Must appear st. line on it's Development.

Solution steps:

Hence draw development, Name it as usual and join A to A This is shortest Length of that string.
Further steps are as usual.
On dev. Name the points of Intersections of this line with Different generators.Bring Those on Fv & Tv and join by smooth curves.
Draw 4' a' part of string dotted As it is on back side of cone.

Problem 9: A particle which is initially on base circle of a cone, standing on Hp, moves upwards and reaches apex in one complete turn around the cone. Draw it's path on projections of cone as well as on it's development.
Take base circle diameter 50 mm and axis 70 mm long.



It's a construction of curve Helix of one turn on cone:

Draw Fv & Tv & dev.as usual
On all form generators & name.

Construction of curve Helix::

Show 8 generators on both views
Divide axis also in same parts.
Draw horizontal lines from those points on both end generators.
1' is a point where first horizontal Line & gen. b'o' intersect.
2' is a point where second horiz. Line & gen. c'o' intersect.
In this way locate all points on Fv.
Project all on Tv.Join in curvature.

For Development:

Then taking each points true Distance From resp.generator from apex, Mark on development & join.

INTERPENETRATION OF SOLIDS

WHEN ONE SOLID PENETRATES ANOTHER SOLID THEN THEIR SURFACES INTERSECT
AND
AT THE JUNCTION OF INTERSECTION A TYPICAL CURVE IS FORMED,
WHICH REMAINS COMMON TO BOTH SOLIDS.

THIS CURVE IS CALLED CURVE OF INTERSECTION
AND
IT IS A RESULT OF INTERPENETRATION OF SOLIDS.

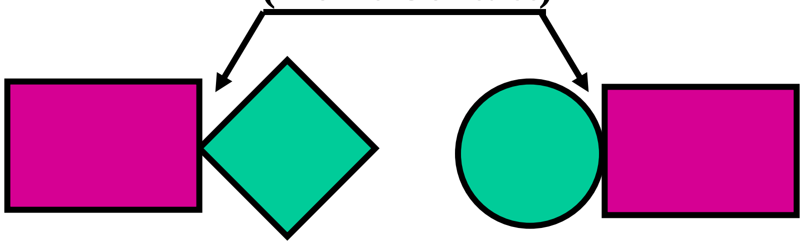
PURPOSE OF DRAWING THESE CURVES:-

WHEN TWO OBJECTS ARE TO BE JOINED TOGATHER, MAXIMUM SURFACE CONTACT BETWEEN BOTH BECOMES A BASIC REQUIREMENT FOR STRONGEST & LEAK-PROOF JOINT.

Curves of Intersections being common to both Intersecting solids, show exact & maximum surface contact of both solids.

Study Following Illustrations Carefully.

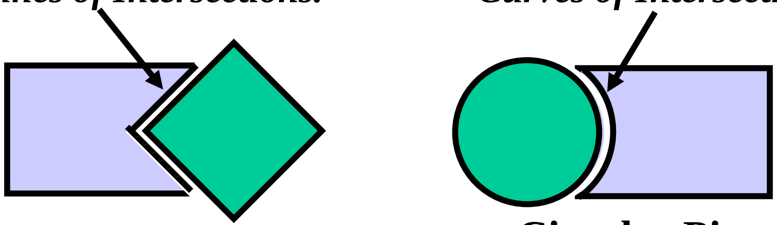
Minimum Surface Contact.
(Point Contact)



Square Pipes. **Circular Pipes.**

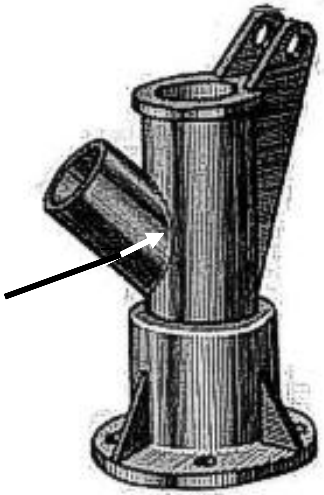
(Maximum Surface Contact)

Lines of Intersections. *Curves of Intersections.*

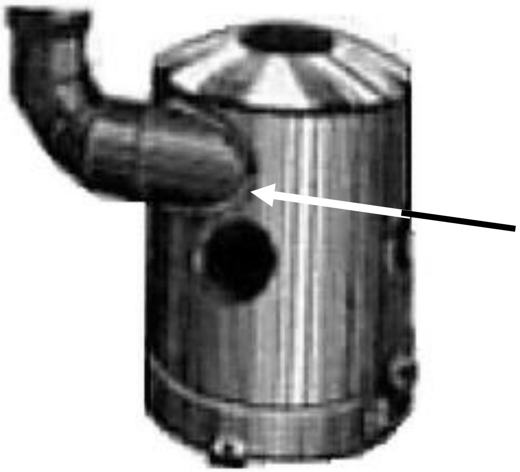


Square Pipes. **Circular Pipes.**

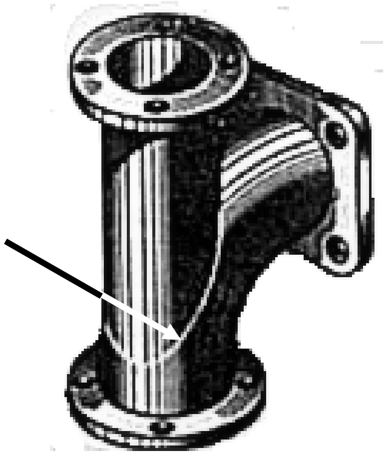
SOME ACTUAL OBJECTS ARE SHOWN, SHOWING CURVES OF INTERSECTIONS. BY WHITE ARROWS.



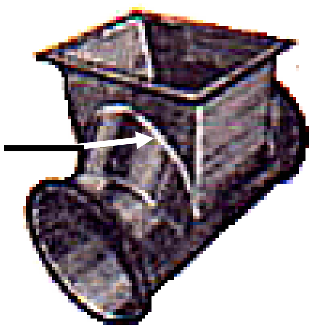
A machine component having two intersecting cylindrical surfaces with the axis at acute angle to each other.



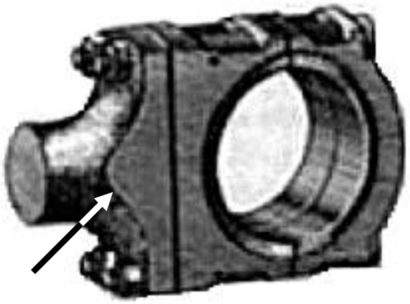
An Industrial Dust collector. Intersection of two cylinders.



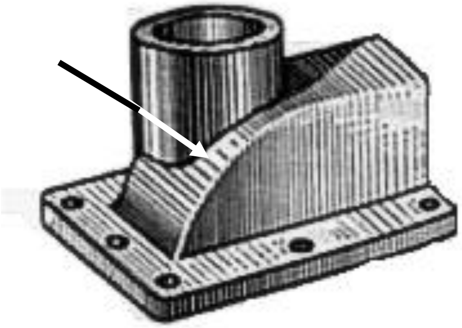
Intersection of a Cylindrical main and Branch Pipe.



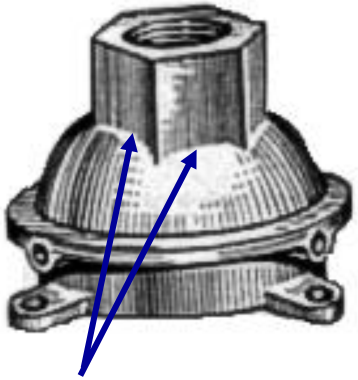
A Feeding Hopper In industry.



Forged End of a Connecting Rod.



Two Cylindrical surfaces.



Pump lid having shape of a hexagonal Prism and Hemi-sphere intersecting each other.

FOLLOWING CASES ARE SOLVED.
REFFER ILLUSTRATIONS
AND
NOTE THE COMMON
CONSTRUCTION
FOR ALL

1.CYLINDER TO CYLINDER2.

2.SQ.PRISM TO CYLINDER

3.CONE TO CYLINDER

4.TRIANGULAR PRISM TO CYLNDER

5.SQ.PRISM TO SQ.PRISM

6.SQ.PRISM TO SQ.PRISM
(SKEW POSITION)

7.SQARE PRISM TO CONE (*from top*)

8.CYLINDER TO CONE

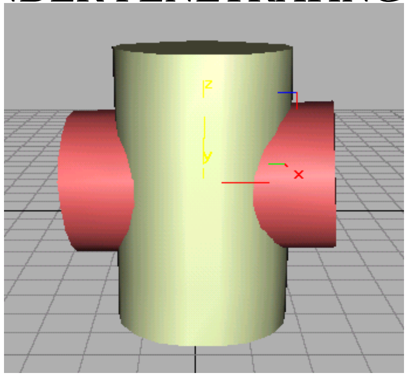
COMMON SOLUTION STEPS

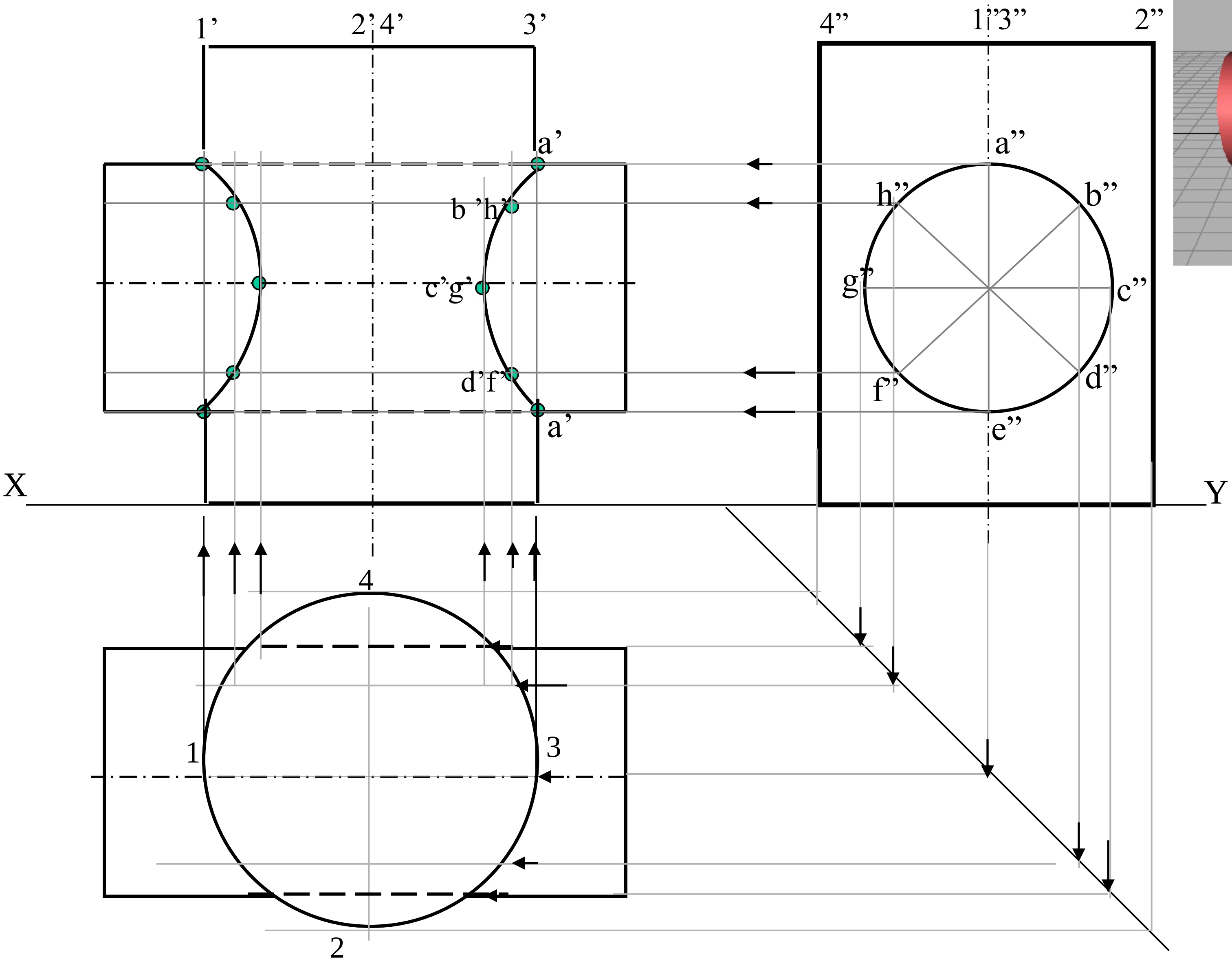
One solid will be standing on HP
Other will penetrate horizontally.
Draw three views of standing solid.
Name views as per the illustrations.
Beginning with side view draw three Views of penetrating solids also.
On it's S.V. mark number of points And name those(either letters or nos.)
The points which are on standard generators or edges of standing solid, (in S.V.) can be marked on respective generators in Fv and Tv. And other points from SV should be brought to Tv first and then projecting upward To Fv.
Dark and dotted line's decision should be taken by observing side view from it's right side as shown by arrow.
Accordingly those should be joined by curvature or straight lines.

Note:
Incase cone is penetrating solid Side view is not necessary.
Similarly in case of penetration from top it is not required.

Problem: A cylinder 50mm dia.and 70mm axis is completely penetrated by another of 40 mm dia.and 70 mm axis horizontally Both axes intersect & bisect each other. Draw projections showing curves of intersections.

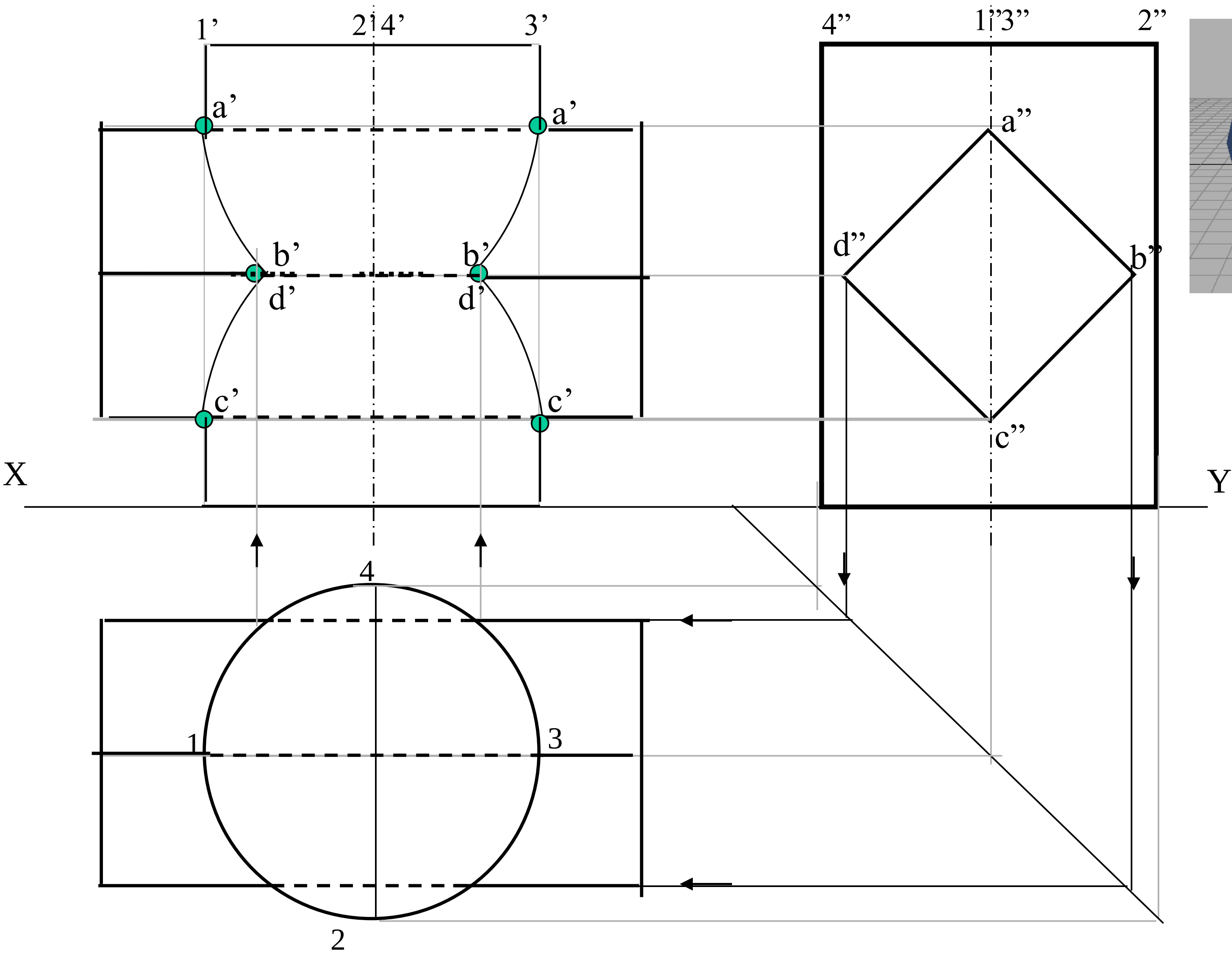
CASE 1.
CYLINDER STANDING
&
CYLINDER PENETRATING

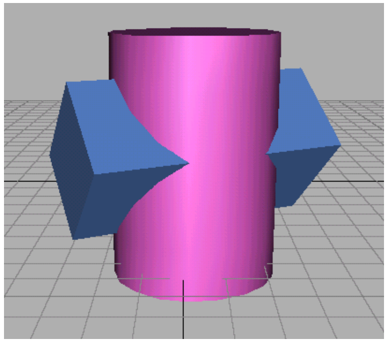




Problem: A cylinder 50mm dia.and 70mm axis is completely penetrated by a square prism of 25 mm sides.and 70 mm axis, horizontally. Both axes Intersect & bisect each other. All faces of prism are equally inclined to Hp. Draw projections showing curves of intersections.

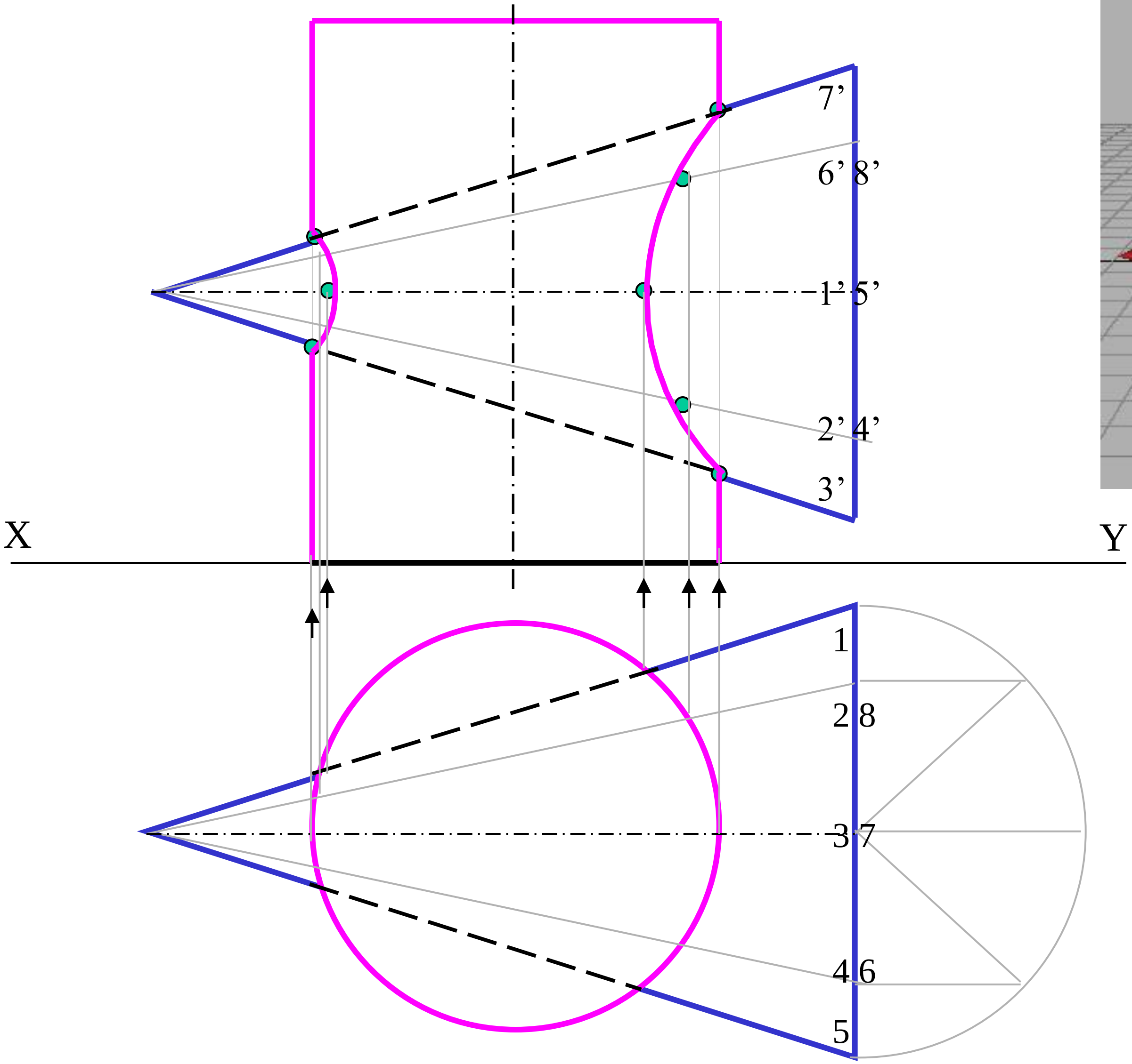
CASE 2.
CYLINDER STANDING
&
SQ.PRISM PENETRATING

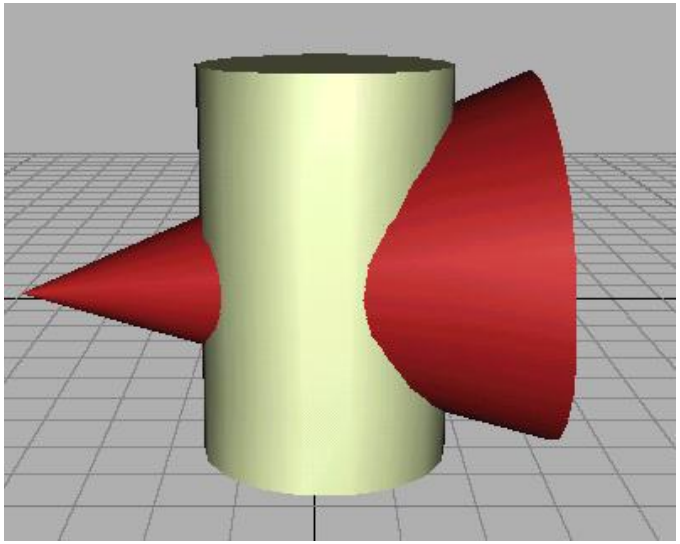




Problem: A cylinder of 80 mm diameter and 100 mm axis is completely penetrated by a cone of 80 mm diameter and 120 mm long axis horizontally.Both axes intersect & bisect each other. Draw projections showing curve of intersections.

CASE 3.
CYLINDER STANDING
&
CONE PENETRATING

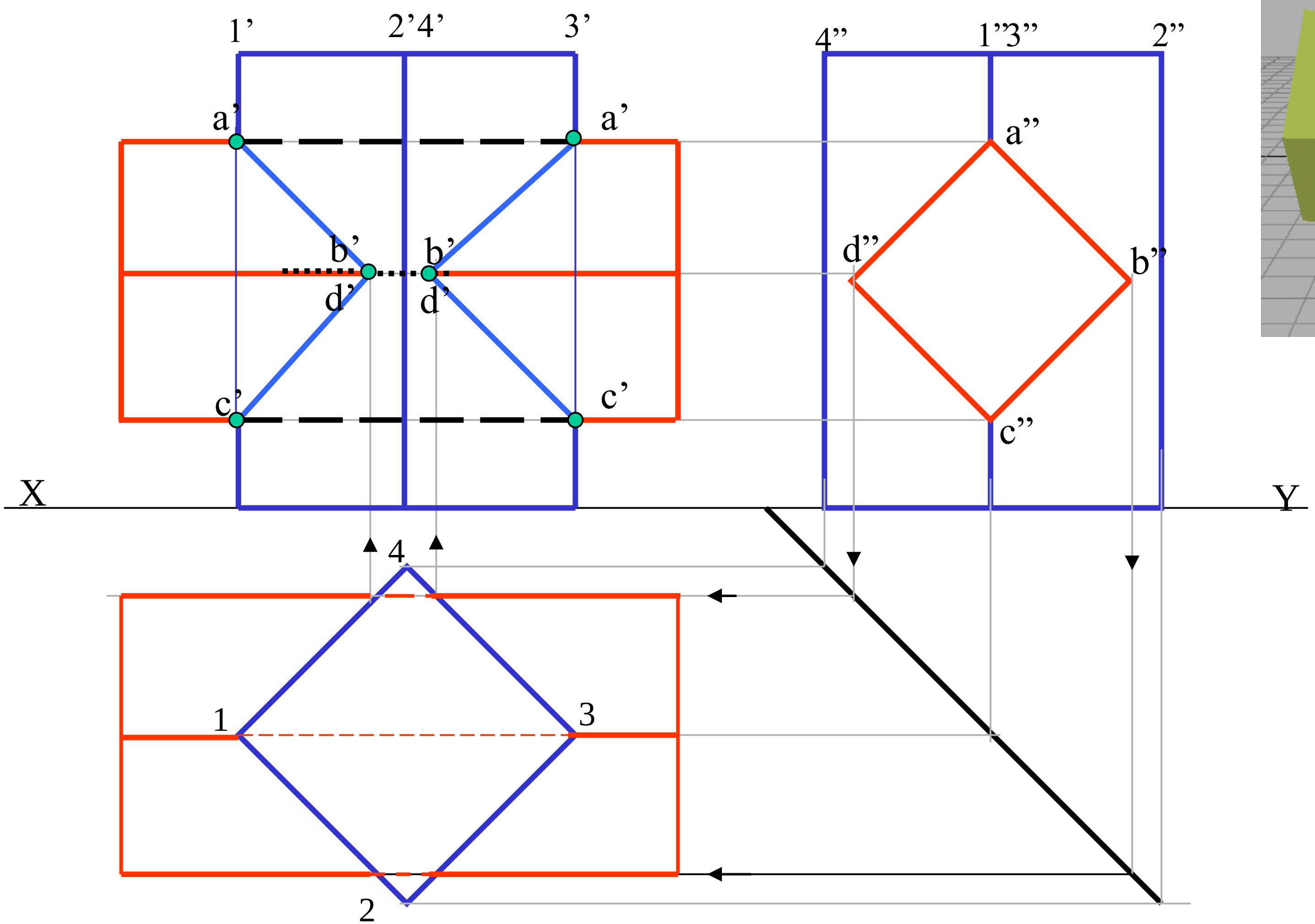


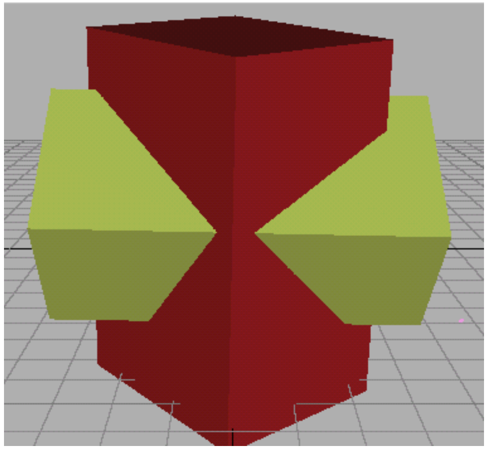


Problem: A sq.prism 30 mm base sides.and 70mm axis is completely penetrated by another square prism of 25 mm sides.and 70 mm axis, horizontally. Both axes Intersects & bisect each other. All faces of prisms are equally inclined to Vp.
Draw projections showing curves of intersections.

CASE 4.

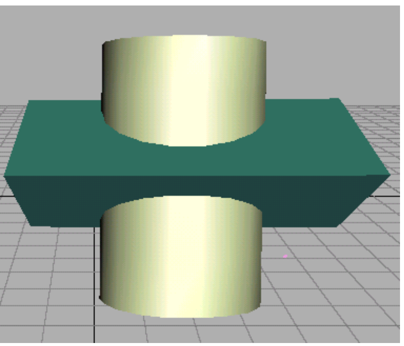
SQ.PRISM STANDING
&
SQ.PRISM PENETRATING

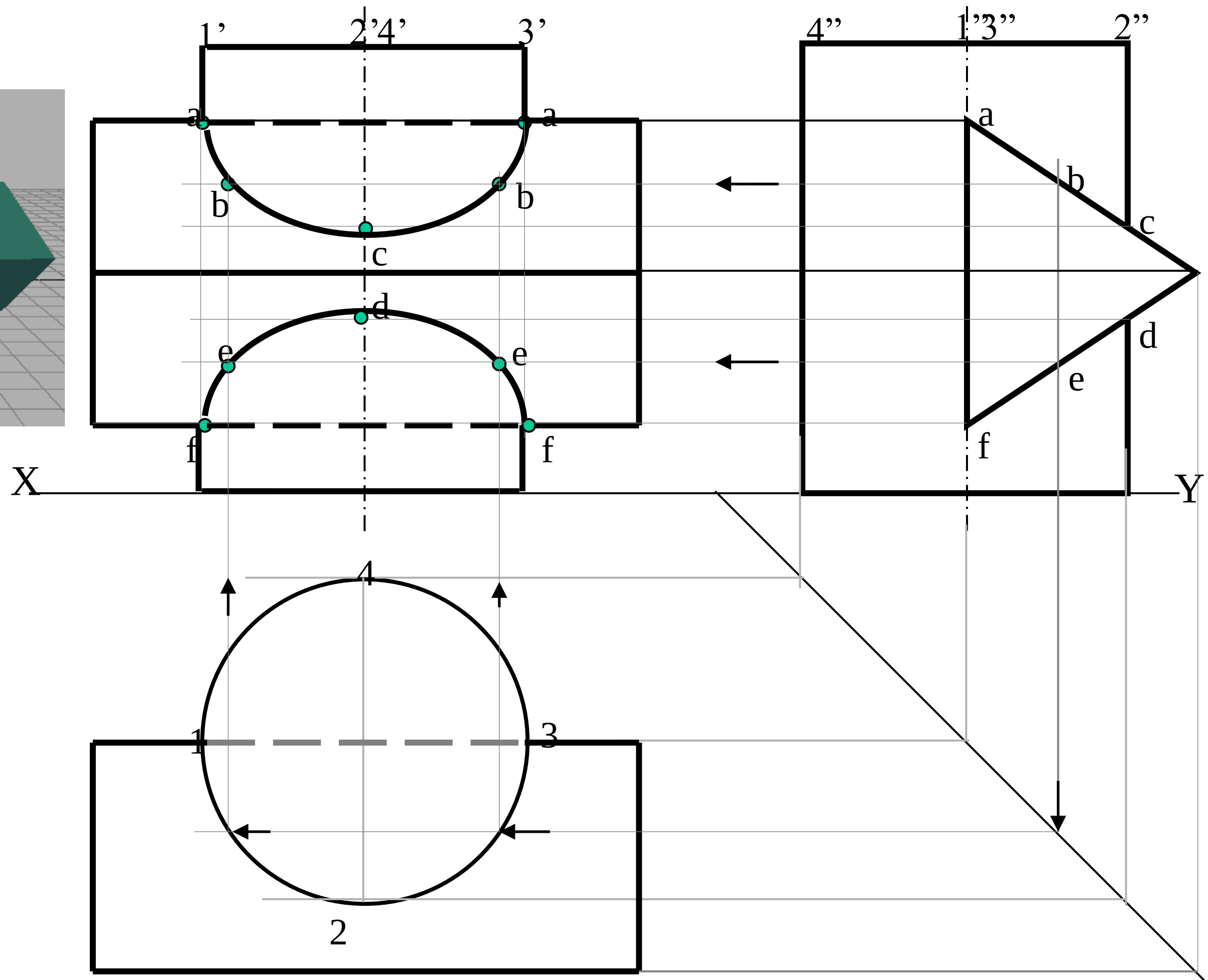


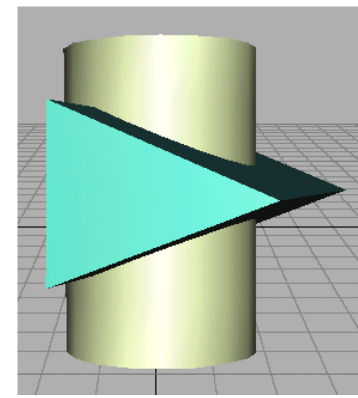


Problem: A cylinder 50mm dia.and 70mm axis is completely penetrated by a triangular prism of 45 mm sides.and 70 mm axis, horizontally. One flat face of prism is parallel to Vp and Contains axis of cylinder. Draw projections showing curves of intersections.

CASE 5. CYLINDER STANDING & TRIANGULAR PRISM PENETRATING

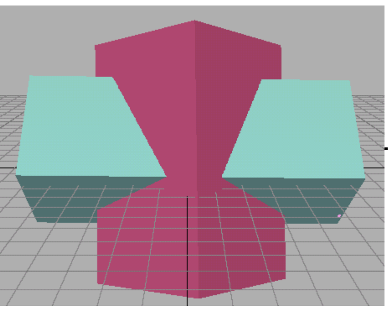


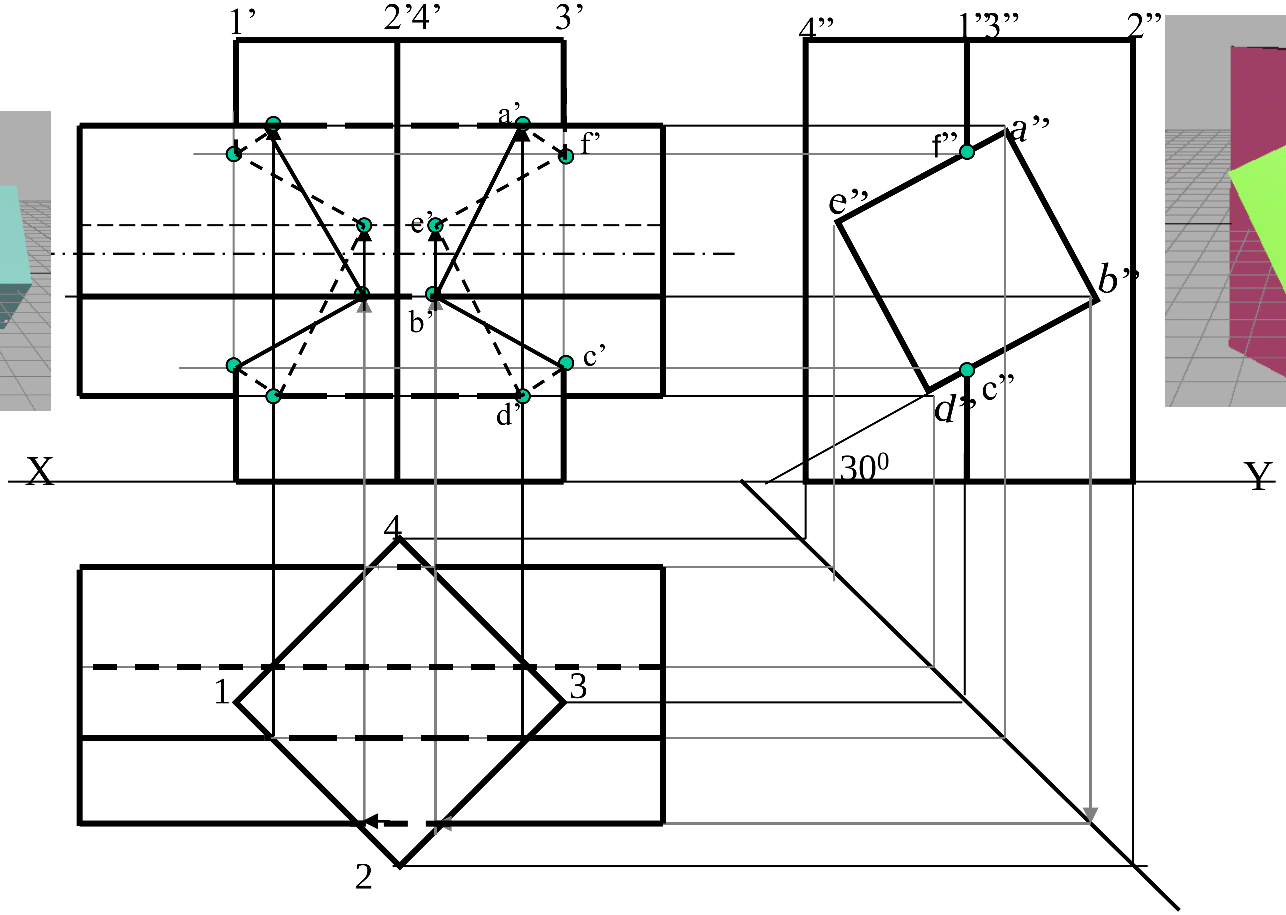


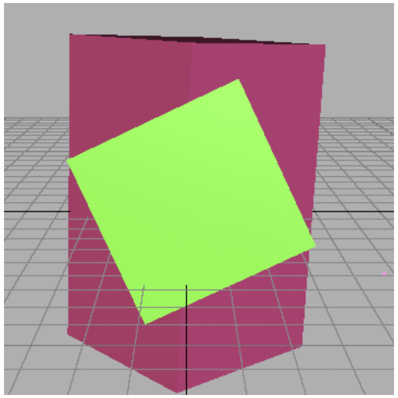


Problem: A sq.prism 30 mm base sides.and 70mm axis is completely penetrated by another square prism of 25 mm side s.and 70 mm axis, horizontally. Both axes Intersect & bisect each other.Two faces of penetrating prism are 30^0 inclined to Hp. Draw projections showing curves of intersections.

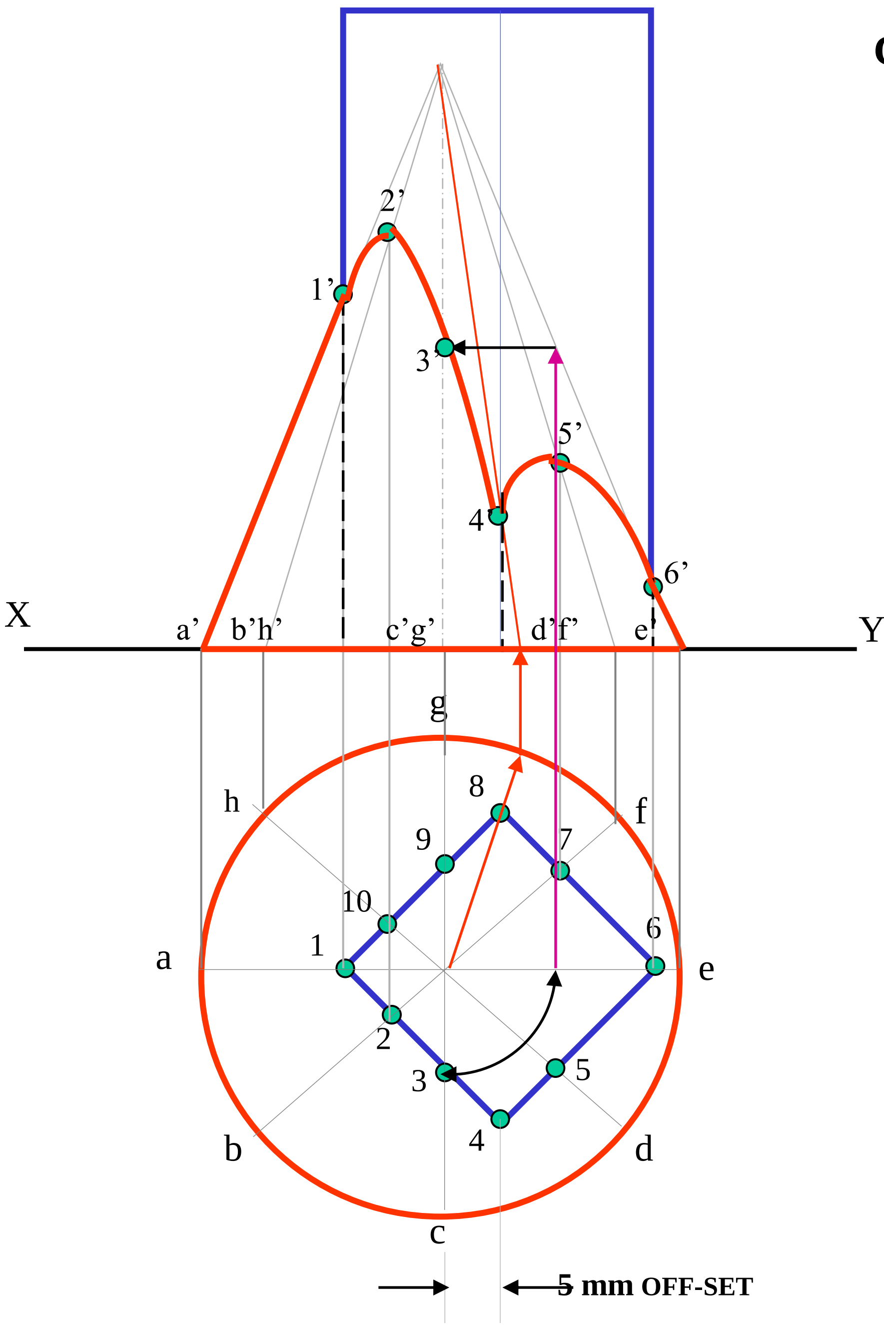
CASE 6.
SQ.PRISM STANDING & SQ.PRISM PENETRATING (30^0 SKEW POSITION)

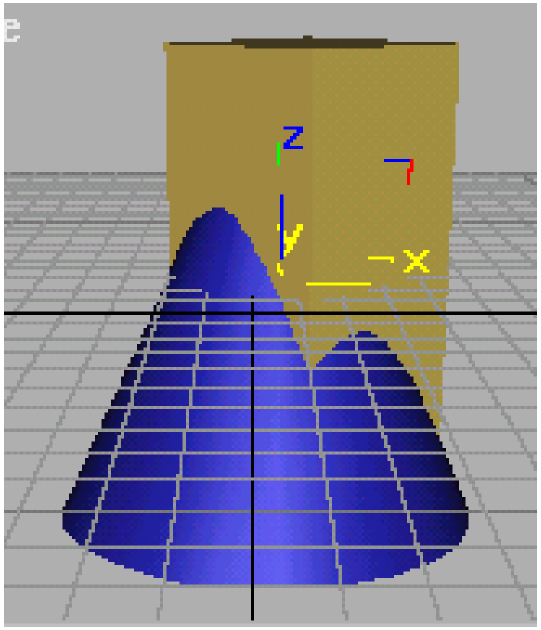






CASE 7.
CONE STANDING & SQ.PRISM PENETRATING (BOTH AXES VERTICAL)

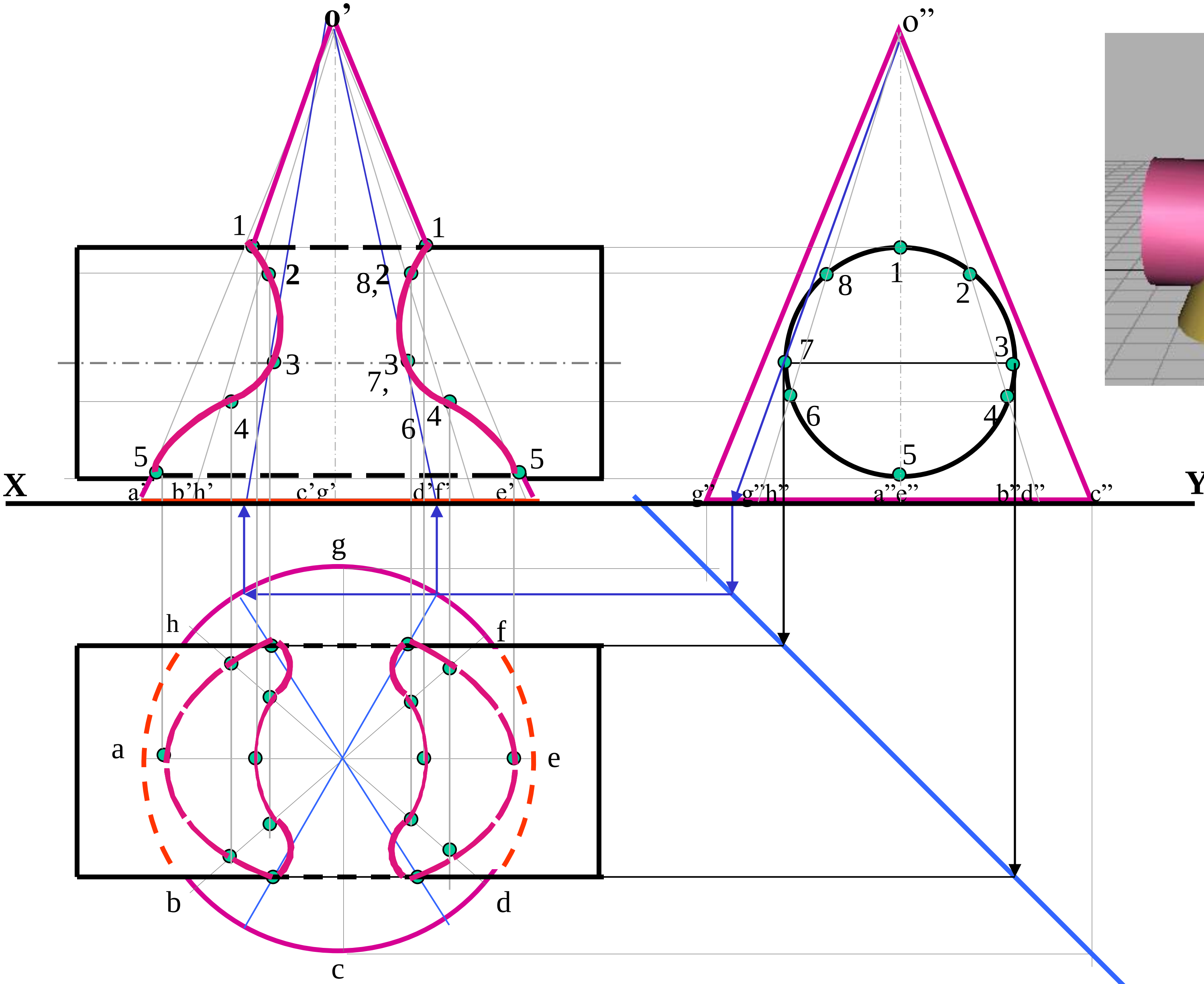


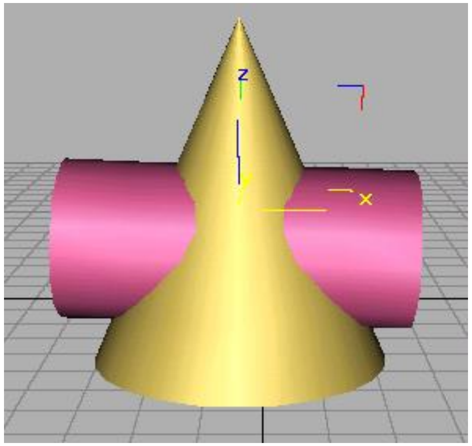


Problem: A cone70 mm base diameter and 90 mm axis is completely penetrated by a square prism from top with it's axis // to cone's axis and 5 mm away from it. a vertical plane containing both axes is parallel to Vp. Take all faces of sq.prism equally inclined to Vp. Base Side of prism is 0 mm and axis is 100 mm long. Draw projections showing curves of intersections.

Problem: A vertical cone, base diameter 75 mm and axis 100 mm long, is completely penetrated by a cylinder of 45 mm diameter. The axis of the cylinder is parallel to Hp and Vp and intersects axis of the cone at a point 28 mm above the base. Draw projections showing curves of intersection.

CASE 8.
CONE STANDING
&
CYLINDER PENETRATING





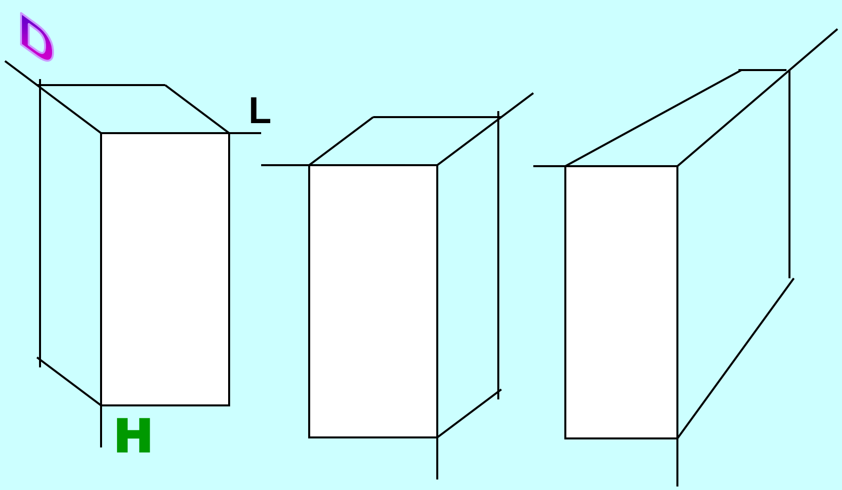
ISOMETRIC DRAWING

IT IS A TYPE OF PICTORIAL PROJECTION IN WHICH ALL THREE DIMENSIONS OF AN OBJECT ARE SHOWN IN ONE VIEW AND IF REQUIRED, THEIR ACTUAL SIZES CAN BE MEASURED DIRECTLY FROM IT.

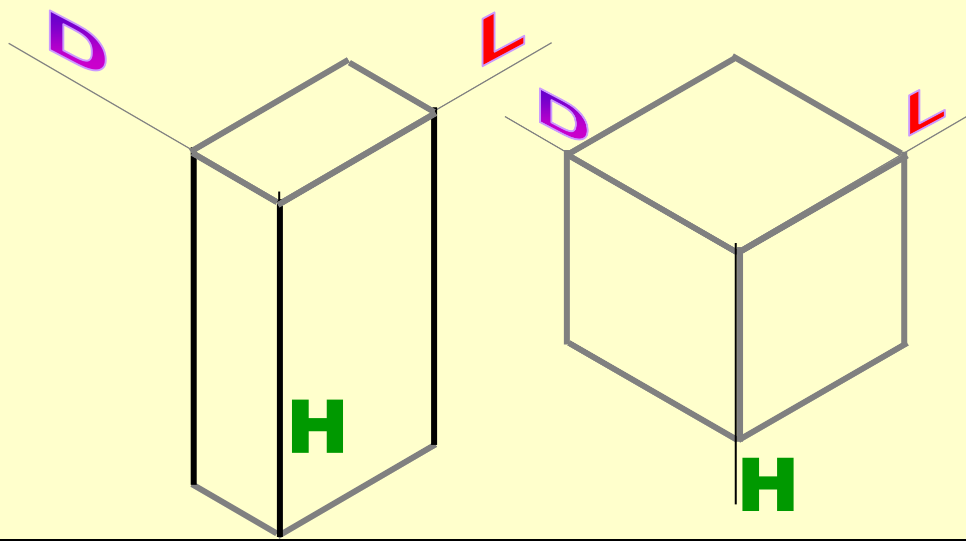
TYPICAL CONDITION.

IN THIS 3-D DRAWING OF AN OBJECT, ALL THREE DIMENSIONAL AXES ARE MENTAINED AT EQUAL INCLINATIONS WITH EACH OTHER.(120^0)

3-D DRAWINGS CAN BE DRAWN IN NUMEROUS WAYS AS SHOWN BELOW. ALL THESE DRAWINGS MAY BE CALLED 3-DIMENSIONAL DRAWINGS, OR PHOTOGRAPHIC OR PICTORIAL DRAWINGS. HERE NO SPECIFIC RELATION AMONG H, L & D AXES IS MENTAINED.



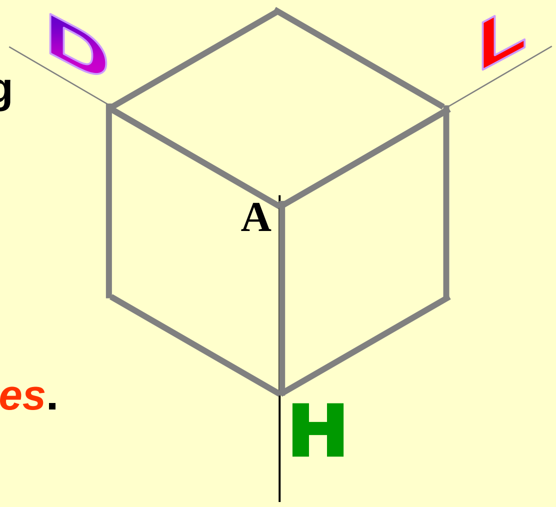
NOW OBSERVE BELOW GIVEN DRAWINGS. ONE CAN NOTE SPECIFIC INCLINATION AMONG H, L & D AXES. ISO MEANS SAME, SIMILAR OR EQUAL. HERE ONE CAN FIND EDUAL INCLINATION AMONG H, L & D AXES. EACH IS 120^0 INCLINED WITH OTHER TWO. HENCE IT IS CALLED ISOMETRIC DRAWING



PURPOSE OF ISOMETRIC DRAWING IS TO UNDERSTAND OVERALL SHAPE, SIZE & APPEARANCE OF AN OBJECT PRIOR TO IT'S PRODUCTION.

SOME IMPORTANT TERMS:

ISOMETRIC AXES, LINES AND PLANES:



The three lines AL, AD and AH, meeting at point A and making 120^0 angles with each other are termed *Isometric Axes.*

The lines parallel to these axes are called *Isometric Lines*.

The planes representing the faces of of the cube as well as other planes parallel to these planes are called *Isometric Planes*.

ISOMETRIC SCALE:

When one holds the object in such a way that all three dimensions are visible then in the process all dimensions become proportionally inclined to observer's eye sight and hence appear apparent in lengths.

This reduction is 0.815 or 9 / 11 (approx.) It forms a reducing scale which Is used to draw isometric drawings and is called *Isometric scale.*

In practice, while drawing isometric projection, it is necessary to convert true lengths into isometric lengths for measuring and marking the sizes. This is conveniently done by constructing an isometric scale as described on next page.

TYPES OF ISOMETRIC DRAWINGS

ISOMETRIC VIEW

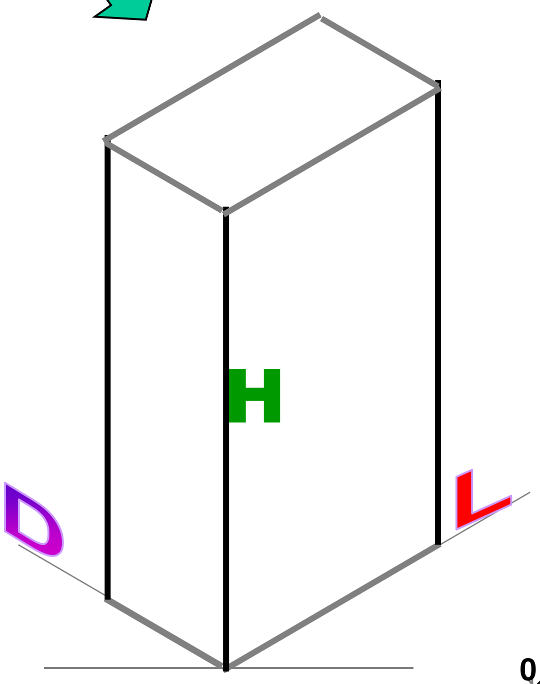
Drawn by using True scale

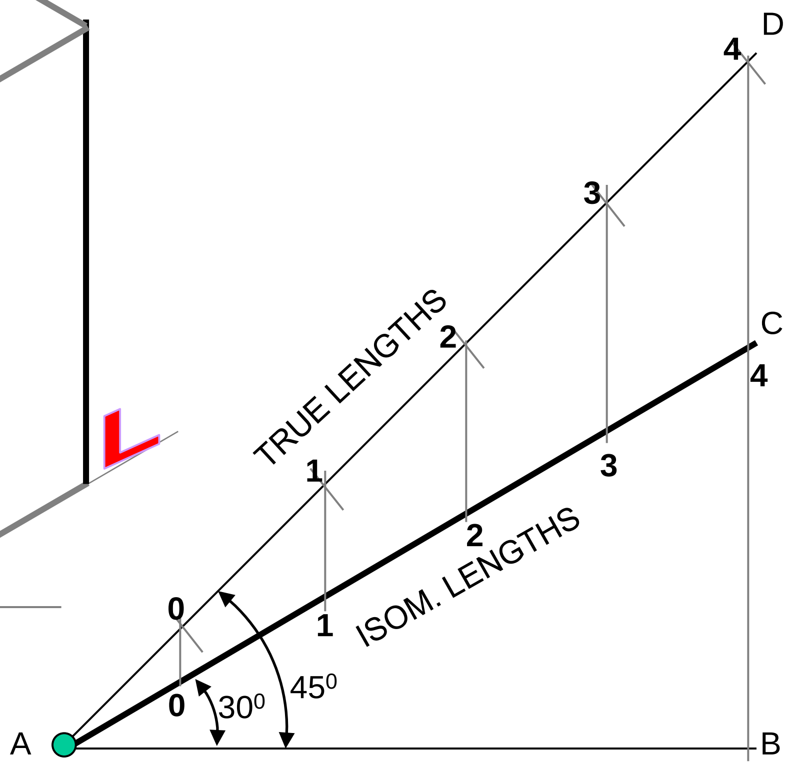
(True dimensions)

ISOMETRIC PROJECTION

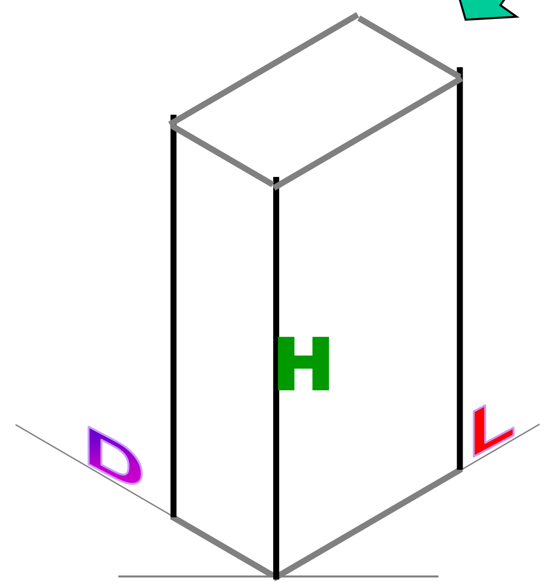
Drawn by using Isometric scale

(Reduced dimensions)





Isometric scale [Line AC]
required for Isometric Projection



CONSTRUCTION OF ISOM.SCALE.

From point A, with line AB draw 30^0 and 45^0 inclined lines AC & AD resp on AD. Mark divisions of true length and from each division-point draw vertical lines upto AC line.

The divisions thus obtained on AC give lengths on isometric scale.

1

ISOMETRIC OF PLANE FIGURES

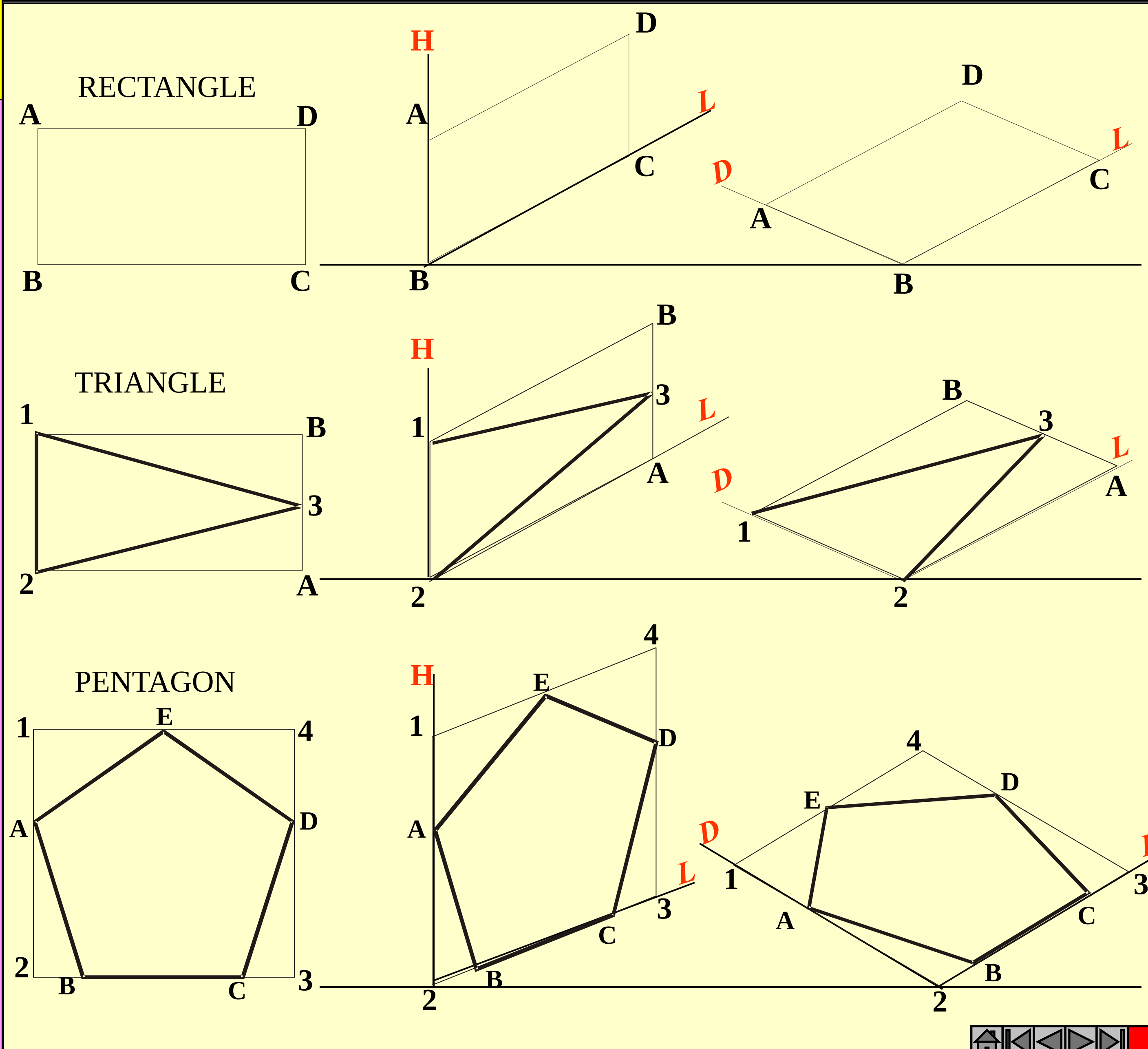
AS THESE ALL ARE 2-D FIGURES WE REQUIRE ONLY TWO ISOMETRIC AXES.

IF THE FIGURE IS FRONT VIEW, H & L AXES ARE REQUIRED.

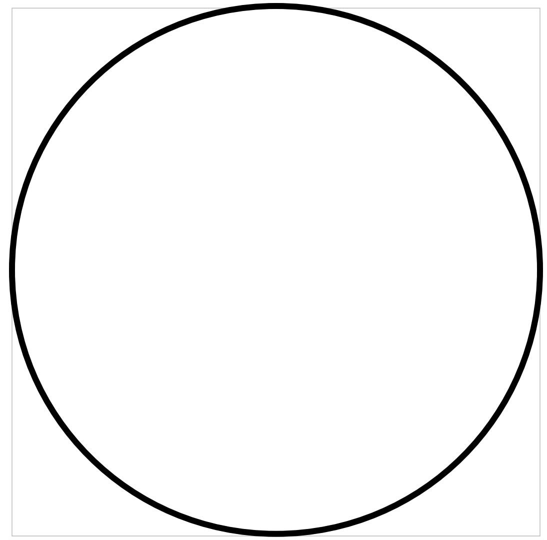
IF THE FIGURE IS TOP VIEW, D & L AXES ARE REQUIRED.

Shapes containing Inclined lines should be enclosed in a rectangle as shown. Then first draw isom. of that rectangle and then inscribe that shape as it is.

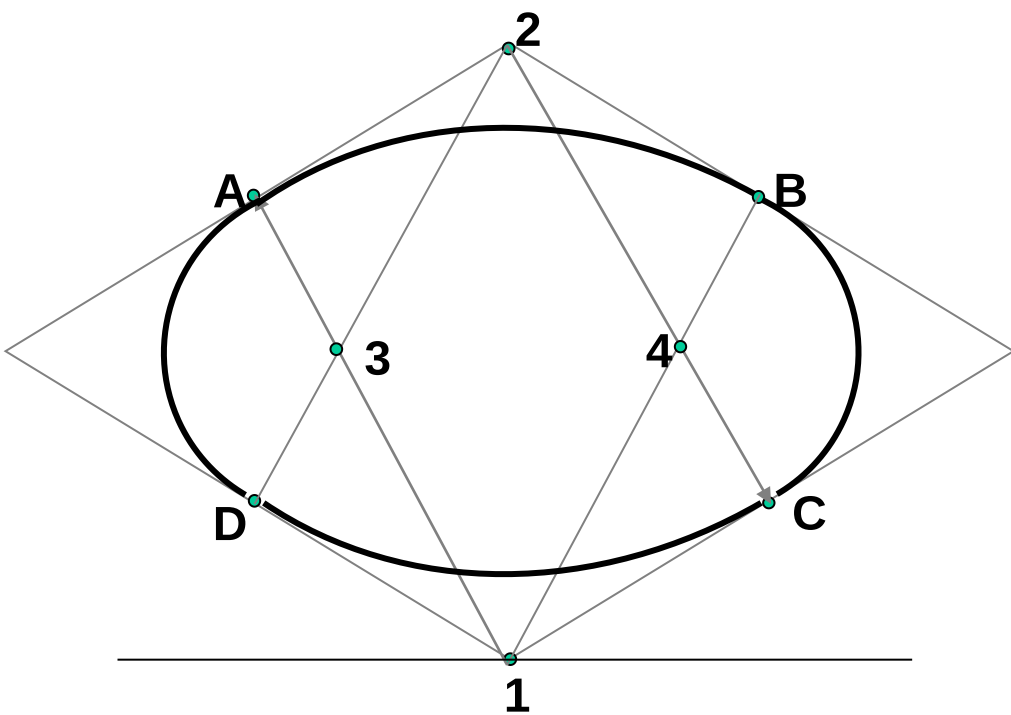
SHAPE	Isometric view if the Shape is F.V.	or T.V.

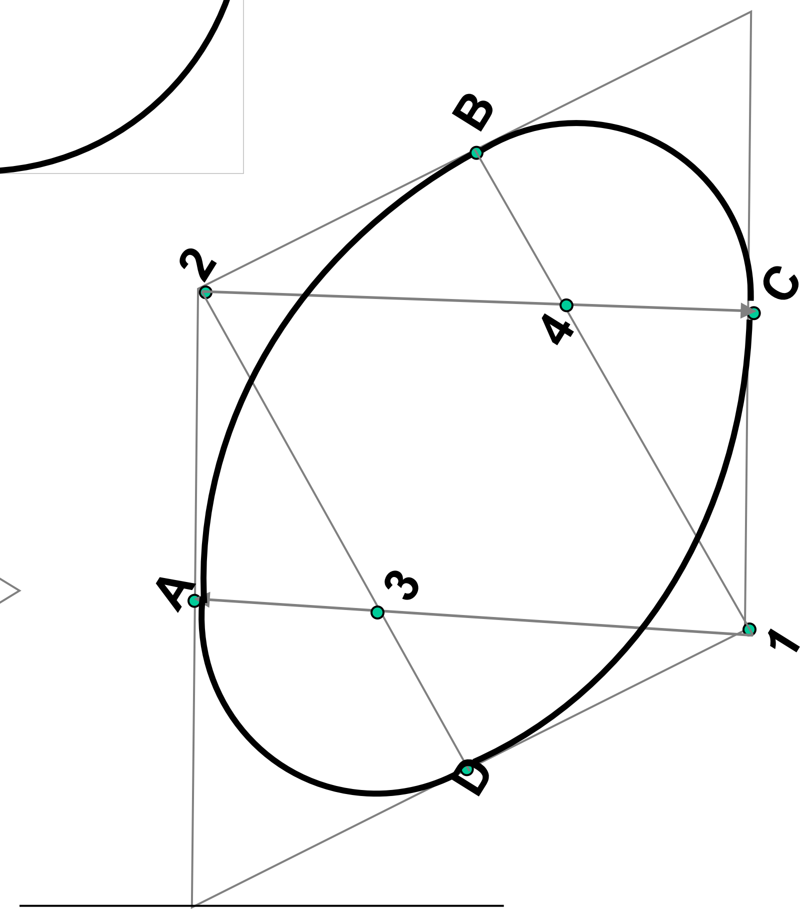


DRAW ISOMETRIC VIEW OF A CIRCLE IF IT IS A TV OR FV.



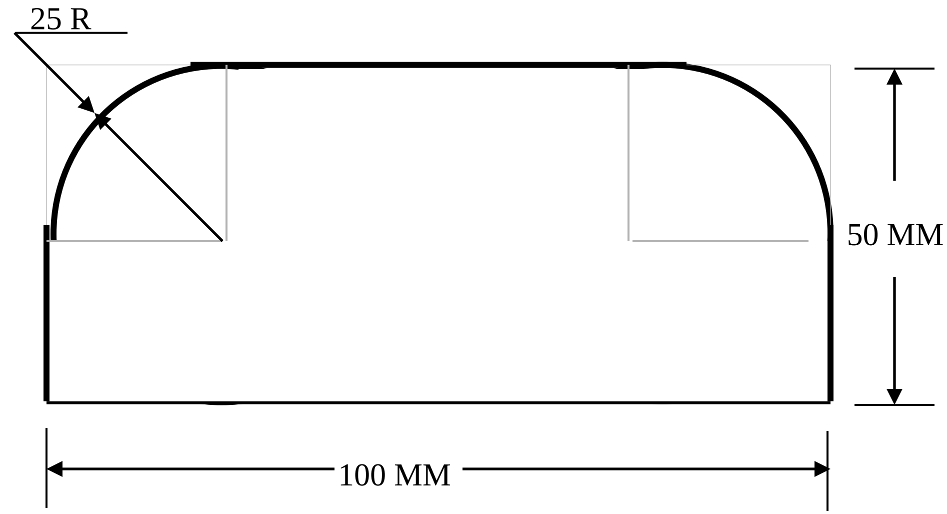
FIRST ENCLOSE IT IN A SQUARE.
IT'S ISOMETRIC IS A RHOMBUS WITH D & L AXES FOR TOP VIEW.
THEN USE H & L AXES FOR ISOMETRIC WHEN IT IS FRONT VIEW.
FOR CONSTRUCTION USE RHOMBUS METHOD SHOWN HERE. STUDY IT.



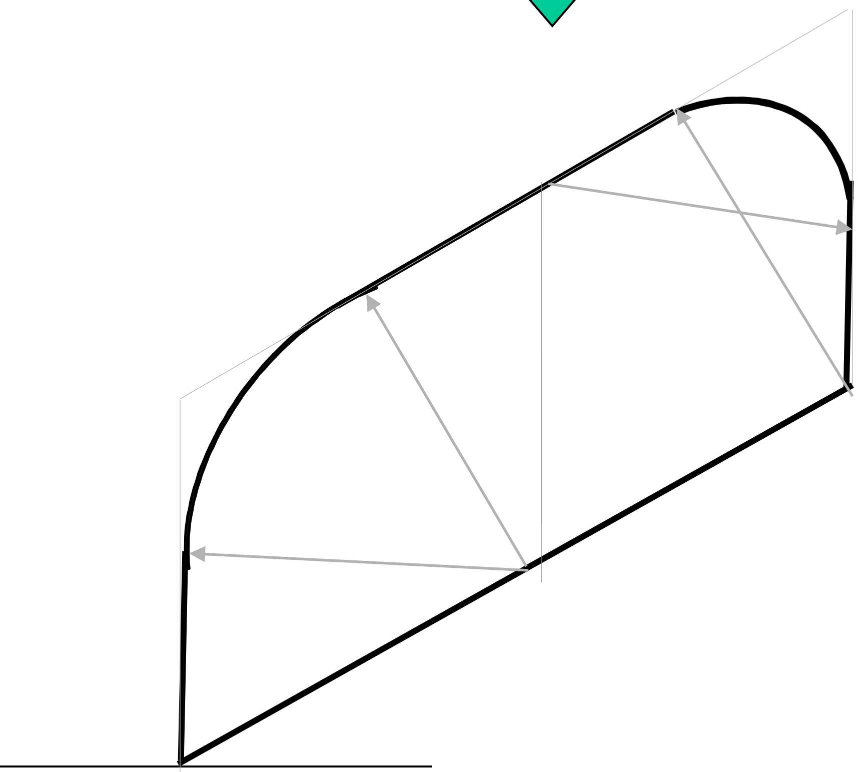


STUDY ILLUSTRATIONS

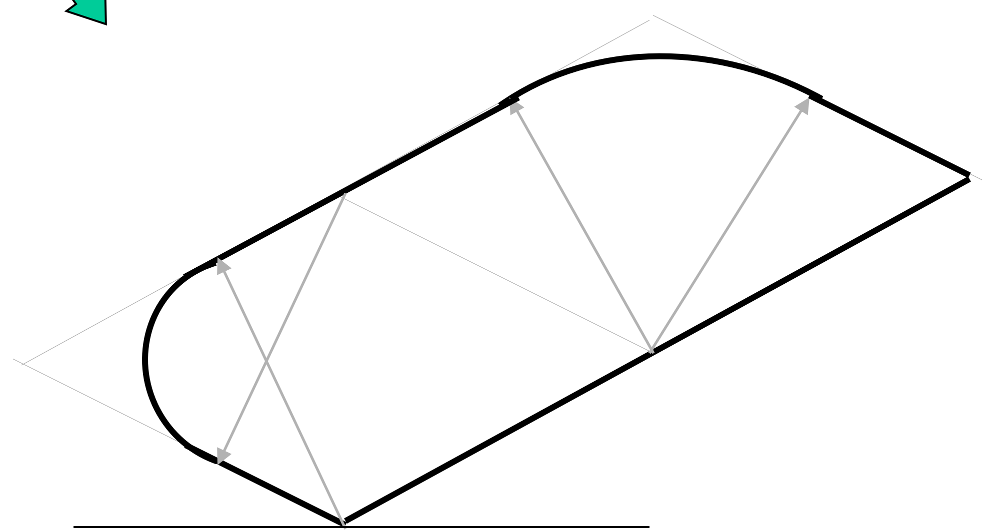
DRAW ISOMETRIC VIEW OF THE FIGURE SHOWN WITH DIMENTIONS (ON RIGHT SIDE) CONSIDERING IT FIRST AS F.V. AND THEN T.V.



IF FRONT VIEW



IF TOP VIEW



ISOMETRIC
OF
PLANE FIGURES

AS THESE ALL ARE 2-D FIGURES WE REQUIRE ONLY TWO ISOMETRIC AXES.

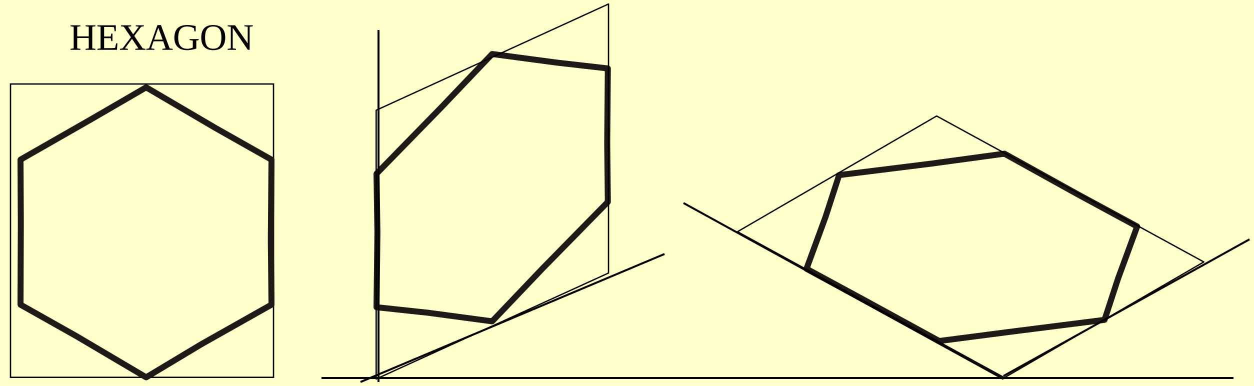
IF THE FIGURE IS FRONT VIEW, H & L AXES ARE REQUIRED.

IF THE FIGURE IS TOP VIEW, D & L AXES ARE REQUIRED.

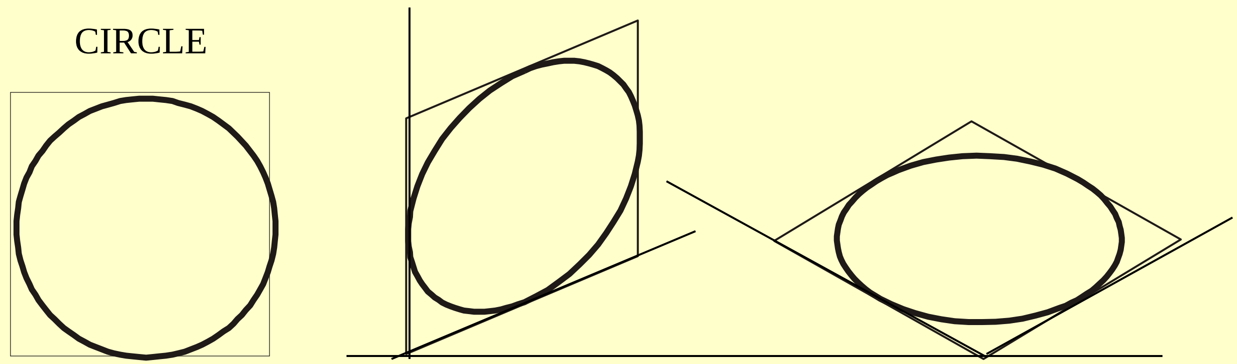
For Isometric of Circle/Semicircle use Rhombus method. Construct it of sides equal to diameter of circle always. (Ref. Previous two pages.)

SHAPE	IF F.V.	IF T.V.

HEXAGON

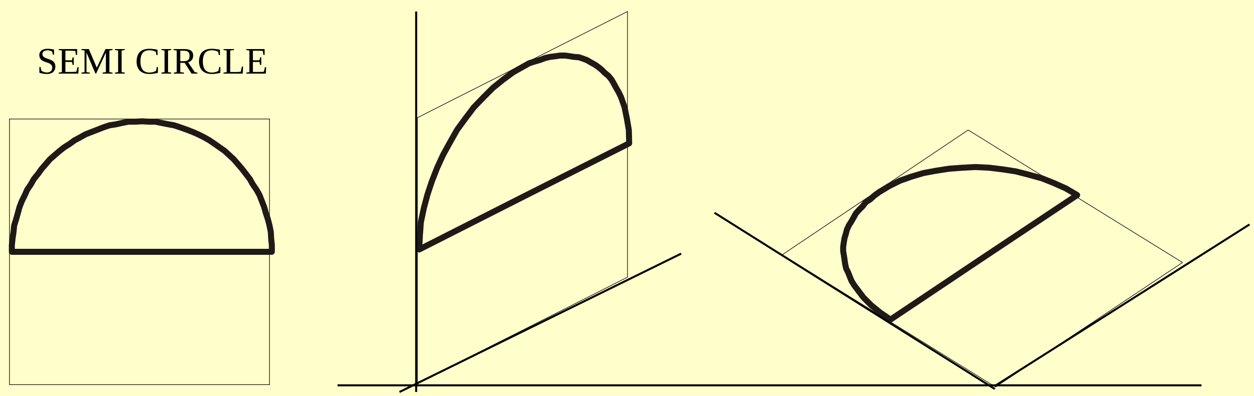


CIRCLE



For Isometric of Circle/Semicircle use **Rhombus method.** ***Construct Rhombus of sides equal to Diameter of circle always.*** **(Ref. topic ENGG. CURVES.)**

SEMI CIRCLE

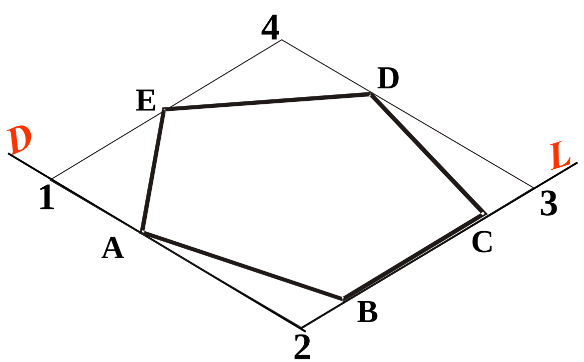


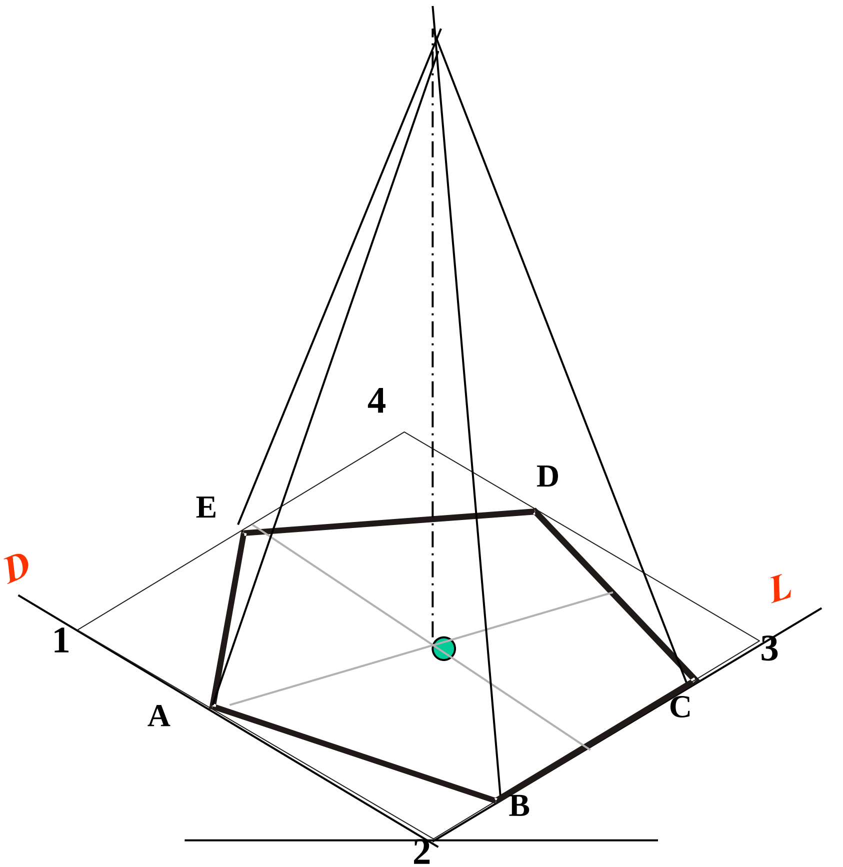
STUDY ILLUSTRATIONS

ISOMETRIC VIEW OF PENTAGONAL PYRAMID STANDING ON H.P.

(Height is added from center of pentagon)

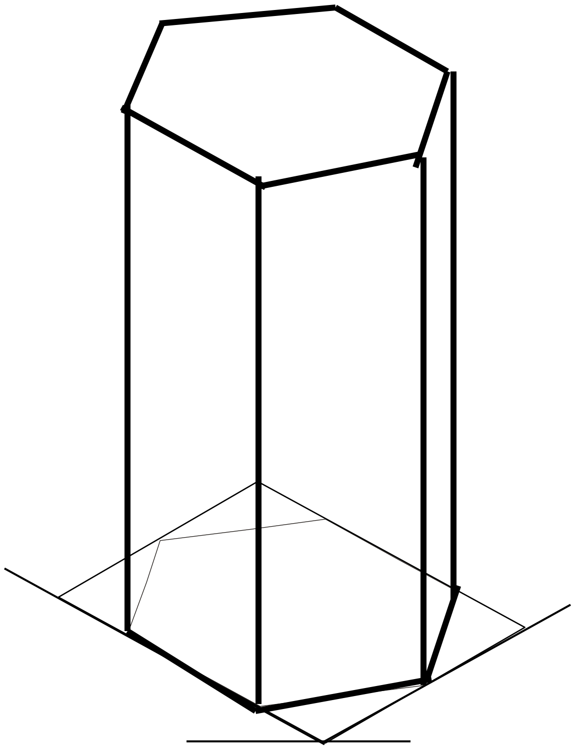
ISOMETRIC VIEW OF BASE OF PENTAGONAL PYRAMID STANDING ON H.P.





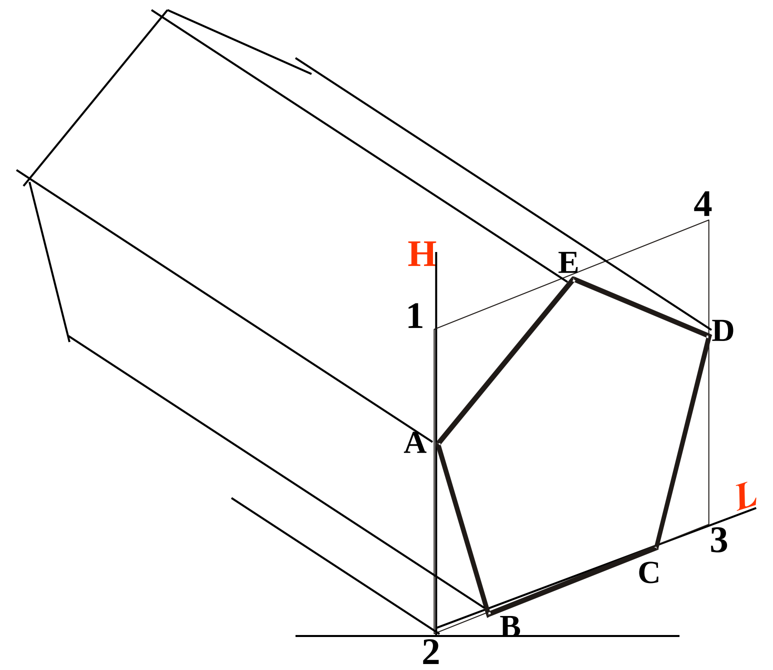
STUDY ILLUSTRATIONS

7



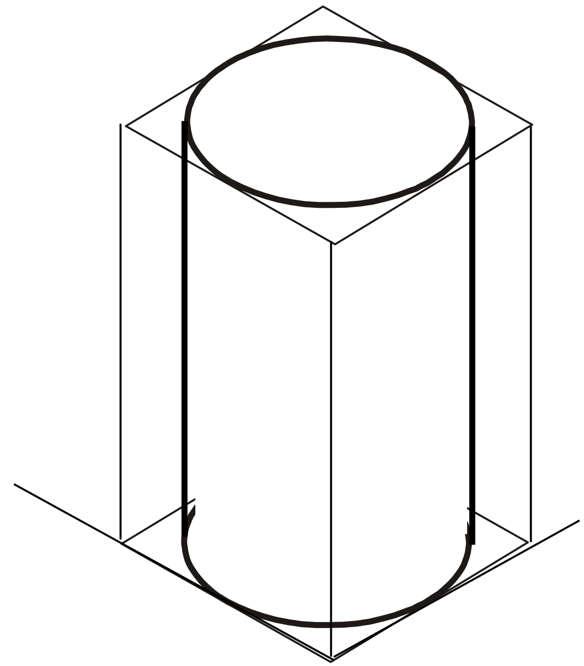
ISOMETRIC VIEW OF
HEXAGONAL PRISM
STANDING ON H.P.

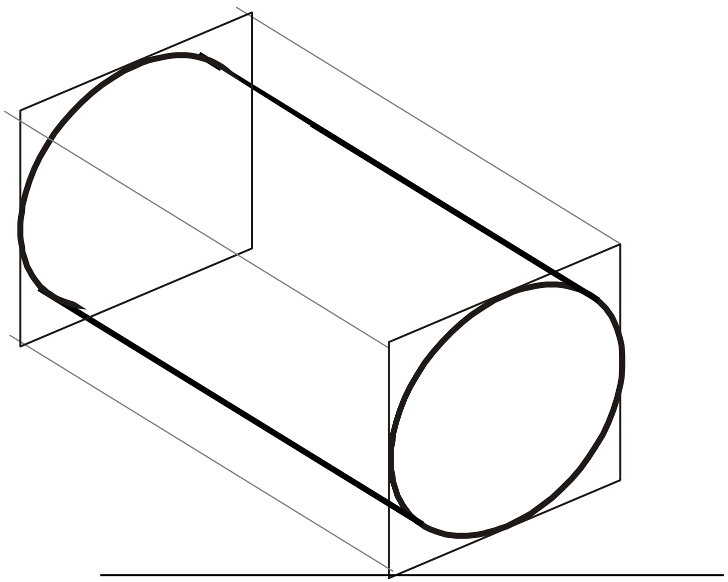
ISOMETRIC VIEW OF
PENTAGONALL PRISM
LYING ON H.P.



STUDY ILLUSTRATIONS

CYLINDER STANDING ON H.P.

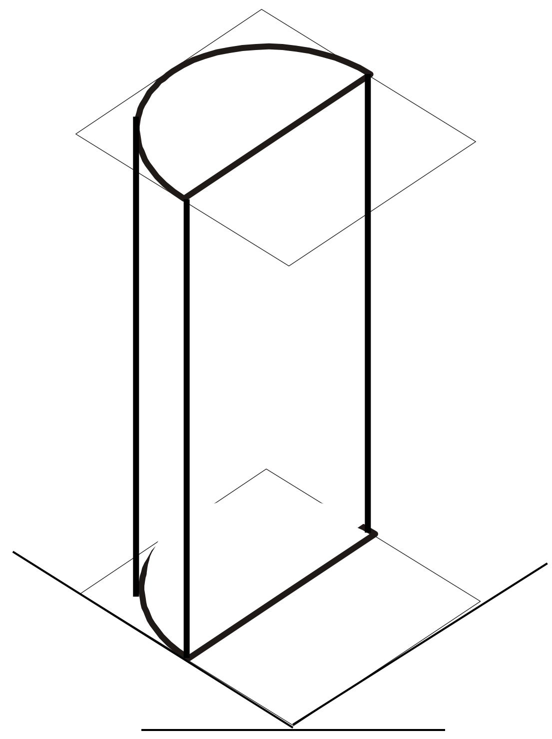


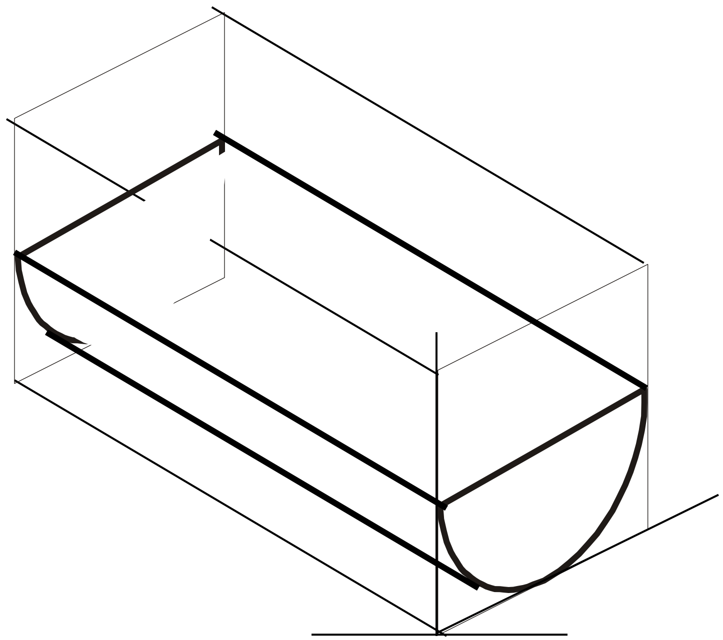


CYLINDER LYING ON H.P.

STUDY ILLUSTRATIONS

HALF CYLINDER STANDING ON H.P.
(ON IT'S SEMICIRCULAR BASE)

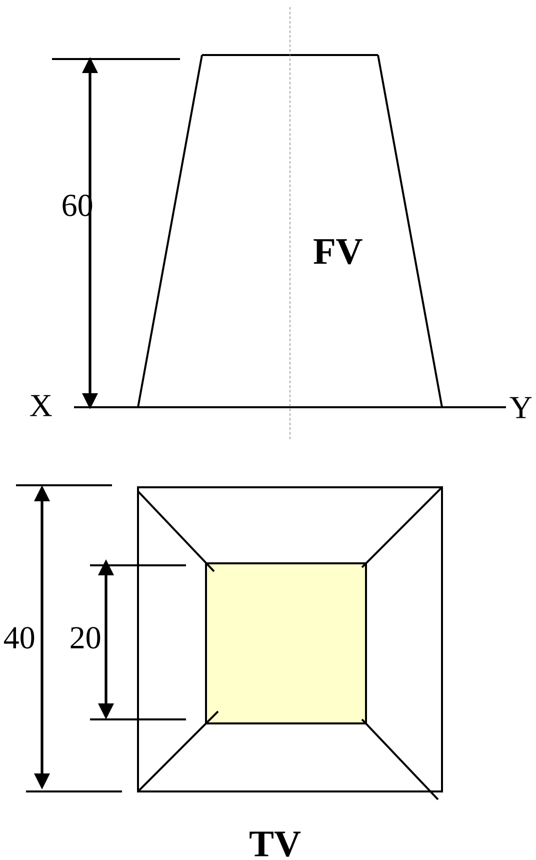


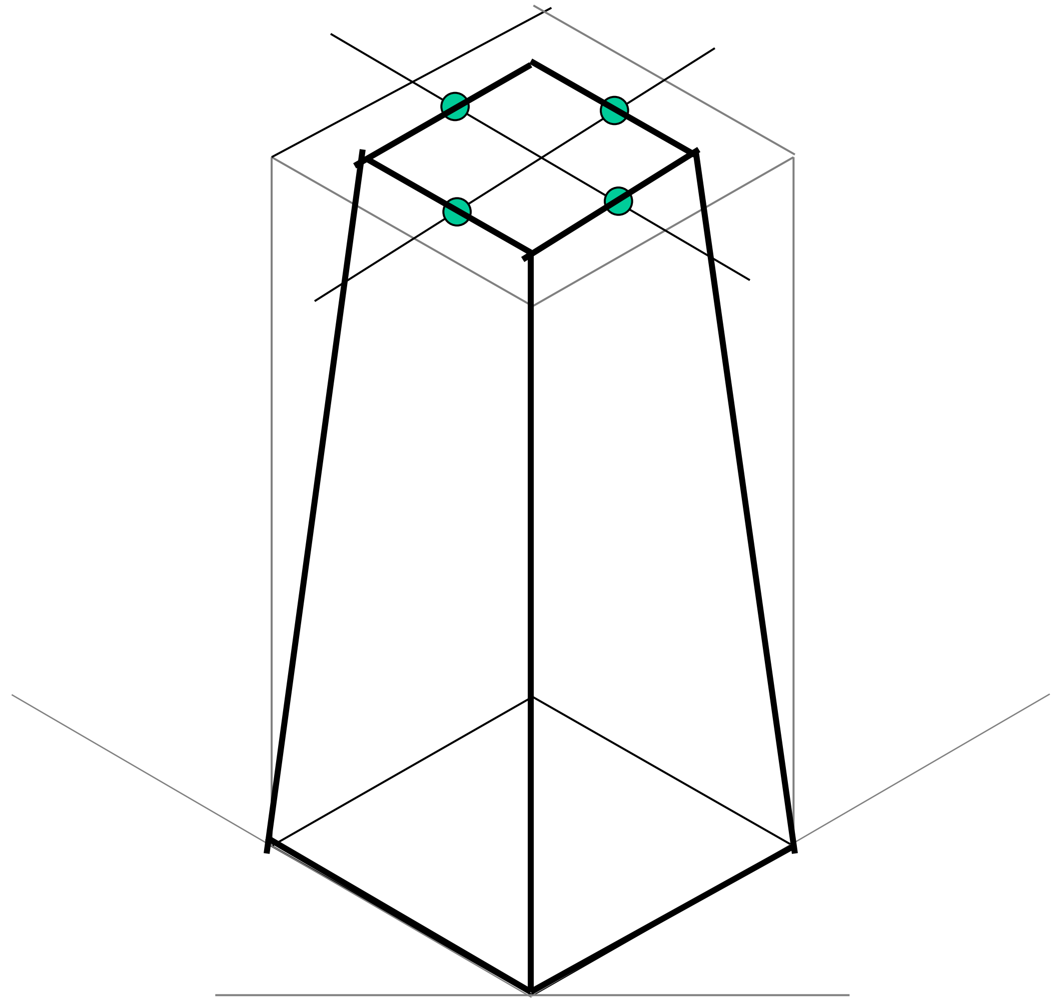


HALF CYLINDER LYING ON H.P.
(with flat face // to H.P.)

STUDY ILLUSTRATIONS

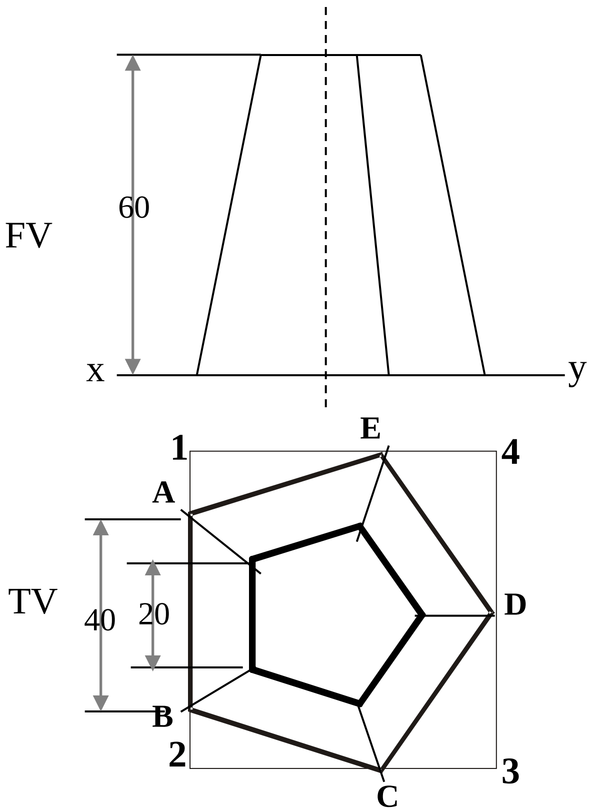
ISOMETRIC VIEW OF
A FRUSTOM OF SQUARE PYRAMID
STANDING ON H.P. ON IT'S LARGER BASE.





STUDY ILLUSTRATION

PROJECTIONS OF FRUSTOM OF PENTAGONAL PYRAMID ARE GIVEN. DRAW IT'S ISOMETRIC VIEW.



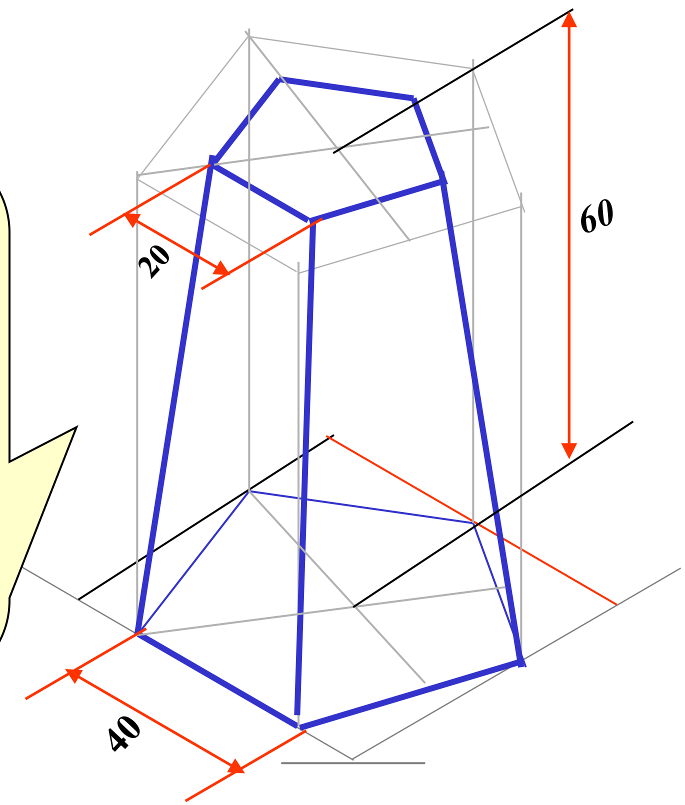
SOLUTION STEPS:

FIRST DRAW ISOMETRIC OF IT'S BASE.

THEN DRAWSAME SHAPE AS TOP, 60 MM ABOVE THE BASE PENTAGON CENTER.

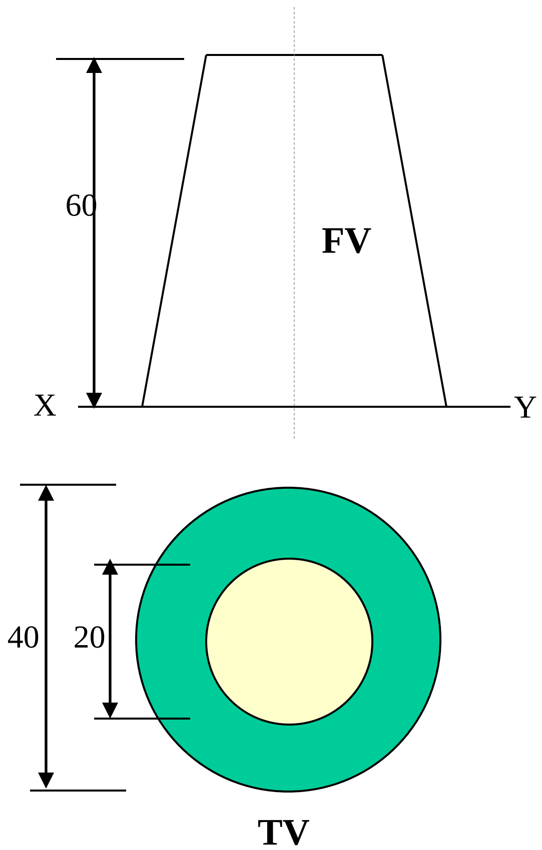
THEN REDUCE THE TOP TO 20 MM SIDES AND JOIN WITH THE PROPER BASE CORNERS.

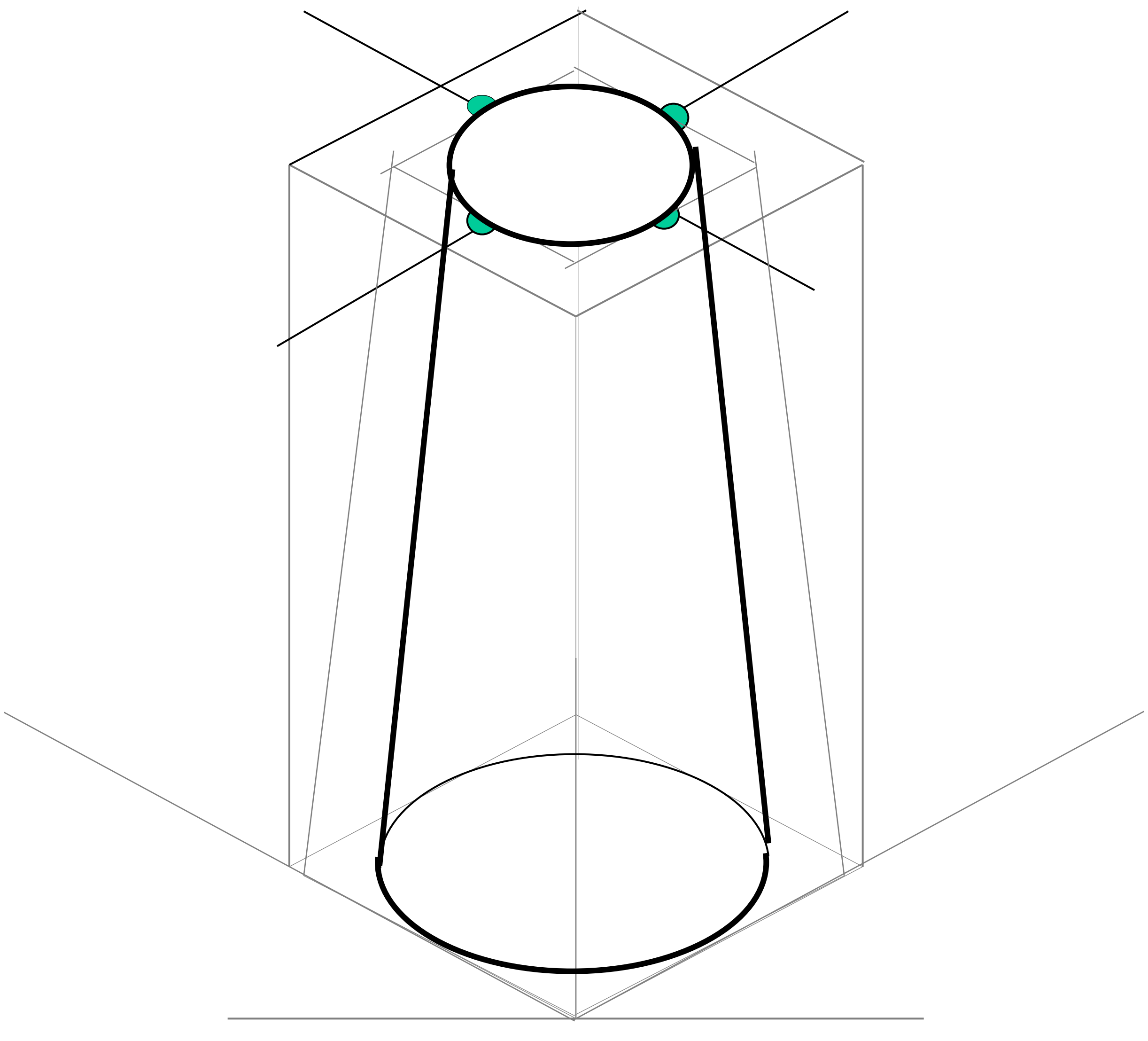
ISOMETRIC VIEW OF FRUSTOM OF PENTAGONAL PYRAMID



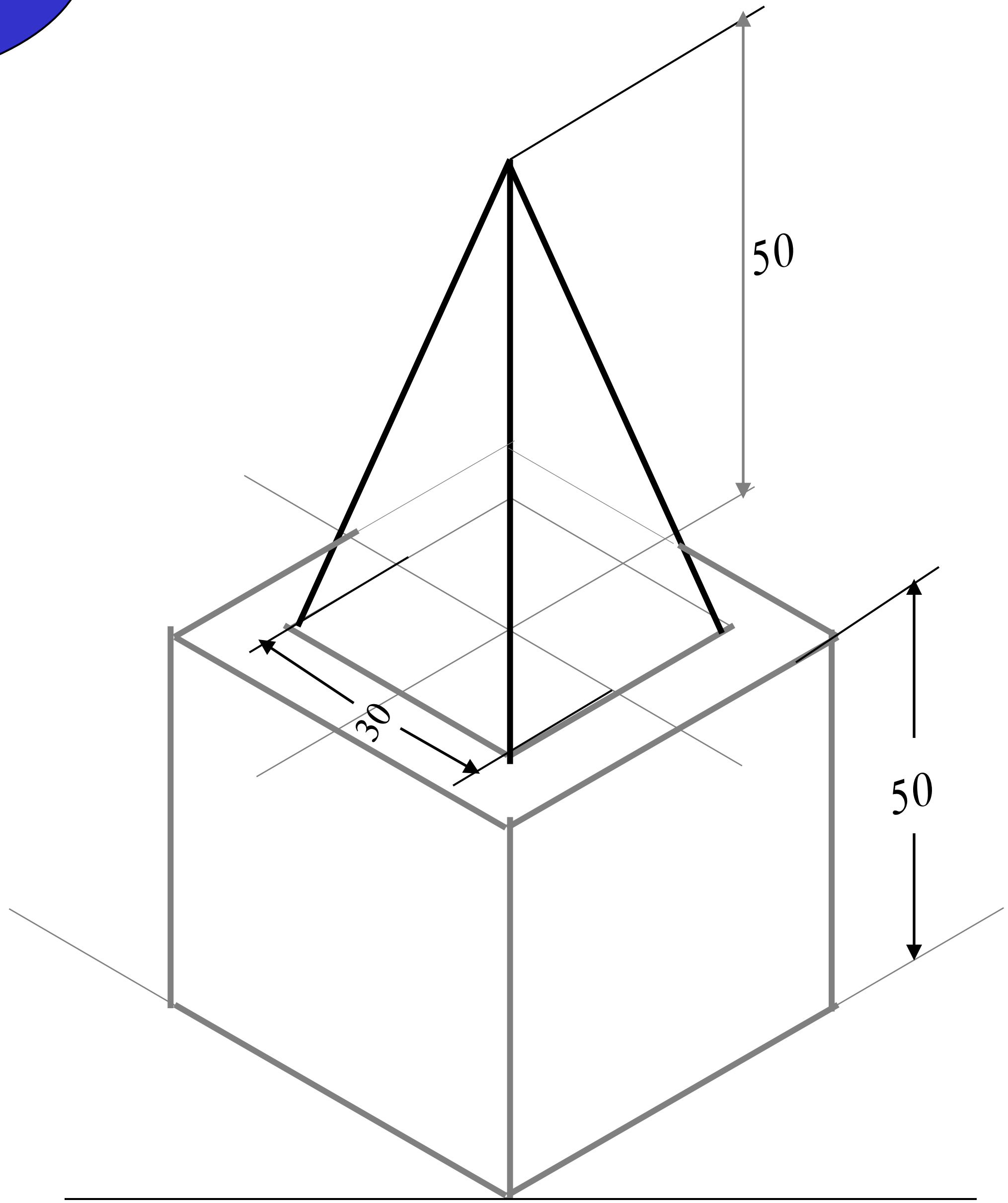
STUDY ILLUSTRATIONS

ISOMETRIC VIEW OF A FRUSTOM OF CONE STANDING ON H.P. ON IT'S LARGER BASE.



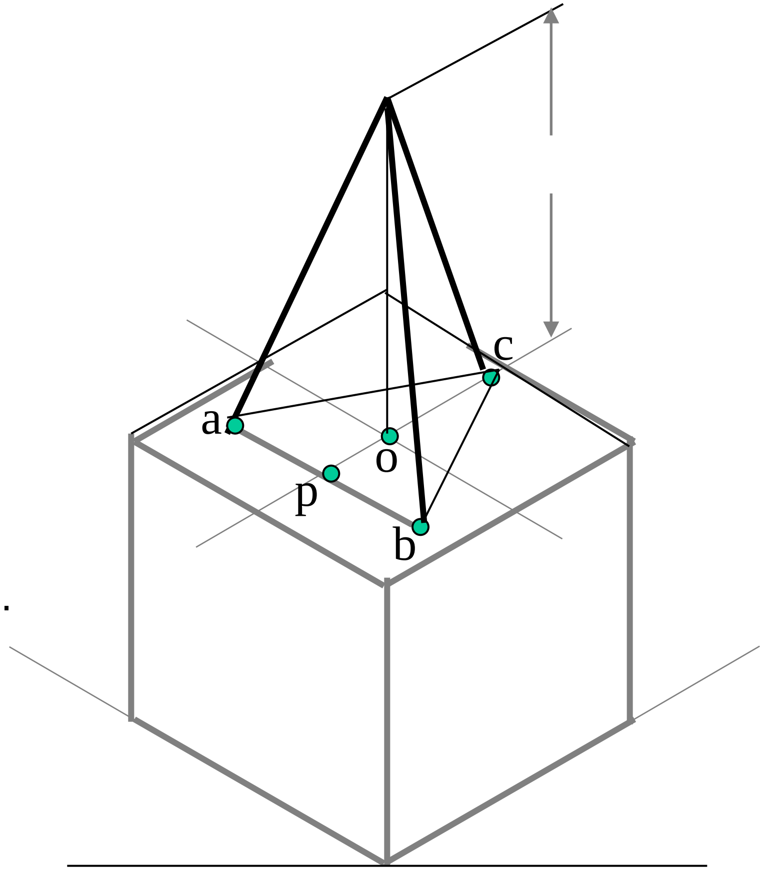


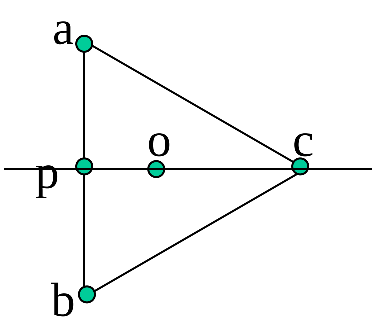
PROBLEM: A SQUARE PYRAMID OF 30 MM BASE SIDES AND 50 MM LONG AXIS, IS CENTRALLY PLACED ON THE TOP OF A CUBE OF 50 MM LONG EDGES.DRAW ISOMETRIC VIEW OF THE PAIR.



STUDY ILLUSTRATIONS

PROBLEM: A TRIANGULAR PYRAMID OF 30 MM BASE SIDES AND 50 MM LONG AXIS, IS CENTRALLY PLACED ON THE TOP OF A CUBE OF 50 MM LONG EDGES.
DRAW ISOMETRIC VIEW OF THE PAIR.





SOLUTION HINTS.

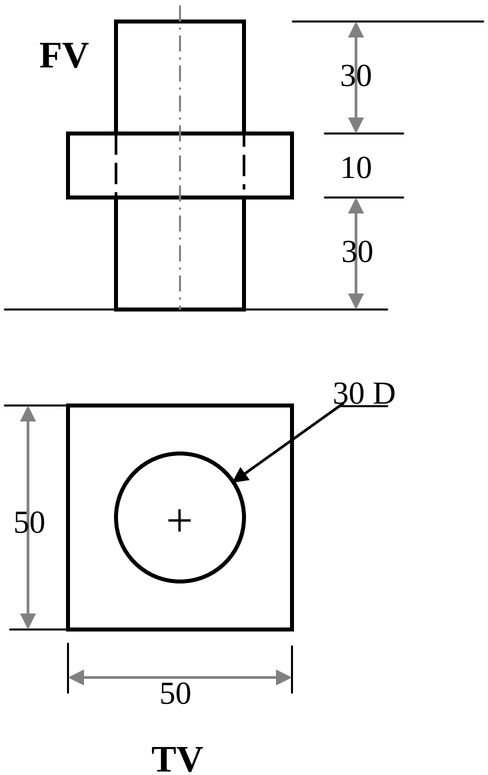
TO DRAW ISOMETRIC OF A CUBE IS SIMPLE. DRAW IT AS USUAL.

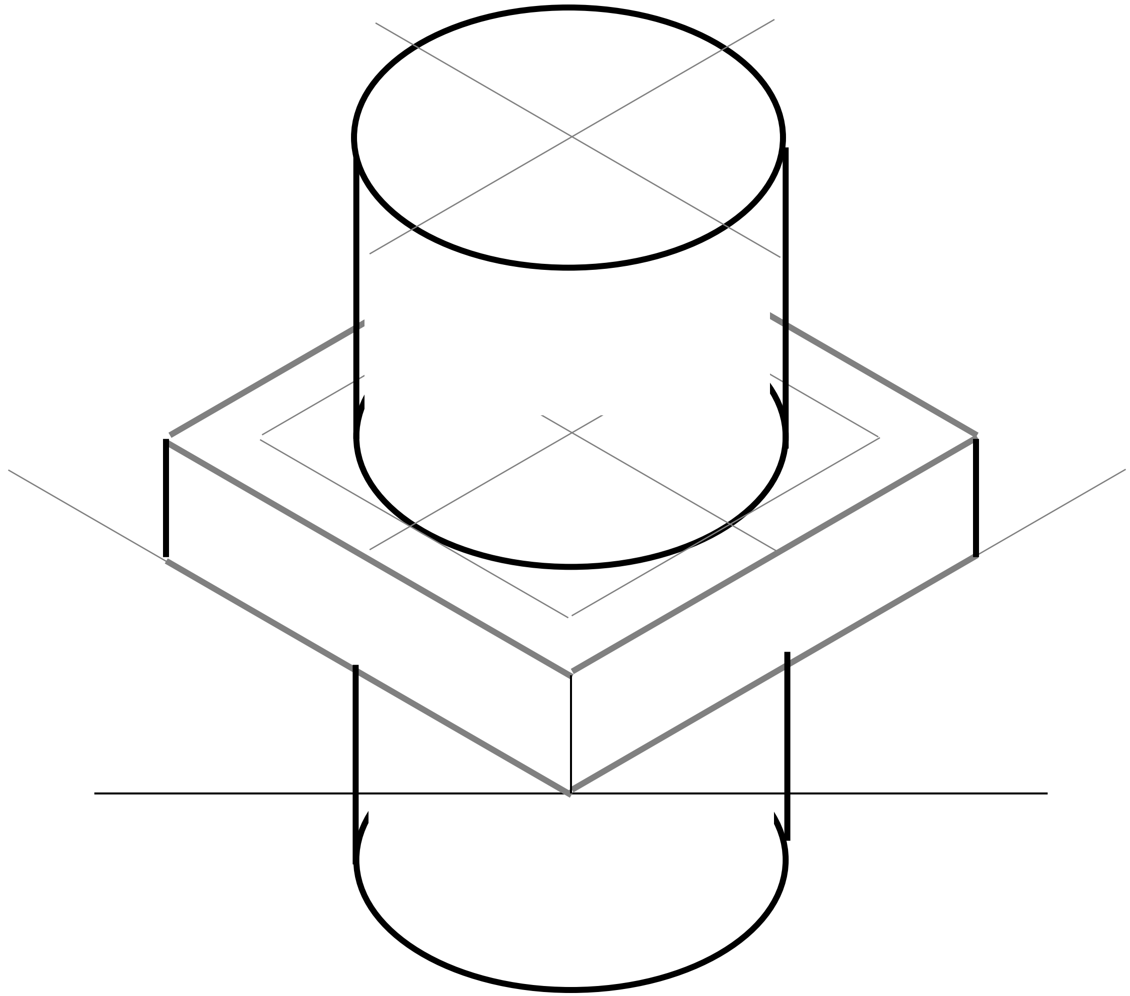
***BUT FOR PYRAMID AS IT'S BASE IS AN EQUILATERAL TRIANGLE, IT CAN NOT BE DRAWN DIRECTLY.SUPPORT OF IT'S TV IS REQUIRED*.**

SO DRAW TRIANGLE AS A TV, SEPARATELY AND NAME VARIOUS POINTS AS SHOWN.
AFTER THIS PLACE IT ON THE TOP OF CUBE AS SHOWN.
THEN ADD HEIGHT FROM IT'S CENTER AND COMPLETE IT'S ISOMETRIC AS SHOWN.

PROBLEM:

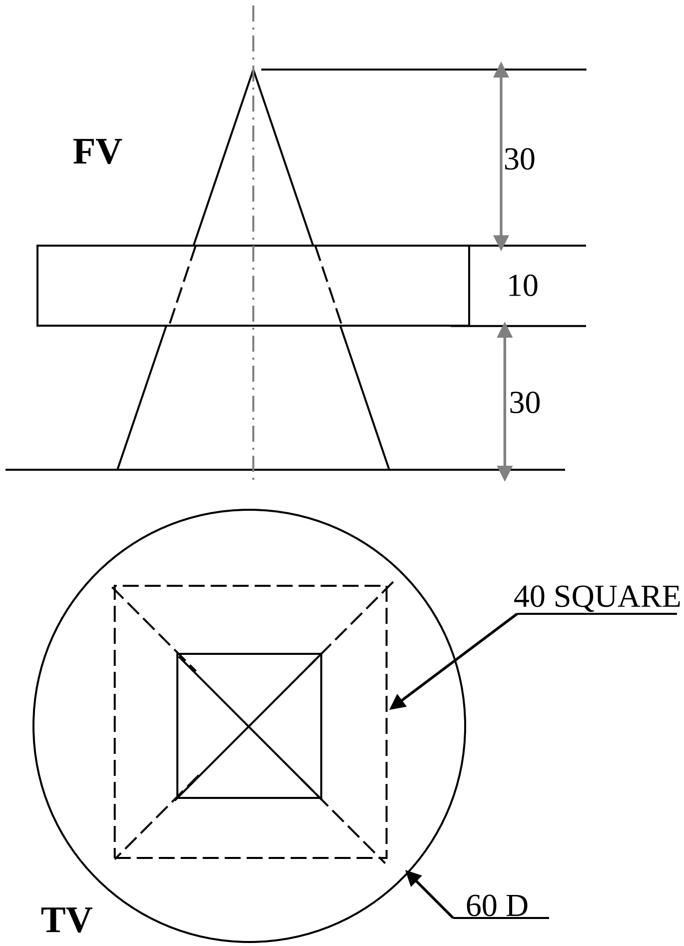
A SQUARE PLATE IS PIERCED THROUGH CENTRALLY BY A CYLINDER WHICH COMES OUT EQUALLY FROM BOTH FACES OF PLATE. IT'S FV & TV ARE SHOWN. DRAW ISOMETRIC VIEW.

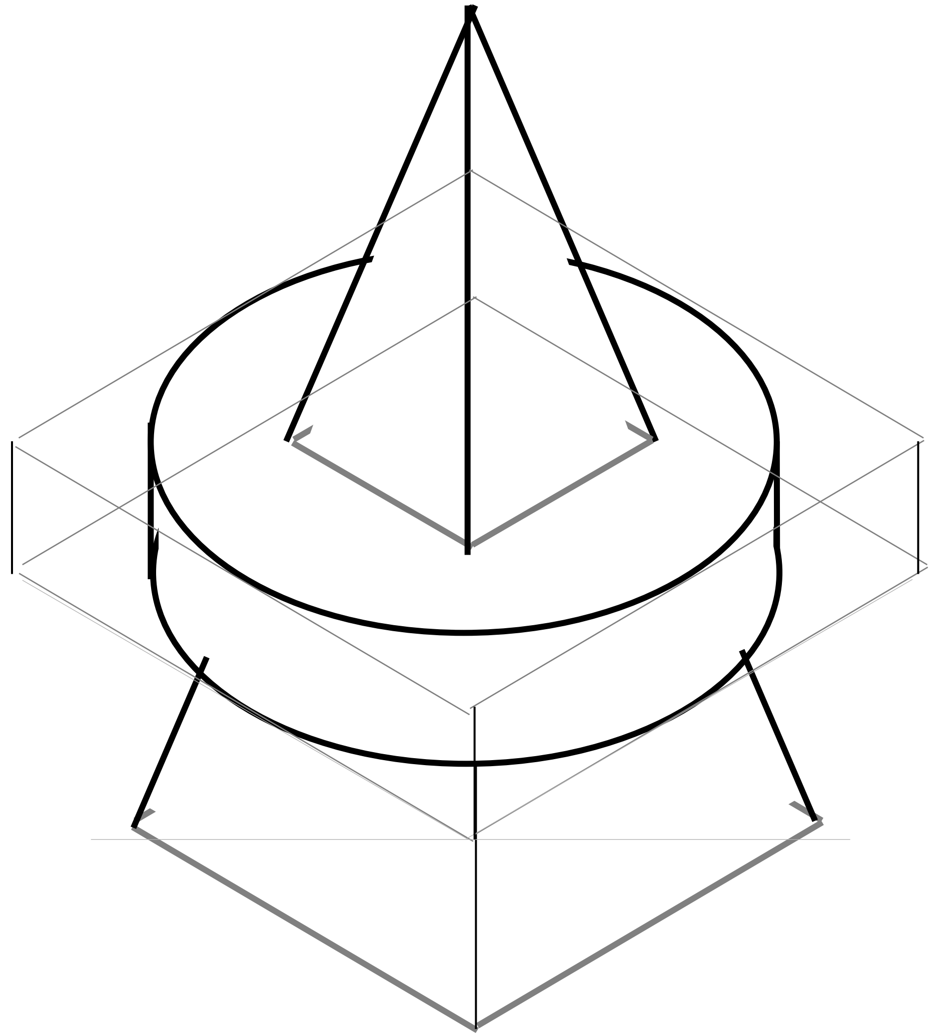




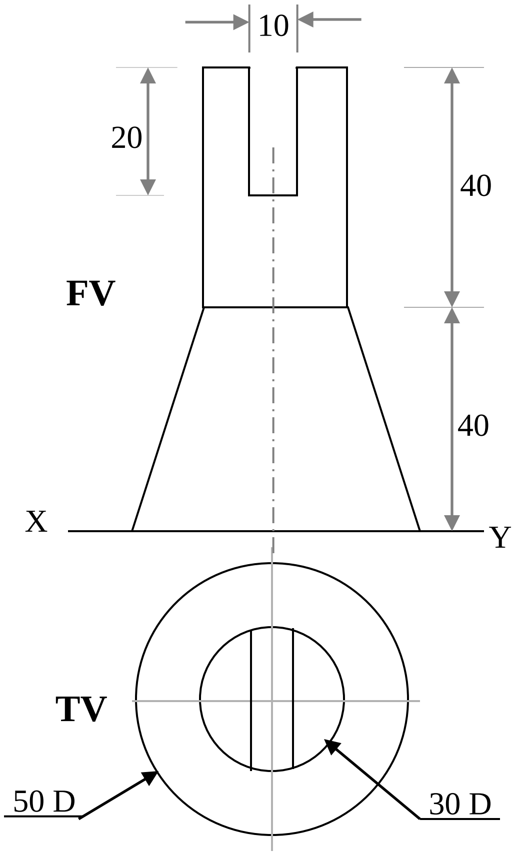
STUDY ILLUSTRATIONS

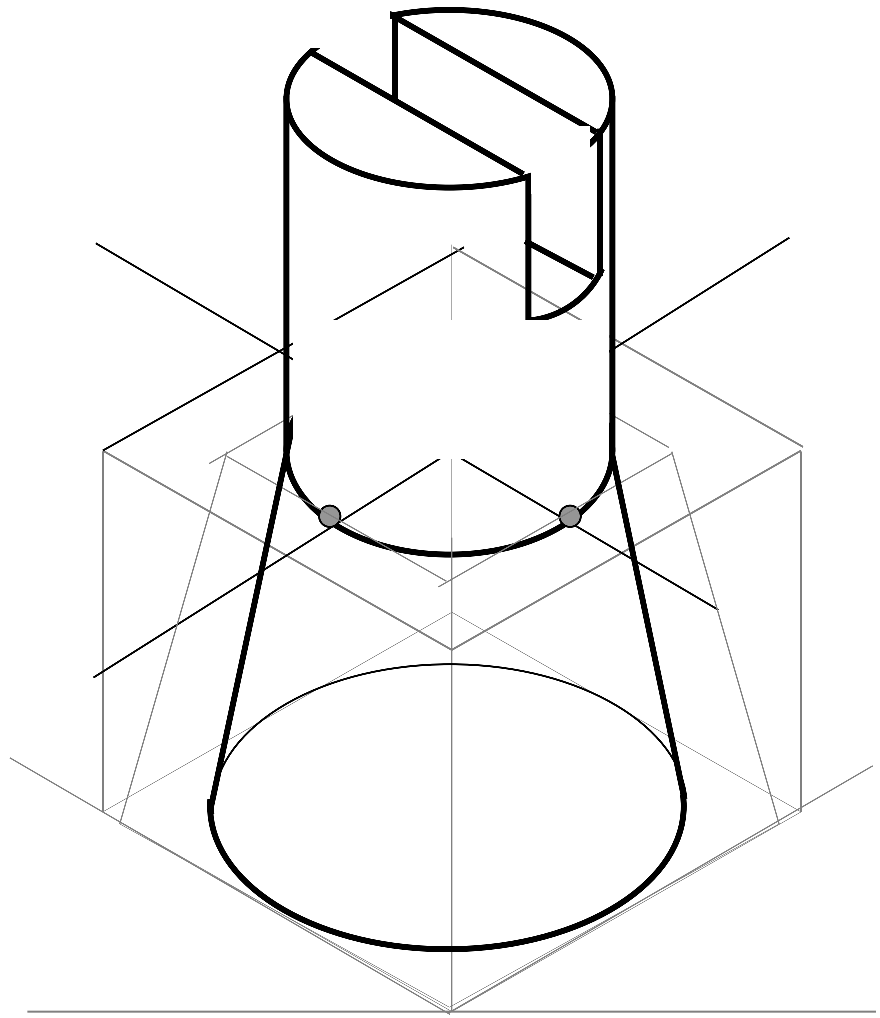
PROBLEM:
A CIRCULAR PLATE IS PIERCED THROUGH CENTRALLY BY A SQUARE PYRAMID WHICH COMES OUT EQUALLY FROM BOTH FACES OF PLATE. IT'S FV & TV ARE SHOWN. DRAW ISOMETRIC VIEW.



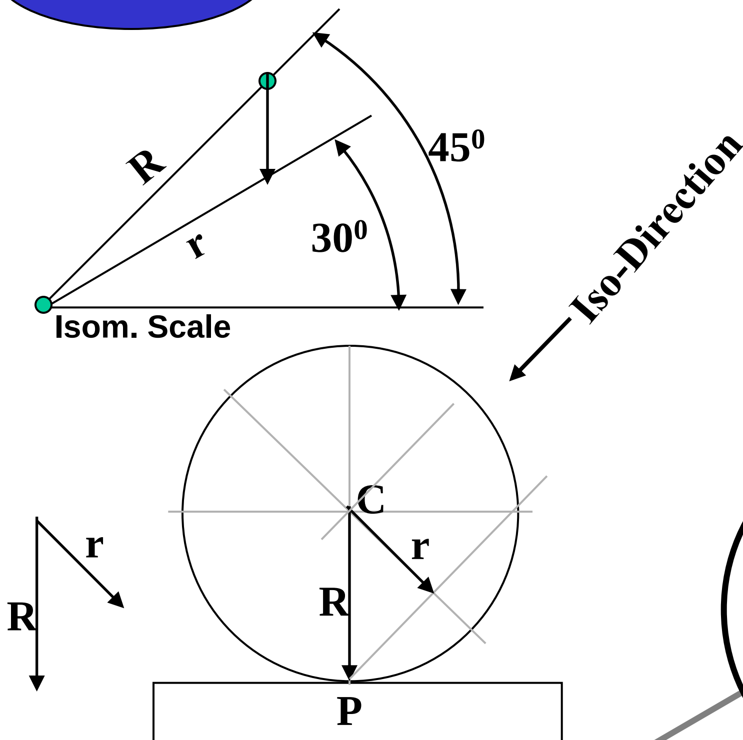


F.V. & T.V. of an object are given. Draw it's isometric view.

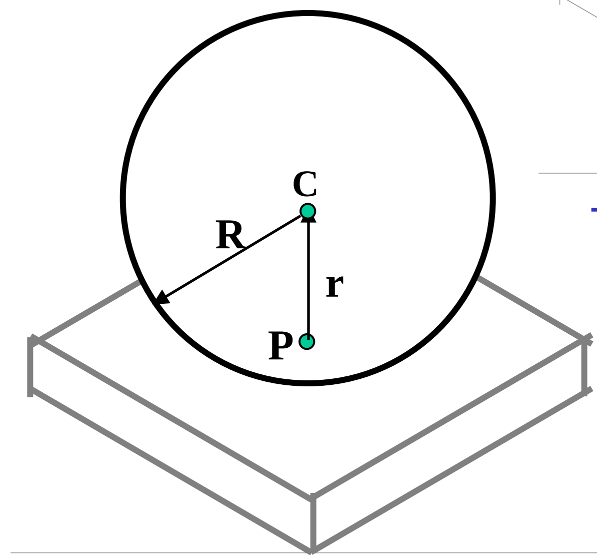




ISOMETRIC PROJECTIONS OF SPHERE & HEMISPHERE

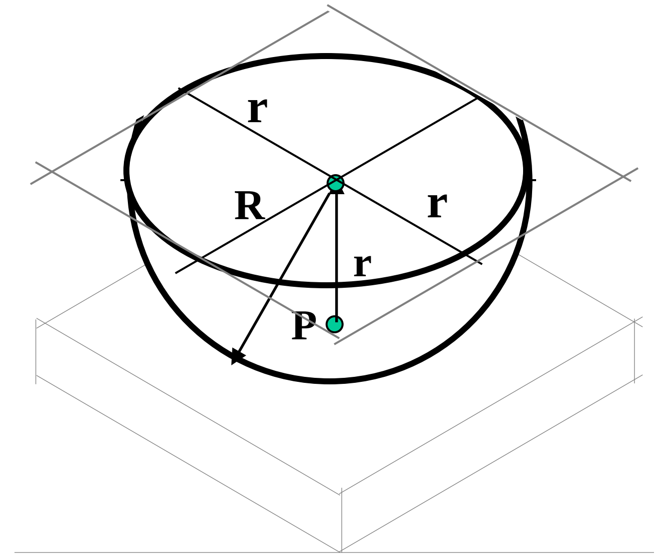


C = Center of Sphere.
P = Point of contact
R = True Radius of Sphere
r = Isometric Radius.



TO DRAW ISOMETRIC PROJECTION OF A SPHERE

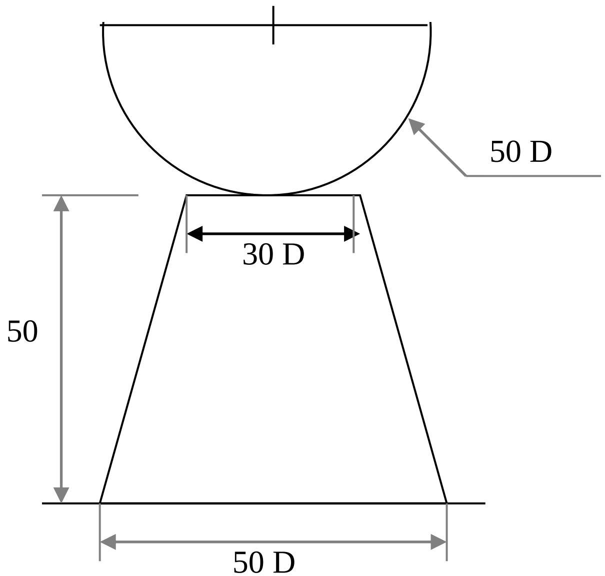
1. FIRST DRAW ISOMETRIC OF SQUARE PLATE.
2. LOCATE IT'S CENTER. NAME IT P.
3. FROM PDRAW VERTICAL LINE UPWARD, LENGTH ' r mm' AND LOCATE CENTER OF SPHERE "C"
4. 'C' AS CENTER, WITH RADIUS 'R' DRAW CIRCLE. *THIS IS ISOMETRIC PROJECTION OF A SPHERE.*



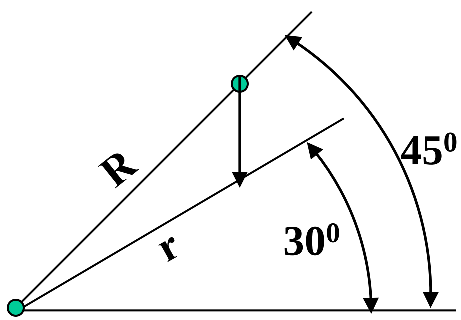
TO DRAW ISOMETRIC PROJECTION OF A HEMISPHERE

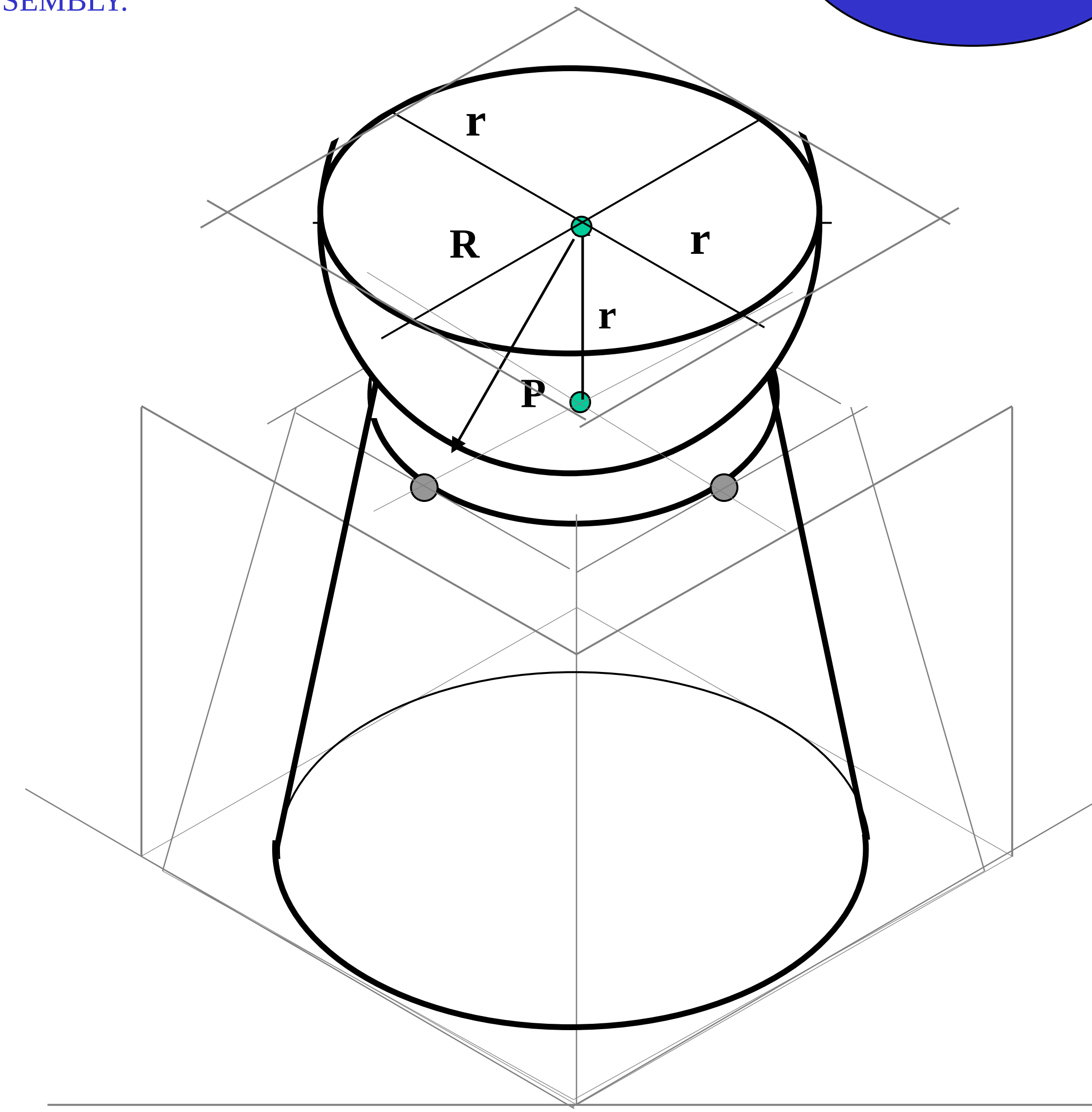
Adopt same procedure.
Draw lower semicircle only.
Then around 'C' construct Rhombus of Sides equal to Isometric Diameter.
For this use iso-scale.
Then construct ellipse in this Rhombus as usual
And Complete Isometric-Projection of Hemi-sphere.

PROBLEM:
A HEMI-SPHERE IS CENTRALLY PLACED ON THE TOP OF A FRUSTOM OF CONE. DRAW ISOMETRIC PROJECTIONS OF THE ASSEMBLY.



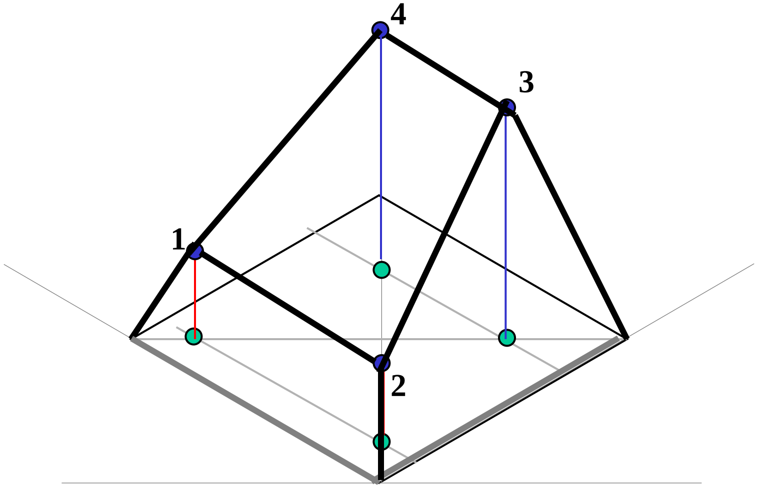
FIRST CONSTRUCT ISOMETRIC SCALE. USE THIS SCALE FOR ALL DIMENSIONS IN THIS PROBLEM.

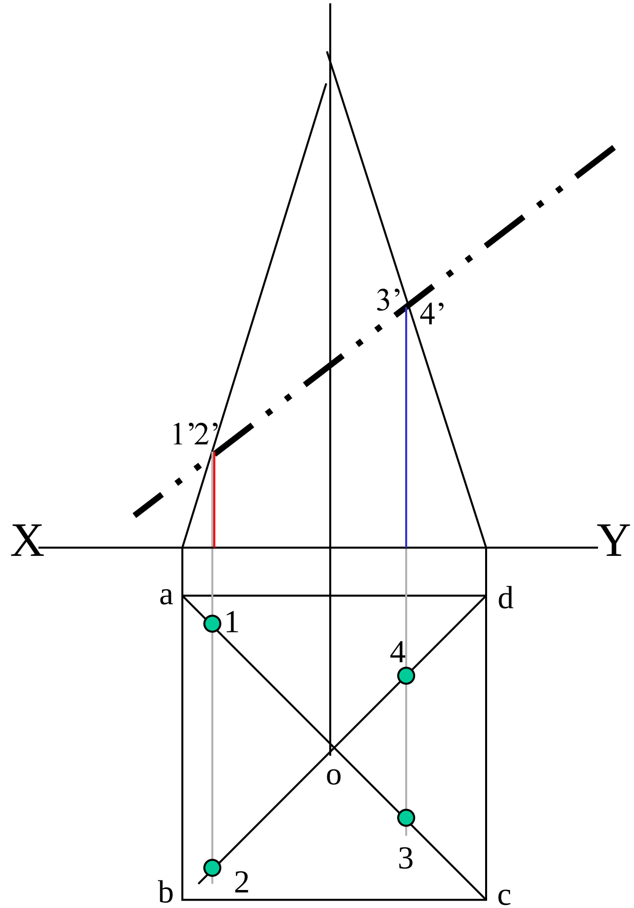




STUDY ILLUSTRATIONS

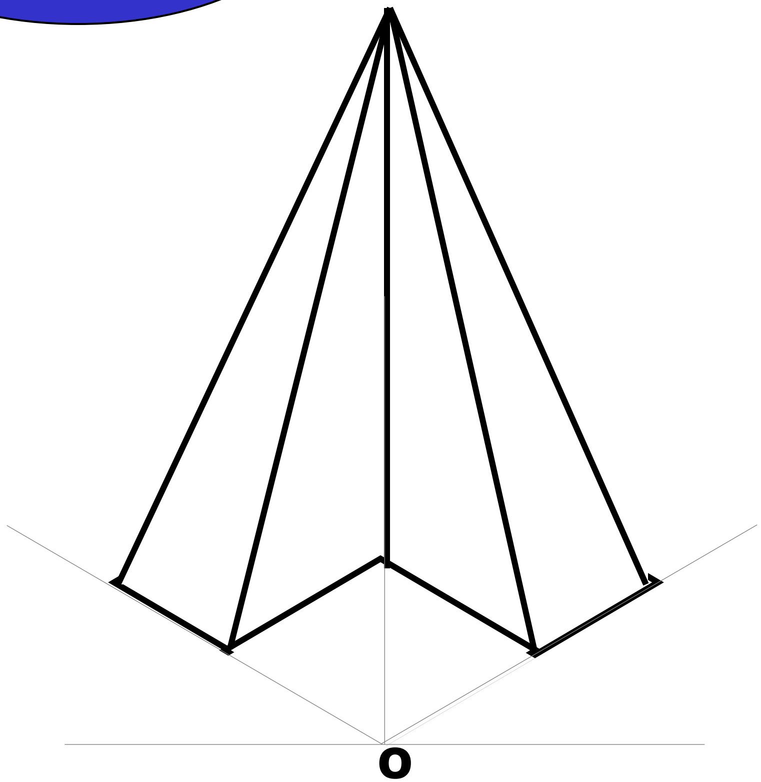
A SQUARE PYRAMID OF 40 MM BASE SIDES AND 60 MM AXIS IS CUT BY AN INCLINED SECTION PLANE THROUGH THE MID POINT OF AXIS AS SHOWN.DRAW ISOMETRIC VIEW OF SECTION OF PYRAMID.

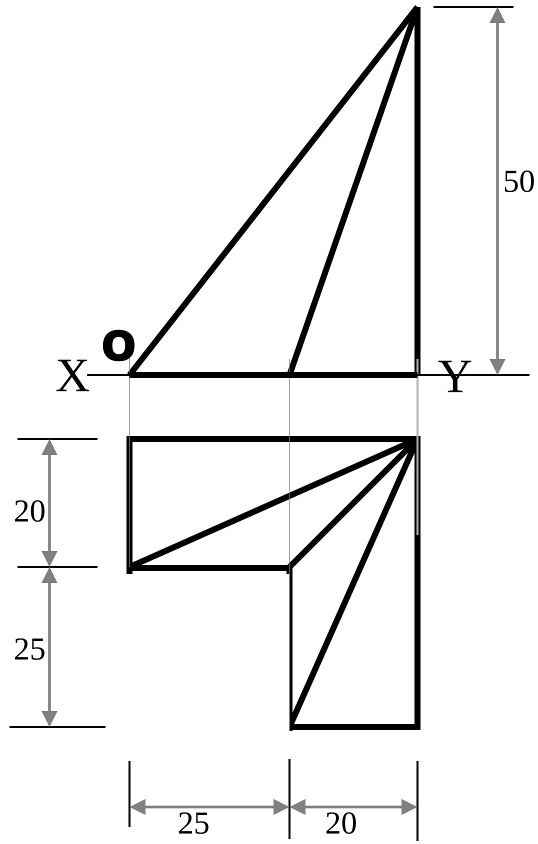




STUDY ILLUSTRATIONS

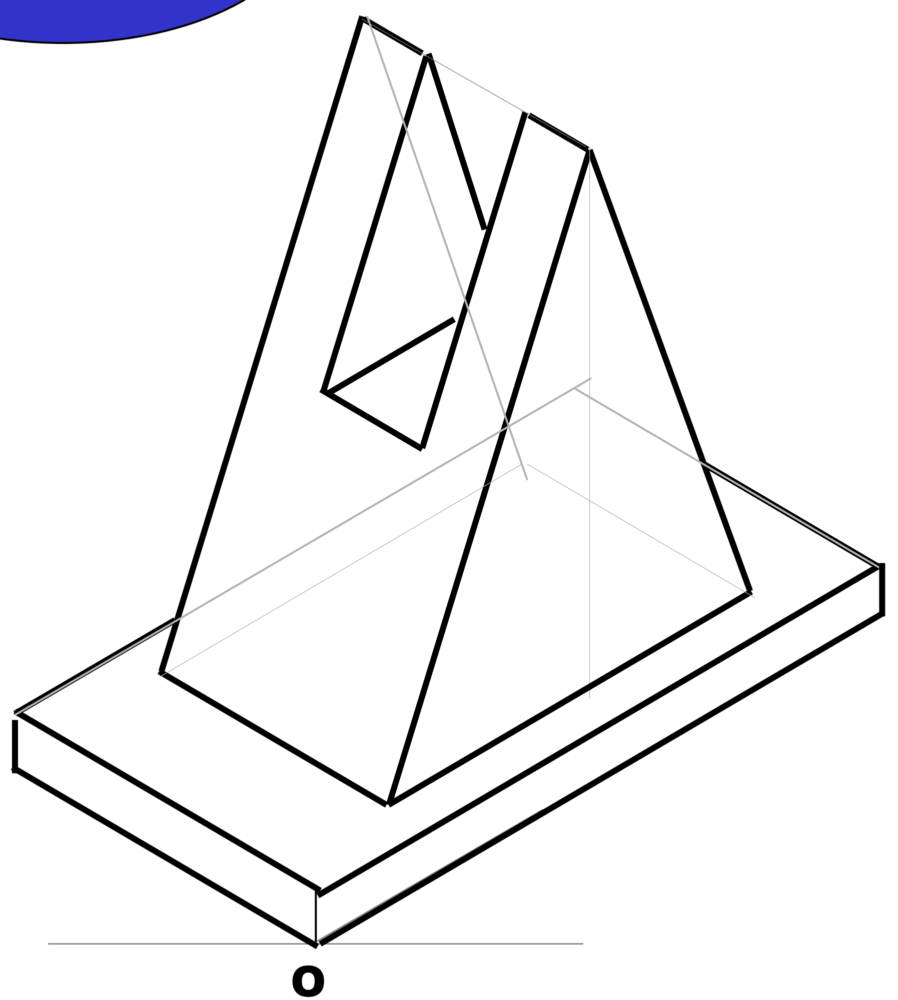
F.V. & T.V. of an object are given. Draw it's isometric view.

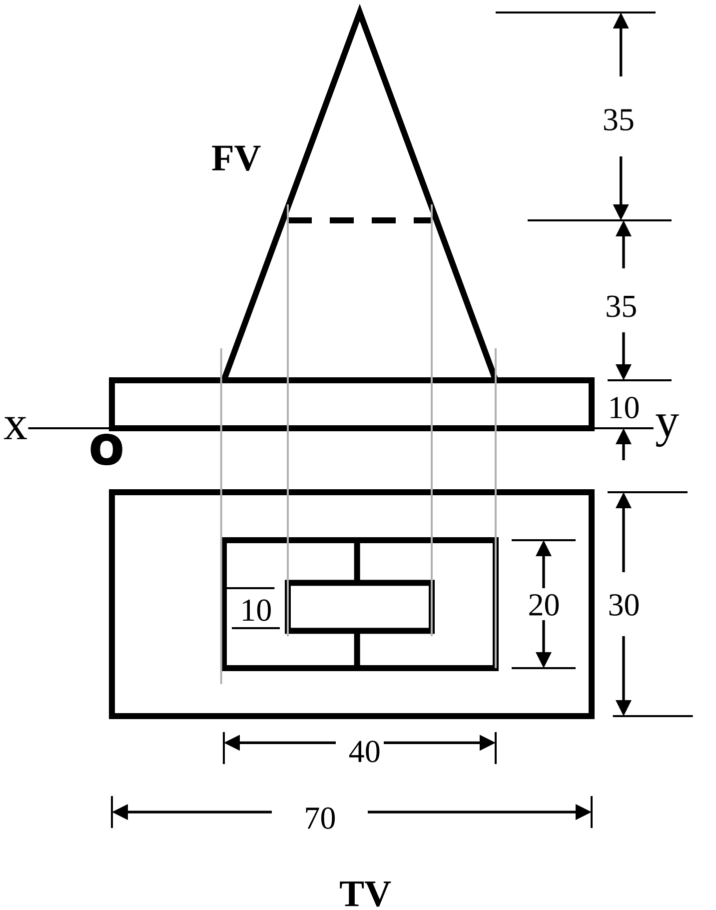




STUDY ILLUSTRATIONS

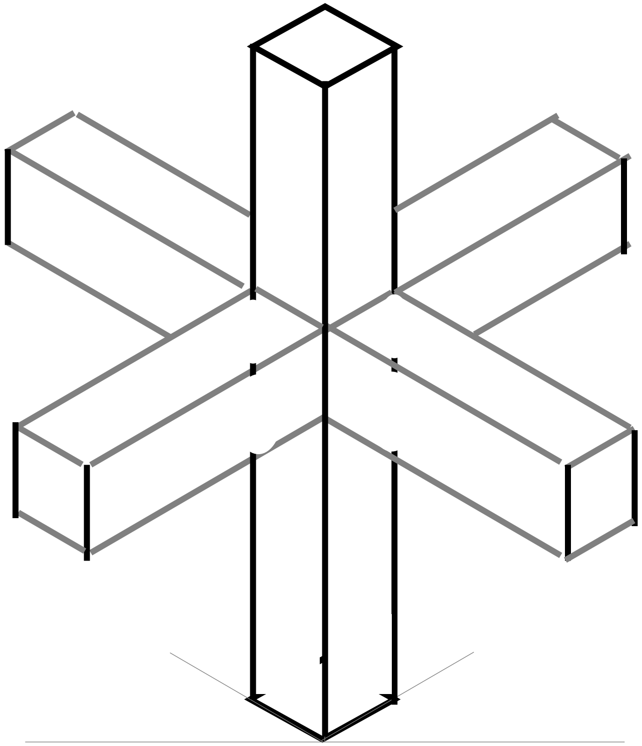
F.V. & T.V. of an object are given. Draw it's isometric view.

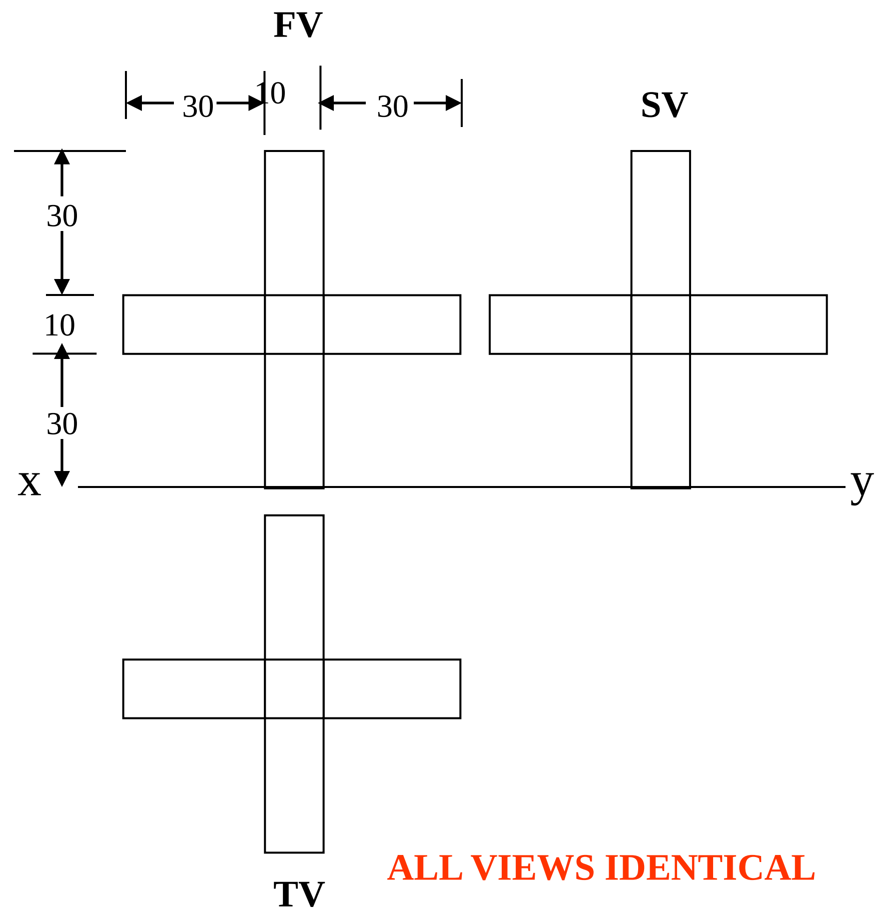




STUDY ILLUSTRATIONS

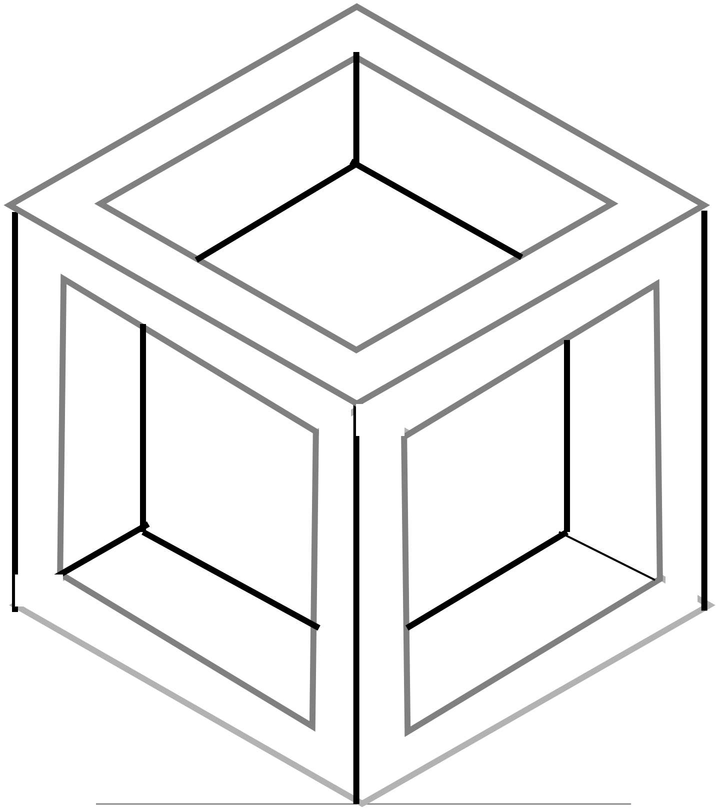
F.V. & T.V. and S.V.of an object are given. Draw it's isometric view.

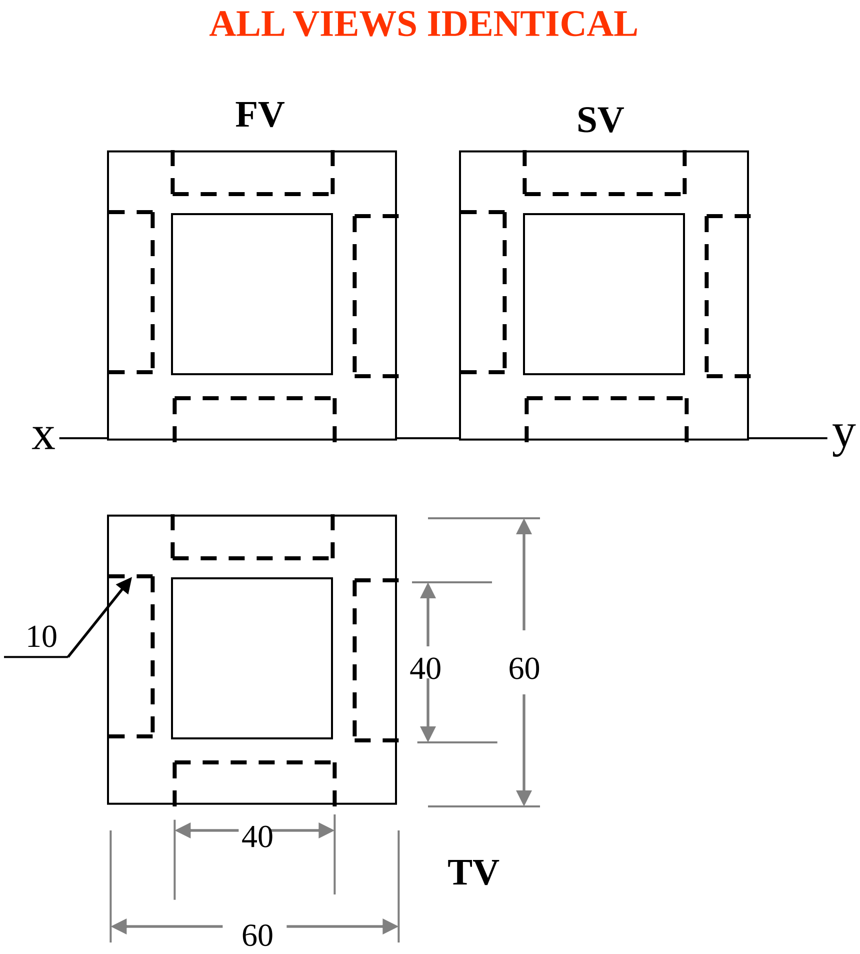




ALL VIEWS IDENTICAL

F.V. & T.V. and S.V.of an object are given. Draw it's isometric view.





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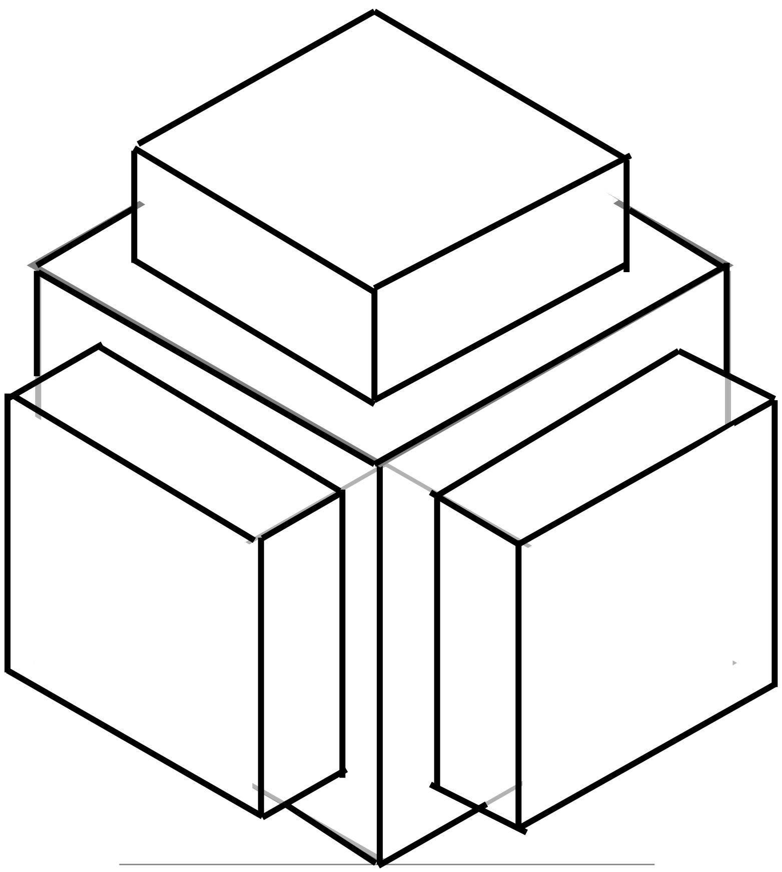
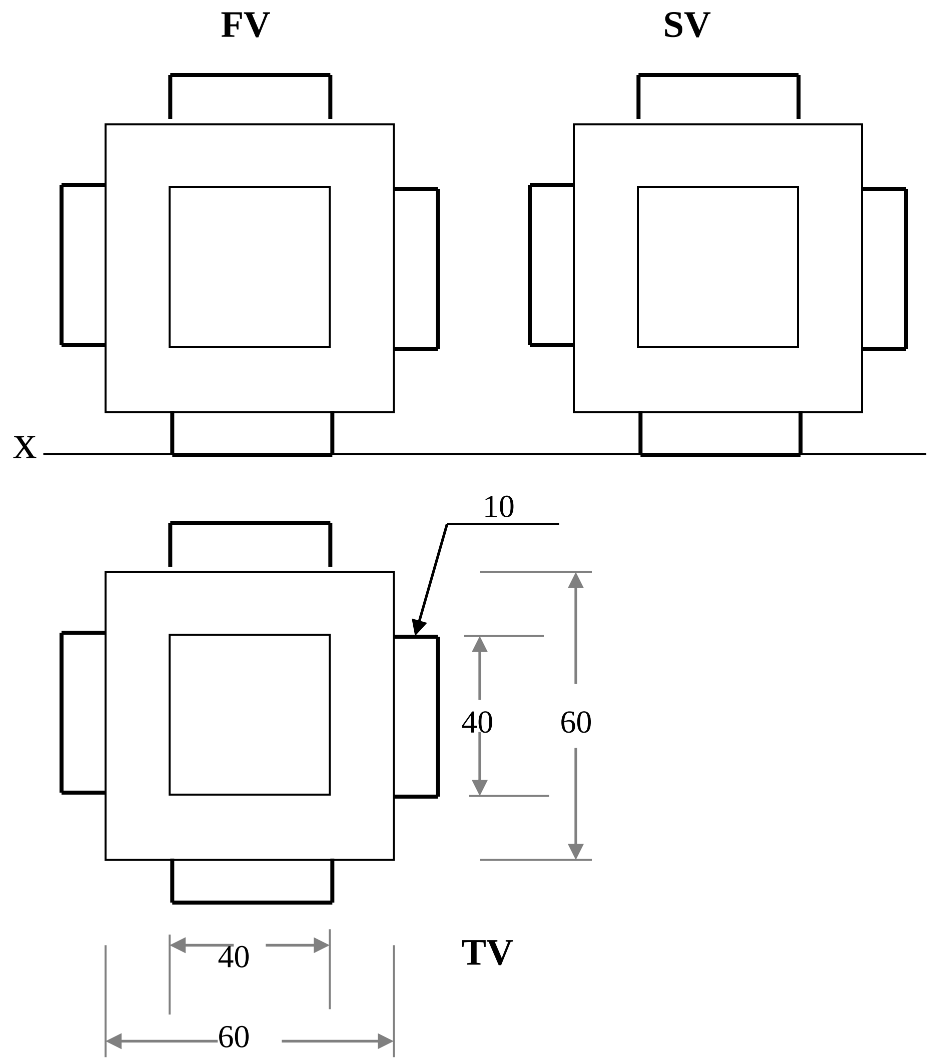
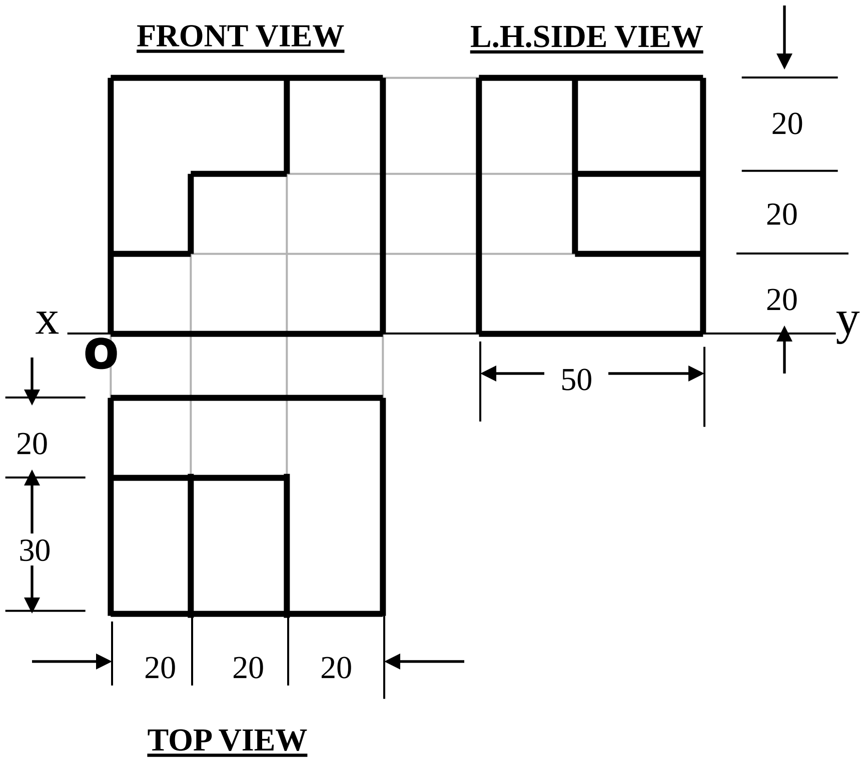


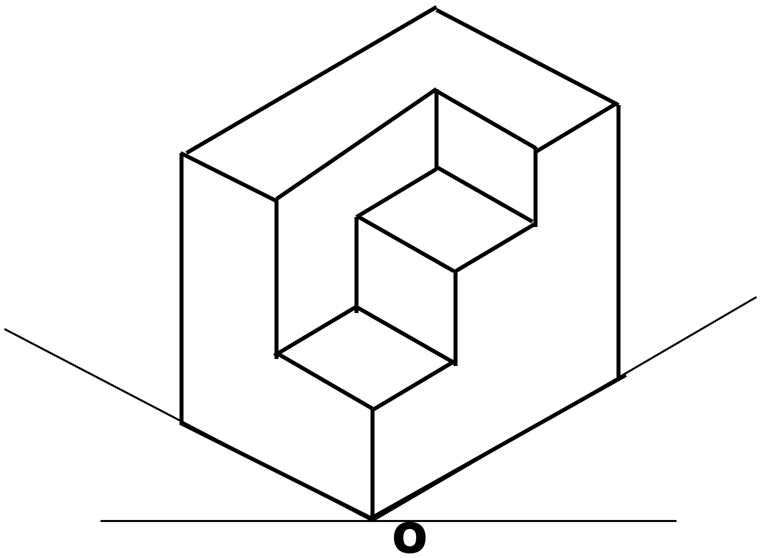


STUDY ILLUSTRATIONS

F.V. & T.V. and S.V.of an object are given. Draw it's isometric view.

ORTHOGRAPHIC PROJECTIONS





STUDY ILLUSTRATIONS

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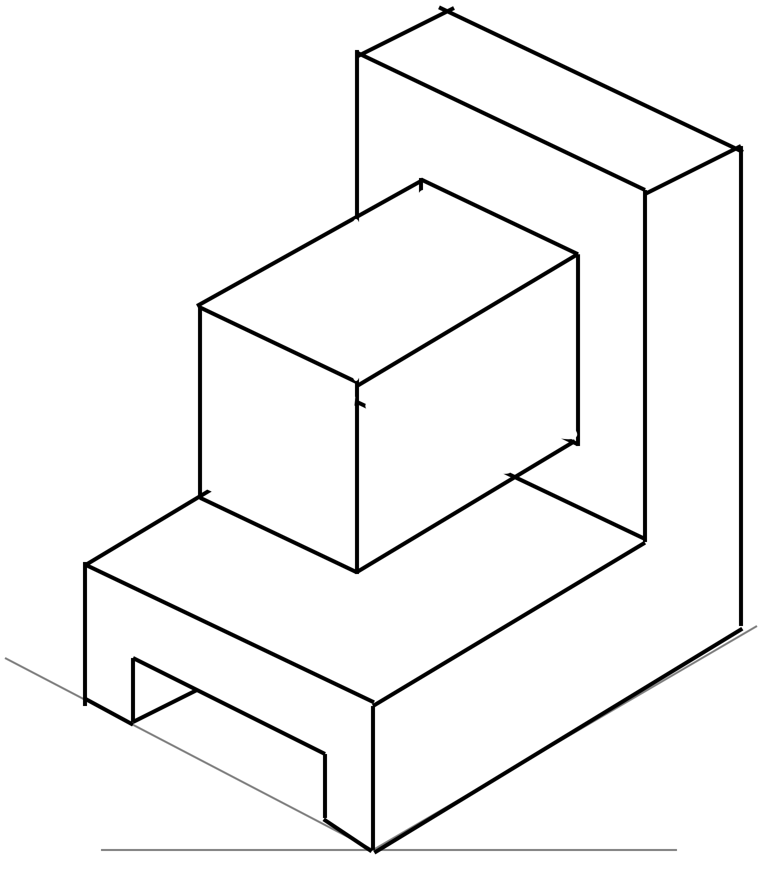
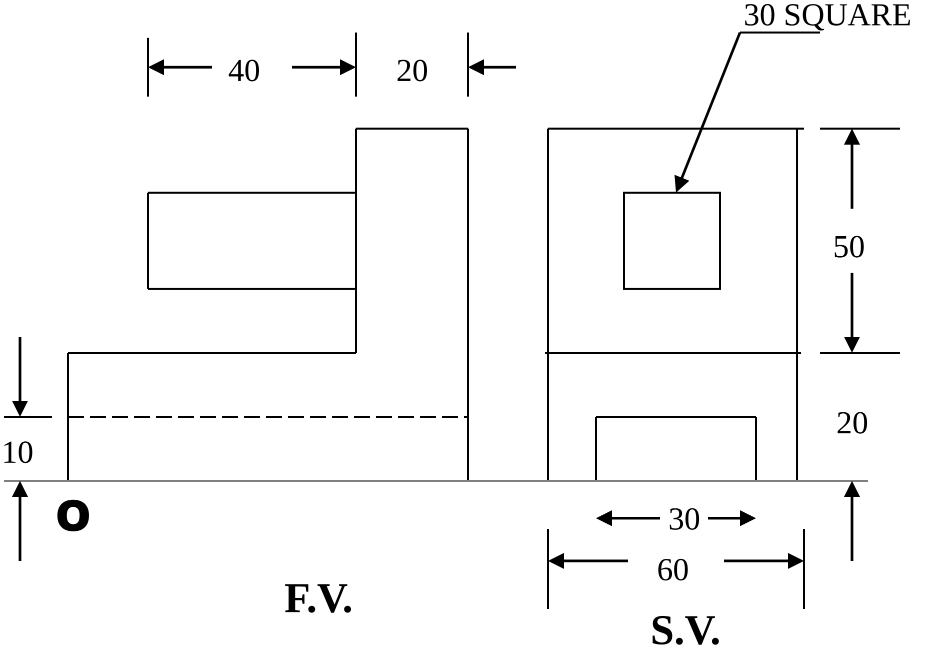
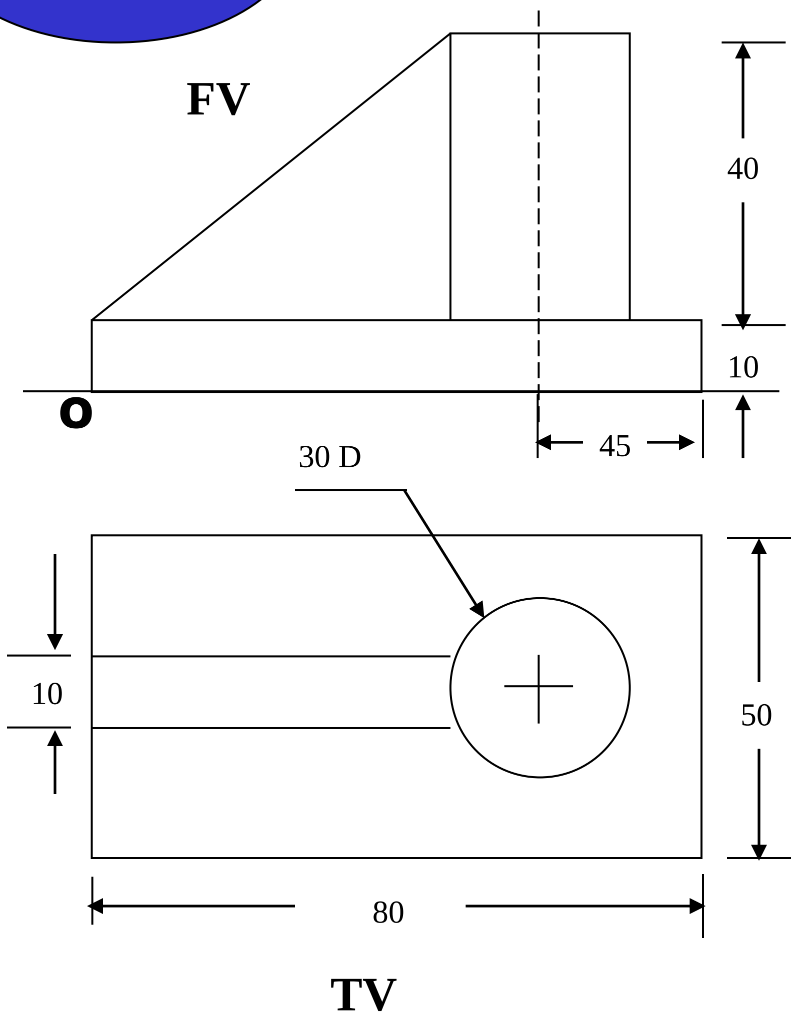
Draw it's isometric view.

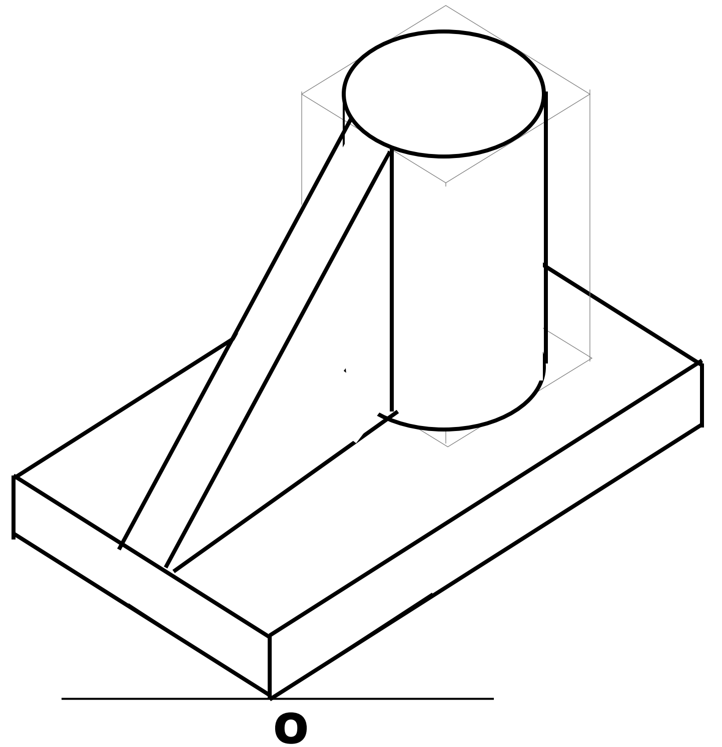




STUDY ILLUSTRATIONS

F.V. & T.V. of an object are given. Draw it's isometric view.





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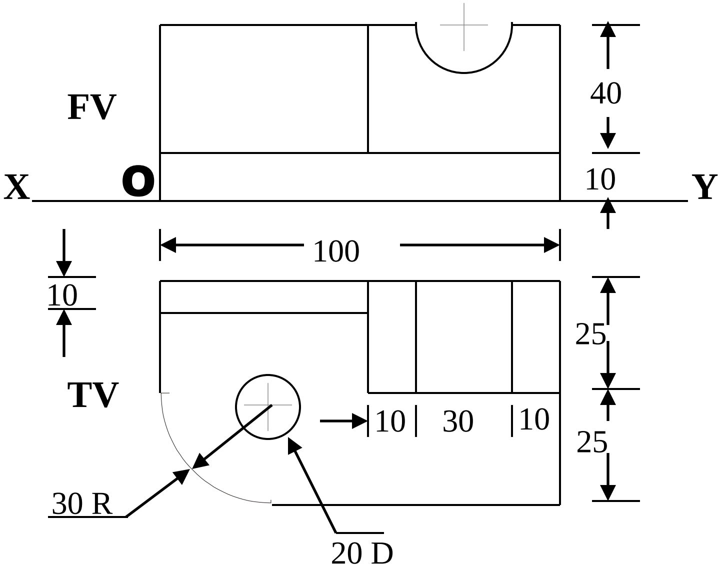

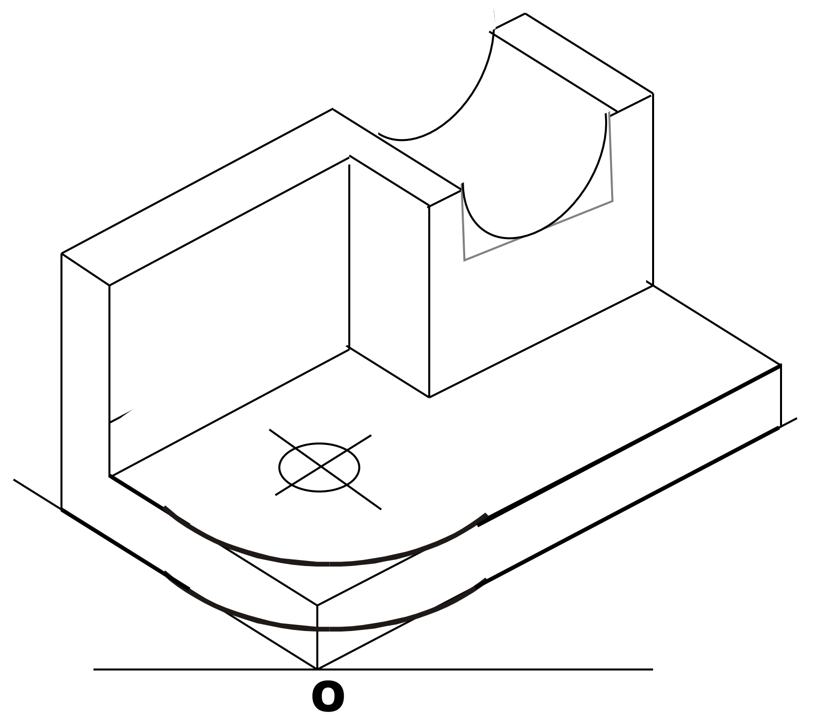

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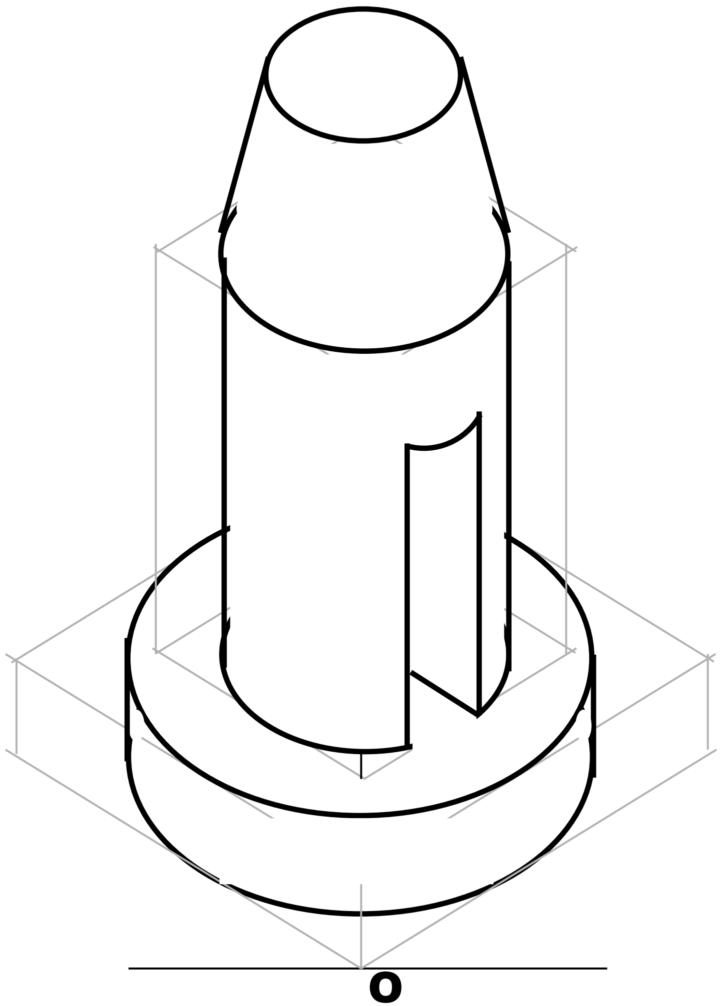

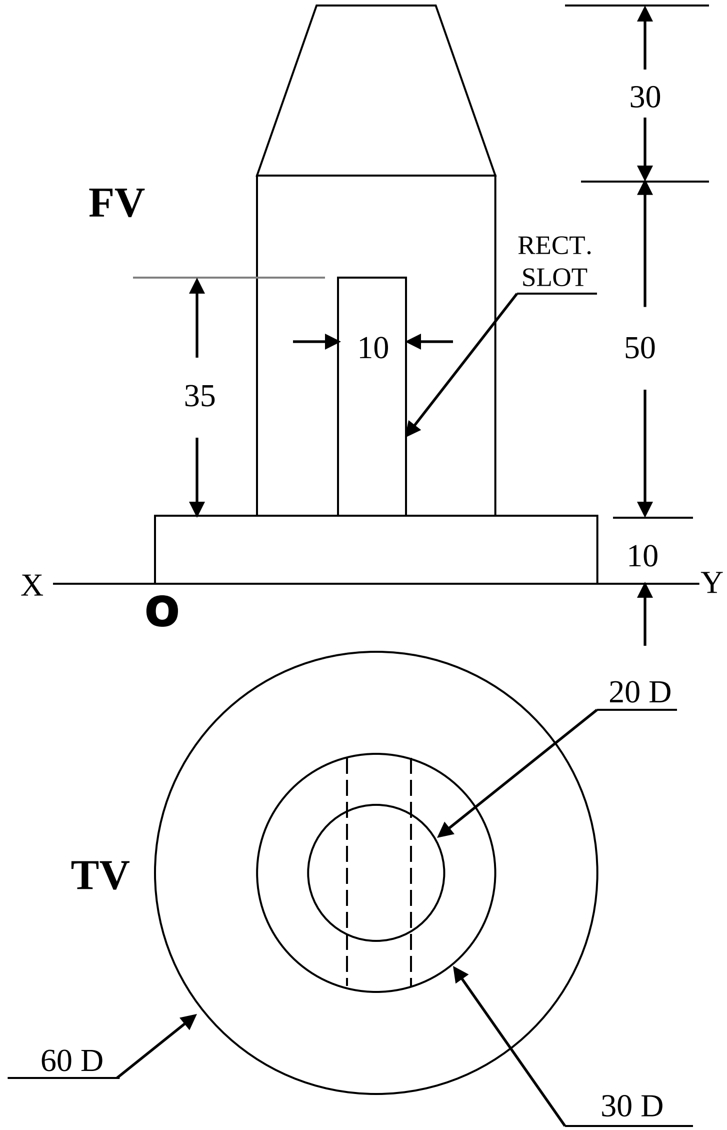

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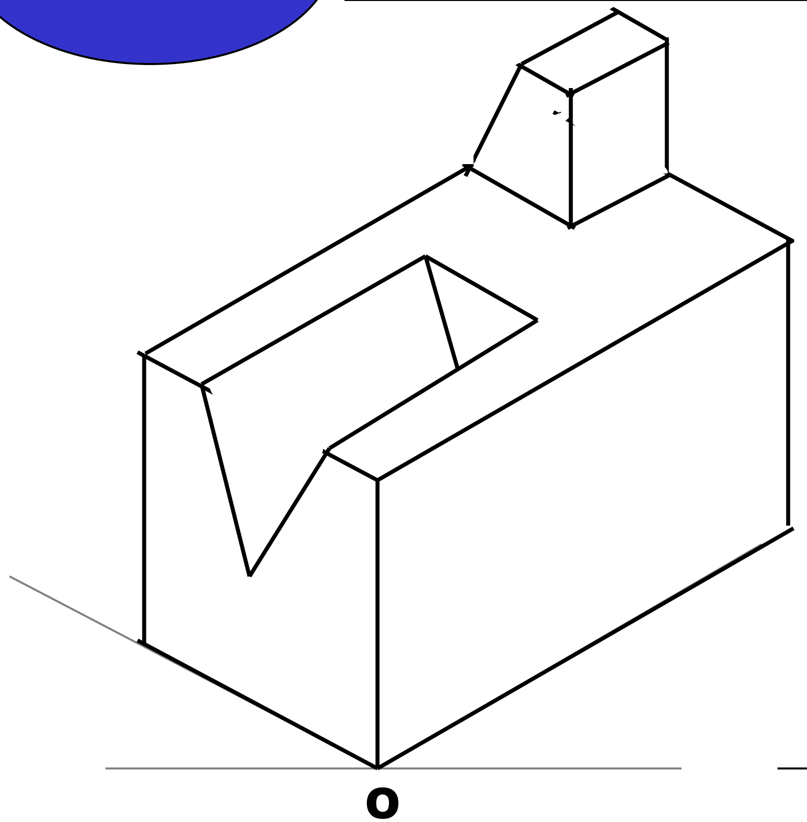

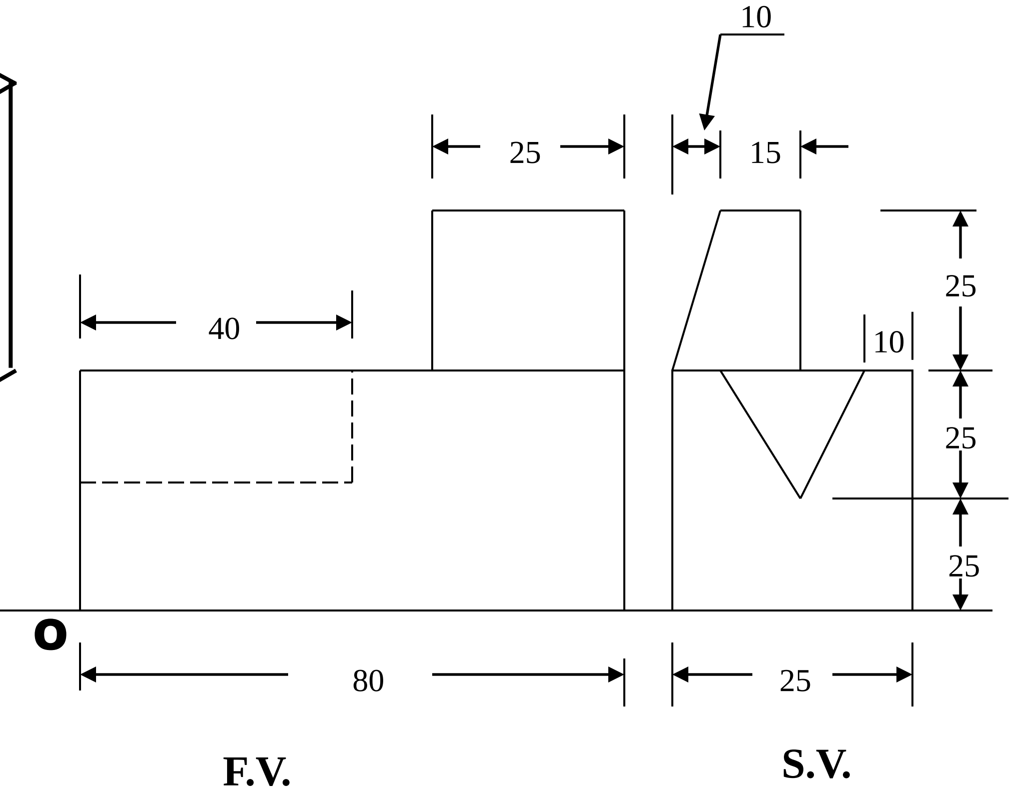

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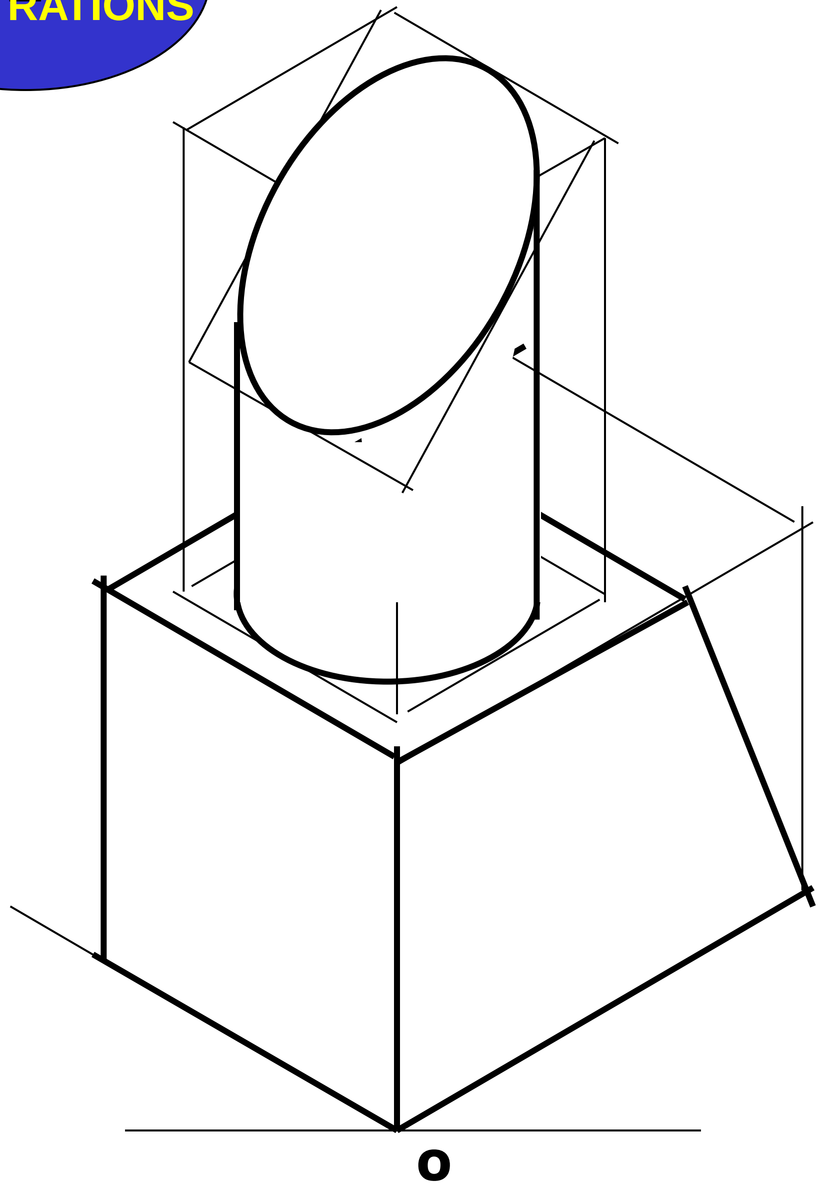

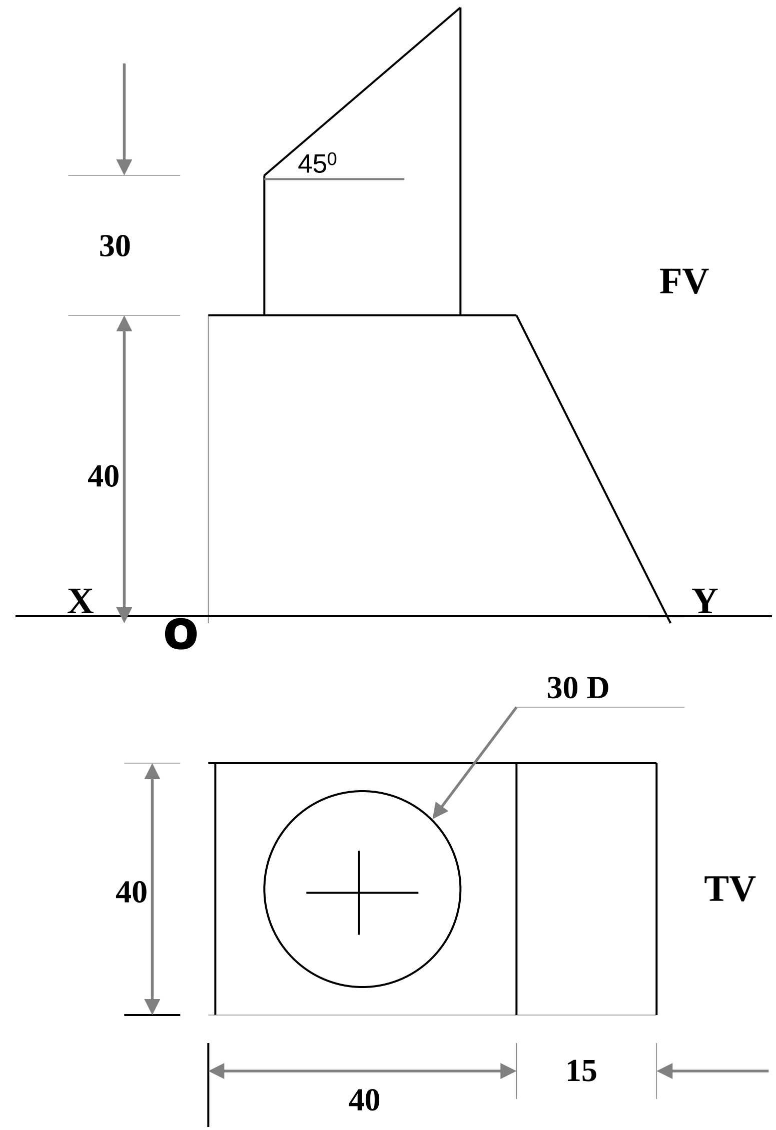

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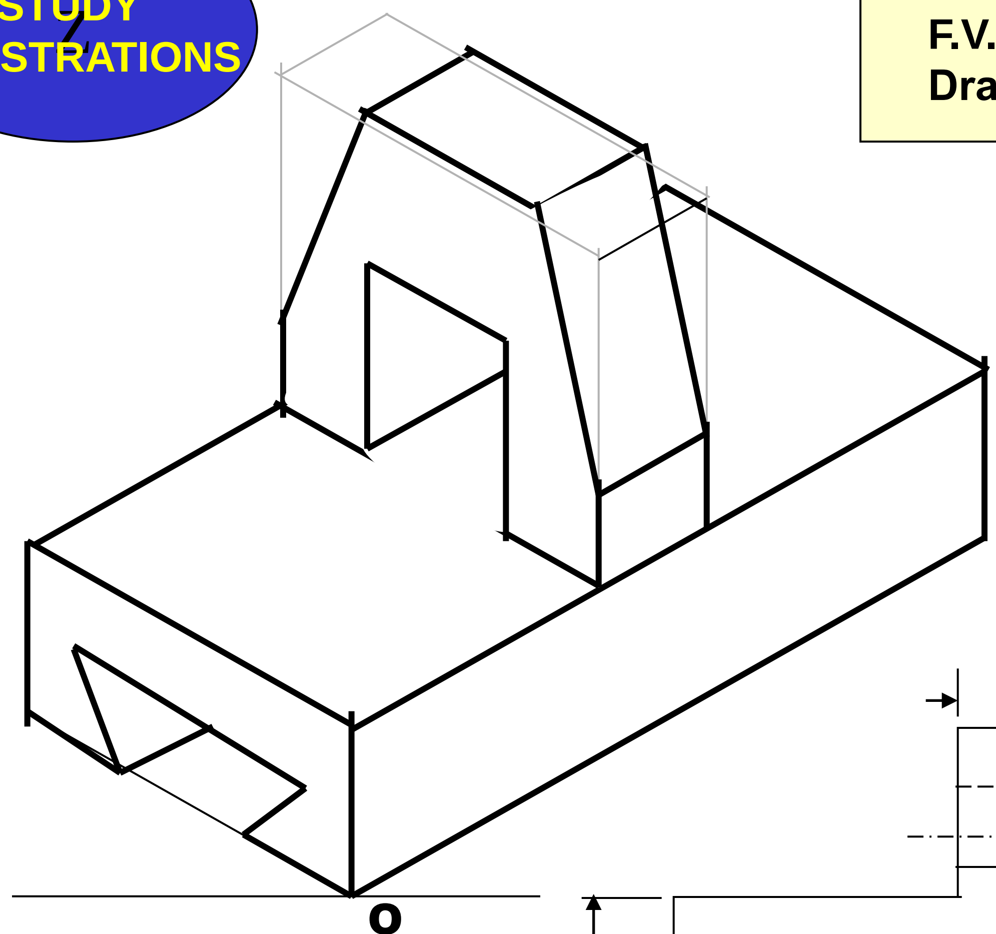
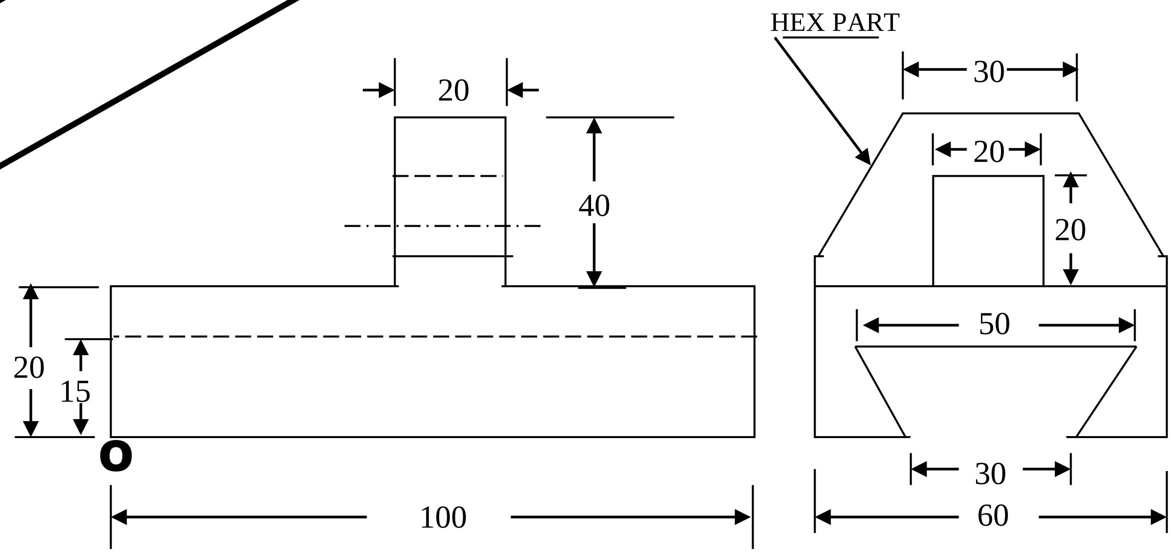
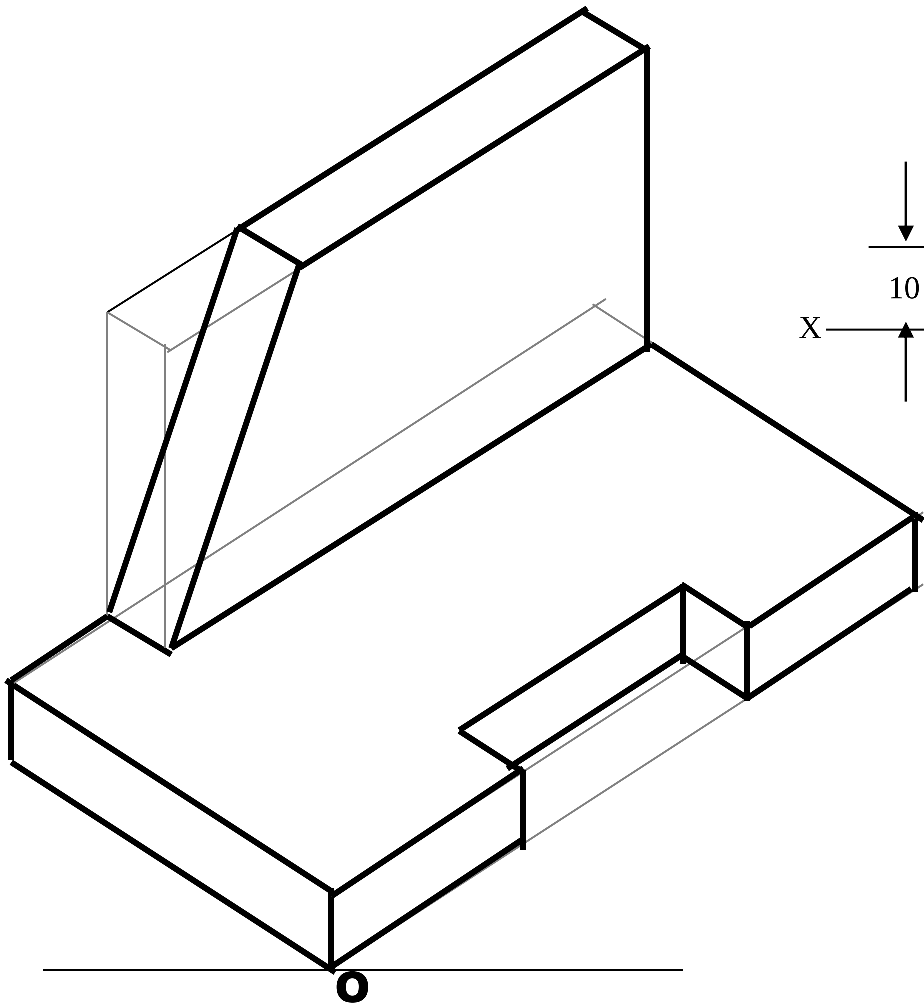
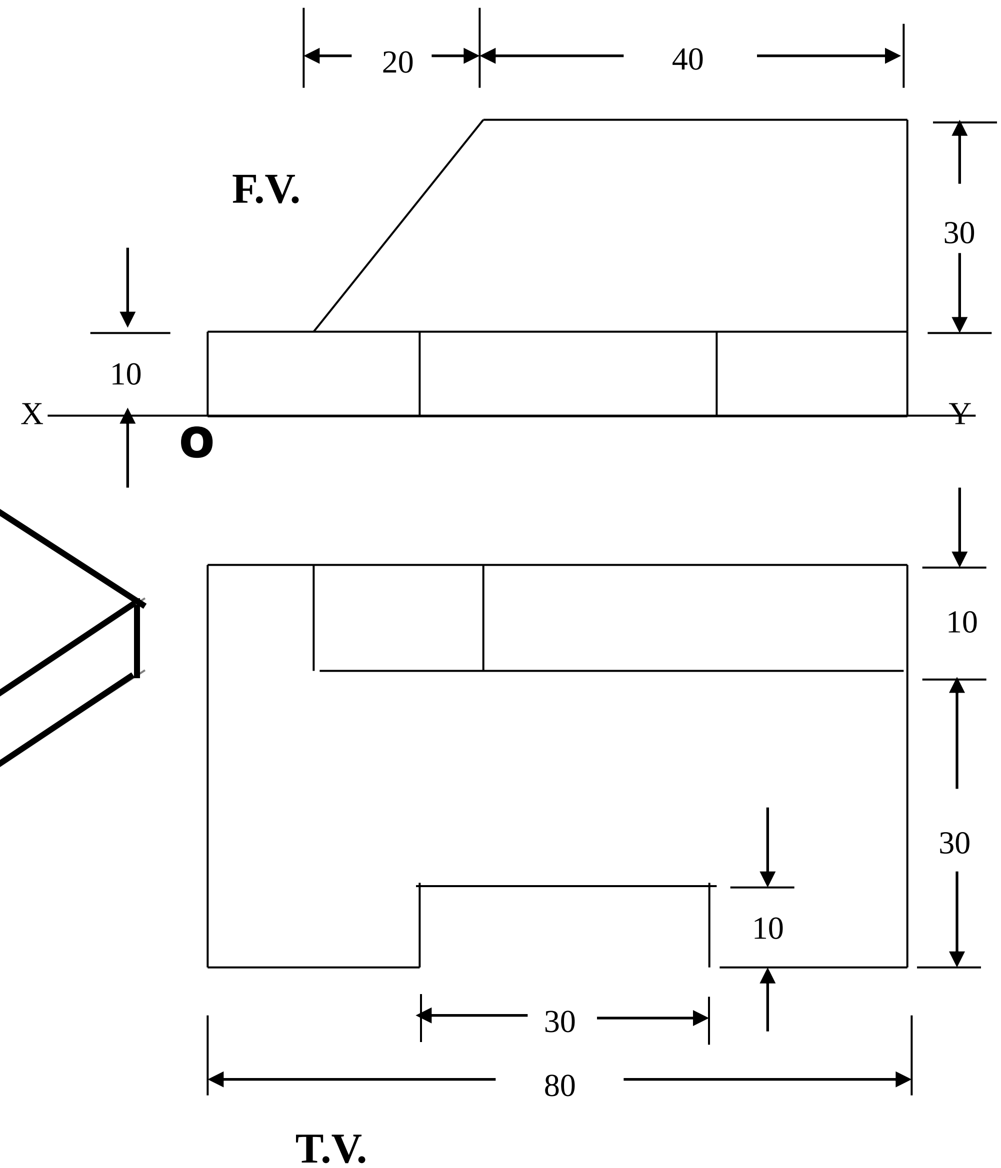




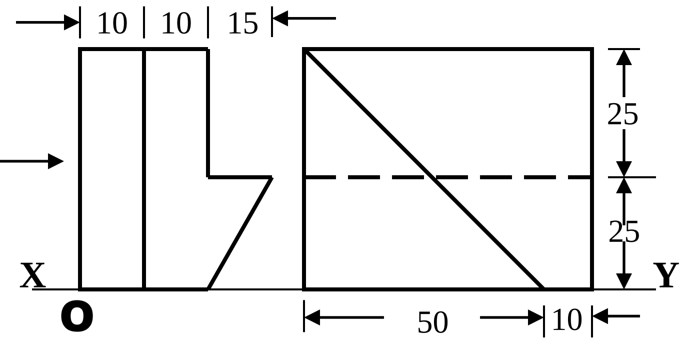
F.V. & T.V. of an object are given. Draw it's isometric view.



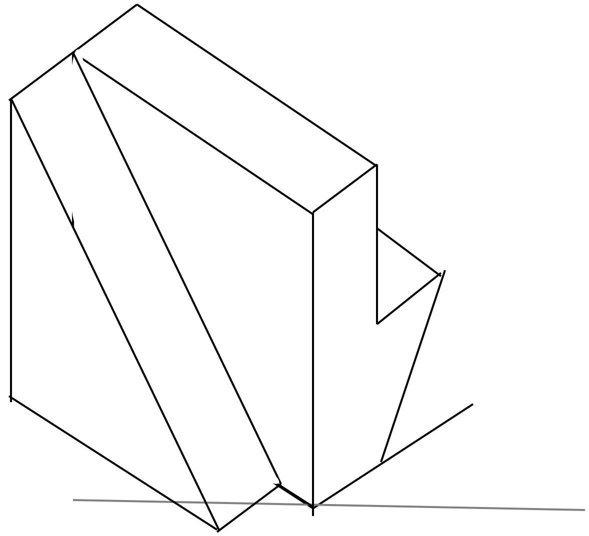


F.V. and S.V.of an object are given.
Draw it's isometric view.

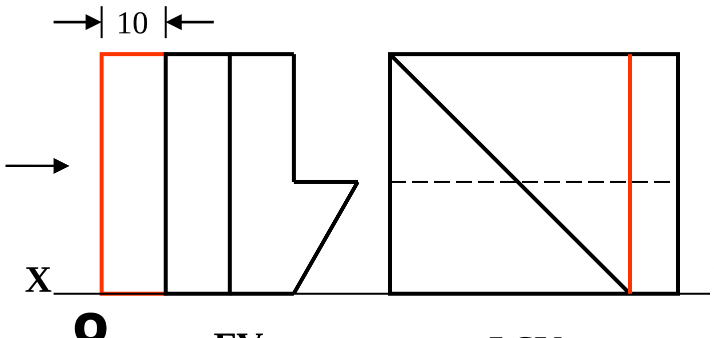
STUDY ILLUSTRATIONS



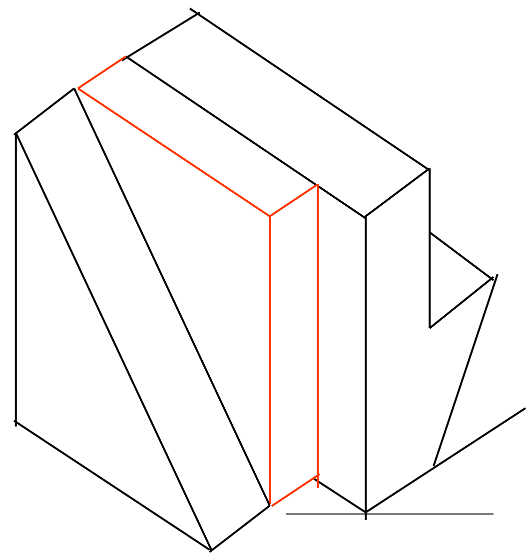
FV LSV



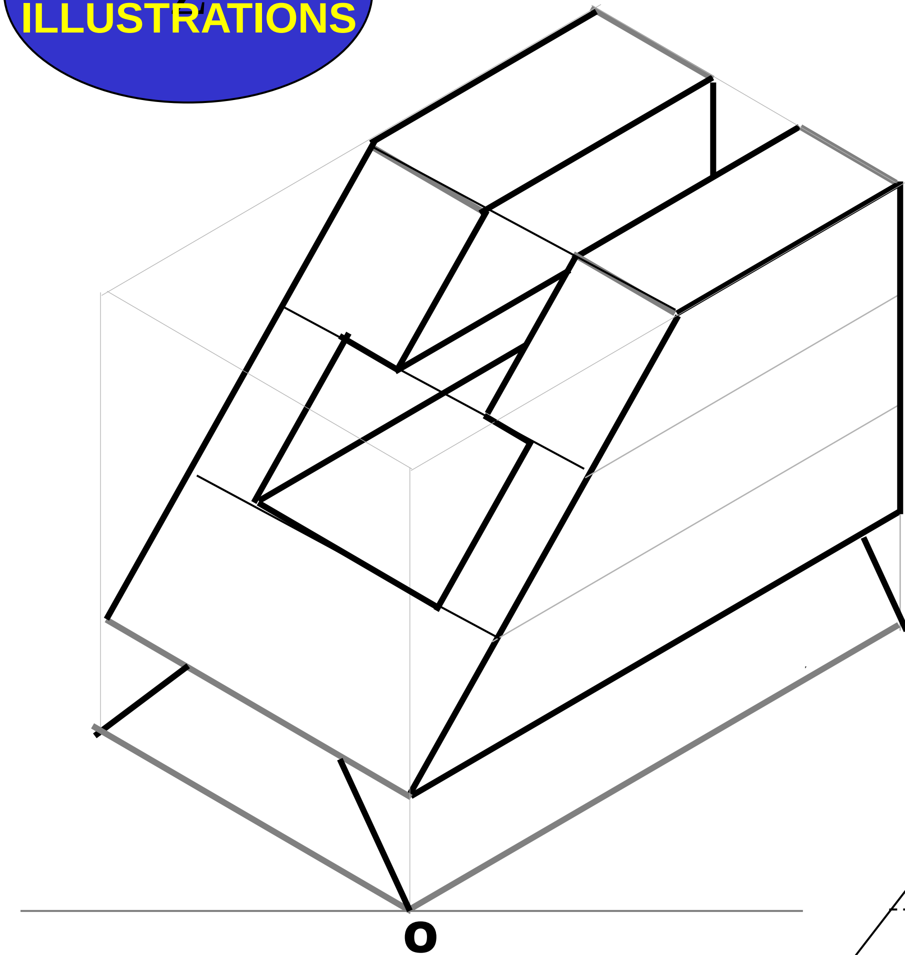
NOTE THE SMALL CHZNGE IN 2ND FV & SV.
DRAW ISOMETRIC ACCORDINGLY.

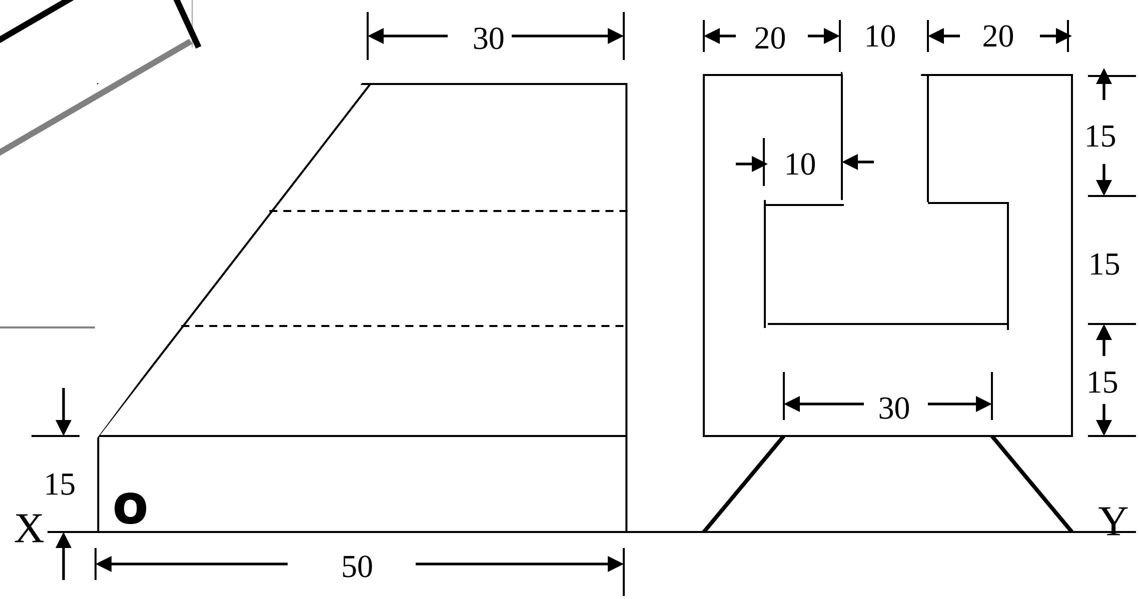


FV LSV



**F.V. and S.V.of an object are given.
Draw it's isometric view.**

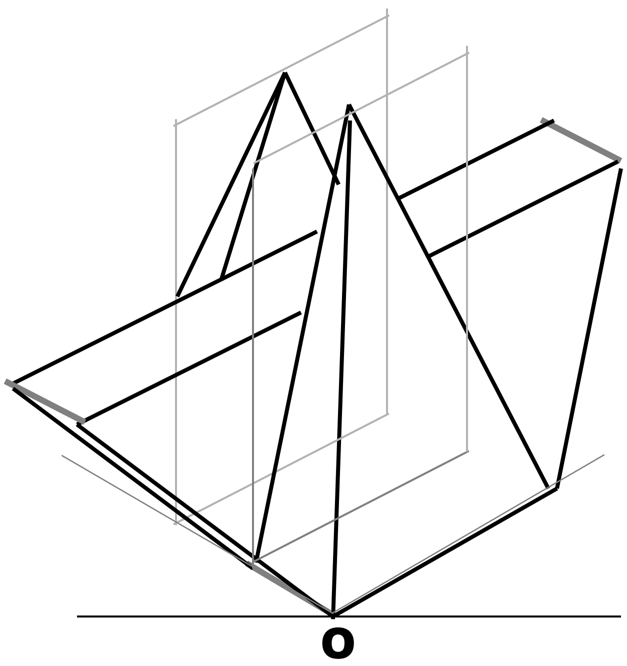


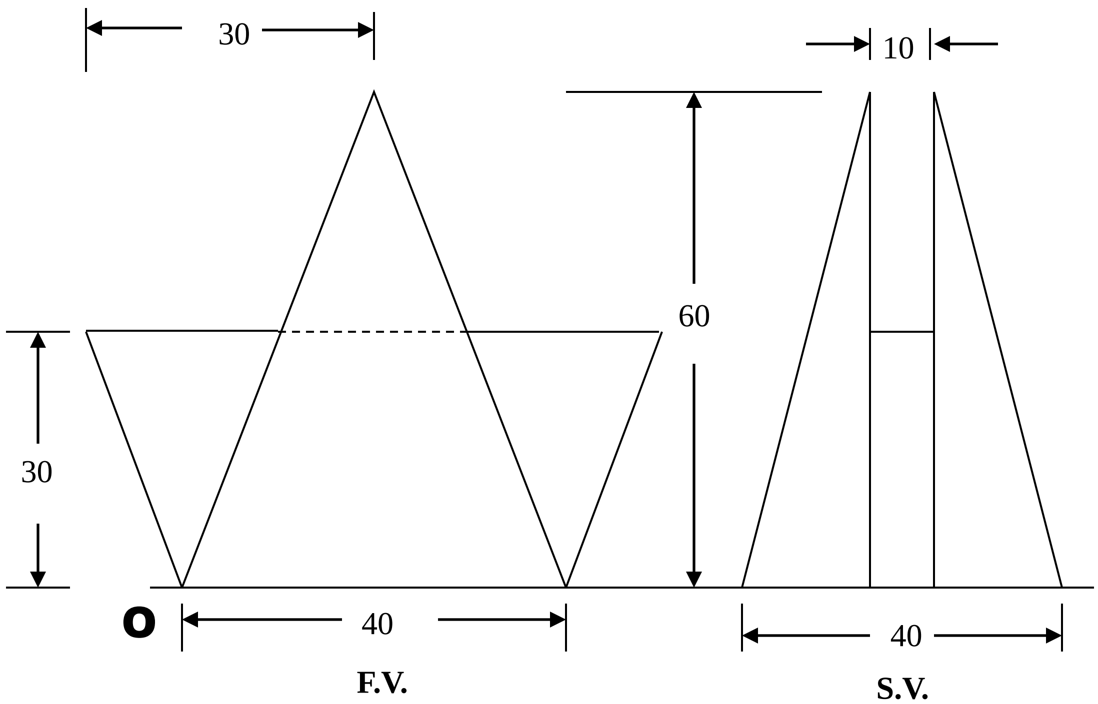


F.V.

LEFT S.V.

**F.V. and S.V.of an object are given.
Draw it's isometric view.**





EXERCISES:

PROJECTIONS OF STRAIGHT LINES

1. A line AB is in first quadrant. Its ends A and B are 25mm and 65mm in front of VP respectively. The distance between the end projectors is 75mm. The line is inclined at 30^0 to VP and its VT is 10mm above HP. Draw the projections of AB and determine its true length and HT and inclination with HP.

2. A line AB measures 100mm. The projections through its VT and end A are 50mm apart. The point A is 35mm above HP and 25mm in front VP. The VT is 15mm above HP. Draw the projections of line and determine its HT and Inclinations with HP and VP.

3. Draw the three views of line AB, 80mm long, when it is lying in profile plane and inclined at 35^0 to HP. Its end A is in HP and 20mm in front of VP, while other end B is in first quadrant. Determine also its traces.

4. A line AB 75 mm long, has its one end A in VP and other end B 15mm above HP and 50mm in front of VP. Draw the projections of line when sum of inclinations with HP and VP is 90^0. Determine the true angles of inclination and show traces.

5. A line AB is 75mm long and lies in an auxiliary inclined plane (AIP) which makes an angle of 45^0 with the HP. The front view of the line measures 55mm. The end A is in VP and 20mm above HP. Draw the projections of the line AB and find its inclination with HP and VP.

6. Line AB lies in an AVP 50^0 inclined to Vp while line is 30^0 inclined to Hp. End A is 10 mm above Hp. & 15 mm in front of Vp.Distance between projectors is 50 mm.Draw projections and find TL and inclination of line with Vp. Locate traces also.

APPLICATIONS OF LINES

Room , compound wall cases

7) A room measures 8m x 5m x4m high. An electric point hang in the center of ceiling and 1m below it. A thin straight wire connects the point to the switch in one of the corners of the room and 2m above the floor. Draw the projections of the and its length and slope angle with the floor.

8) A room is of size 6m\5m\3.5m high. Determine graphically the real distance between the top corner and its diagonally apposite bottom corners. consider appropriate scale

9) Two pegs A and B are fixed in each of the two adjacent side walls of the rectangular room 3m x 4m sides. Peg A is 1.5m above the floor, 1.2m from the longer side wall and is protruding 0.3m from the wall. Peg B is 2m above the floor, 1m from other side wall and protruding 0.2m from the wall. Find the distance between the ends of the two pegs. Also find the height of the roof if the shortest distance between peg A and and center of the ceiling is 5m.

10) Two fan motors hang from the ceiling of a hall 12m x 5m x 8m high at heights of 4m and 6m respectively. Determine graphically the distance between the motors. Also find the distance of each motor from the top corner joining end and front wall.

11) Two mangos on a two tree are 2m and 3m above the ground level and 1.5m and 2.5m from a 0.25m thick wall but on apposite sides of it. Distances being measured from the center line of the wall. The distance between the apples, measured along ground and parallel to the wall is 3m. Determine the real distance between the ranges.

POLES,ROADS, PIPE LINES,, NORTH- EAST-SOUTH WEST, SLOPE AND GRADIENT CASES.

12)Three vertical poles AB, CD and EF are lying along the corners of equilateral triangle lying on the ground of 100mm sides. Their lengths are 5m, 8m and 12m respectively. Draw their projections and find real distance between their top ends.

13) A straight road going up hill from a point A due east to another point B is 4km long and has a slop of 25^0. Another straight road from B due 30^0 east of north to a point C is also 4 kms long but going downward and has slope of 15^0. Find the length and slope of the straight road connecting A and C.

14) An electric transmission line laid along an uphill from the hydroelectric power station due west to a substation is 2km long and has a slop of 30^0. Another line from the substation, running W 45^0 N to village, is 4km long and laid on the ground level. Determine the length and slope of the proposed telephone line joining the the power station and village.

15) Two wire ropes are attached to the top corner of a 15m high building. The other end of one wire rope is attached to the top of the vertical pole 5m high and the rope makes an angle of depression of 45^0. The rope makes 30^0 angle of depression and is attached to the top of a 2m high pole. The pole in the top view are 2m apart. Draw the projections of the wire ropes.

16) Two hill tops A and B are 90m and 60m above the ground level respectively. They are observed from the point C, 20m above the ground. From C angles and elevations for A and B are 45^0 and 30^0 respectively. From B angle of elevation of A is 45^0. Determine the two distances between A, B and C.

PROJECTIONS OF PLANES:-

1. A thin regular pentagon of 30mm sides has one side // to Hp and 30^0 inclined to Vp while its surface is 45^0 inclines to Hp. Draw its projections.

2. A circle of 50mm diameter has end A of diameter AB in Hp and AB diameter 300 inclined to Hp. Draw its projections if

a) the TV of same diameter is 45^0 inclined to Vp, OR b) Diameter AB is in profile plane.

3. A thin triangle PQR has sides PQ = 60mm. QR = 80mm. and RP = 50mm. long respectively. Side PQ rest on ground and makes 30^0 with Vp. Point P is 30mm in front of Vp and R is 40mm above ground. Draw its projections.

4. An isosceles triangle having base 60mm long and altitude 80mm long appears as an equilateral triangle of 60mm sides with one side 30^0 inclined to XY in top view. Draw its projections.

5. A 30^0-60^0 set-square of 40mm long shortest side in Hp appears is an isosceles triangle in its TV. Draw projections of it and find its inclination with Hp.

6. A rhombus of 60mm and 40mm long diagonals is so placed on Hp that in TV it appears as a square of 40mm long diagonals. Draw its FV.

7. Draw projections of a circle 40 mm diameter resting on Hp on a point A on the circumference with its surface 30^0 inclined to Hp and 45^0 to Vp.

8. A top view of plane figure whose surface is perpendicular to Vp and 60^0 inclined to Hp is regular hexagon of 30mm sides with one side 30^0 inclined to xy.Determine it's true shape.

9. Draw a rectangular abcd of side 50mm and 30mm with longer 35^0 with XY, representing TV of a quadrilateral plane ABCD. The point A and B are 25 and 50mm above Hp respectively. Draw a suitable Fv and determine its true shape.

10.Draw a pentagon abcde having side 50^0 to XY, with the side ab =30mm, bc = 60mm, cd =50mm, de = 25mm and angles abc 120^0, cde 125^0. A figure is a TV of a plane whose ends A,B and E are 15, 25 and 35mm above Hp respectively. Complete the projections and determine the true shape of the plane figure.0

PROJECTIONS OF SOLIDS

1. Draw the projections of a square prism of 25mm sides base and 50mm long axis. The prism is resting with one of its corners in VP and axis inclined at 30^0 to VP and parallel to HP.

2. A pentagonal pyramid, base 40mm side and height 75mm rests on one edge on its base on the ground so that the highest point in the base is 25mm. above ground. Draw the projections when the axis is parallel to Vp. Draw an another front view on an AVP inclined at 30^0 to edge on which it is resting so that the base is visible.

3. A square pyramid of side 30mm and axis 60 mm long has one of its slant edges inclined at 45^0 to HP and a plane containing that slant edge and axis is inclined at 30^0 to VP. Draw the projections.

4. A hexagonal prism, base 30mm sides and axis 75mm long, has an edge of the base parallel to the HP and inclined at 45^0 to the VP. Its axis makes an angle of 60^0 with the HP. Draw its projections. Draw another top view on an auxiliary plane inclined at 50^0 to the HP.

5. Draw the three views of a cone having base 50 mm diameter and axis 60mm long It is resting on a ground on a point of its base circle. The axis is inclined at 40^0 to ground and at 30^0 to VP.

6. Draw the projections of a square prism resting on an edge of base on HP. The axis makes an angle of 30^0 with VP and 45^0 with HP. Take edge of base 25mm and axis length as 125mm.

7. A right pentagonal prism is suspended from one of its corners of base. Draw the projections (three views) when the edge of base apposite to the point of suspension makes an angle of 30^0 to VP. Take base side 30mm and axis length 60mm.s

8. A cone base diameter 50mm and axis 70mm long, is freely suspended from a point on the rim of its base. Draw the front view and the top view when the plane containing its axis is perpendicular to HP and makes an angle of 45^0 with VP.

CASES OF COMPOSITE SOLIDS.

9. A cube of 40mm long edges is resting on the ground with its vertical faces equally inclined to the VP. A right circular cone base 25mm diameter and height 50mm is placed centrally on the top of the cube so that their axis are in a straight line. Draw the front and top views of the solids. Project another top view on an AIP making 45^0 with the HP

10.A square bar of 30mm base side and 100mm long is pushed through the center of a cylindrical block of 30mm thickness and 70mm diameter, so that the bar comes out equally through the block on either side. Draw the front view, top view and side view of the solid when the axis of the bar is inclined at 30^0 to HP and parallel to VP, the sides of a bar being 45^0 to VP.

11.A cube of 50mm long edges is resting on the ground with its vertical faces equally inclined to VP. A hexagonal pyramid , base 25mm side and axis 50mm long, is placed centrally on the top of the cube so that their axes are in a straight line and two edges of its base are parallel to VP. Draw the front view and the top view of the solids, project another top view on an AIP making an angle of 45^0 with the HP.

12.A circular block, 75mm diameter and 25mm thick is pierced centrally through its flat faces by a square prism of 35mm base sides and 125mm long axis, which comes out equally on both sides of the block. Draw the projections of the solids when the combined axis is parallel to HP and inclined at 30^0 to VP, and a face of the prism makes an angle of 30^0 with HP. Draw side view also.

SECTION & DEVELOPMENT

1) A square pyramid of 30mm base sides and 50mm long axis is resting on its base in HP. Edges of base is equally inclined to VP. It is cut by section plane perpendicular to VP and inclined at 450 to HP. The plane cuts the axis at 10mm above the base. Draw the projections of the solid and show its development.

2) A hexagonal pyramid, edge of base 30mm and axis 75mm, is resting on its edge on HP which is perpendicular toVP. The axis makes an angle of 300to HP. the solid is cut by a section plane perpendicular to both HP and VP, and passing through the mid point of the axis. Draw the projections showing the sectional view, true shape of section and development of surface of a cut pyramid containing apex.

3) A cone of base diameter 60mm and axis 80mm, long has one of its generators in VP and parallel to HP. It is cut by a section plane perpendicular HP and parallel to VP. Draw the sectional FV, true shape of section and develop the lateral surface of the cone containing the apex.

4) A cube of 50mm long slid diagonal rest on ground on one of its corners so that the solid diagonal is vertical and an edge through that corner is parallel to VP. A horizontal section plane passing through midpoint of vertical solid diagonal cuts the cube. Draw the front view of the sectional top view and development of surface.

5) A vertical cylinder cut by a section plane perpendicular to VP and inclined to HP in such a way that the true shape of a section is an ellipse with 50mm and 80mm as its minor and major axes. The smallest generator on the cylinder is 20mm long after it is cut by a section plane. Draw the projections and show the true shape of the section. Also find the inclination of the section plane with HP. Draw the development of the lower half of the cylinder.

6) A cube of 75mm long edges has its vertical faces equally inclined to VP. It is cut by a section plane perpendicular to VP such that the true shape of section is regular hexagon. Determine the inclination of cutting plane with HP.Draw the sectional top view and true shape of section.

7) The pyramidal portion of a half pyramidal and half conical solid has a base ofthree sides, each 30mm long. The length of axis is 80mm. The solid rest on its base with the side of the pyramid base perpendicular to VP. A plane parallel to VP cuts the solid at a distance of 10mm from the top view of the axis. Draw sectional front view and true shape of section. Also develop the lateral surface of the cut solid.

8) A hexagonal pyramid having edge to edge distance 40mm and height 60mm has its base in HP and an edge of base perpendicular to VP. It is cut by a section plane, perpendicular to VP and passing through a point on the axis 10mm from the base. Draw three views of solid when it is resting on its cut face in HP, resting the larger part of the pyramid. Also draw the lateral surface development of the pyramid.

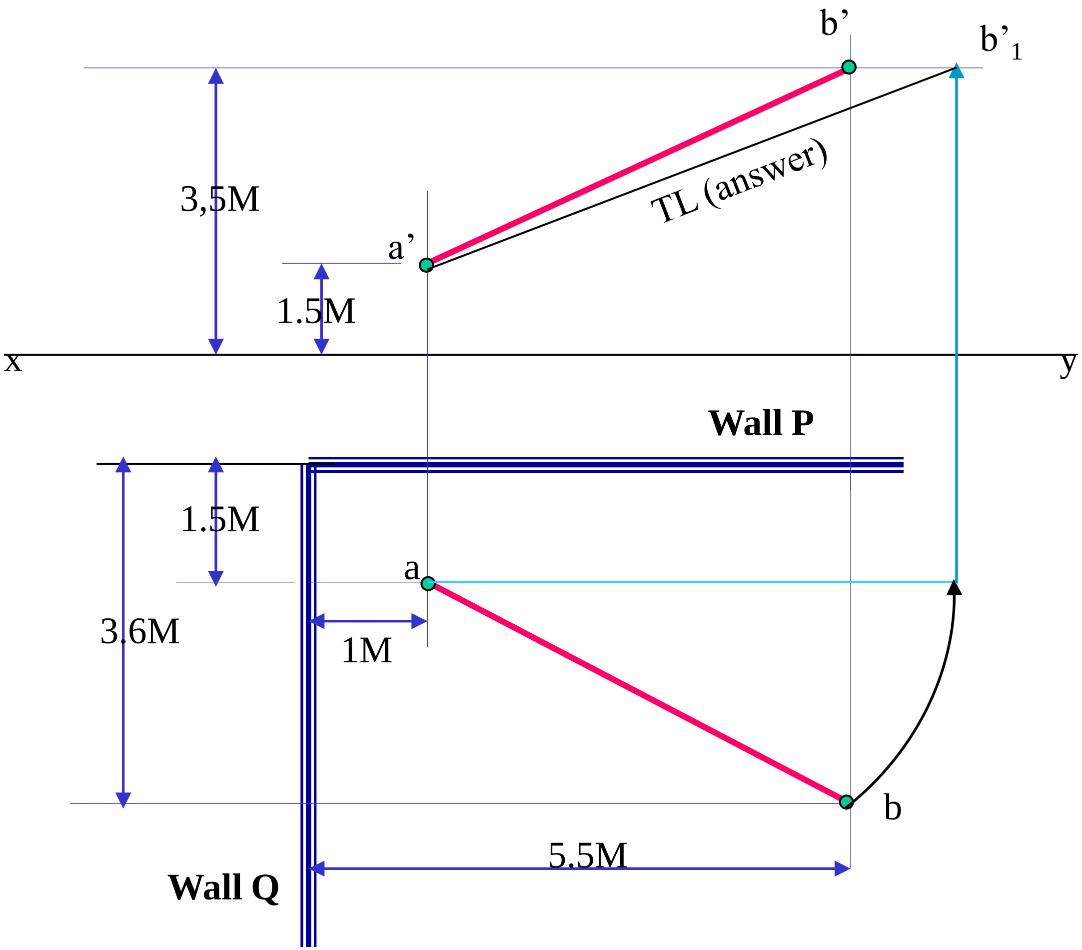
9) A cone diameter of base 50mm and axis 60mm long is resting on its base on ground. It is cut by a section plane perpendicular to VP in such a way that the true shape of a section is a parabola having base 40mm. Draw three views showing section, true shape of section and development of remaining surface of cone removing its apex.

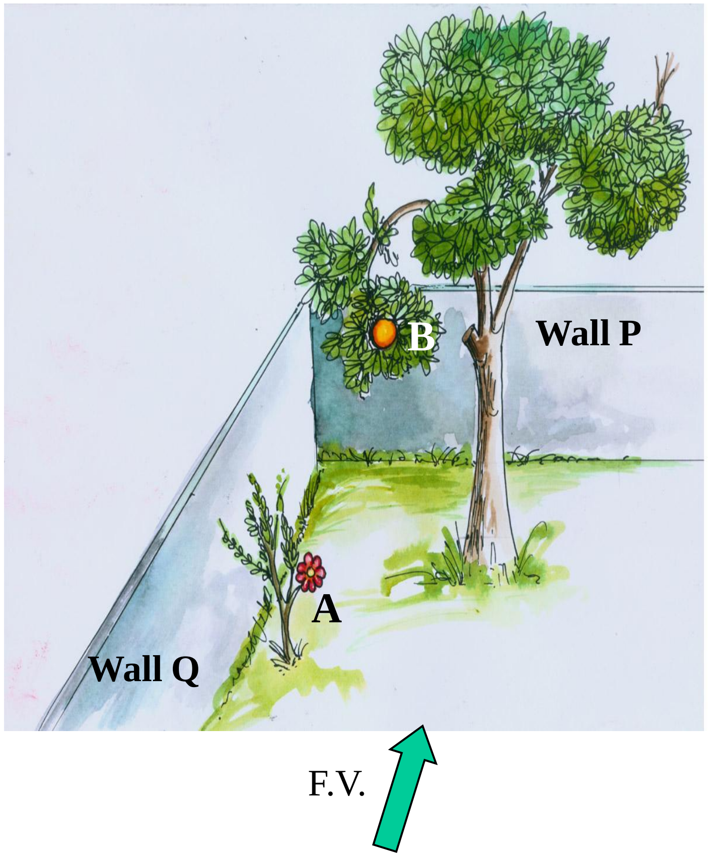
10) A hexagonal pyramid, base 50mm side and axis 100mm long is lying on ground on one of its triangular faces with axis parallel to VP. A vertical section plane, the HT of which makes an angle of 300 with the reference line passes through center of base, the apex being retained. Draw the top view, sectional front view and the development of surface of the cut pyramid containing apex.

11) Hexagonal pyramid of 40mm base side and height 80mm is resting on its base on ground. It is cut by a section plane parallel to HP and passing through a point on the axis 25mm from the apex. Draw the projections of the cut pyramid. A particle P, initially at the mid point of edge of base, starts moving over the surface and reaches the mid point of apposite edge of the top face. Draw the development of the cut pyramid and show the shortest path of particle P. Also show the path in front and top views

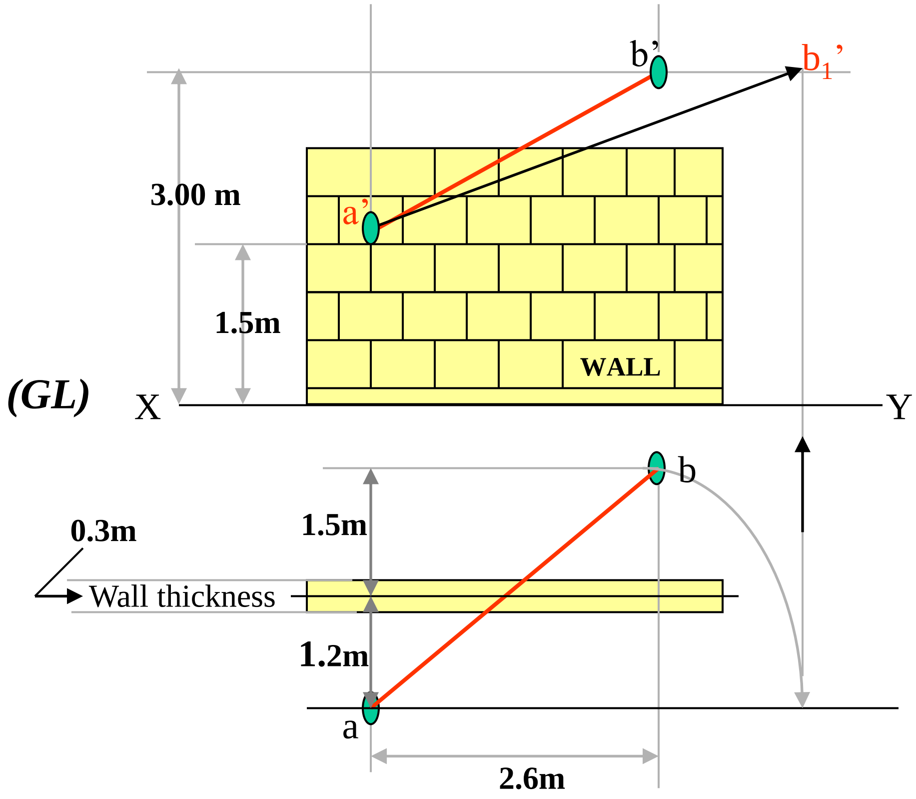
12) A cube of 65 mm long edges has its vertical face equally inclined to the VP. It is cut by a section plane, perpendicular to VP, so that the true shape of the section is a regular hexagon, Determine the inclination of the cutting plane with the HP and draw the sectional top view and true shape of the section.

PROBLEM 14:-Two objects, a flower (A) and an orange (B) are within a rectangular compound wall, whose P & Q are walls meeting at 90^0. Flower A is 1.5M & 1 M from walls P & Q respectively. Orange B is 3.5M & 5.5M from walls P & Q respectively. Drawing projection, find distance between them If flower is 1.5 M and orange is 3.5 M above the ground. Consider suitable scale..

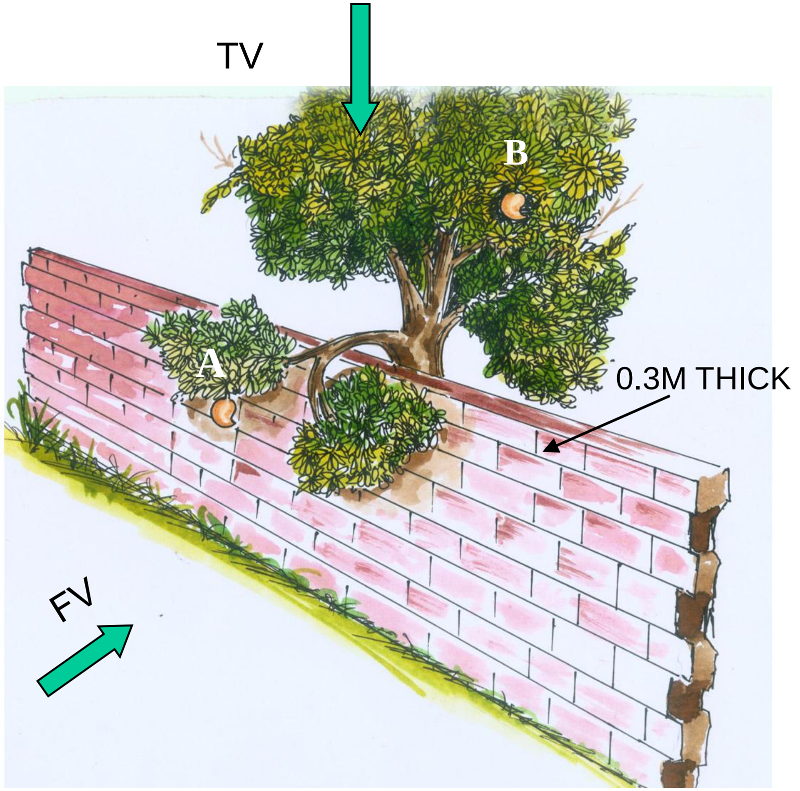




PROBLEM 15 :- **Two mangos on a tree A & B are 1.5 m and 3.00 m above ground and those are 1.2 m & 1.5 m from a 0.3 m thick wall but on opposite sides of it. If the distance measured between them along the ground and parallel to wall is 2.6 m, Then find real distance between them by drawing their projections.**

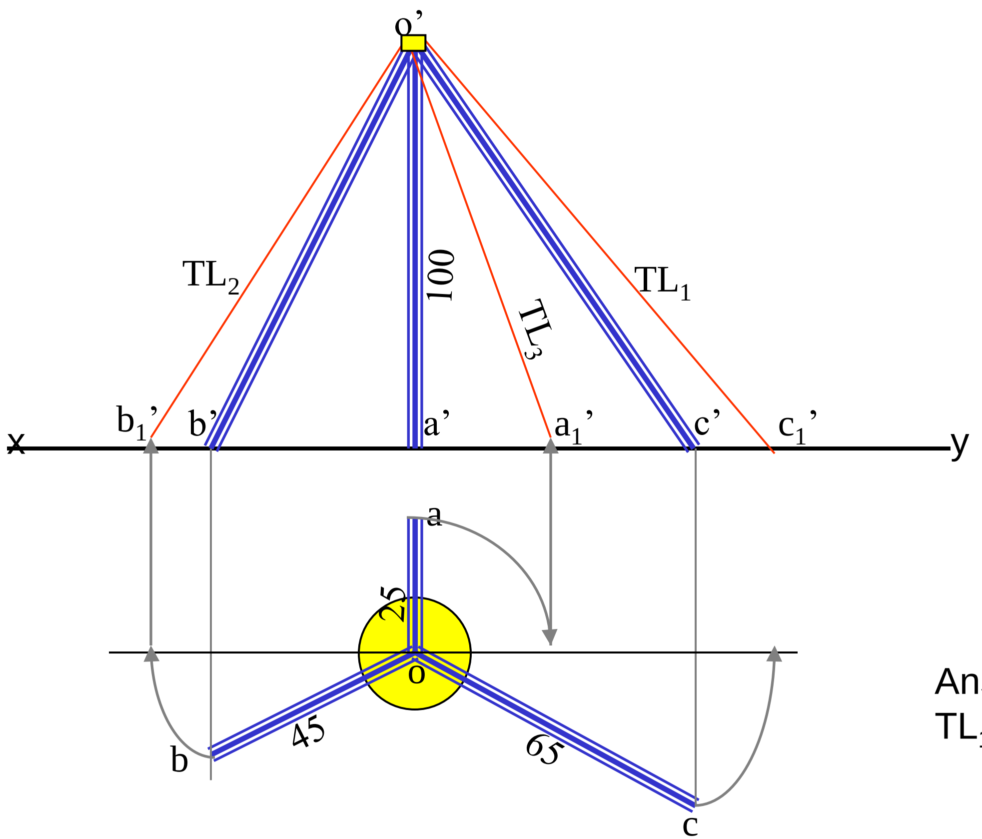


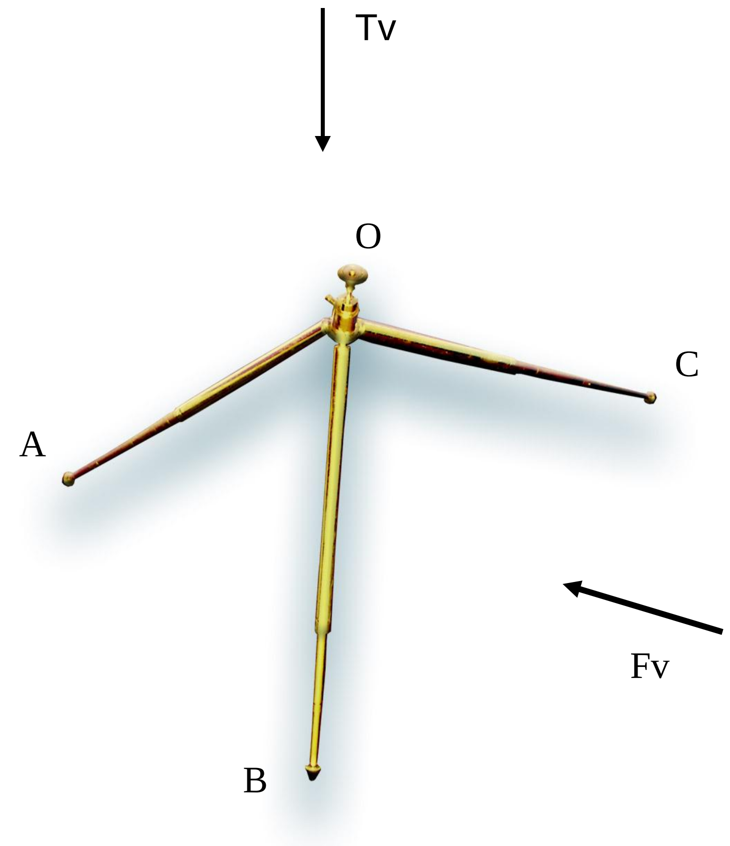
REAL DISTANCE BETWEEN MANGOS A & B IS = $a' b_1'$



PROBLEM 16 :-

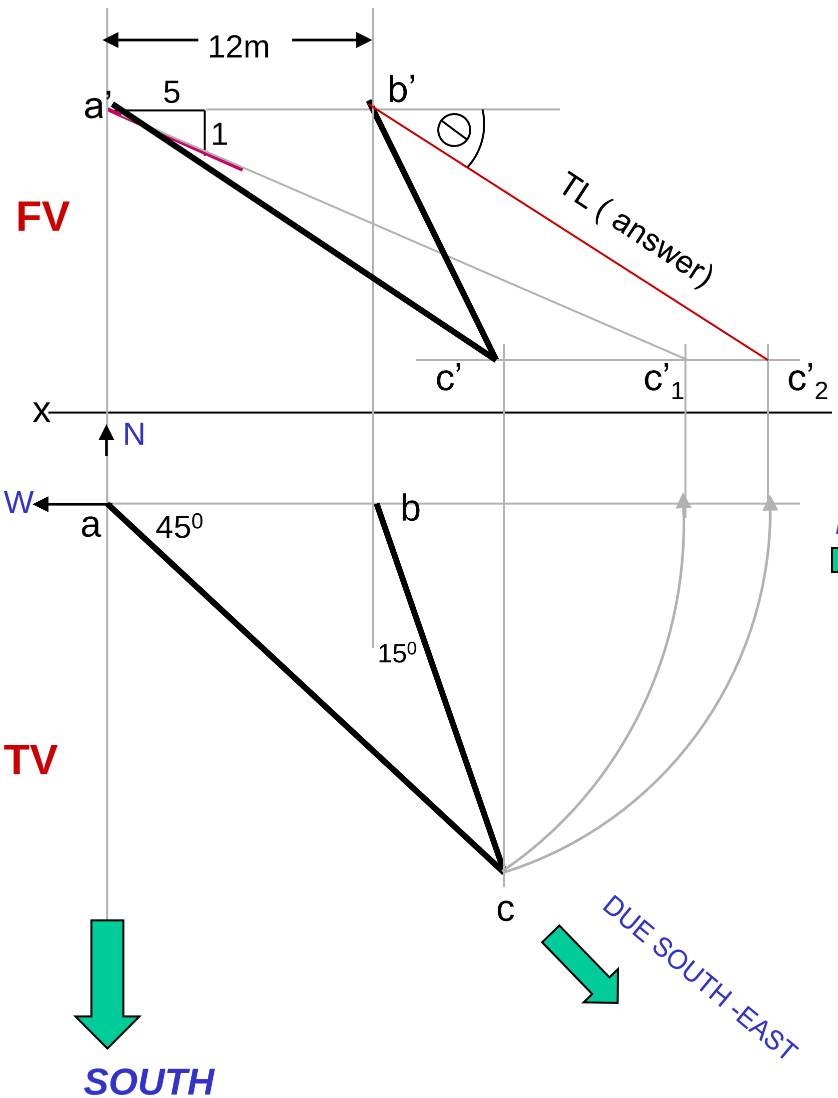
oa, ob & oc are three lines, 25mm, 45mm and 65mm long respectively.All equally inclined and the shortest is vertical.This fig. is TV of three rods OA, OB and OC whose ends A,B & C are on ground and end O is 100mm above ground. Draw their projections and find length o each along with their angles with ground.

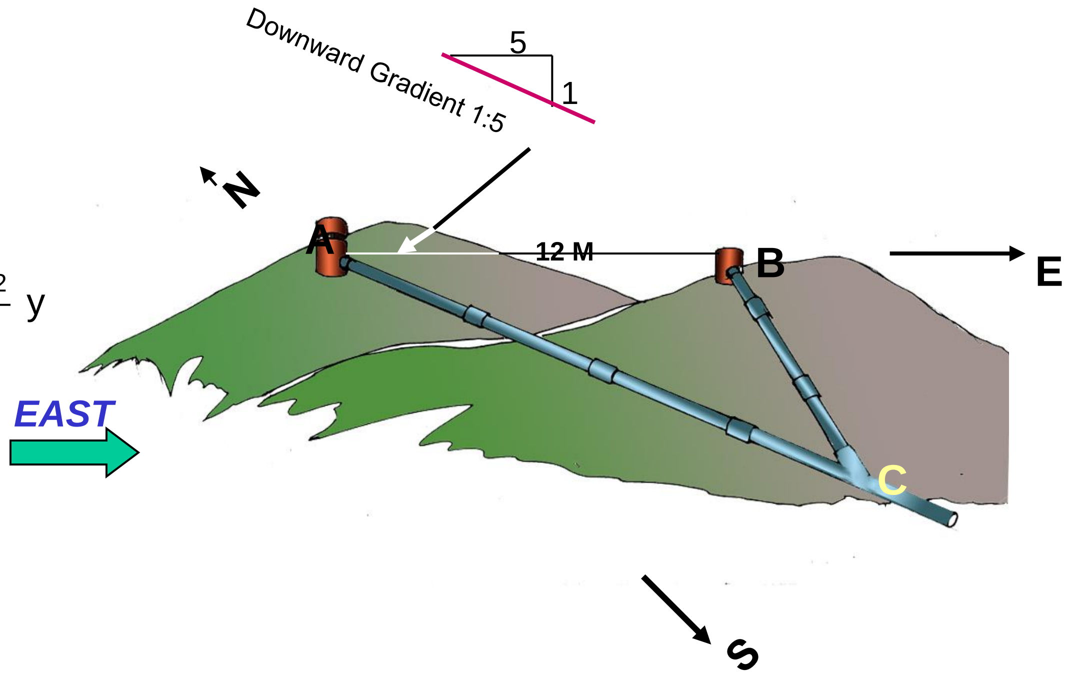




Answers:
TL_1 TL_2 & TL_3

PROBLEM 17:- A pipe line from point A has a downward gradient 1:5 and it runs due South - East. Another Point B is 12 M from A and due East of A and in same level of A. Pipe line from B runs 15^0 Due East of South and meets pipe line from A at point C.
Draw projections and find length of pipe line from B and it's inclination with ground.

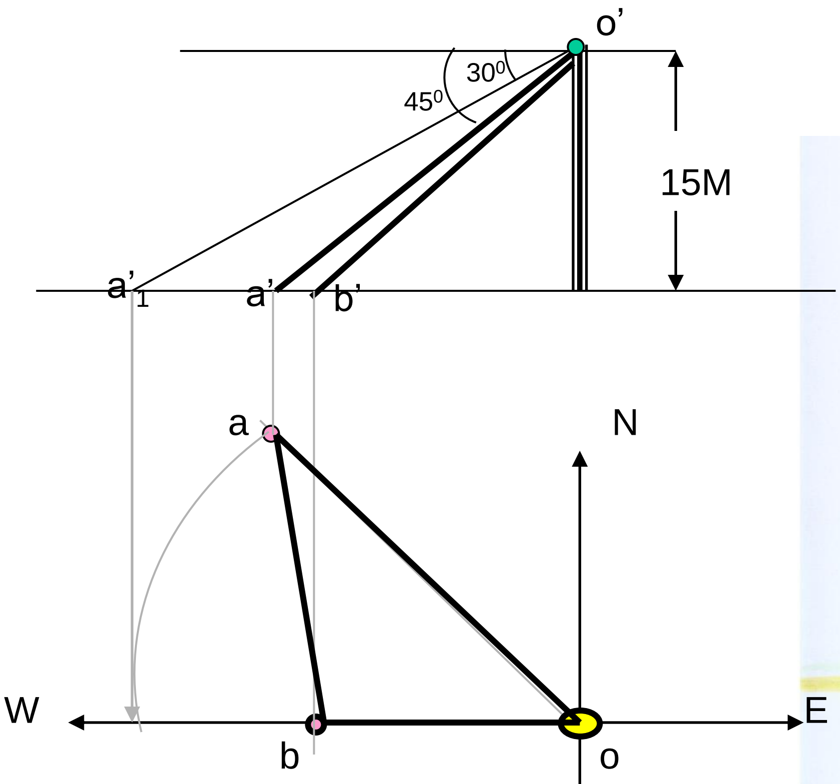


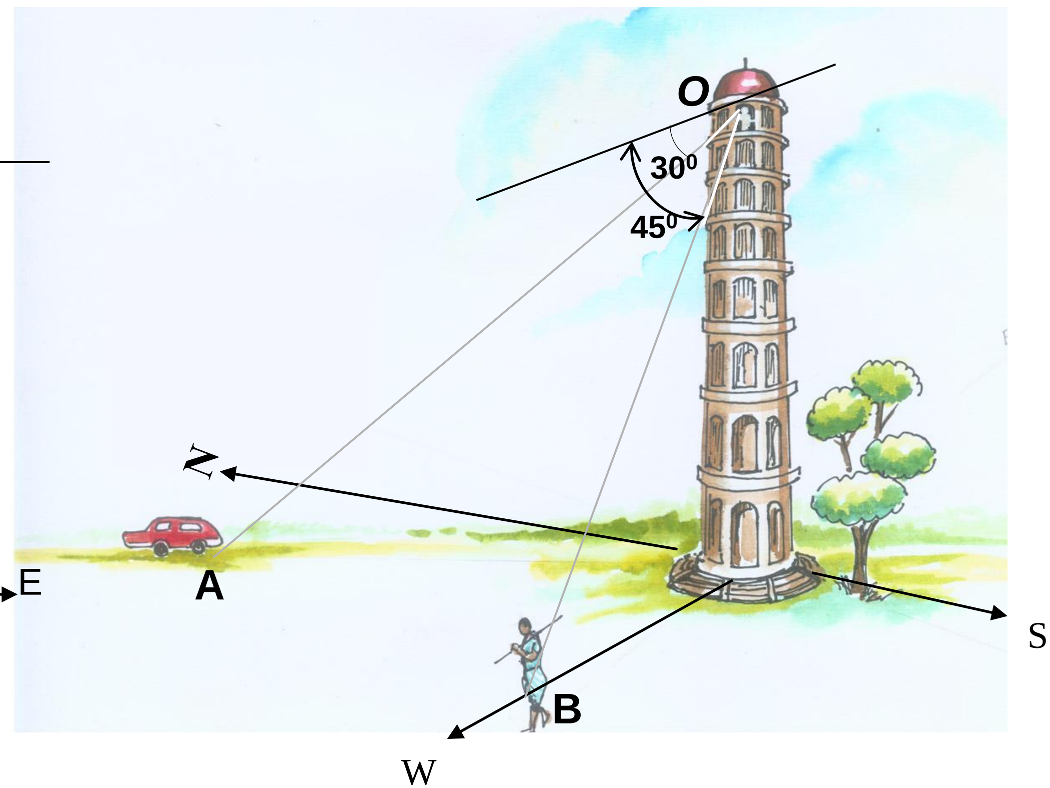


TL (answer) = a' c'_2

⦸ = Inclination of pipe line BC

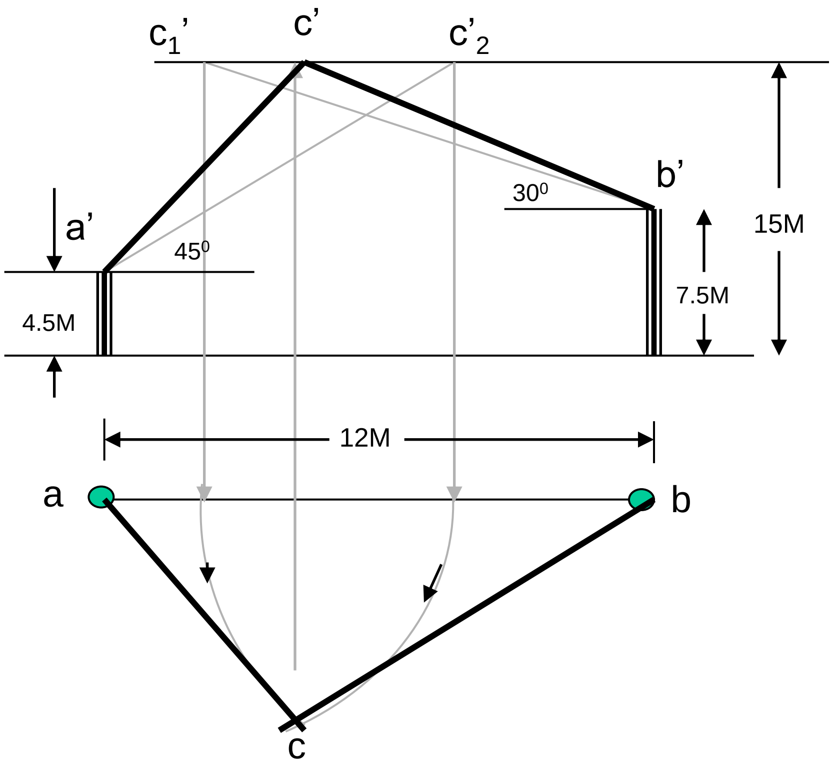
PROBLEM 18: **A person observes two objects, A & B, on the ground, from a tower, 15 M high, At the angles of depression 30^0 & 45^0. Object A is is due North-West direction of observer and object B is due West direction. Draw projections of situation and find distance of objects from observer and from tower also.**

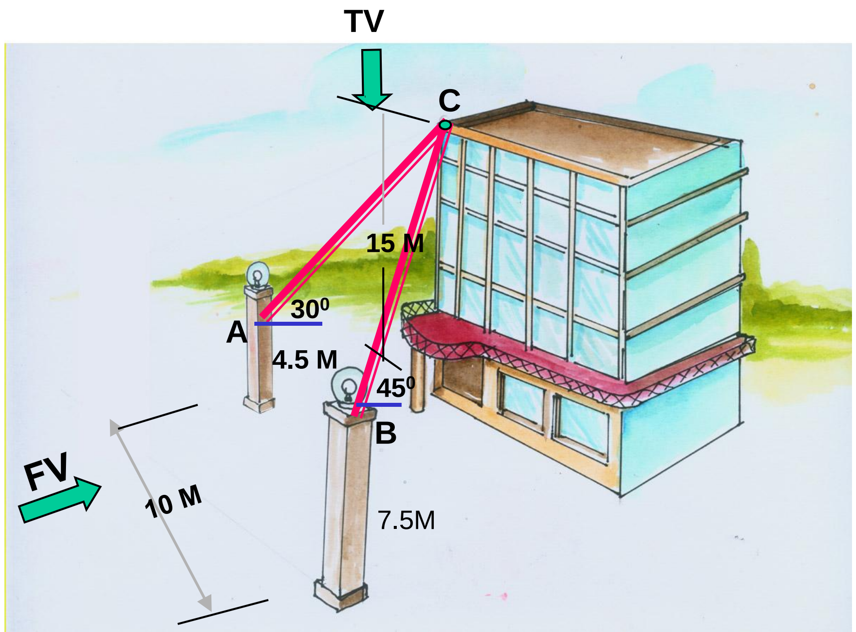




Answers:
Distances of objects
from observe
$o'a'_1$ & $o'b'$
From tower
oa & ob

PROBLEM 19:-Guy ropes of two poles fixed at 4.5m and 7.5 m above ground, are attached to a corner of a building 15 M high, make 30^0 and 45^0 inclinations with ground respectively.The poles are 10 M apart. Determine by drawing their projections,Length of each rope and distance of poles from building.



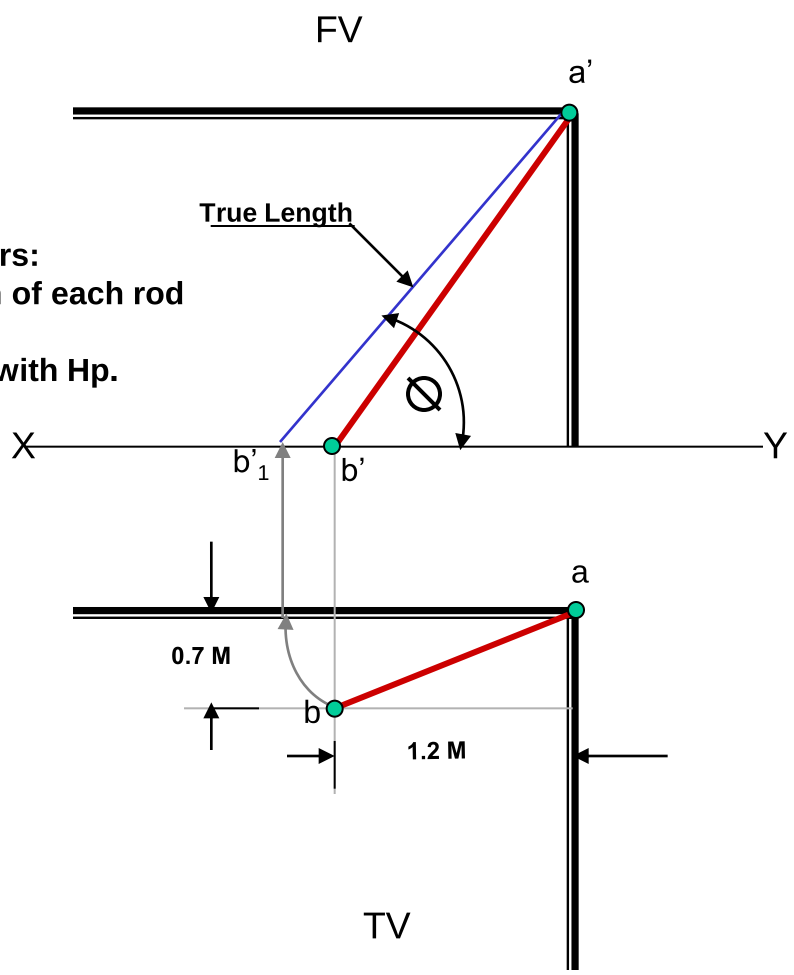


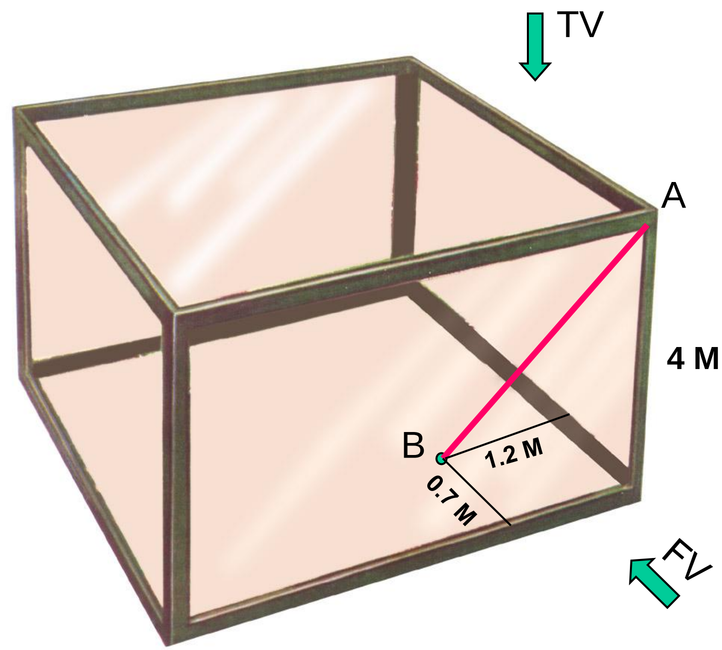
Answers:
Length of Rope BC= $b'c'_2$
Length of Rope AC= $a'c'_1$

Distances of poles from building = ca & cb

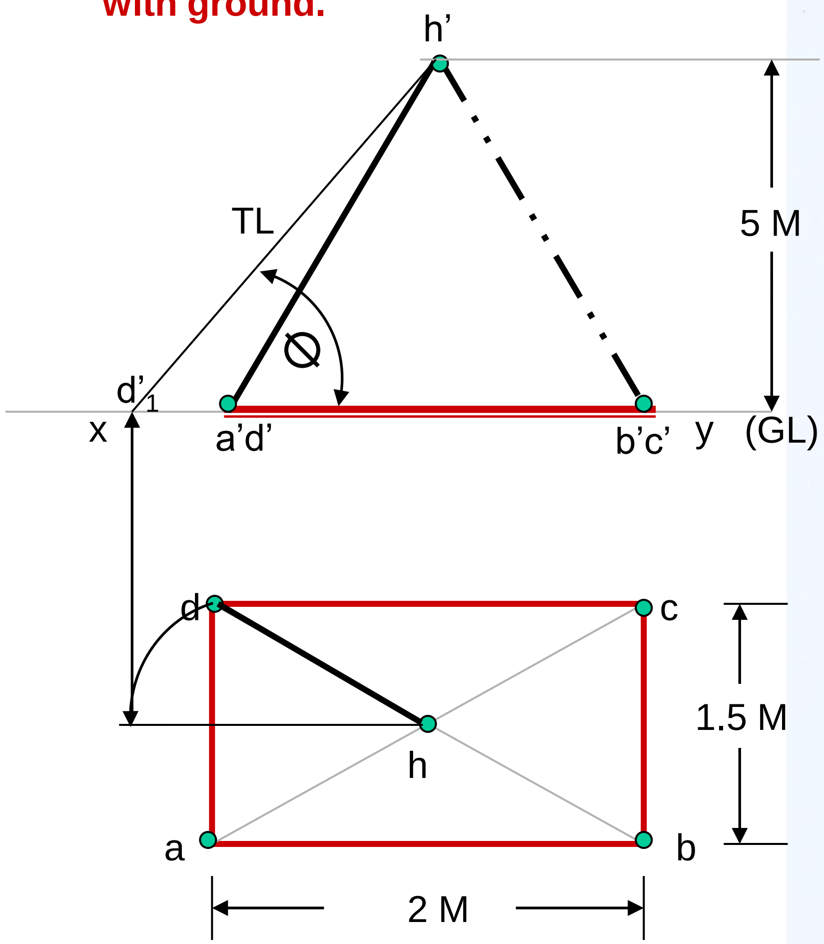
PROBLEM 20:- A tank of 4 M height is to be strengthened by four stay rods from each corner by fixing their other ends to the flooring, at a point 1.2 M and 0.7 M from two adjacent walls respectively, as shown. Determine graphically length and angle of each rod with flooring.

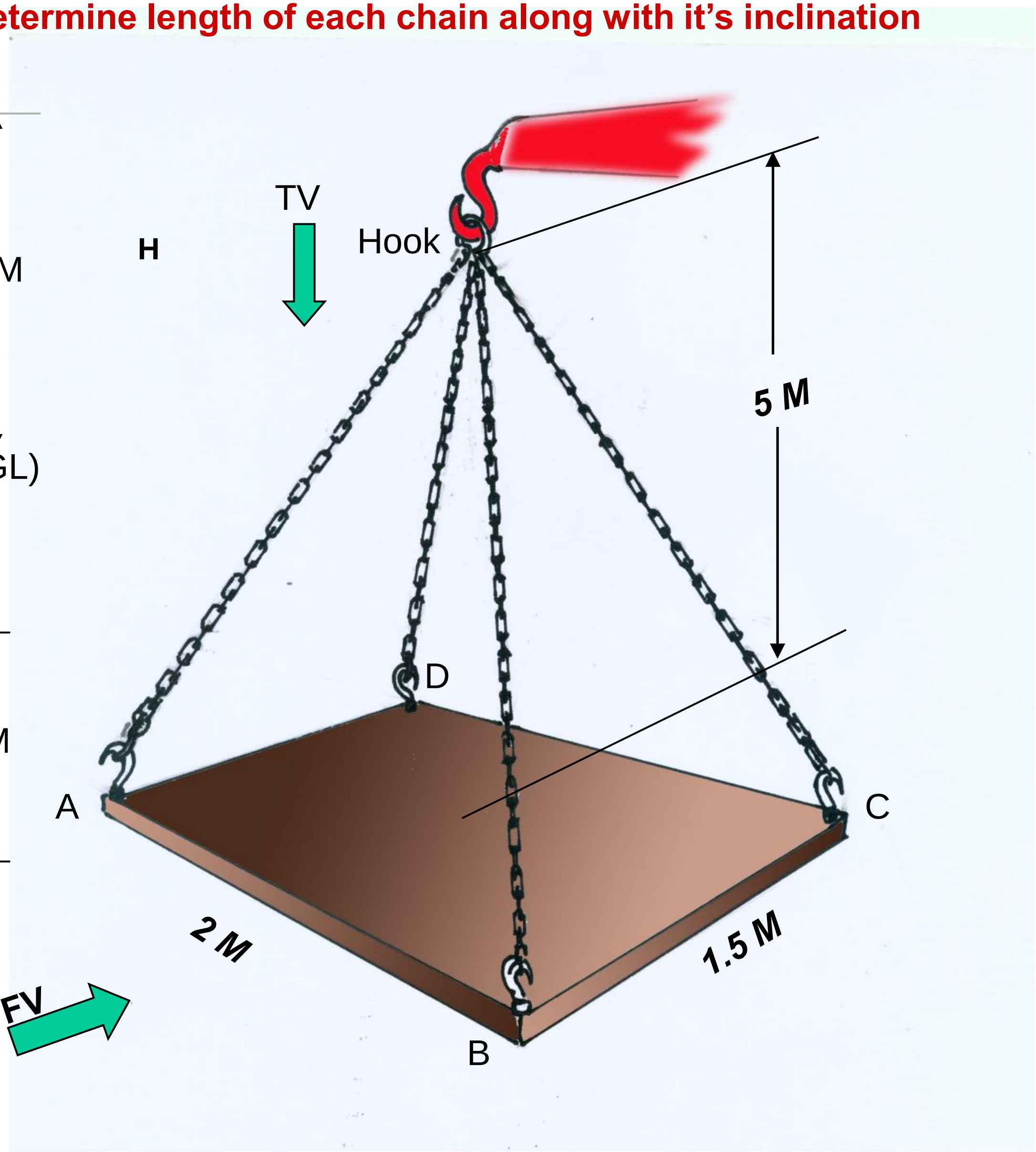
Answers:
Length of each rod
= a'b'$_1$
Angle with Hp.
= Ø





PROBLEM 21:- A horizontal wooden platform 2 M long and 1.5 M wide is supported by four chains from it's corners and chains are attached to a hook 5 M above the center of the platform. Draw projections of the objects and determine length of each chain along with it's inclination with ground.

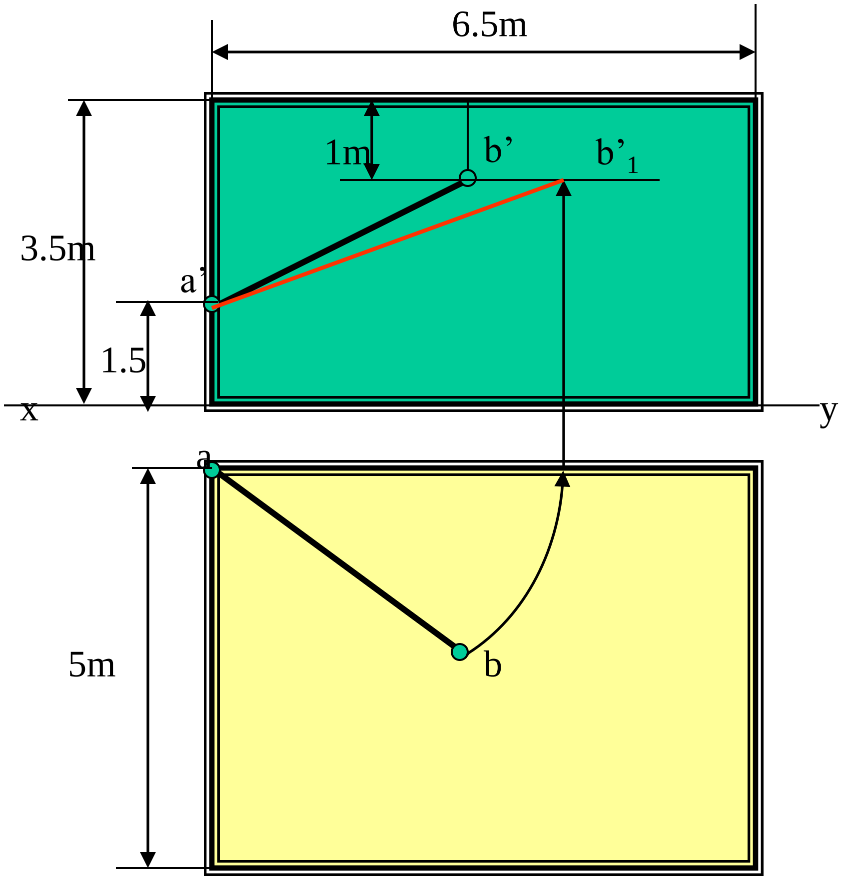


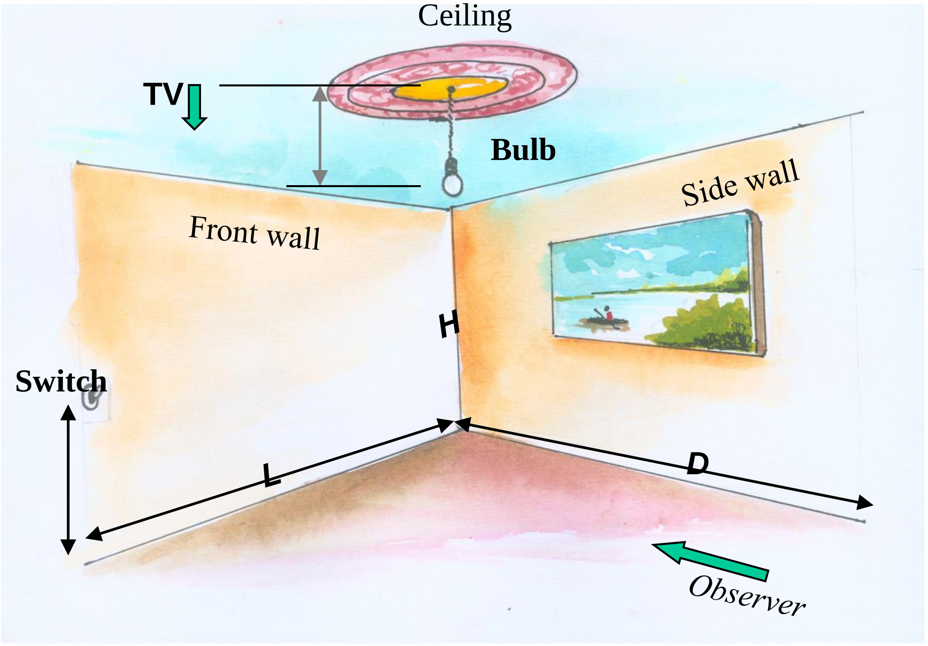


Answers:
Length of each chain
= a'd'$_1$
Angle with Hp.
= Ø

PROBLEM 22.

A room is of size 6.5m L ,5m D,3.5m high.
An electric bulb hangs 1m below the center of ceiling.
A switch is placed in one of the corners of the room, 1.5m above the flooring.
Draw the projections an determine real distance between the bulb and switch.

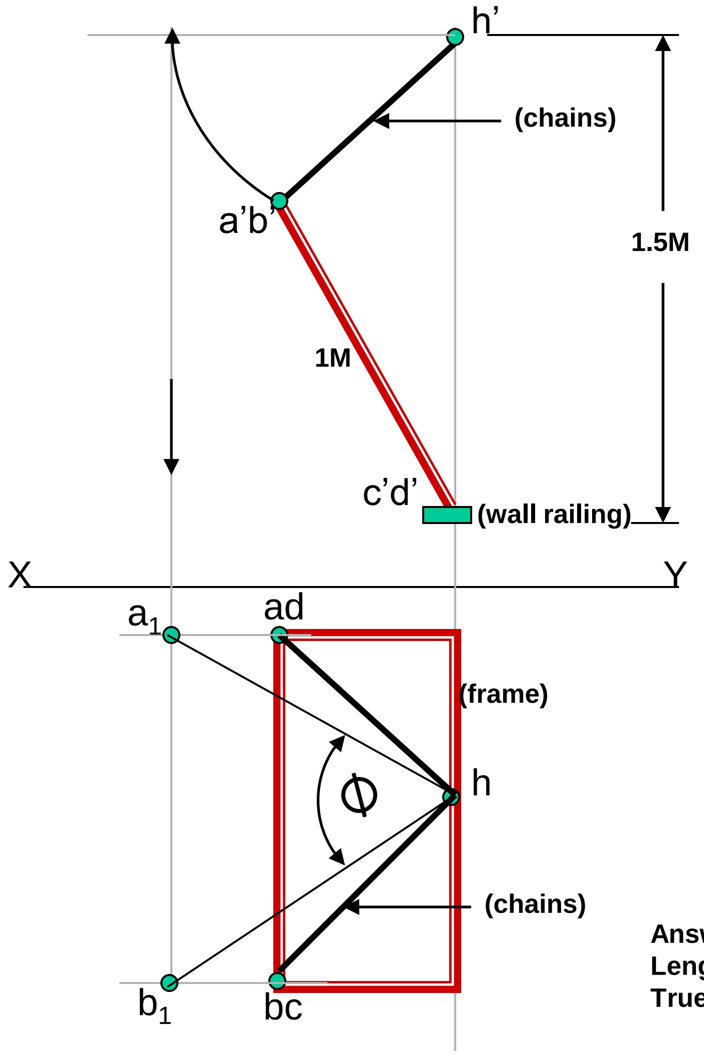


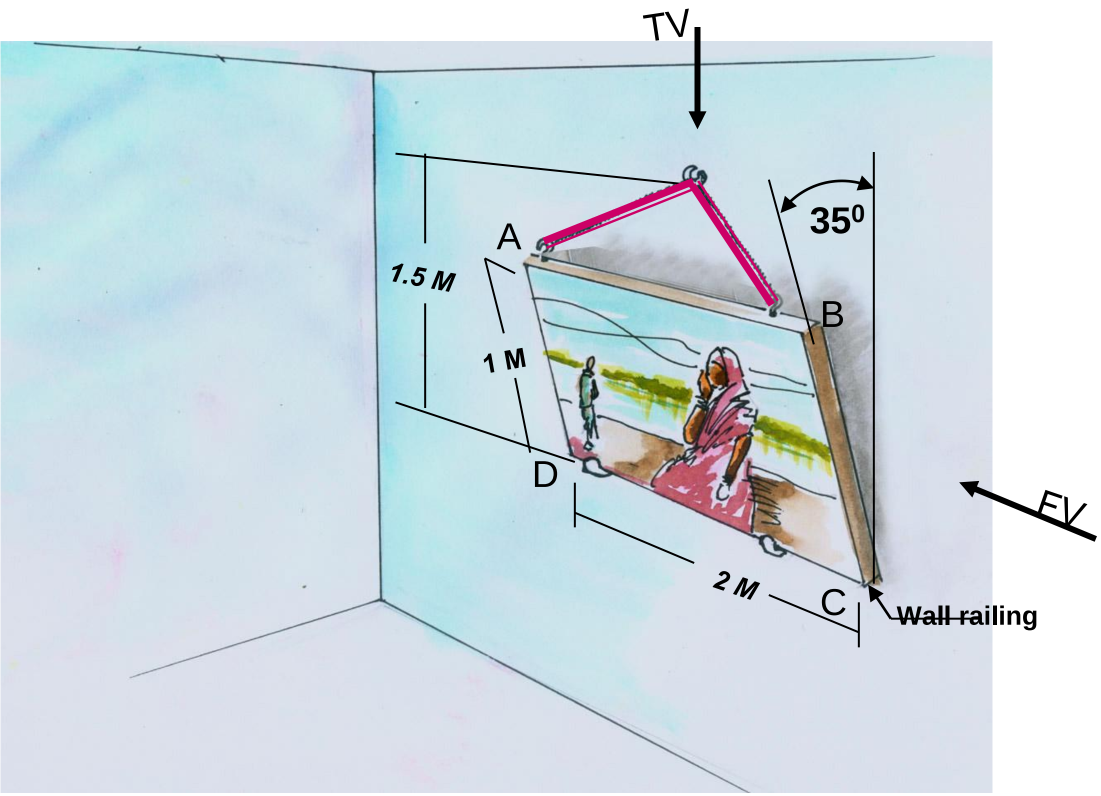


B- Bulb
A-Switch
Answer :- a' b'_1

PROBLEM 23:-

A PICTURE FRAME 2 M WIDE AND 1 M TALL IS RESTING ON HORIZONTAL WALL RAILING MAKES 35^0 INCLINATION WITH WALL. IT IS ATTAACHED TO A HOOK IN THE WALL BY TWO STRINGS. THE HOOK IS 1.5 M ABOVE WALL RAILING. DETERMINE LENGTH OF EACH CHAIN AND TRUE ANGLE BETWEEN THEM





Answers:
Length of each chain= hb_1
True angle between chains = ϕ