Vellore Institute of Technology Chennai

Presented By:

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Course Objective and Outcome

Course Objectives

- To introduce fundamental principles of major engineering disciplines.
- To create awareness of interdisciplinary engineering systems and their applications

Course Outcomes

At the end of the course students will be able to

1. Analyse the electrical circuits, electrical motors and the role of power electronics in industrial applications.
2. Acquire foundational knowledge of electronic devices and communication systems.
3. Apply BIS standards to create basic 2D and 3D representations of engineering components.
4. Explain the fundamental principles and applications of manufacturing processes, energy conversion systems, and mechanical automation technologies.
5. Analyze real-world examples where bio-inspired solutions have led to breakthroughs in engineering.

Syllabus

Module:1	Principles of Electrical Engineering: Circuits and Power conversion equipment	12 hours

Electric circuit components, Mesh current analysis, Node voltage analysis, Thevenin's and Superposition theorems, Single phase AC circuits- RL, RC, RLC, Power and Energy Calculations, Power Factor, Basics of Electrical Safety and Earthing.

Introduction to electro mechanical energy conversion, principle of operation of Electrical Machines - DC Motor, Induction motors, BLDC Motor and single phase Transformer, Concepts of Power Electronics and Industrial Applications of Electrical Drives (Qualitative Analysis)

Module:2	Foundations of Electronics and Communication systems: Devices, Circuits, and Systems	8 hours

Characteristics of PN Junction Diode, Zener Diode, BJT and MOSFET. Rectifiers and Voltage Regulators. Introduction to Operational Amplifiers. Electromagnetic Specturm. Elements of Communication Systems. Overview of cellular communication. Fundamentals of Satellite Communication and Radar.

Syllabus

Module:3	**Engineering Graphics and CAD**	**9 hours**
Introduction to Engineering Drawing – Importance and scope of engineering graphics, BIS standards for lines, lettering and dimensioning. Orthographic Projections – Principles of projection, first angle and third angle projections. Introduction to Projection of Solids- Isometric Projections and perspective projections. Freehand Sketching – Sketching of simple machine components and objects. Drawing of a simple residential floor plan as per IS SP7, Introduction to CAD.		
Module:4	**Manufacturing Processs, Energy conversions and Mechanical Automation**	**9 hours**
Basic Metal Casting, Forming, Joining and Cutting Processes - Introduction to CNC Machining. Additive Manufacturing (3D Printing): Principles and Applications. Fundamentals of Thermal engineering systems, Internal Combustion Engine. Introduction to Power Plants. Introduction to Refrigeration and Air Conditioning. Basics of Fuel Cells and Sustainable Energy Technologies. Introduction to Mechanisms - Four-bar mechanism and its inversions- Hexapod mechanisms. Mechanical Components and Motion Control in mechanical systems. Introduction to Robotics and Automation – Pneumatic and hydraulic actuators.		

Syllabus

Module:5	**Bio-Inspired Design in Engineering**	**5 hours**
Introduction to Biomimicry- Core principles. Case Studies Across Disciplines: Velcro inspired by burrs, self-healing materials based on skin regeneration -Termite mound-inspired ventilation systems in green buildings-Insect-inspired drones and soft robotics-Neural networks based on the human brain -Identify a problem and brainstorm a bio-inspired solution.		
Module: 6	**Contemporary Topics**	**2 hours**
Lectures by Industry or Research experts		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Allan R. Hambley, "Electrical Engineering -Principles & Applications", 2019, 6th Edition, Pearson Education
2	R.L. Boylestad and L. Nashelsky, "Electronic Devices and circuit theory", 11th Edition, person Publications
3	Louis E Frenzel Jr, "Principles of Electronics Communication Systems", 2016, McGraw Hill Eduation.
4	Bhatt N. D., Engineering Drawing, Charotar Publishing House Pvt. Ltd, 2019.

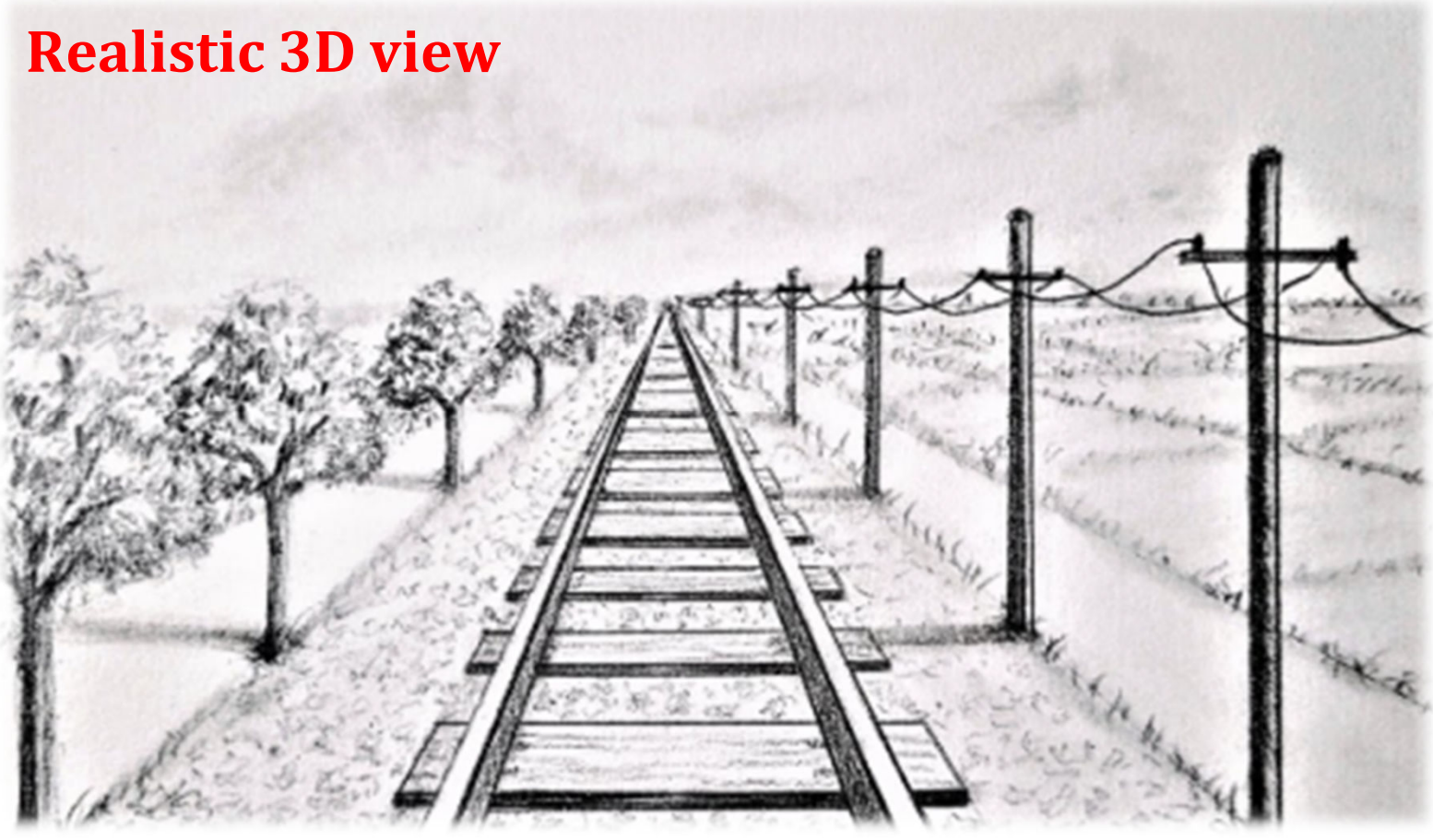
Evaluation Pattern

Assessment	Marks
Continuous Assessment Test 1	15
Continuous Assessment Test 2	15
Digital Assignments (3)	30
Final Assessment Test	40

Is this a Technical Drawing?

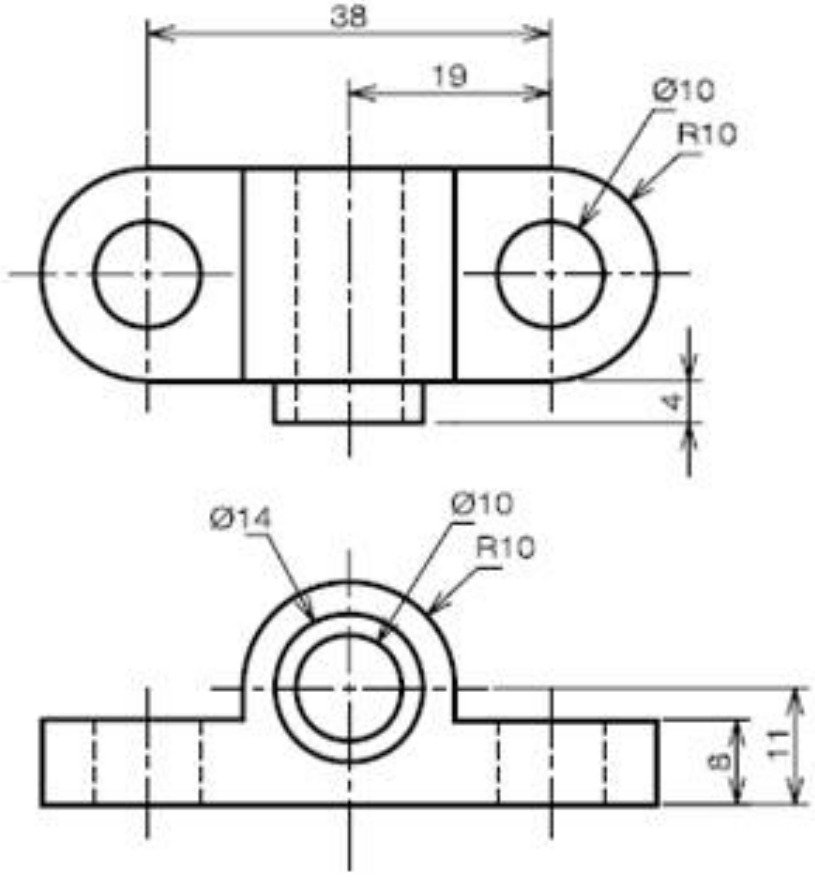
- **This picture doesn't preserve true measurements and shapes. This type of projections are often used where visual appeal is important.**

Realistic 3D view



What is Engineering Drawing?

- Engineering drawing is a type of technical drawing that engineers **use to communicate design ideas and technical information about a product** or structure.



Engineering Drawing - Why? (Language of Engineers)

- All Engineered components worldwide rely on Engineering drawings to translate design concepts into manufacturable products.

- An Engineering drawing is essential for the fabrication of any component, as it provides comprehensive visual information, including geometry, dimensions, tolerances, and other critical specifications.

- The process of representing a three-dimensional object through multiple two-dimensional views—typically the front, top, and side—is known as ***orthographic projection***.

Applications of Engineering Drawing

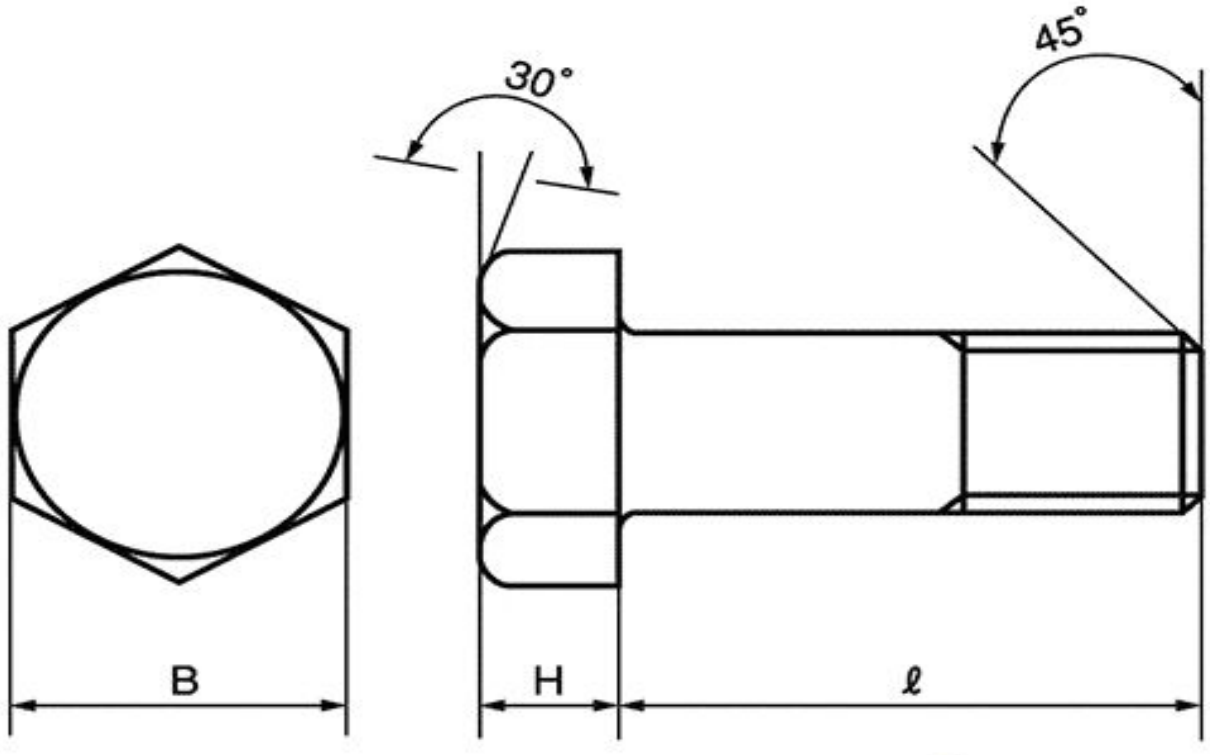
- Engineering drawings are essential across all manufacturing processes to ensure components are produced within specified dimensions and tolerances.

From small scale to larger scale products

https://www.coxmanufacturing.com/micromachining

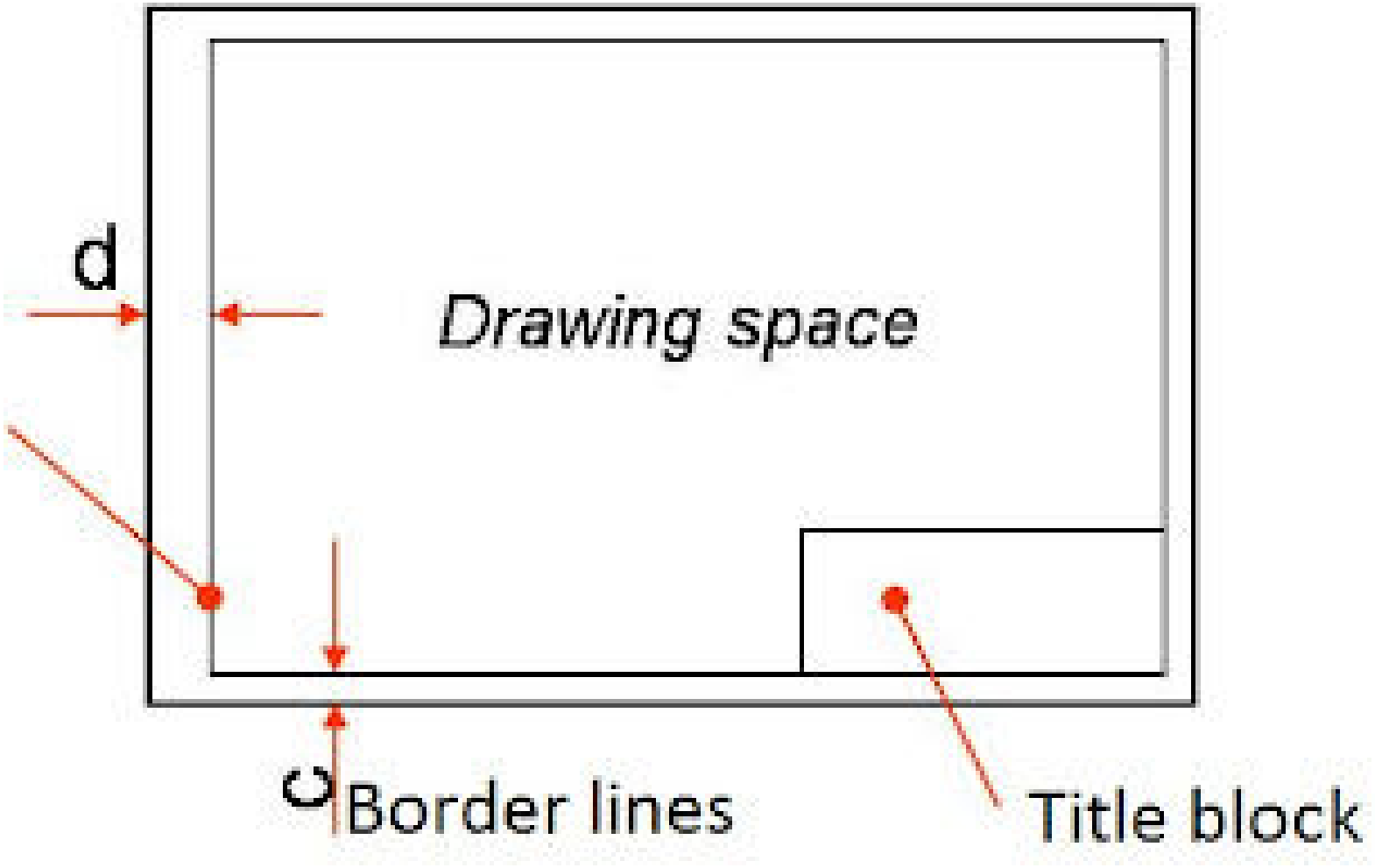
https://www.unigensteel.us/large-diameter-turning.php

Engineering Drawing - Example

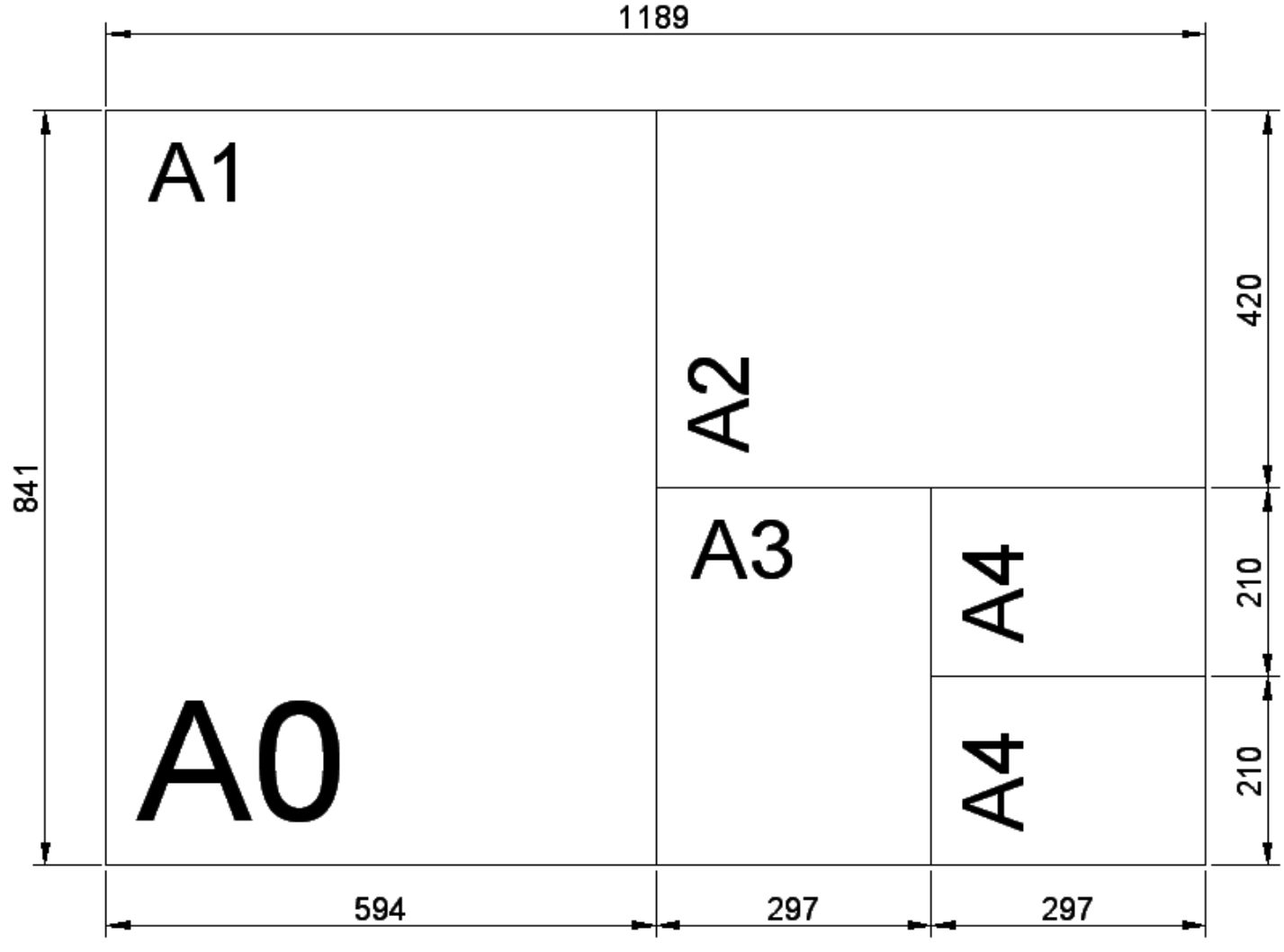


Nominal Diameter	M20
B×H	30×13
Pitch	2.5
Threaded Portion	50

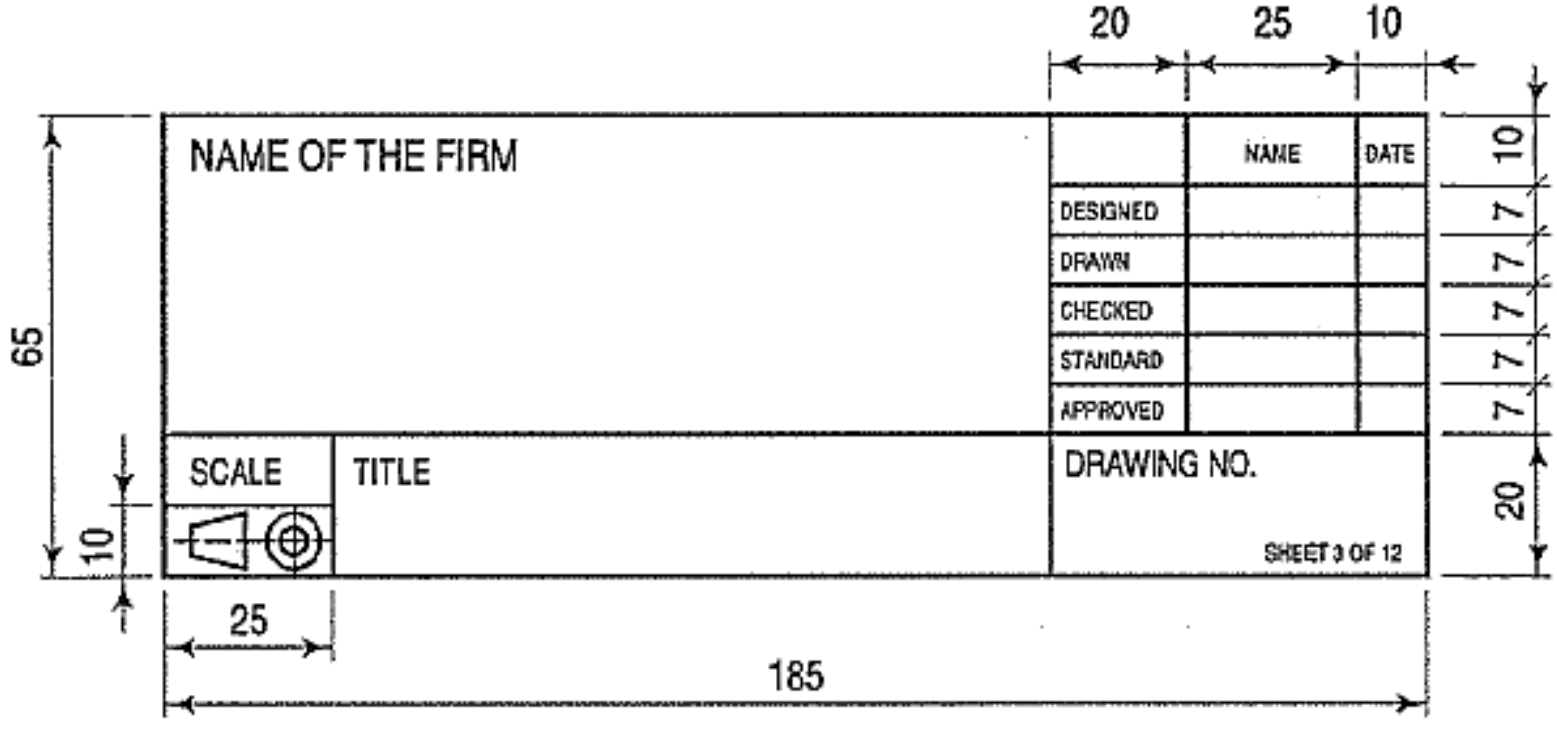
Drawing Sheet - Layout



Standard sizes of Drawing sheets as per BIS



Title Block Details



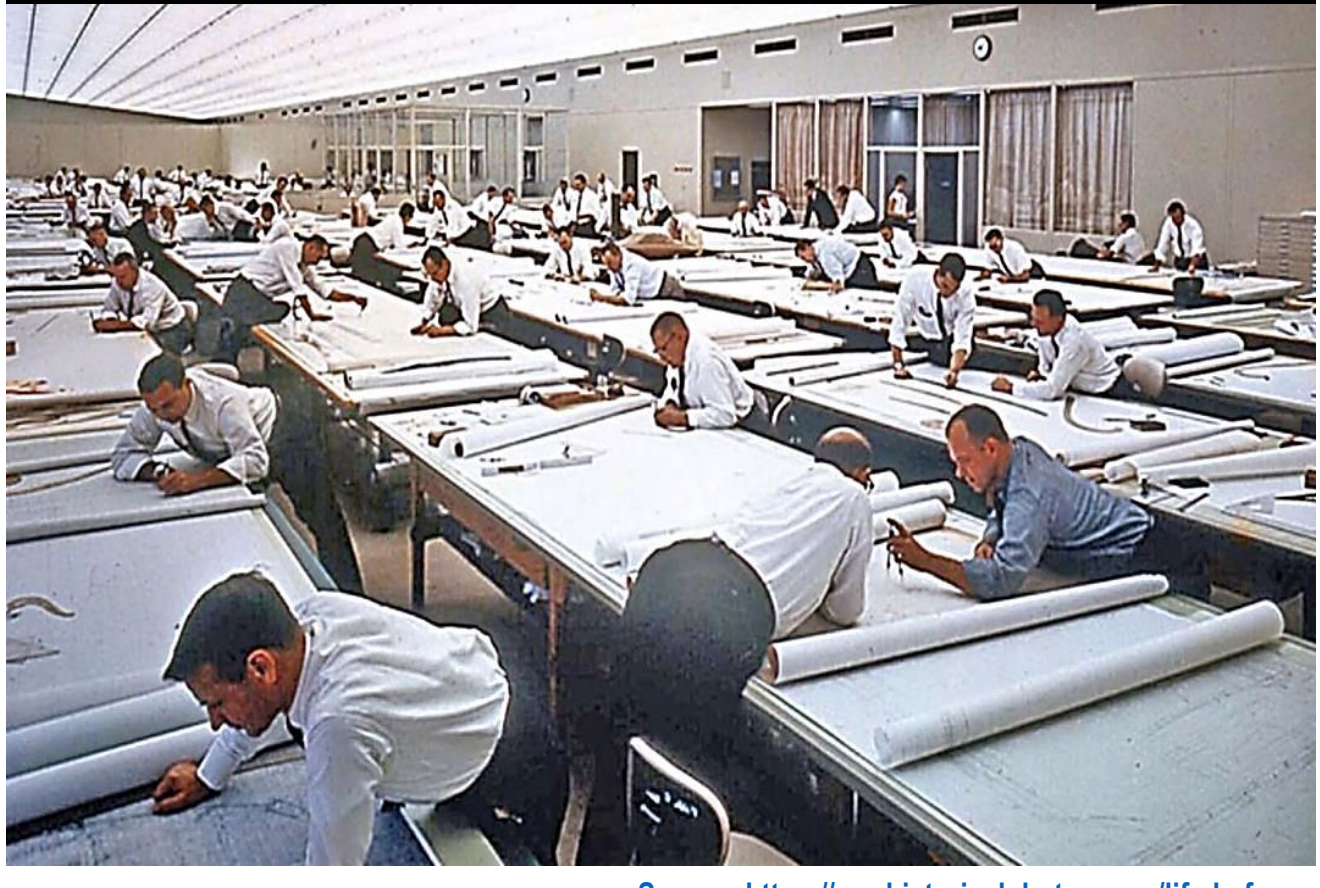
Key Functions of a Title Block:

- Identifies the drawing (title, number, revision)
- Shows ownership (company name, designer, approver)
- Provides scale and projection method
- Tracks revisions and dates
- Lists material and technical details
- Ensures standardization and compliance
- Helps with drawing organization (sheet numbers, references)

Manual Draft to CAD Migration

Before the invention of CAD, 1950-1980

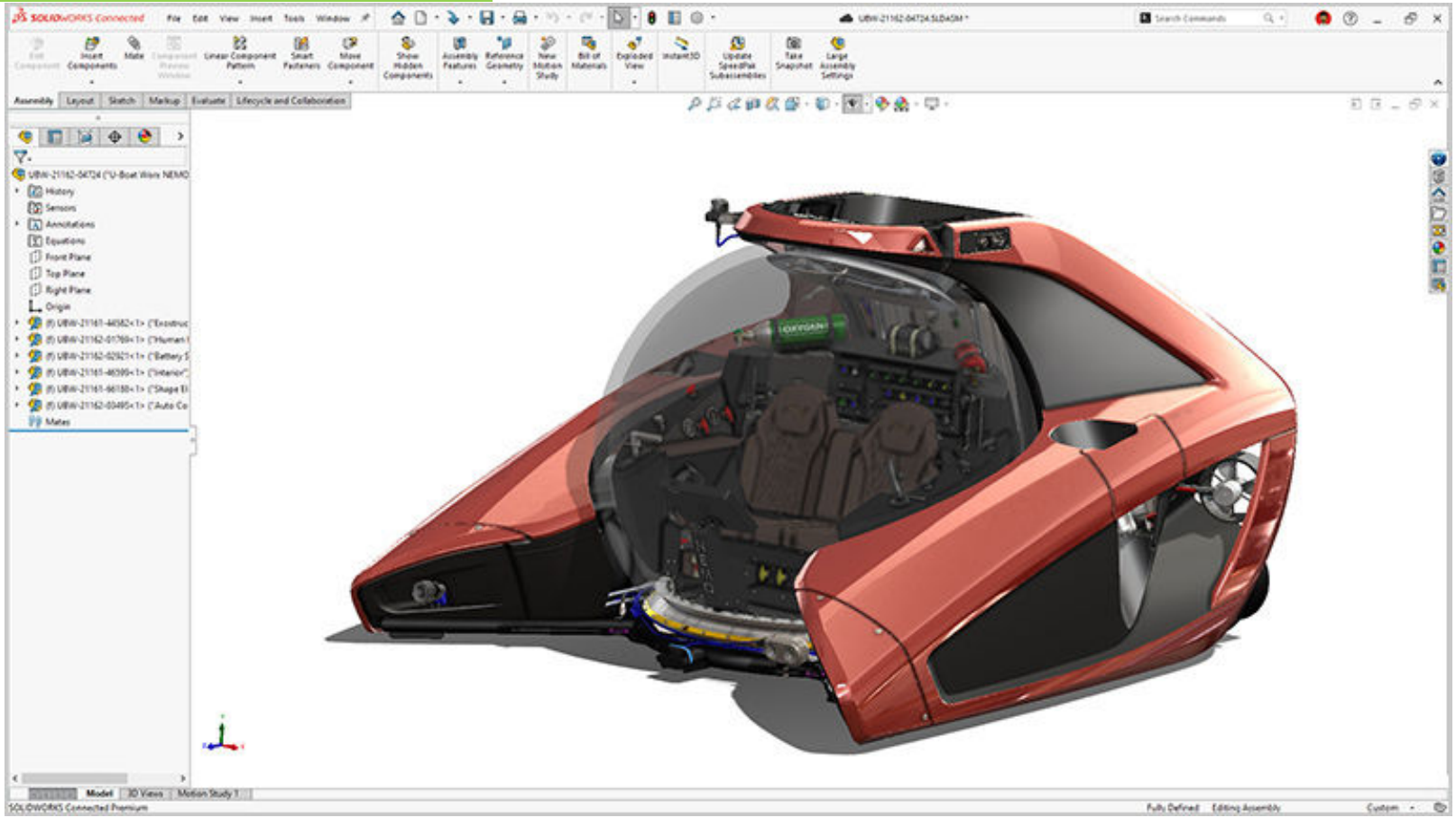
General Motors Technical Center in Warren Michigan.



Source: https://rarehistoricalphotos.com/life-before-autocad-1950-1980/

Manual Draft to CAD Migration

Today's world of Design

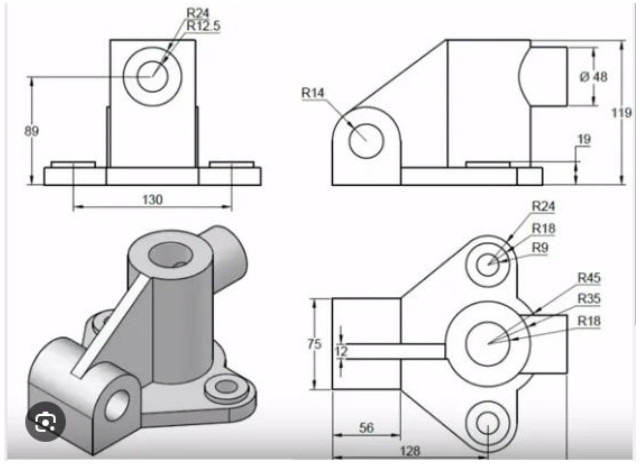


https://www.solidworks.com/product/3dexperience-solidworks

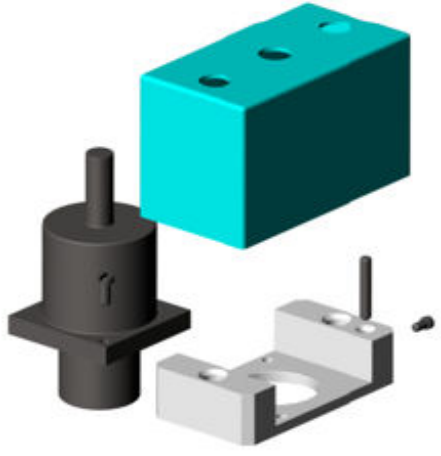
Applications of CAD

- Computer Aided Drafting
- Geometric modelling
- Computer Aided Assembly
- Computer Aided Simulation & Analysis
- Optimization
- Collaborative design
- CAD/CAM integration

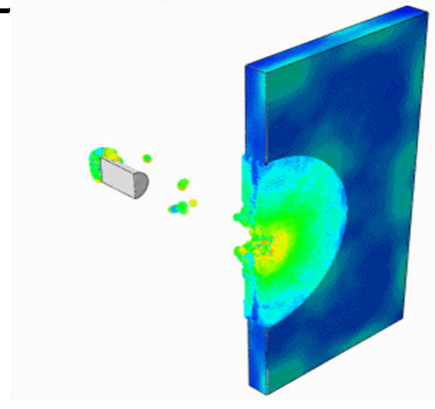
Applications of CAD



Drafting



Modelling & Assembly



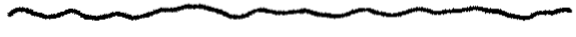
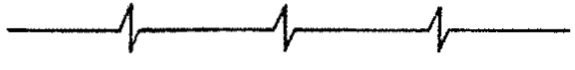
Simulation

Optimization

CAM

3D Printing

Types of Lines

A 	Continuous thick or Continuous wide	Visible outlines, visible edges; crests of screw threads; limits of length of full deph thread,lines of cuts and section arrows; parting lines of moulds in views; main representations in diagrams, maps, flow charts; system lines(structural metal engg.)
B	Continuous thin (narrow) (straight or curved)	Imaginary lines of intersection; grid, dimension, extension, projection, short centre, leader, reference lines; hatching; outlines of revolved sections; root of screw threads; interpretation lines of tapered features; framing of details; indication of repetitiv details;
C 	Continuous thin (narrow) freehand	Limits of partial or interrupted views and sections, if the limit is not a chain thin line
D 	Continuous thin (narrow) with zigzags (straight)	Long-break line
E	Dashed thick (wide)	Line showing permissible of surface treatment

Source: Engineering Drawing, N.D. Bhatt

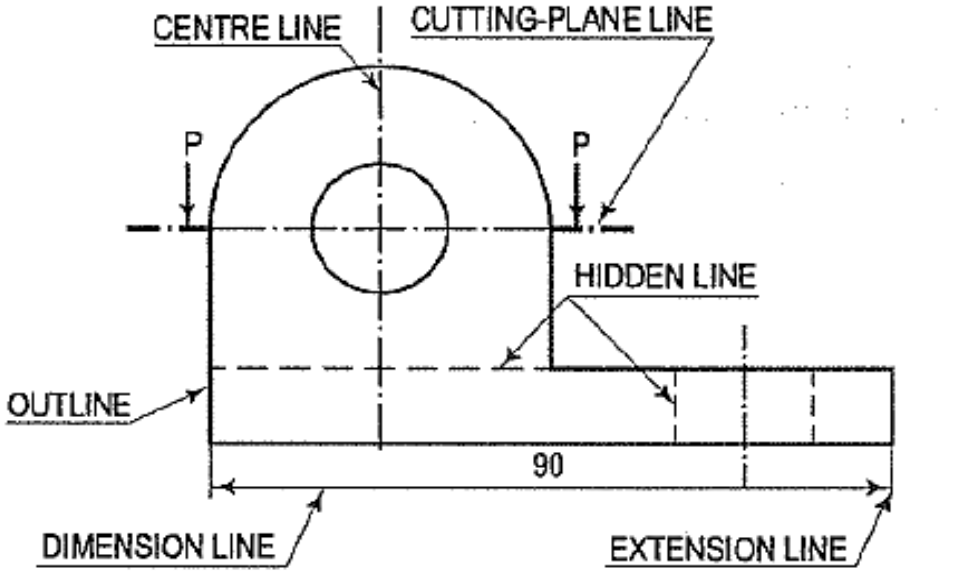
Types of Lines

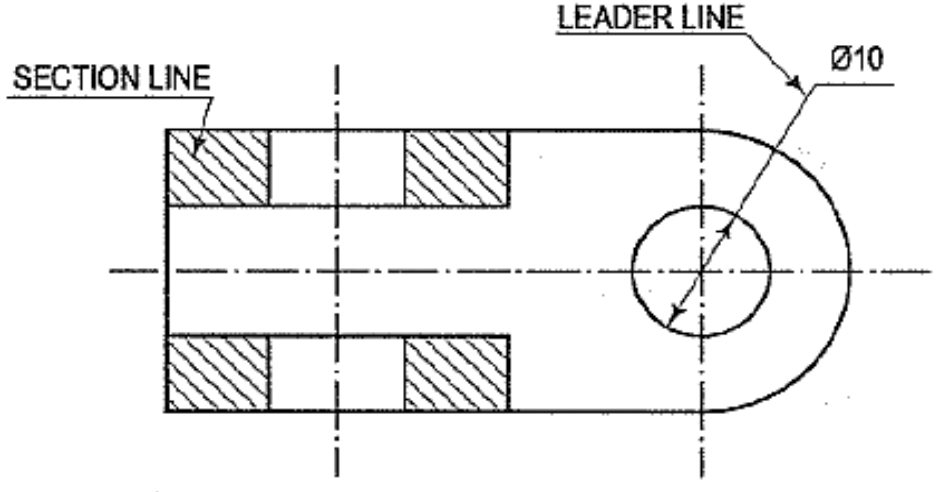
F — — — — — —	Dashed thin (narrow)	Hidden outlines; hidden edges
G — · — · — · — · — · — · —	Chain thin Long-dashed dotted (narrow)	Centre line; lines of symmetry; trajectories; pitch circle of gears, pitch circle of holes,
H THICK THIN THICK	Chain thin (narrow) with thick (wide) at the ends and at changing of position	Cutting planes
J — · — · — · —	Chain thick or Long-dashed dotted (wide)	Indication of lines or surfaces to which a special requirement applies
K — · · — · · — · · —	Chain thin double-dashed or long-dashed double-dotted (narrow)	Outlines of adjacent parts Alternative and extreme positions of movable parts Centroidal lines Initial outlines prior to forming Parts situated in front of the cutting plane

Source: Engineering Drawing, N.D. Bhatt

Thick Lines – HB
Thin Lines – 2H

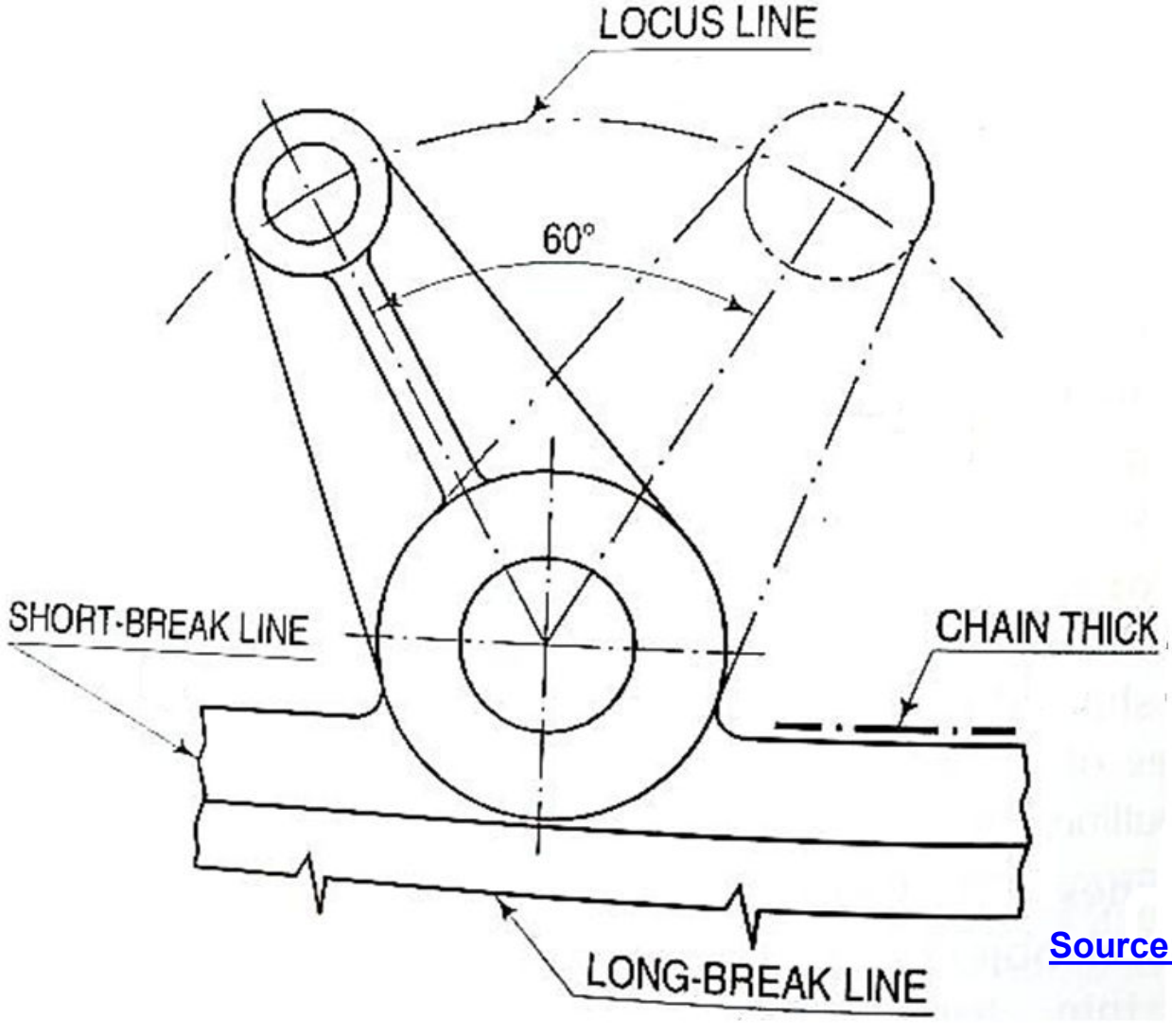
Types of Lines





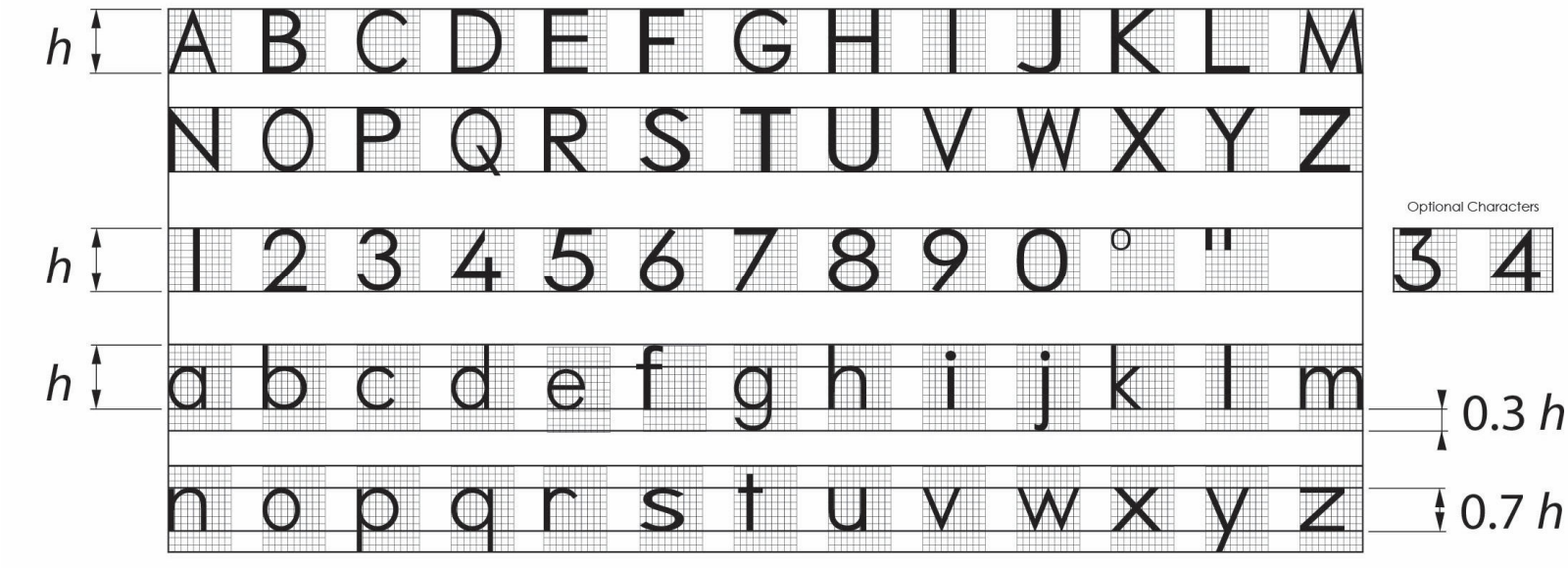
Source: Engineering Drawing, N.D. Bhatt

Types of Lines



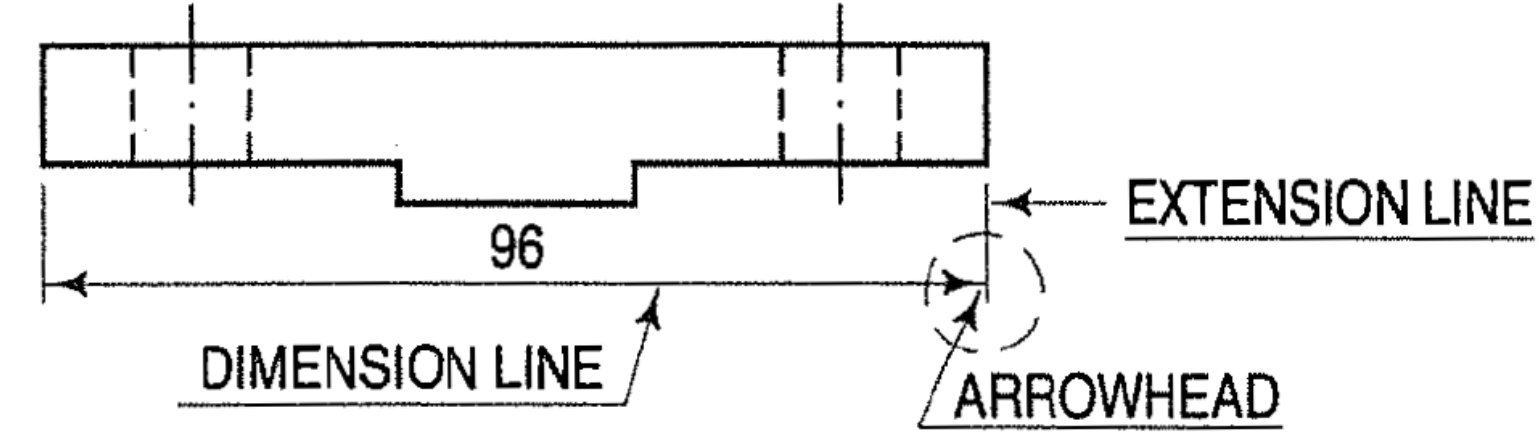
Source: Engineering Drawing, N.D. Bhatt

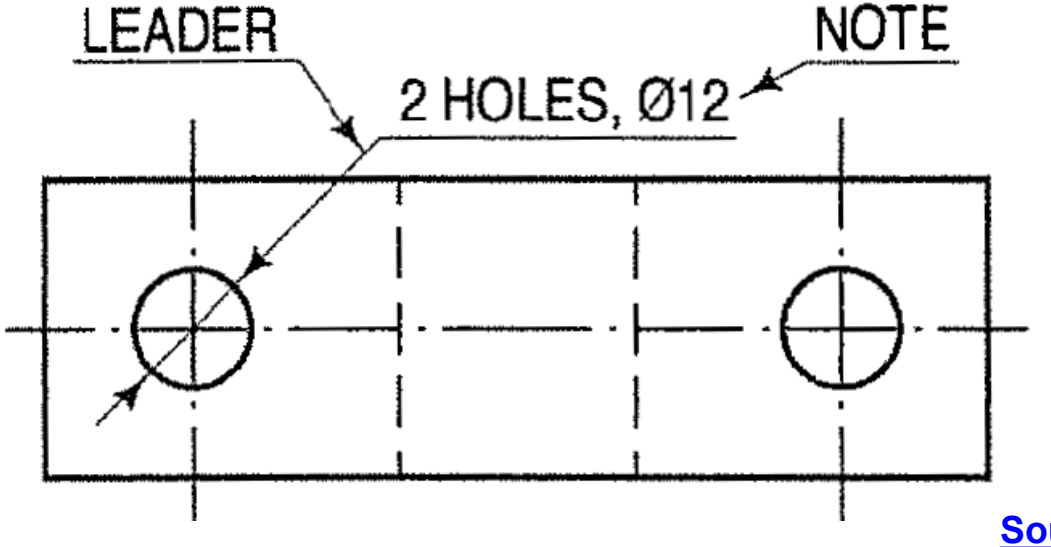
Lettering Standard



- Lettering is generally done in capital letters. Different sizes of letters are used for different purposes.
- The main titles are generally written in 6 mm to 8 mm size, sub-titles in 3 mm to 6 mm size, while notes, dimension figures etc. in 3 mm to 5 mm size.
- The drawing number in the title block is written in numerals of 10 mm to 12 mm size.

Elements of Dimensioning

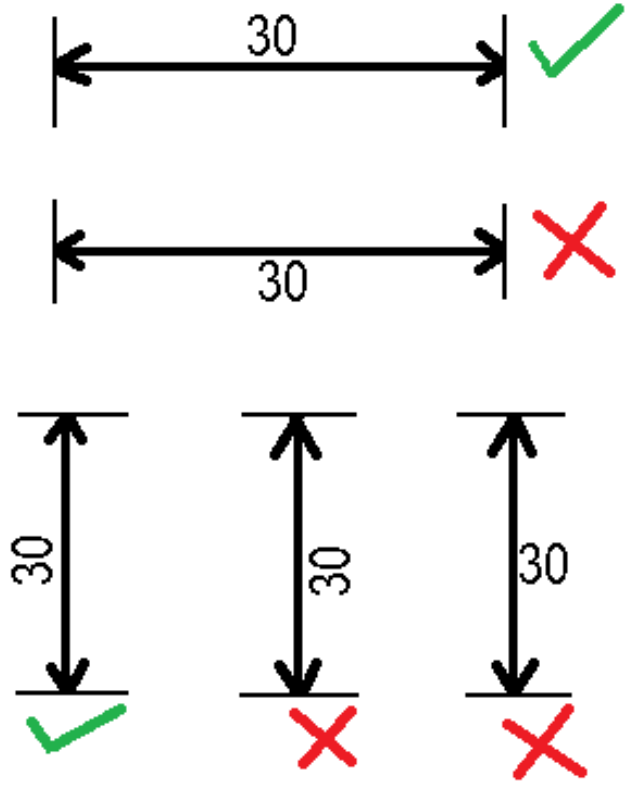




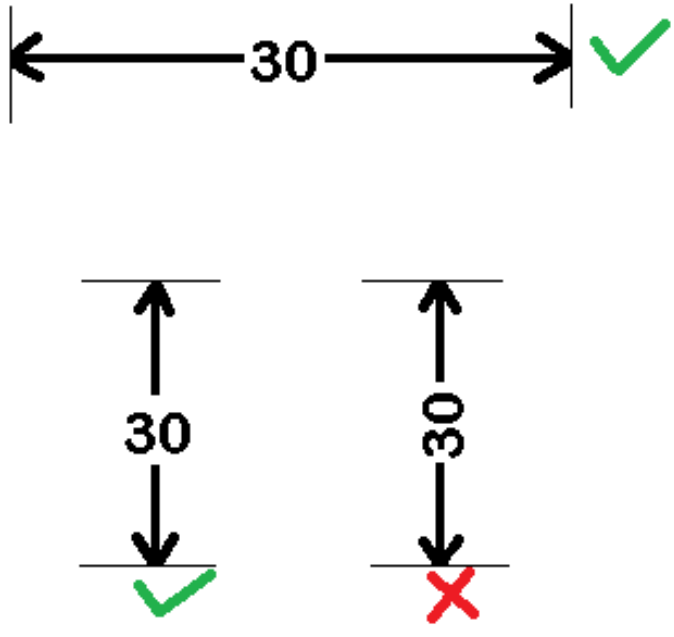
Source: Engineering Drawing, N.D. Bhatt

Two systems of dimensioning

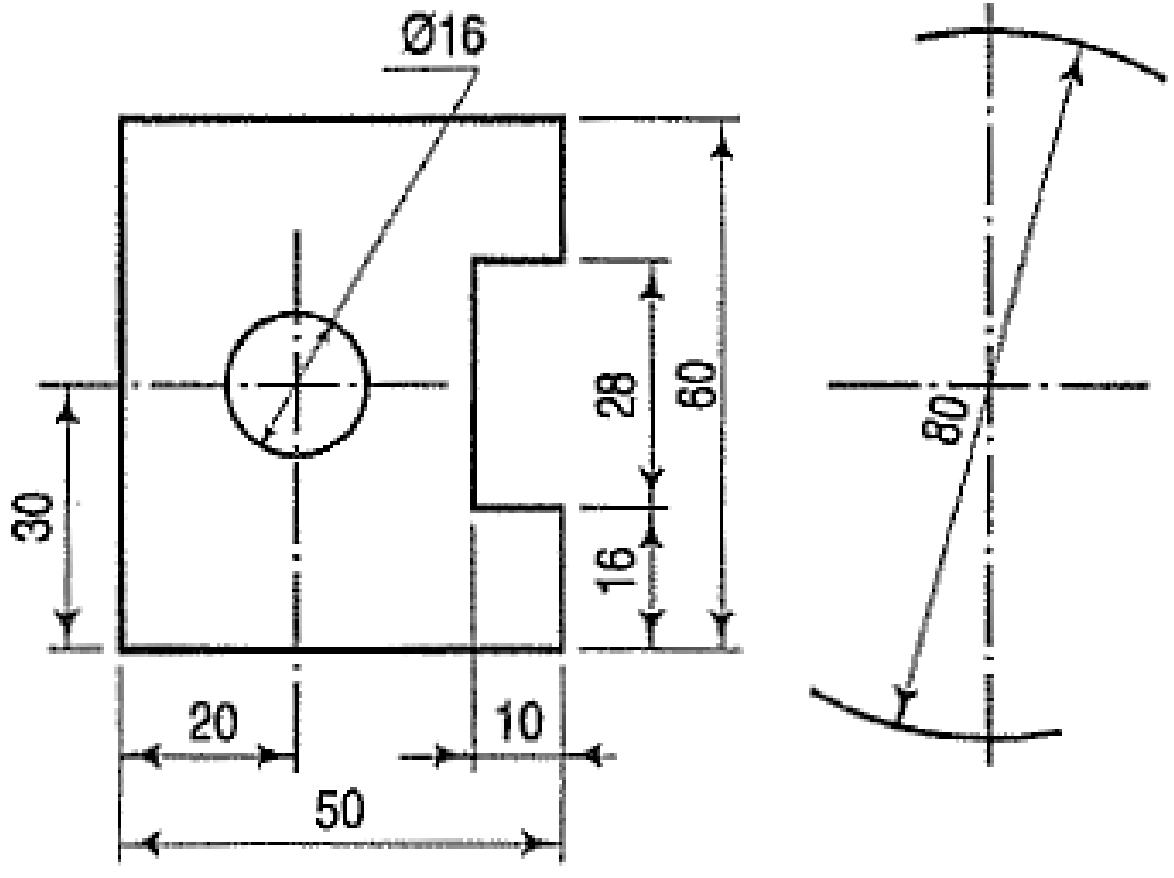
Aligned System



Unidirectional System



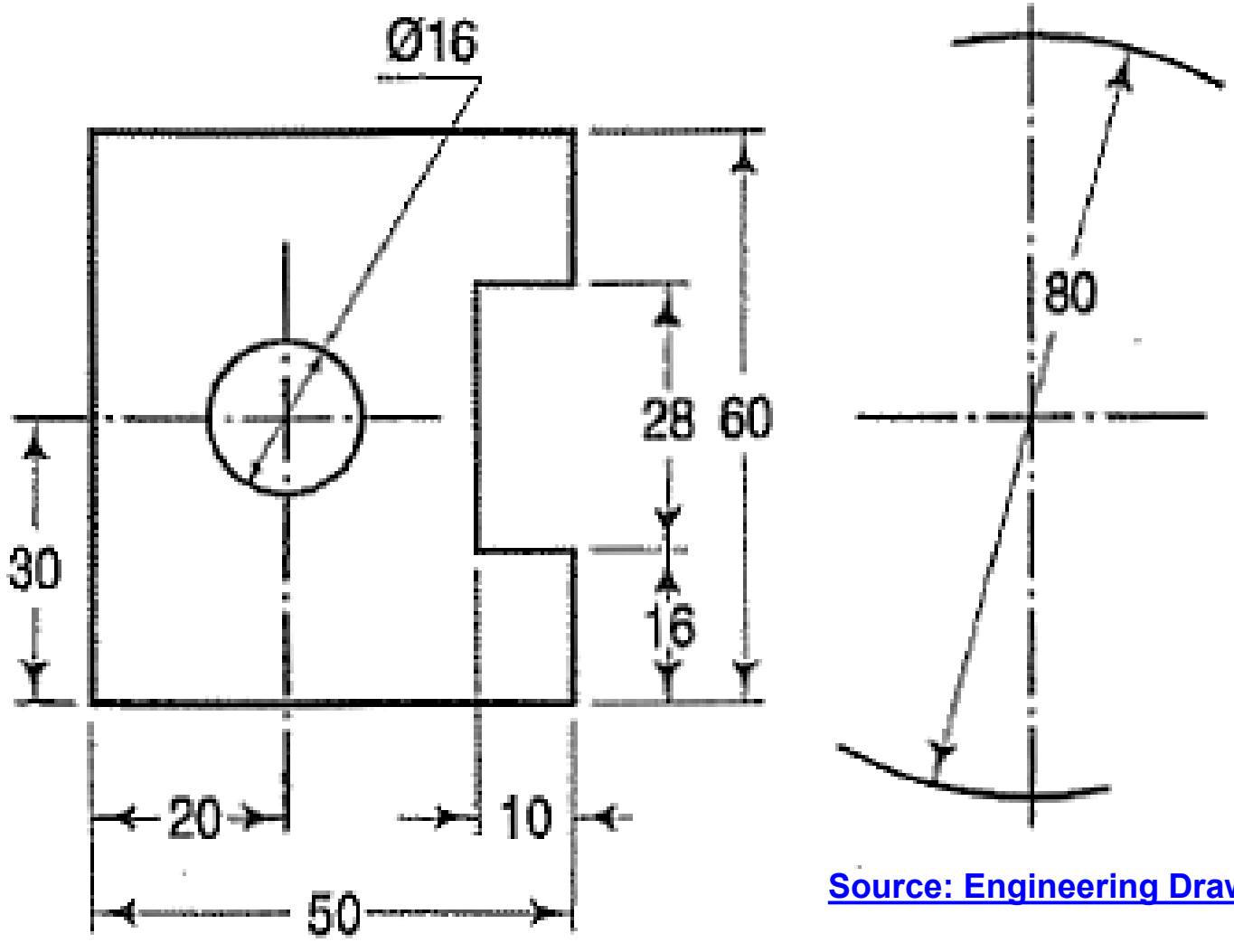
Aligned system



Generally, Aligned system of dimensioning is recommended.

Source: Engineering Drawing, N.D. Bhatt

Unidirectional system



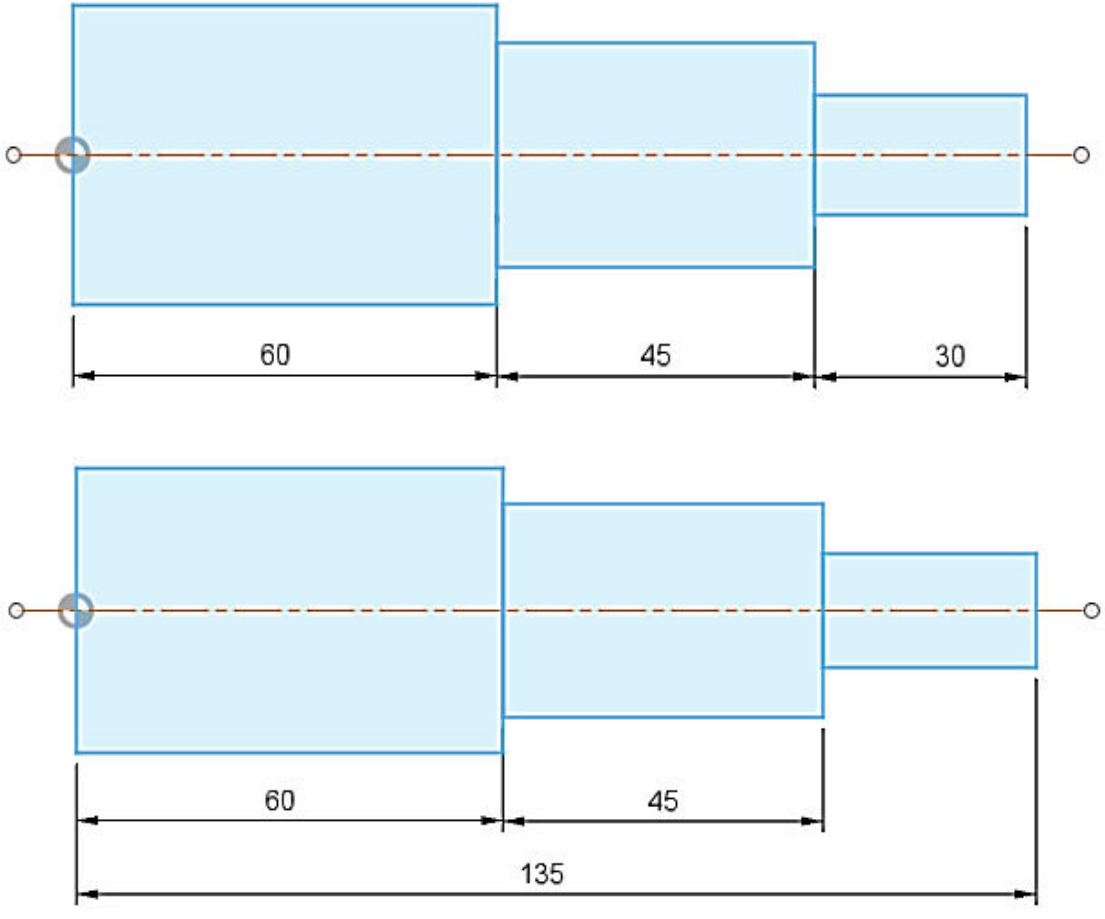
Source: Engineering Drawing, N.D. Bhatt

General Rules for Dimensioning

- Dimensioning should be done so completely that further calculation or assumption of any dimension, or direct measurement from the drawing is not necessary.
- None of the dimension should be mentioned more than once.
- Dimension should be placed on the view where its use is shown more clearly.
- Mutual crossing of dimension lines and dimensioning between hidden lines should be avoided.
- An object line or a centre line should never be used as a dimension line.

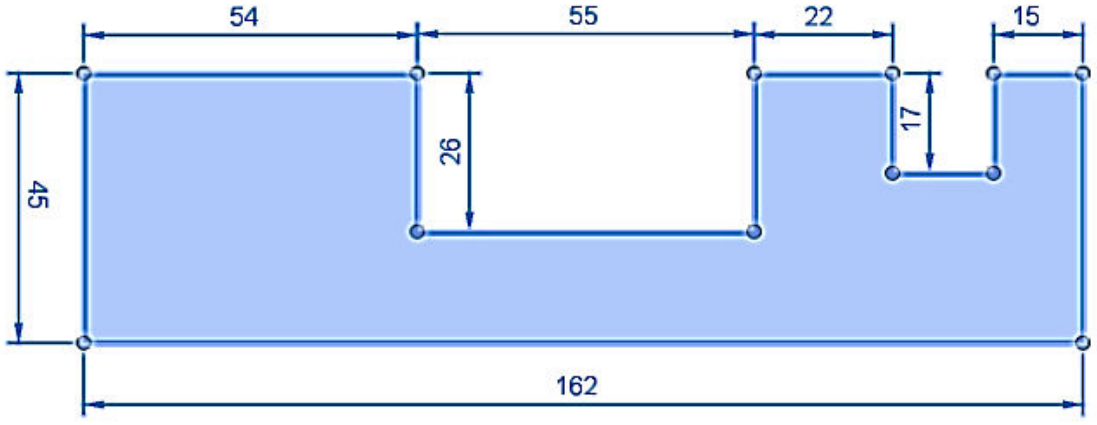
Hints on Dimensioning

- Dimension lines should be drawn at least 8 mm away from the outlines and from each other.

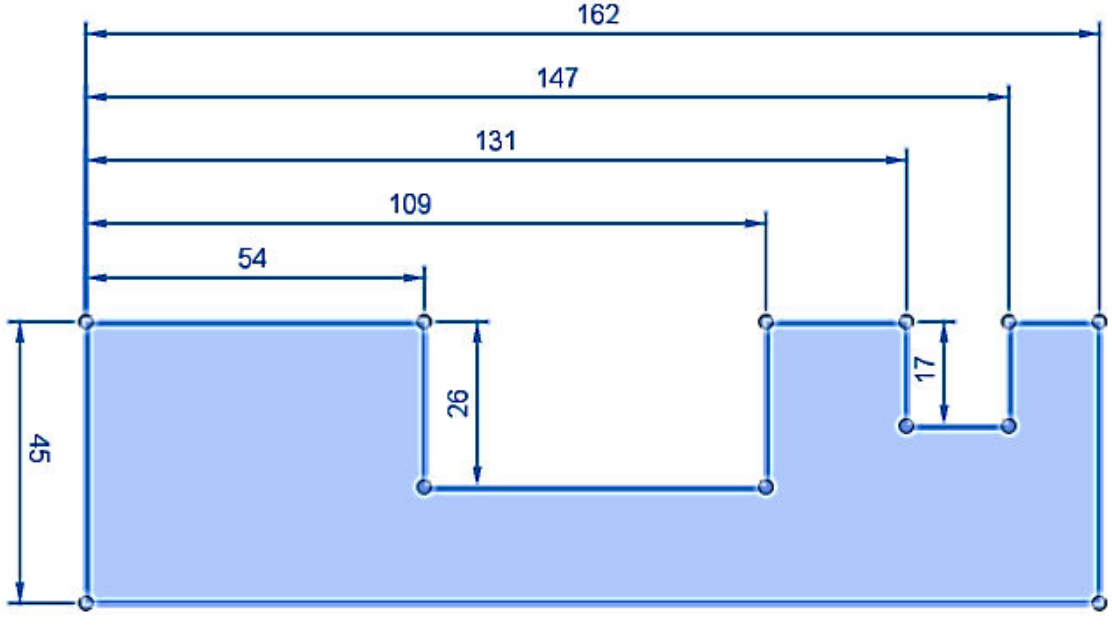


Hints on Dimensioning

Continuous or Chain Dimensioning



Progressive or Parallel Dimensioning



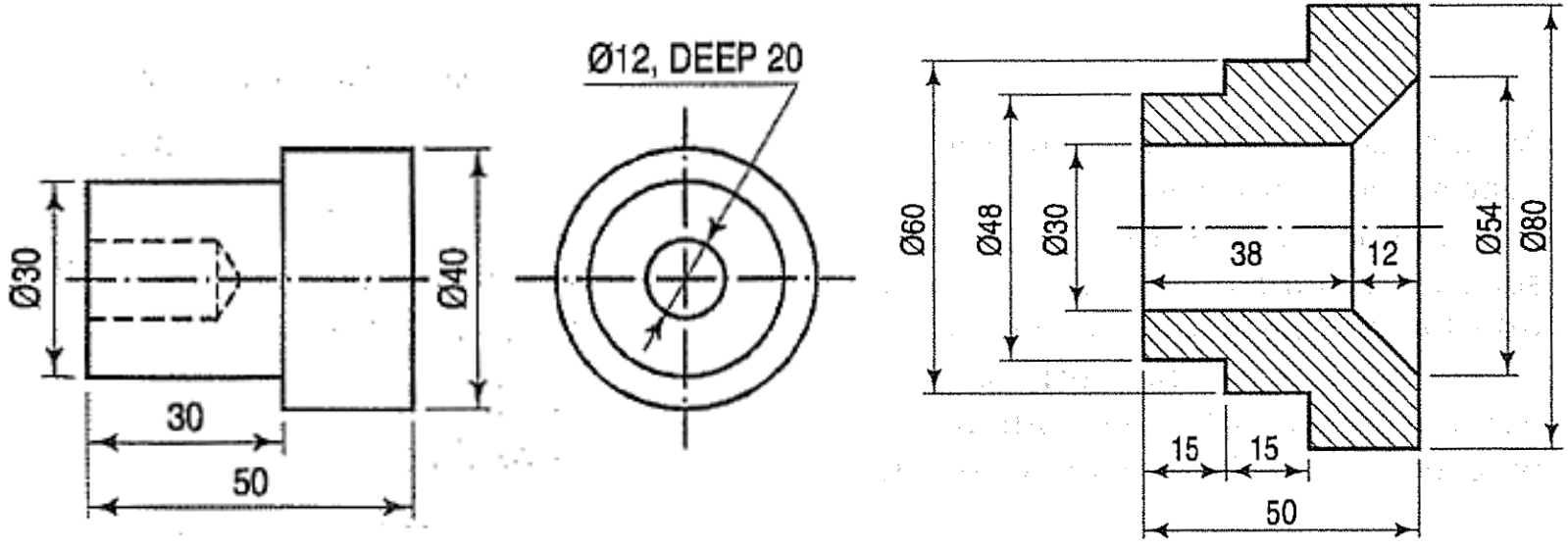
Cumulative error is avoided by this method.

Hints on Dimensioning

- Smaller dimensions should be placed nearer the view and the larger further away so that extension lines do not cross dimension lines.

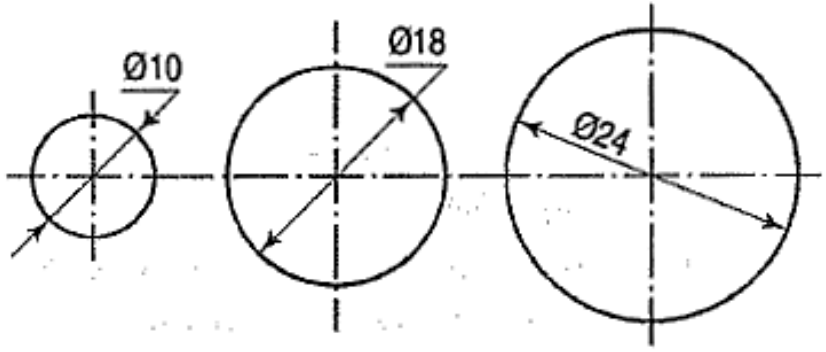
- Arrowheads should ordinarily be drawn within the limits of the dimensioned feature. They may be placed outside when the space is too narrow.

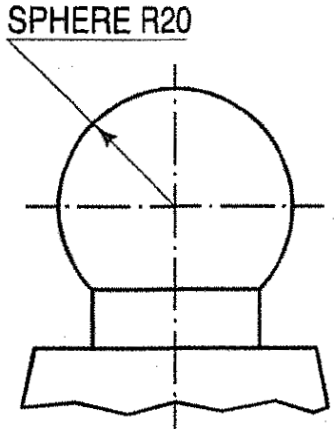
- Dimensions of cylindrical parts should as far as possible be placed in the views in which they are seen as rectangles. Diameter should always be preceded by a symbol Ø.



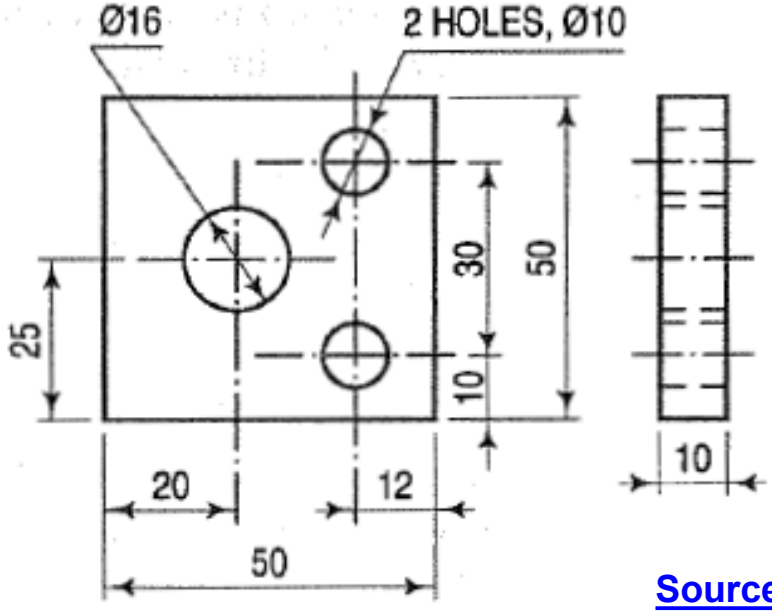
Hints on Dimensioning

Dimensioning of Circle





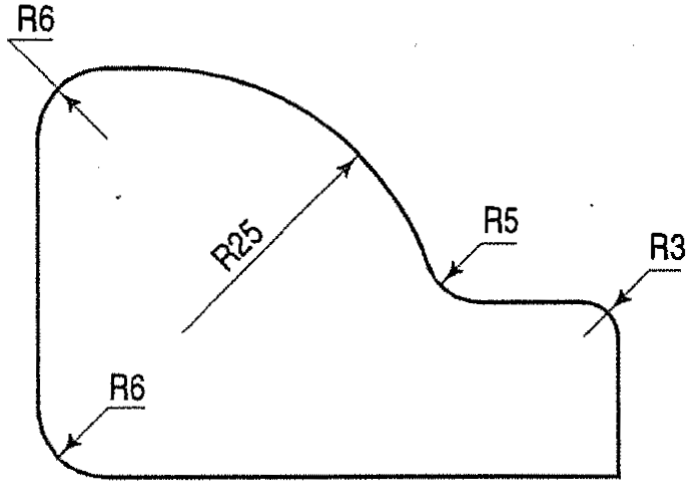
Dimensioning of Holes



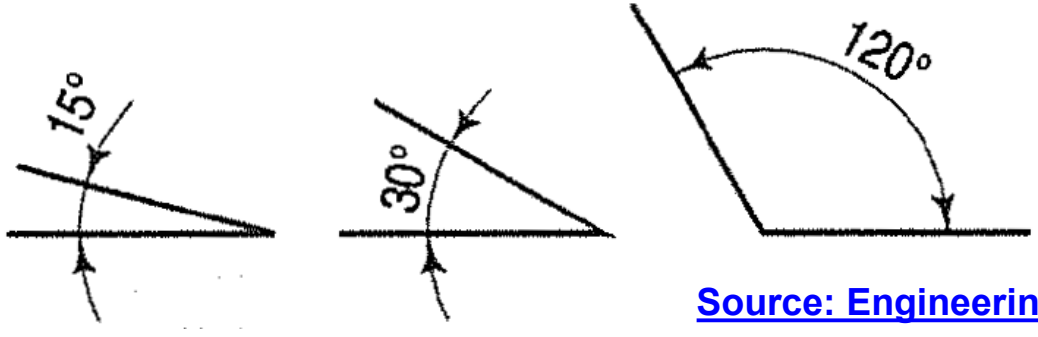
Source: Engineering Drawing, N.D. Bhatt

Hints on Dimensioning

Dimensioning of Arcs



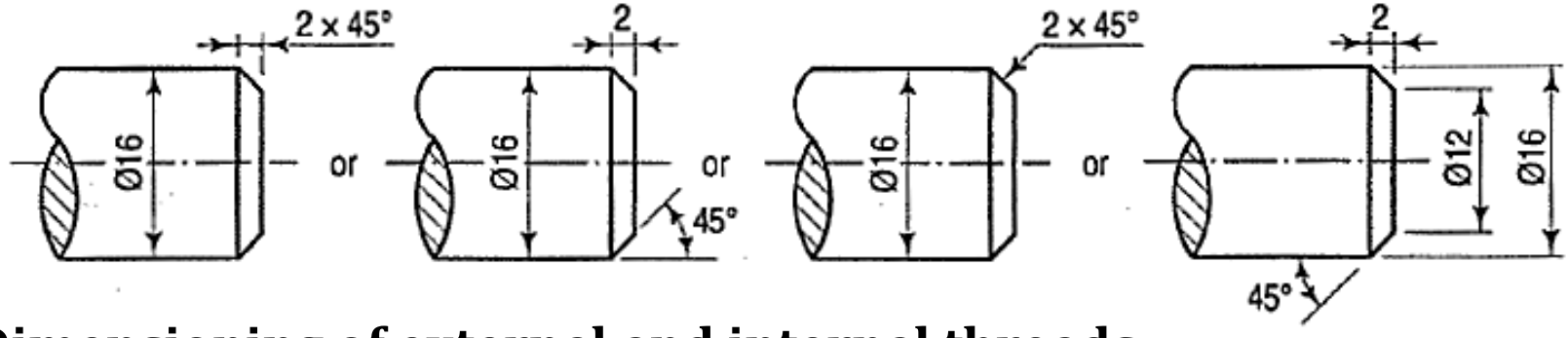
Dimensioning of Angles



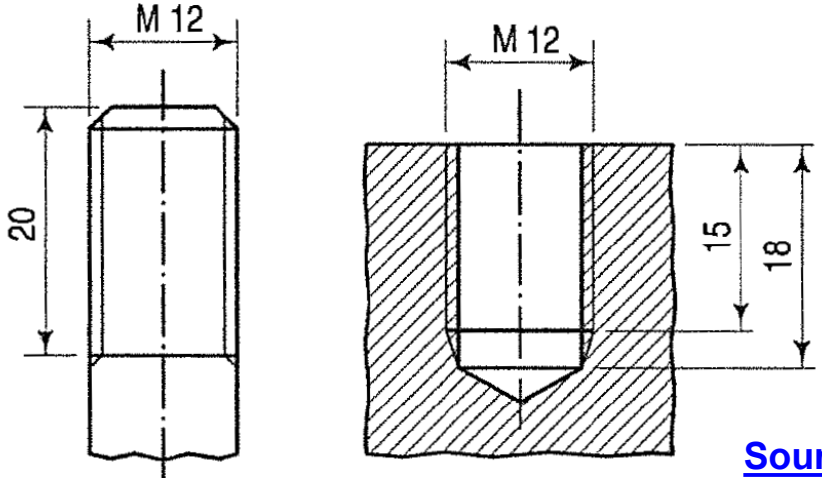
Source: Engineering Drawing, N.D. Bhatt

Hints on Dimensioning

Dimensioning a chamfer

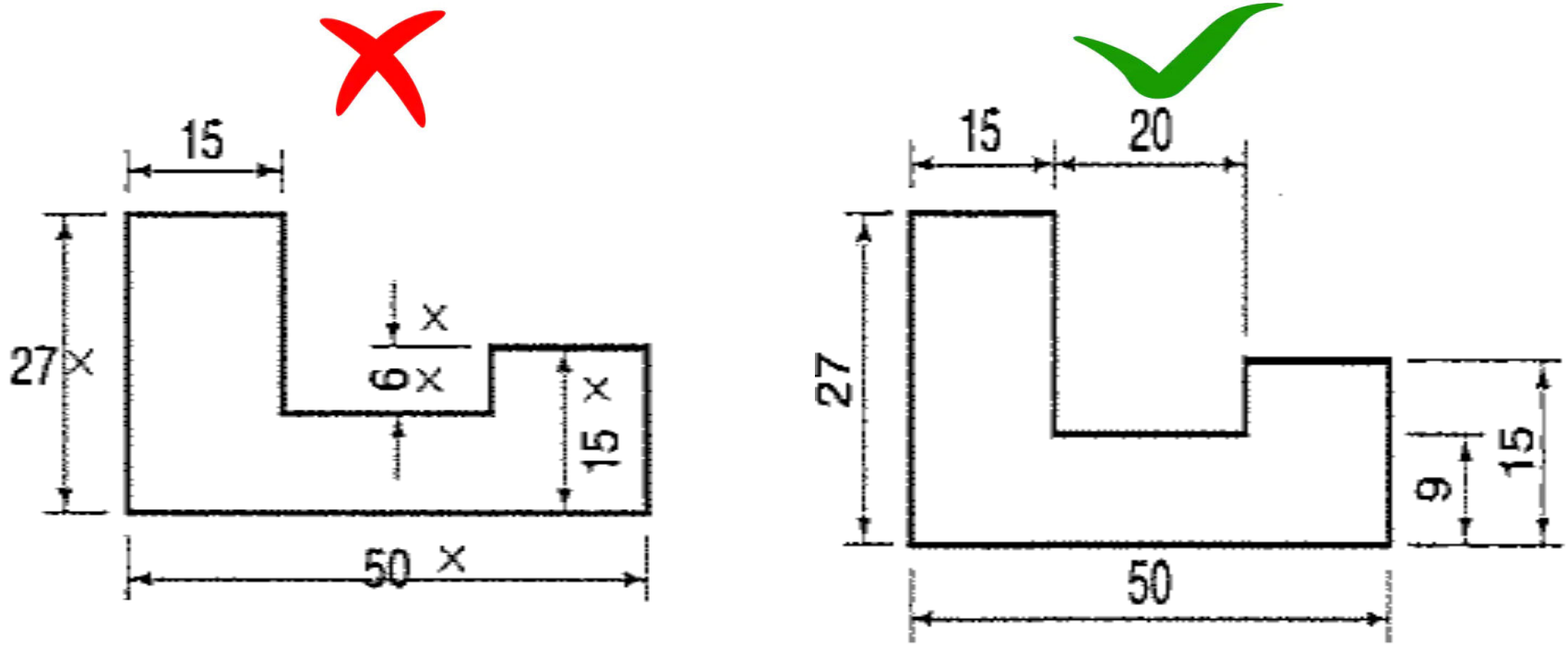


Dimensioning of external and internal threads



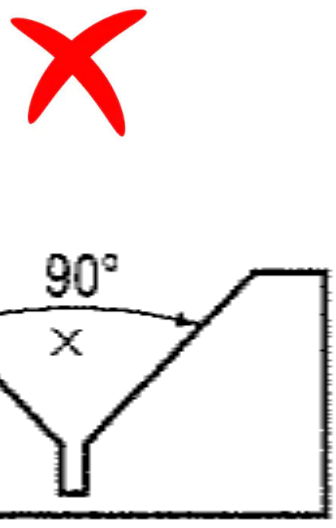
Source: Engineering Drawing, N.D. Bhatt

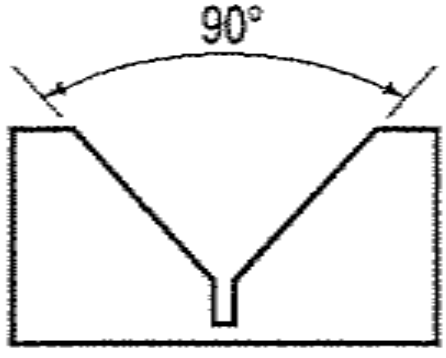
Hints on Dimensioning

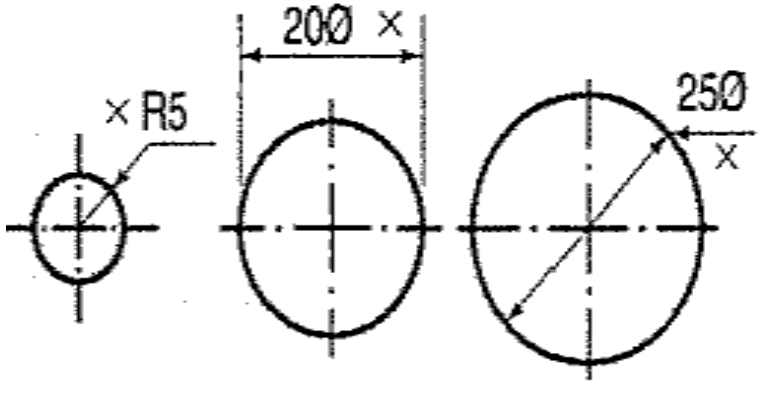


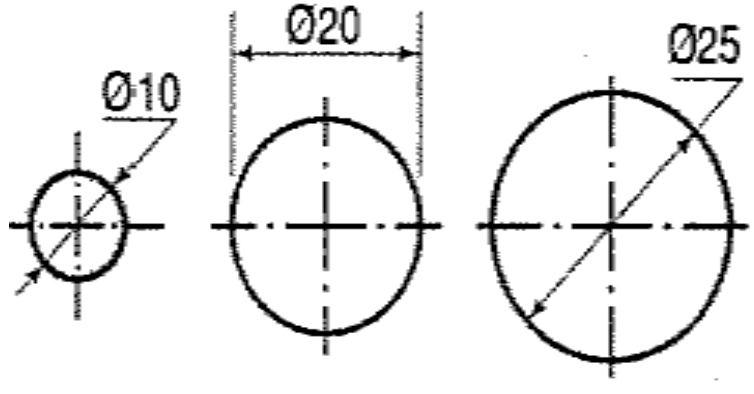
- Dimension lines are used as extension.
- Dimensions are placed inside the view.
- Dimension 27 and 50 not written according to aligned system.

Hints on Dimensioning

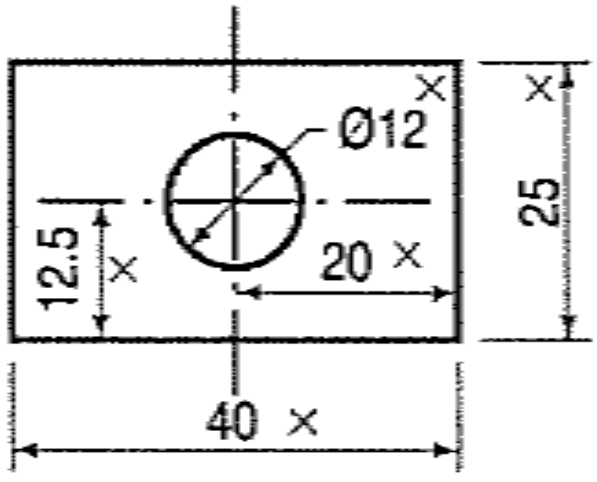


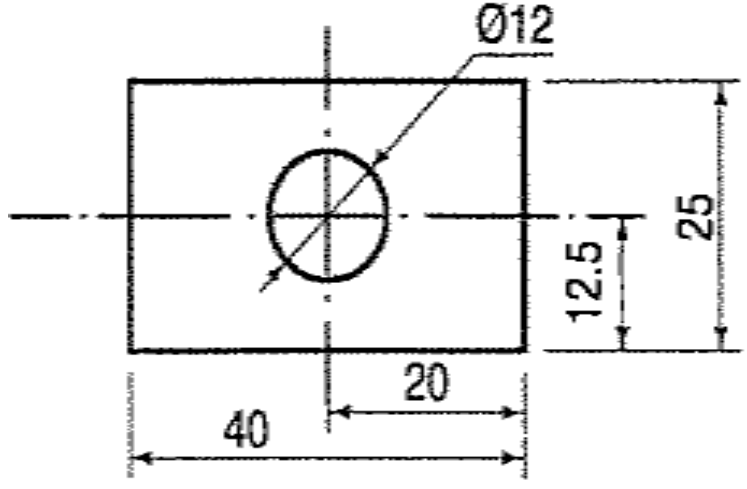






Hints on Dimensioning

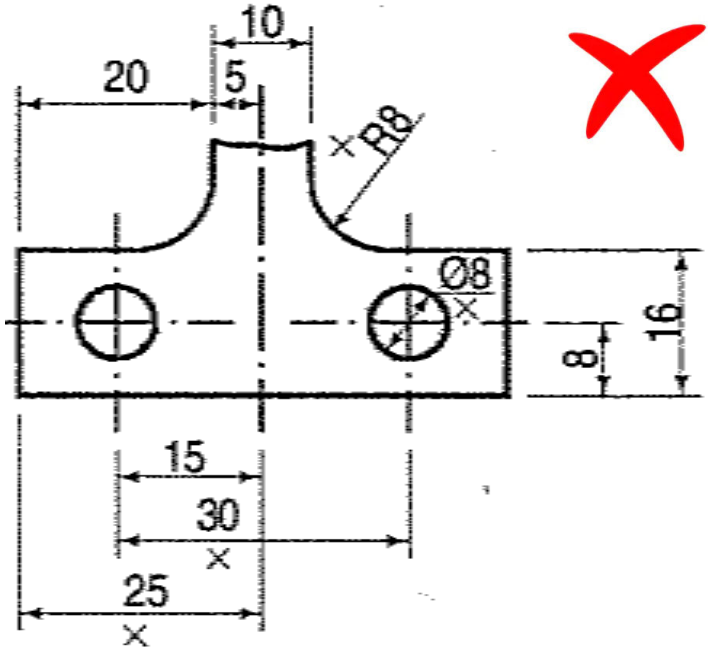


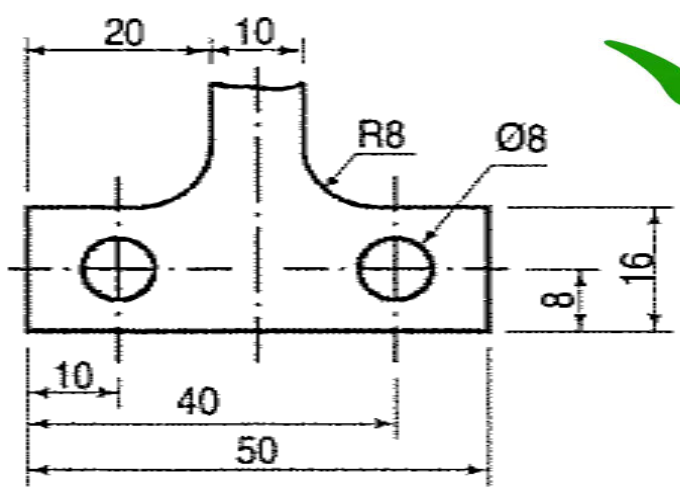


Dimensions should be placed outside view

- Arrow head not proportionate.
- Hole dimension shown in figure. Leader line not ends horizontally.
- Dimension '40' is too close.
- Placing dimensions methods mix. Dimension '40' is according to aligned method.

Hints on Dimensioning



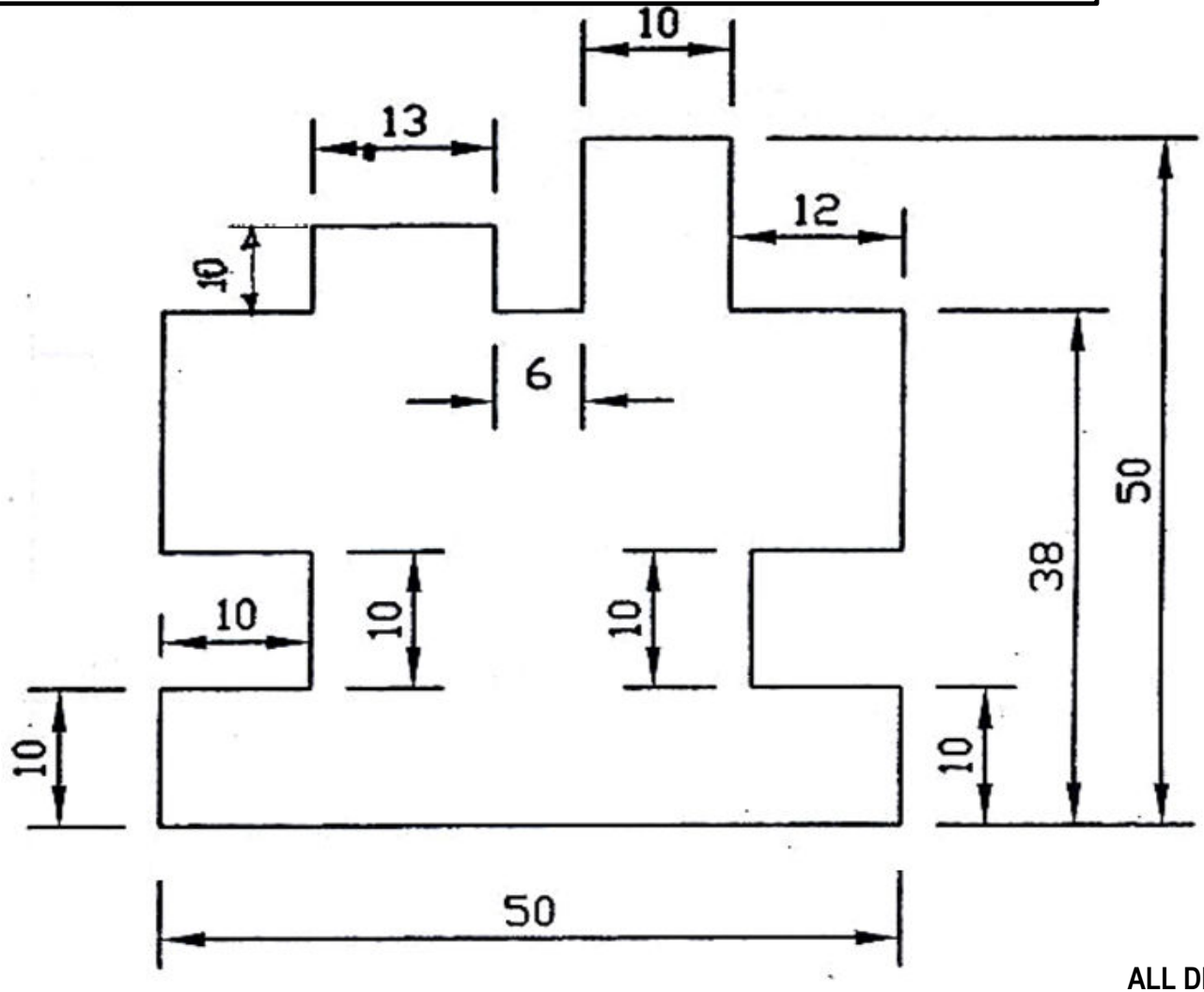


Dimensions should be given from the outlines (finished surface) or a centre line of a hole

- Dimensions are given form the mid-line of the object.
- Dimensions of holes are shown inside the figure.
- Dimensions are shown in vertical line.
- Smaller dimensions (25 mm) precedes the larger dimensions (30 mm).
- Fillet radius is not shown.

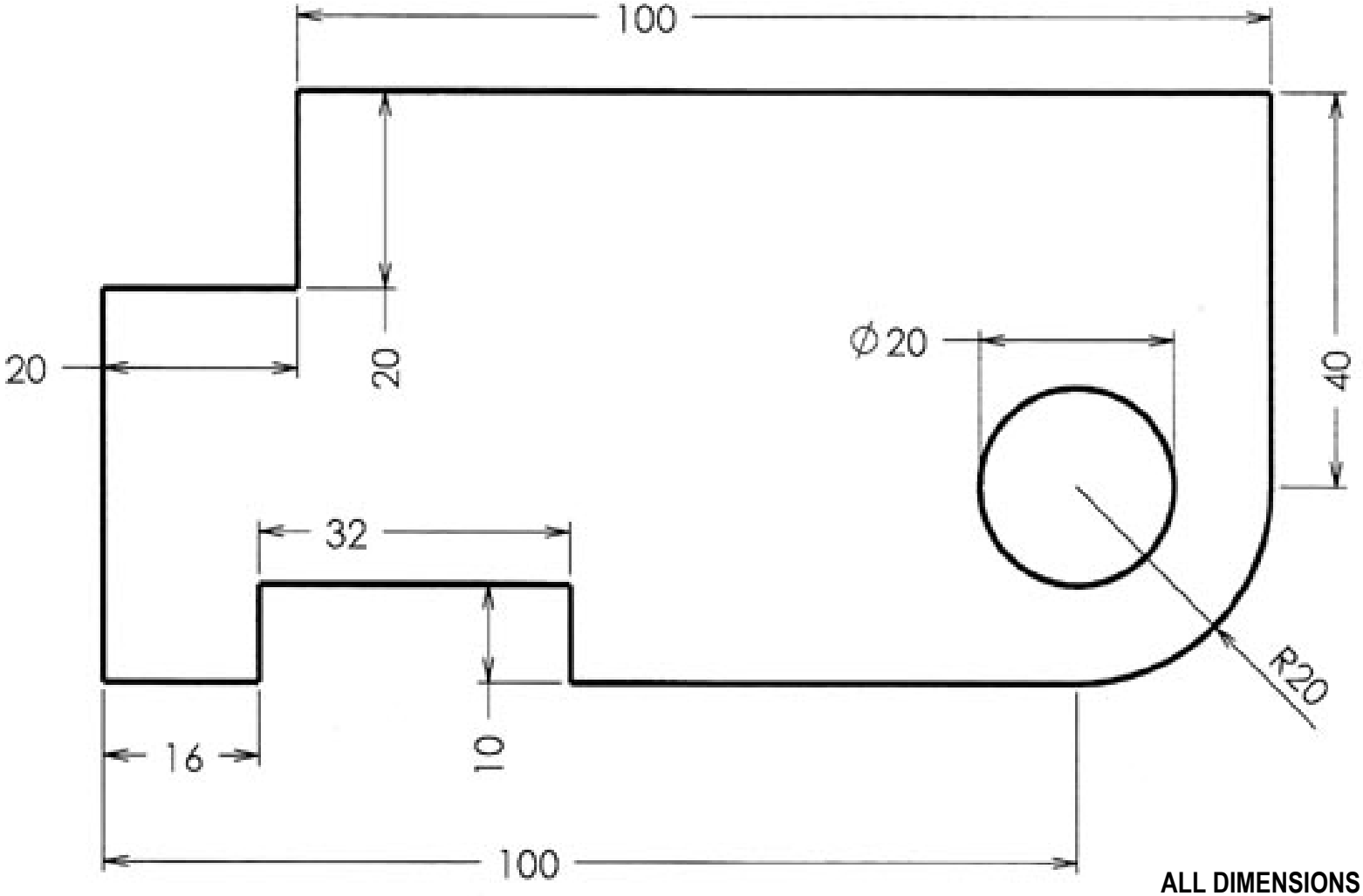
Source: Engineering Drawing, N.D. Bhatt

Sketching & Dimensioning Practice



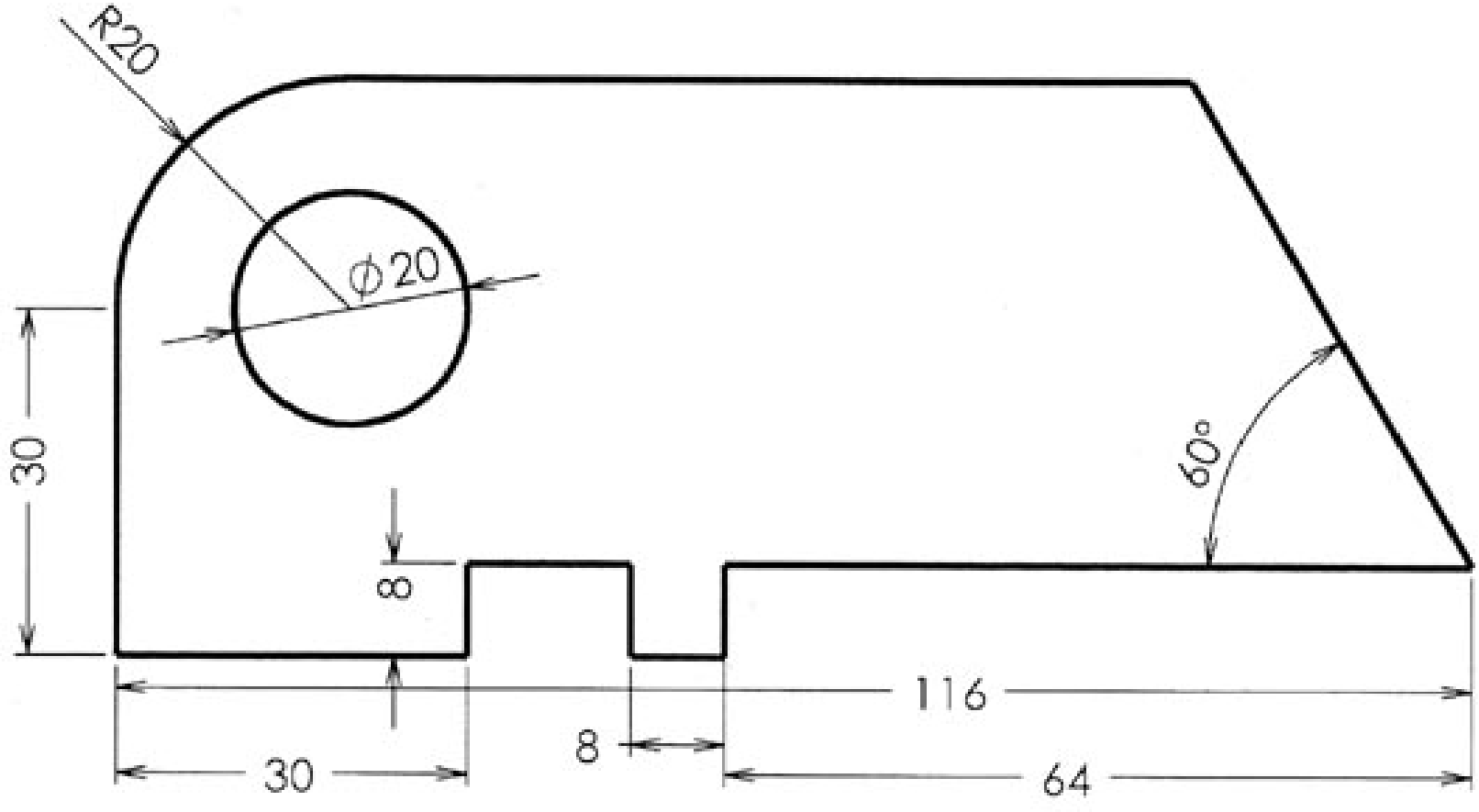
ALL DIMENSIONS ARE IN mm

Sketching & Dimensioning Practice



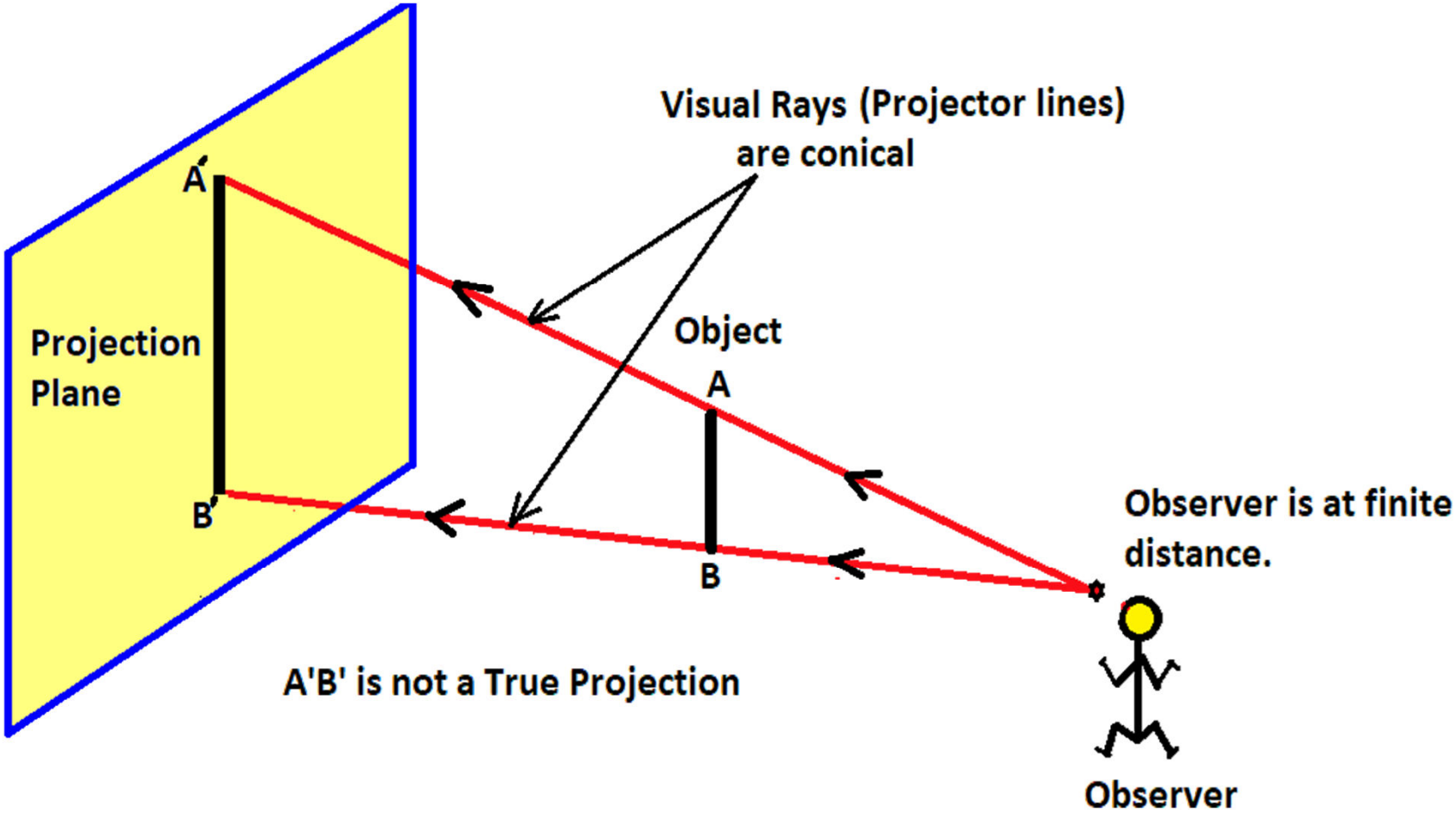
ALL DIMENSIONS ARE IN mm

Sketching & Dimensioning Practice



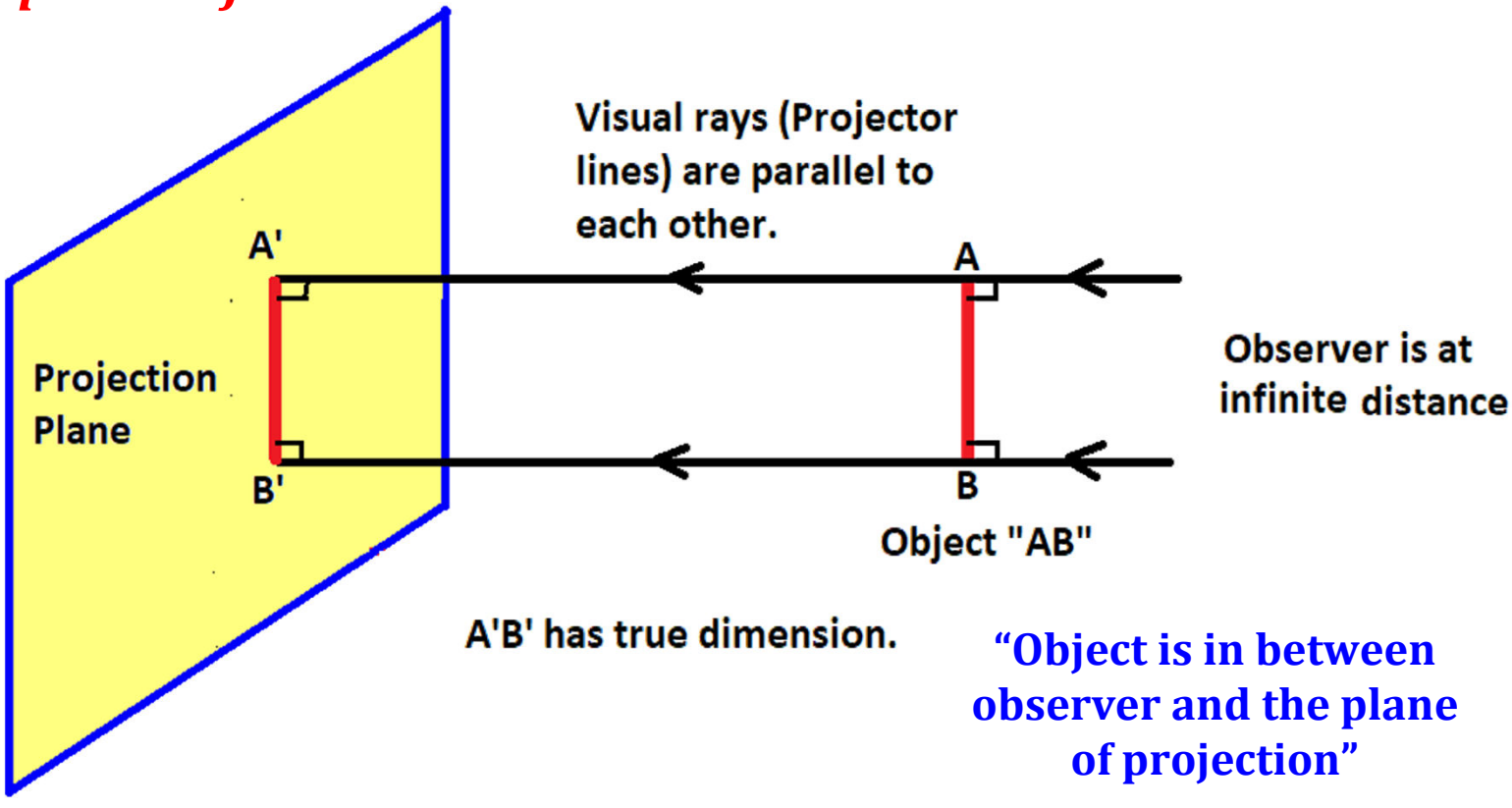
ALL DIMENSIONS ARE IN mm

Projection of an Object



Projection of an Object

Orthographic Projection

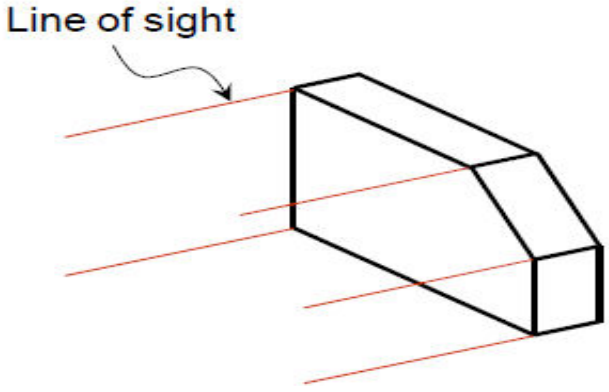


"Object is in between observer and the plane of projection"

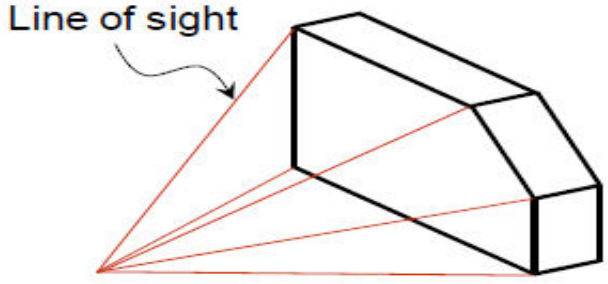
- When the projectors are parallel to each other and also perpendicular to the plane, the projection is called **"orthographic projection".**

Projection of an Object

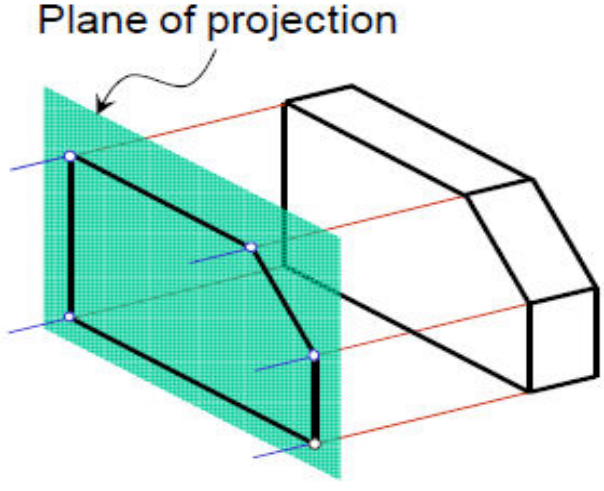
Parallel projection



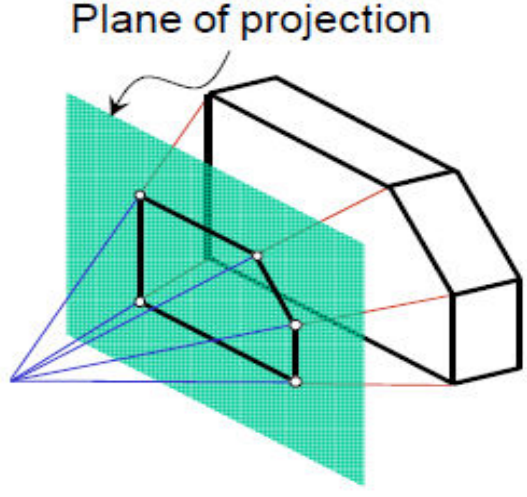
Perspective projection



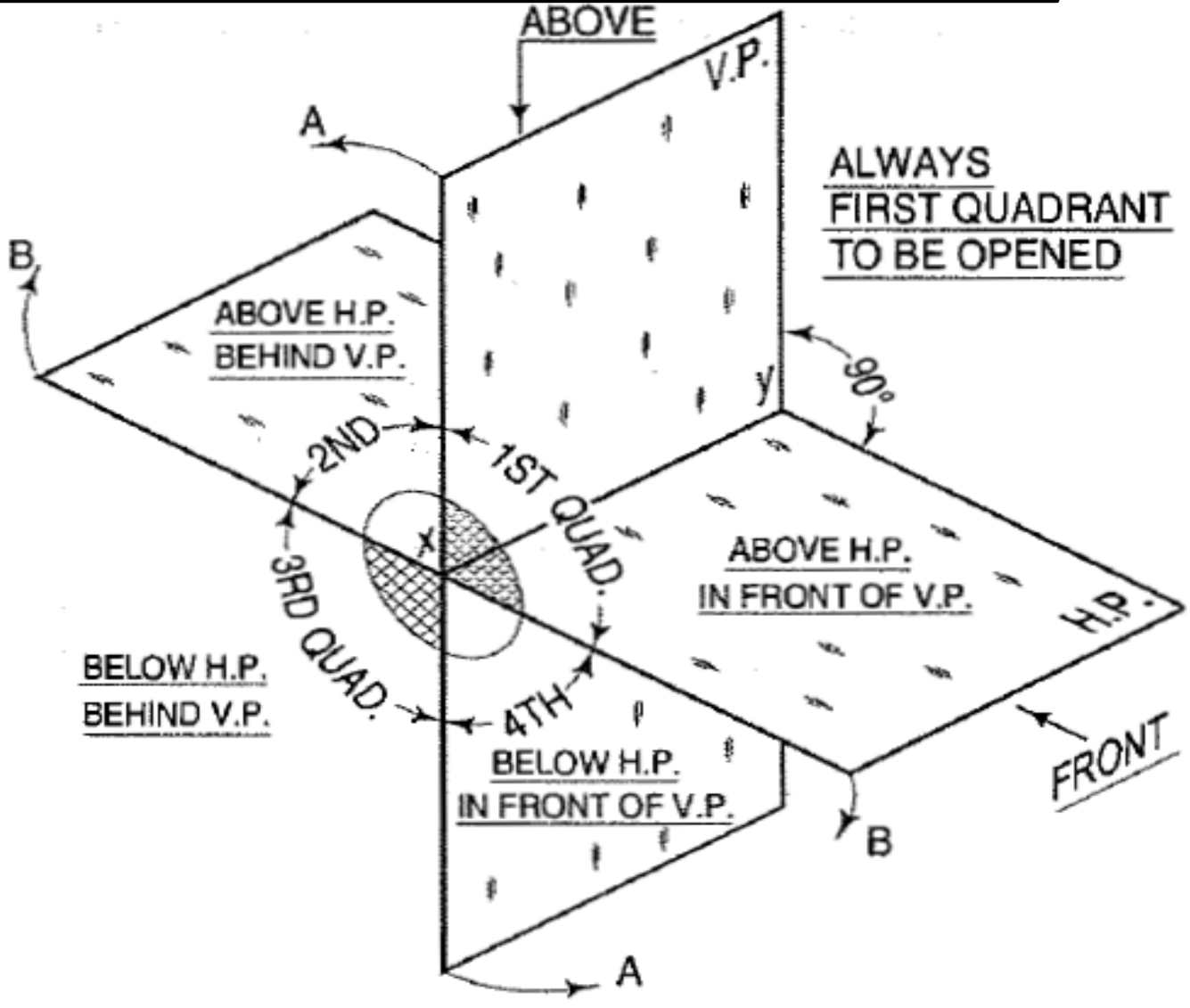
Parallel projection



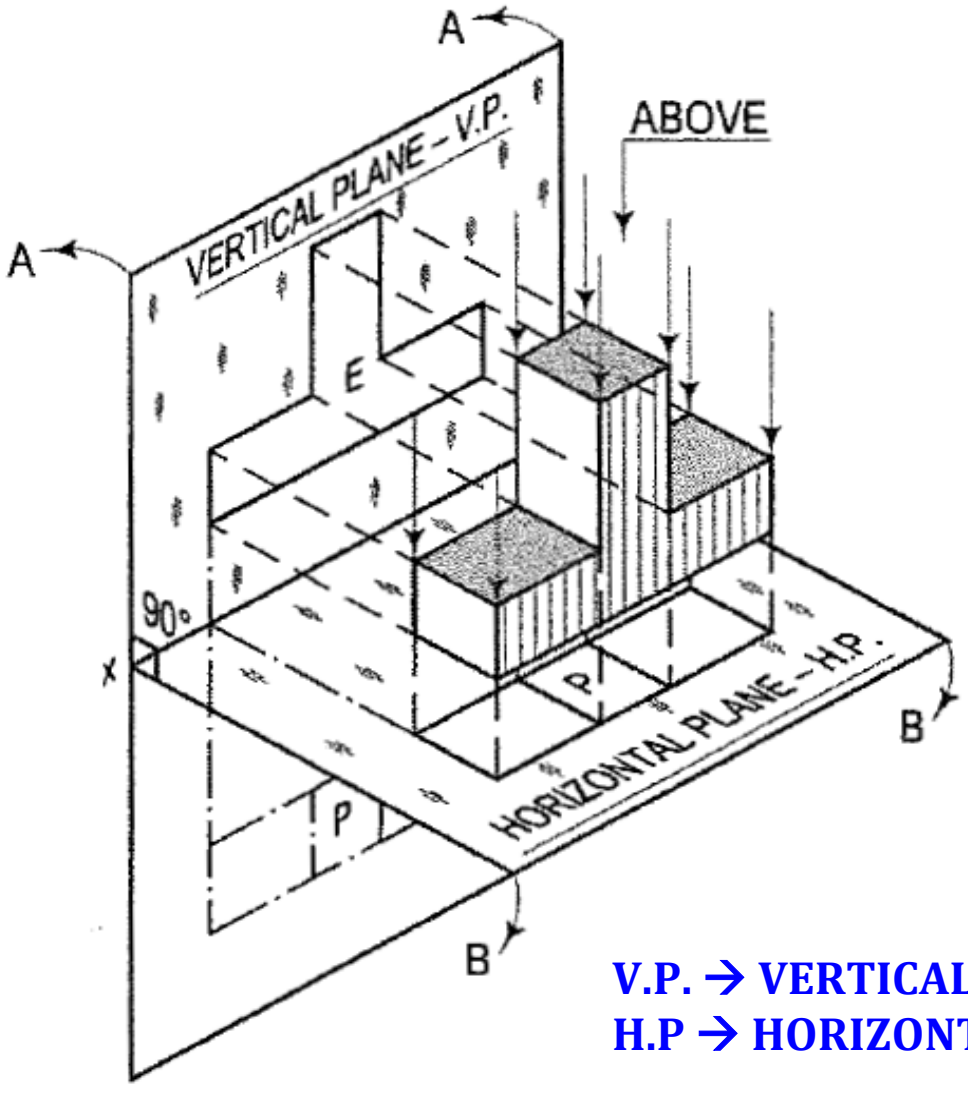
Perspective projection

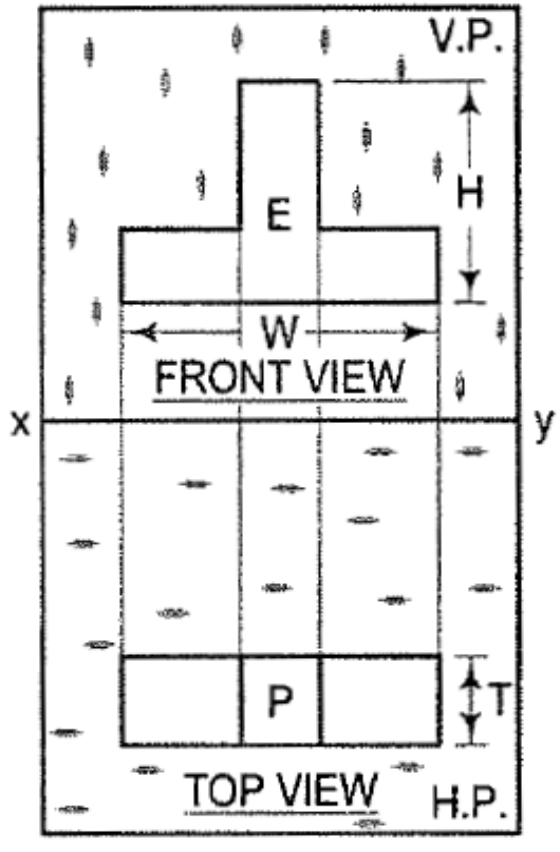


FOUR QUADRANTS



Planes of Projection

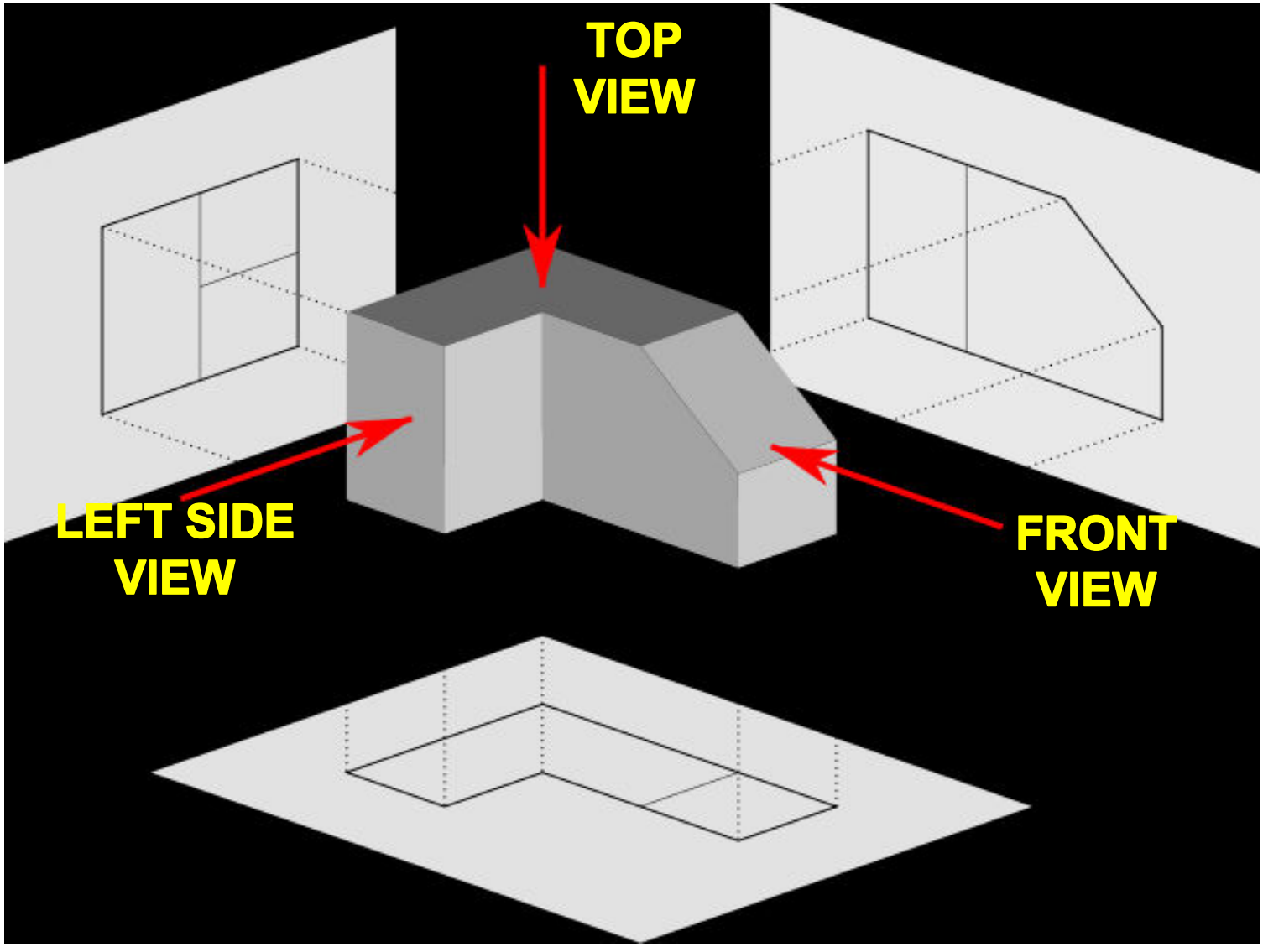




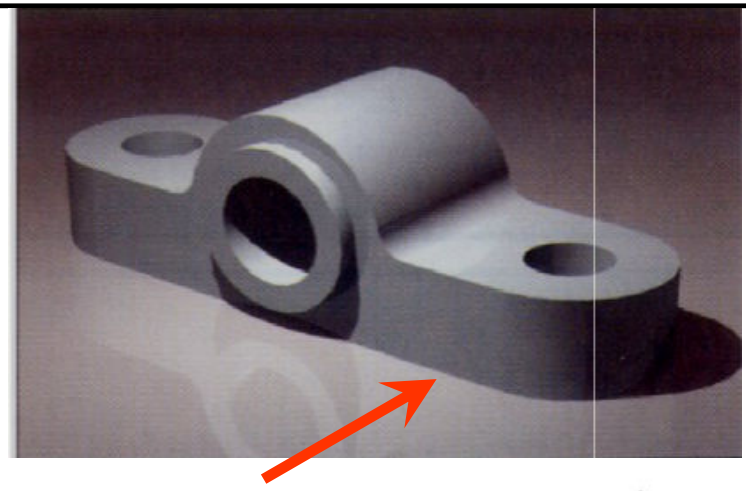
V.P. → VERTICAL PLANE
H.P → HORIZONTAL PLANE

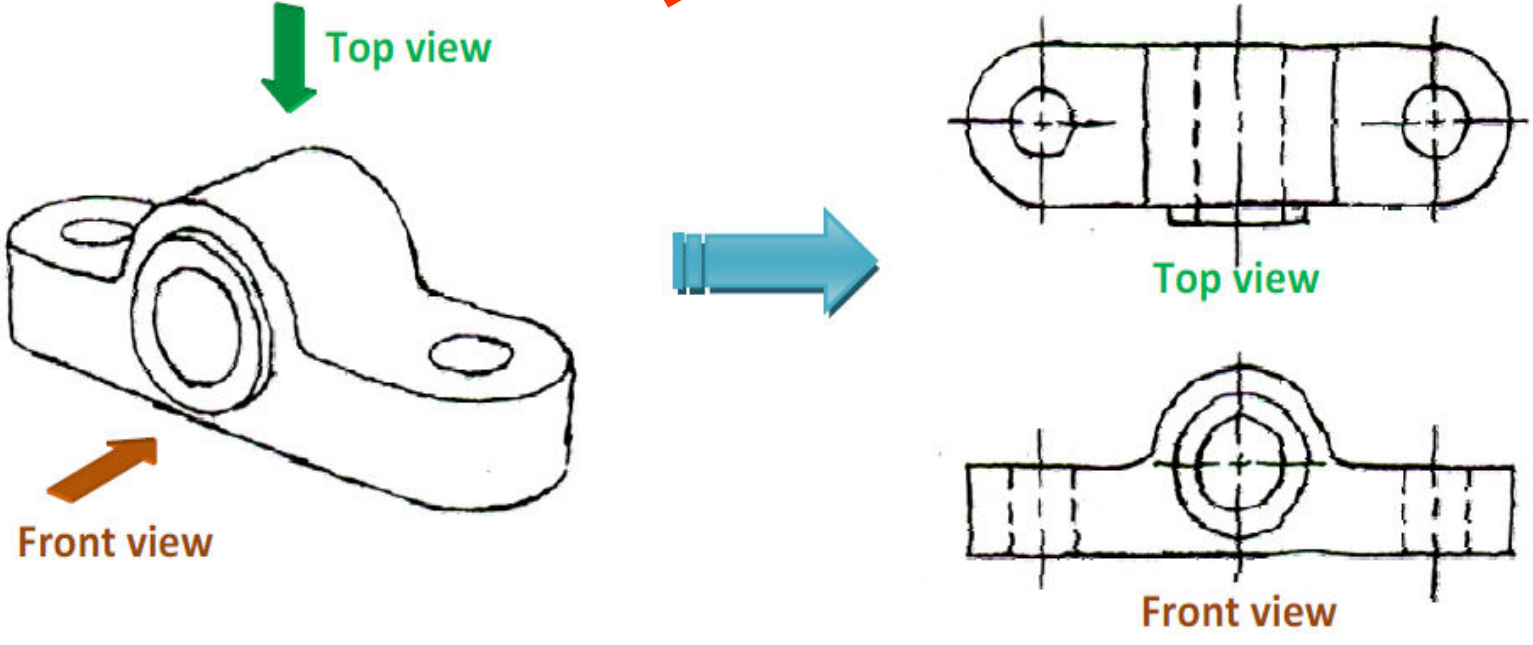
FIRST ANGLE PROJECTION

Planes of Projection

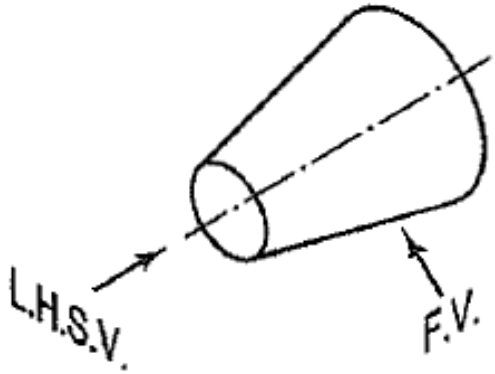


Orthographic Projection of a Product

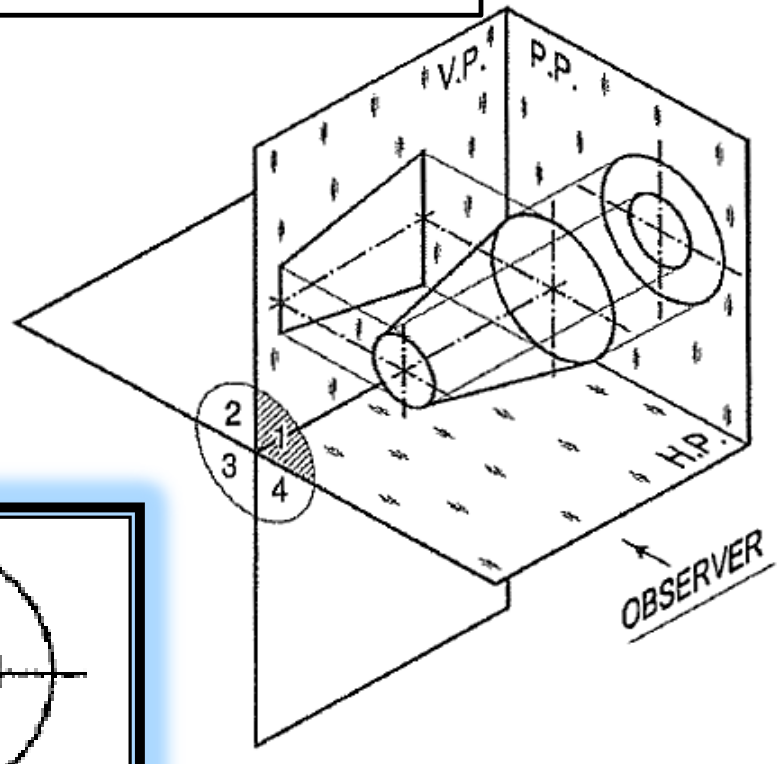


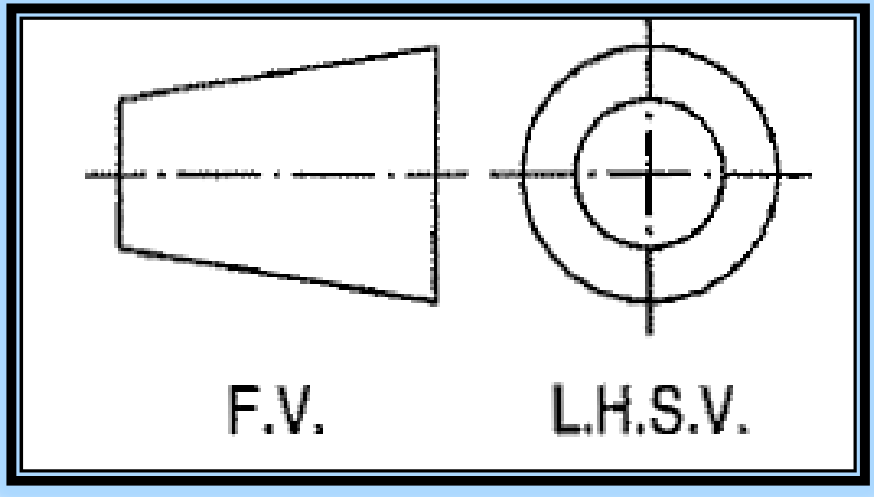


GRAPHICAL SYMBOL OF FIRST ANGLE PROJECTION



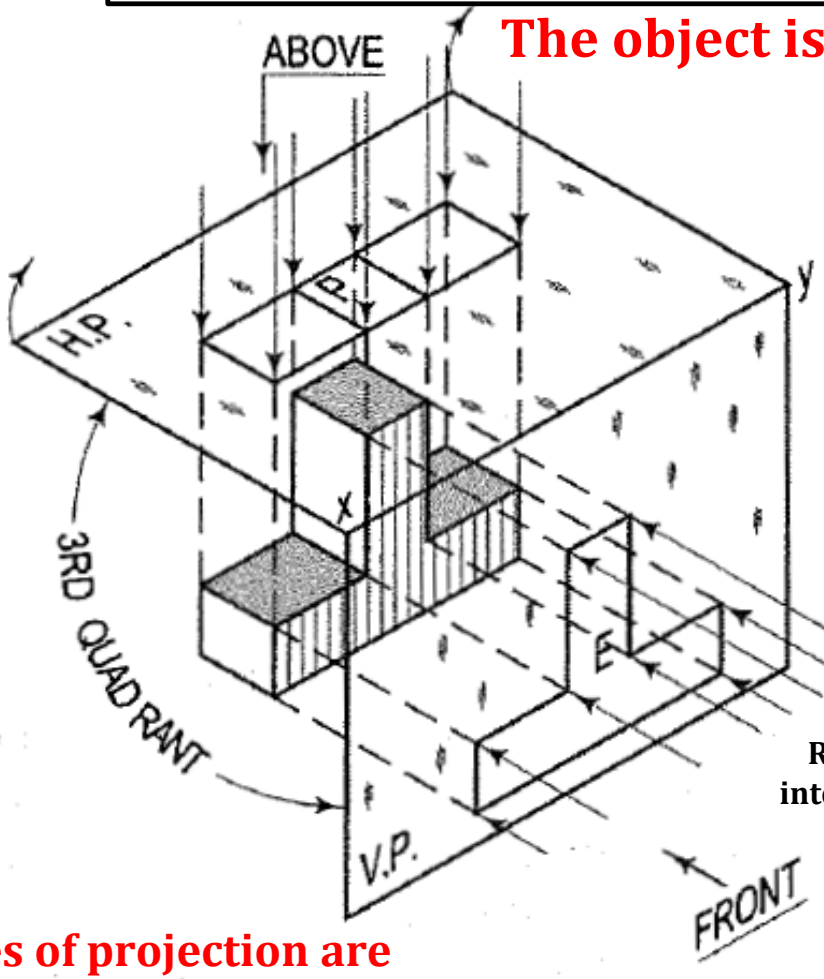
PICTORIAL VIEW



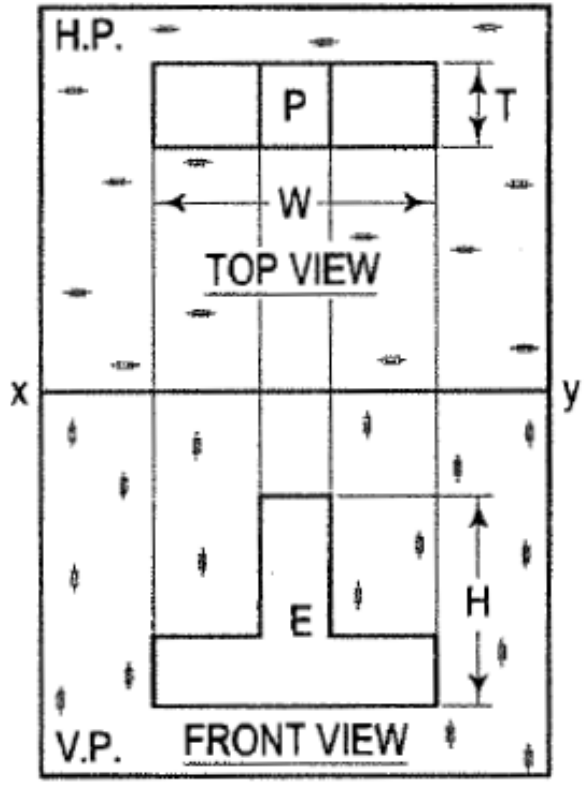


Third Angle Projection

The object is in the third quadrant.



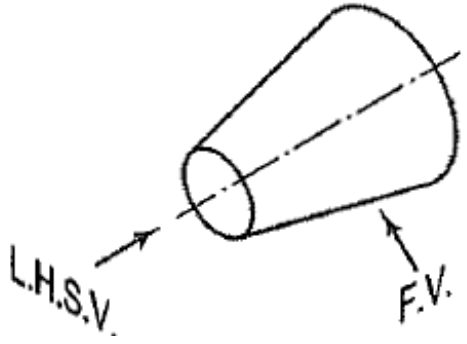
Rays of sight intersect the V.P

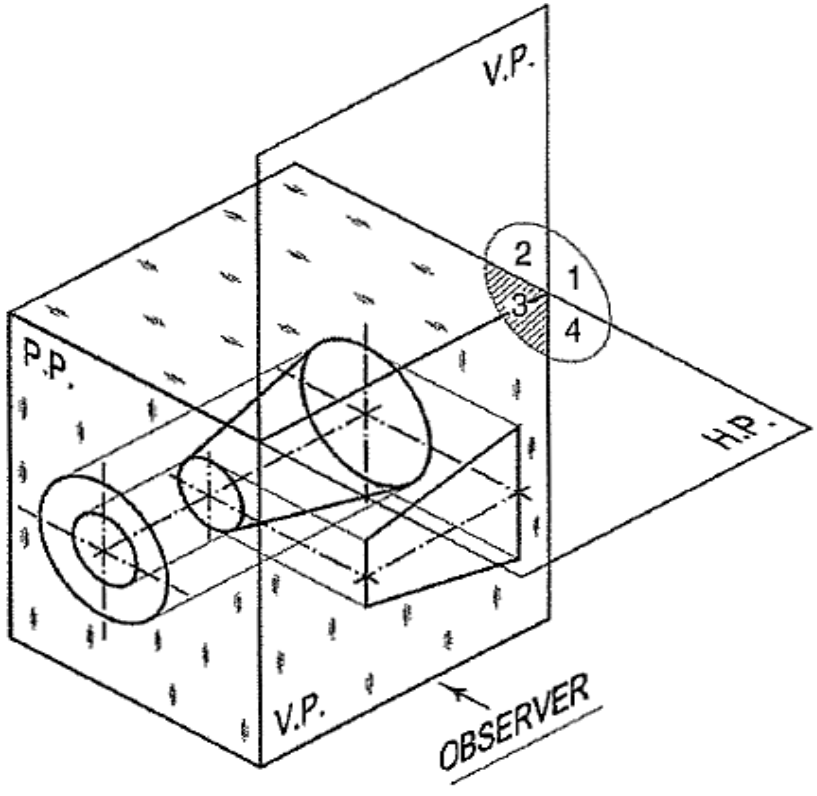


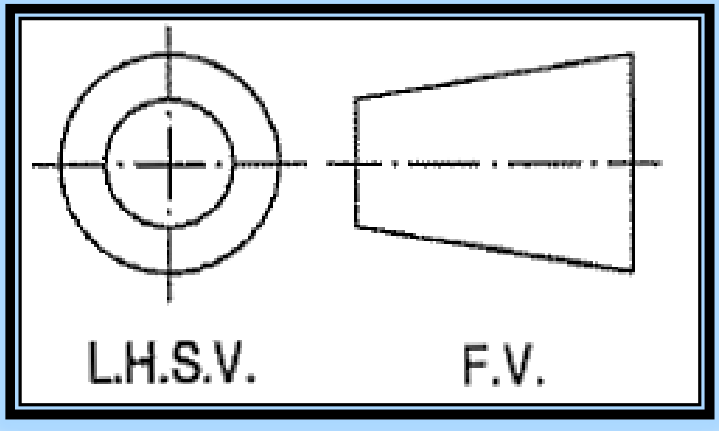
Planes of projection are assumed to be transparent

Top view comes above the front view.

Graphical Symbol of Third Angle Projection





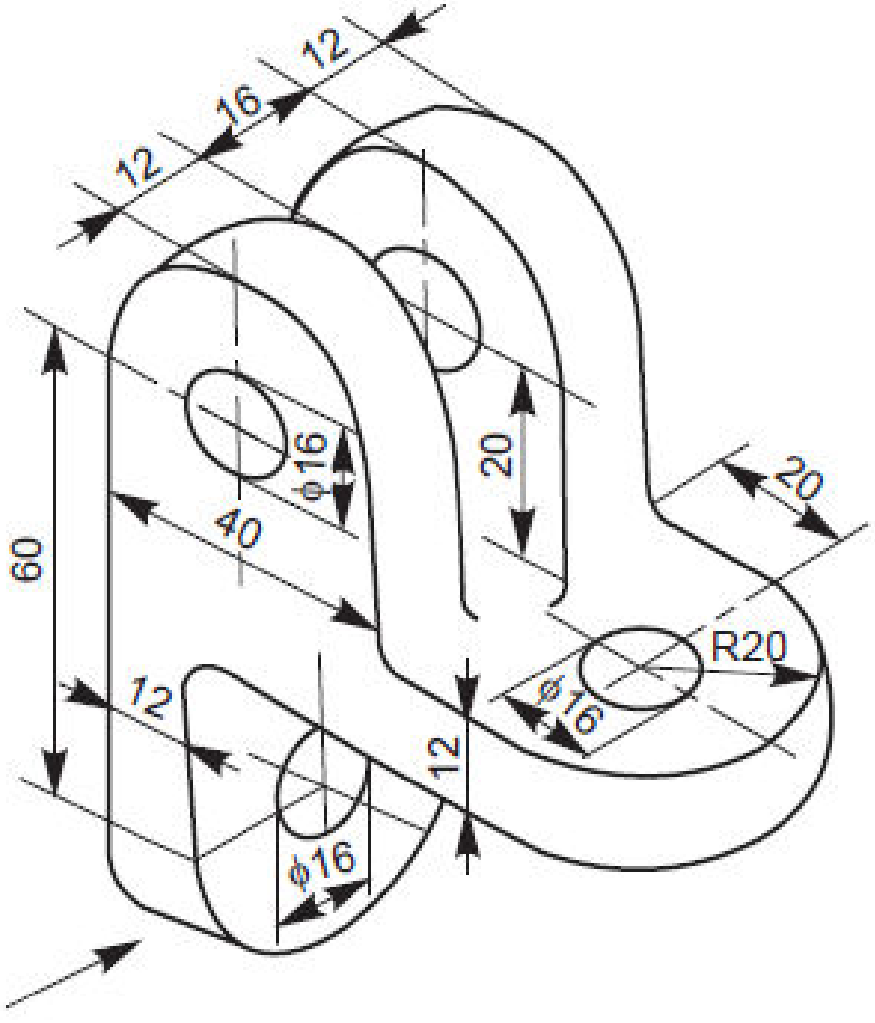


Source: Engineering Drawing, N.D. Bhatt

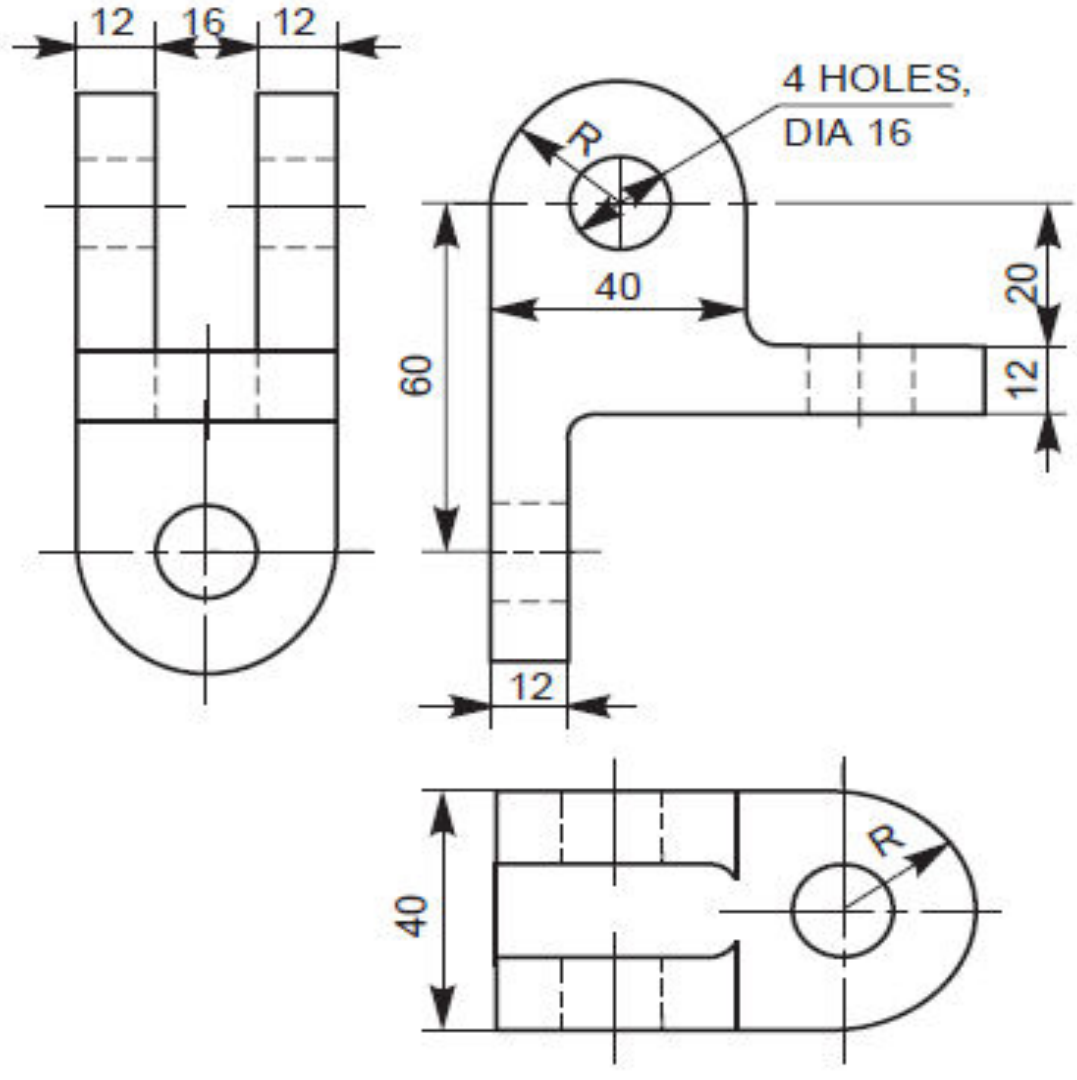
1st & 3rd Angle Projection – Comparison

First Angle Projection	Third Angle Projection
The object is kept in the first quadrant.	The object is assumed to be kept in the third quadrant.
The object lies between the observer and the plane of projection.	The plane of projection lies between the observer and the object.
The plane of projection is assumed to be non-transparent.	The plane of projection is assumed to be transparent.
The top view (plan) comes below the Front view (elevation).	The top view (plan) comes above the Front view (elevation).
The view of the object as observed from the left-side is drawn to the right of elevation.	Left hand side view is drawn to the left hand side of the elevation.
This method of projection is now recommended by the "Bureau of Indian Standards' from 1991.	This method of projection is used in U.S.A. and also in other countries.

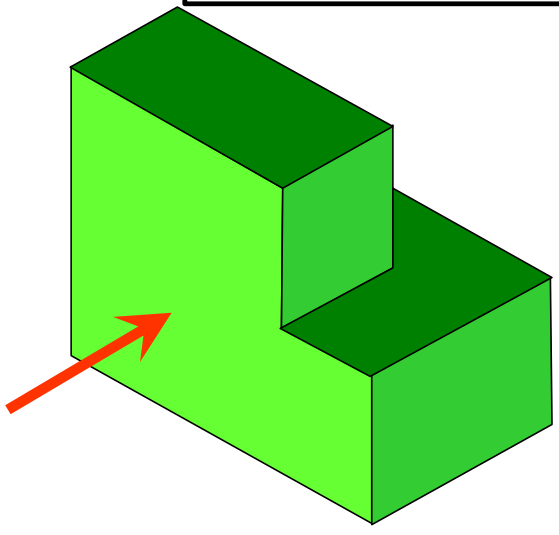
Orthographic Projection - Exercise

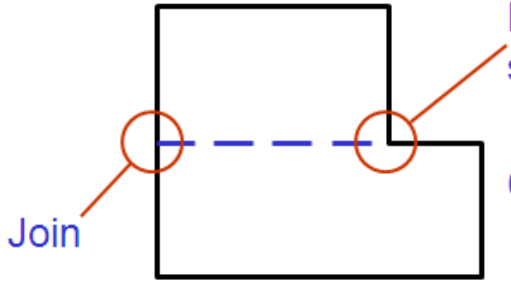


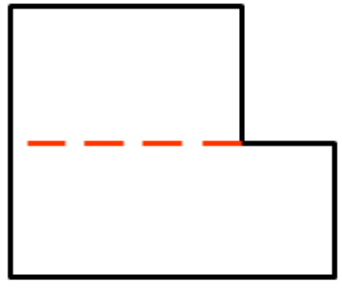
Orthographic Projection - Exercise

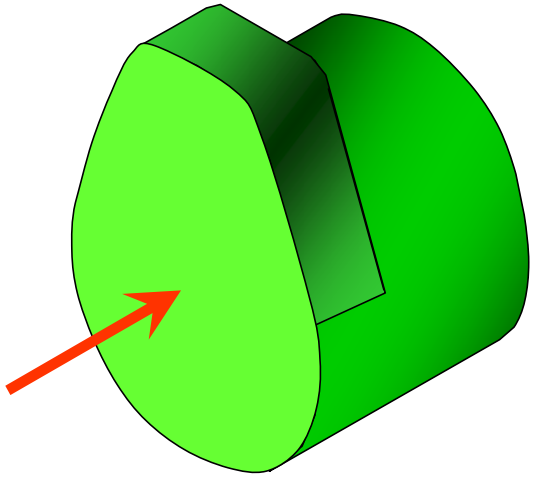


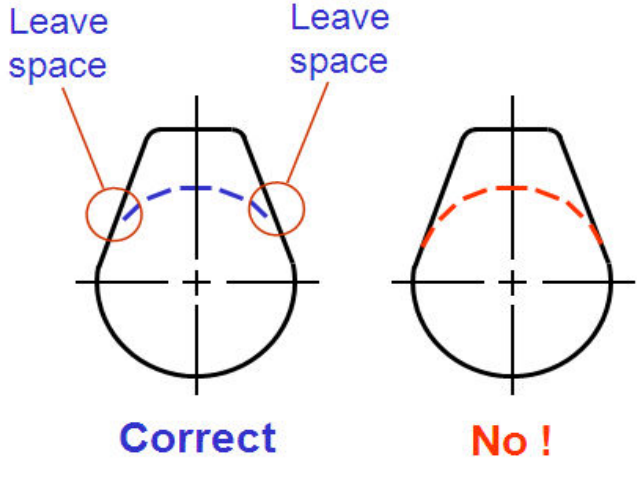
Hidden Edge Representation



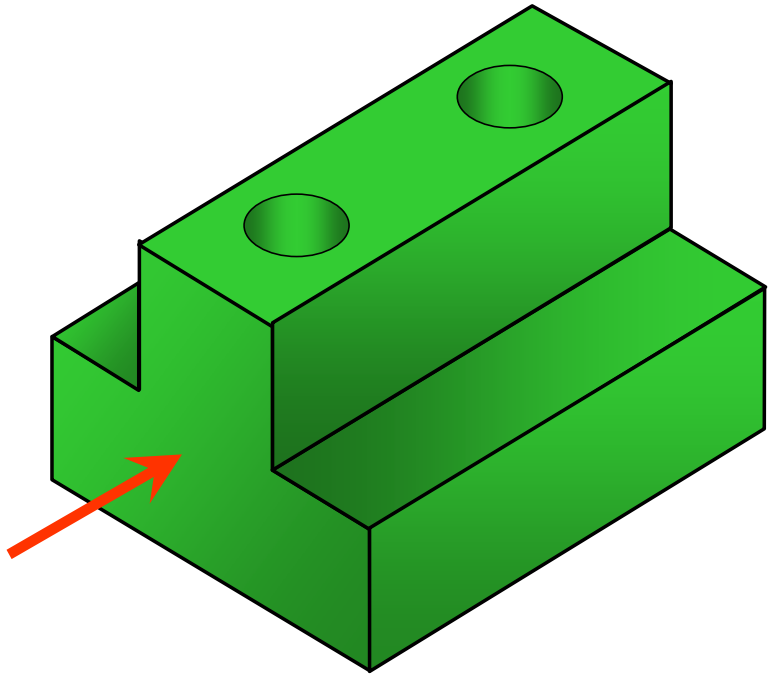


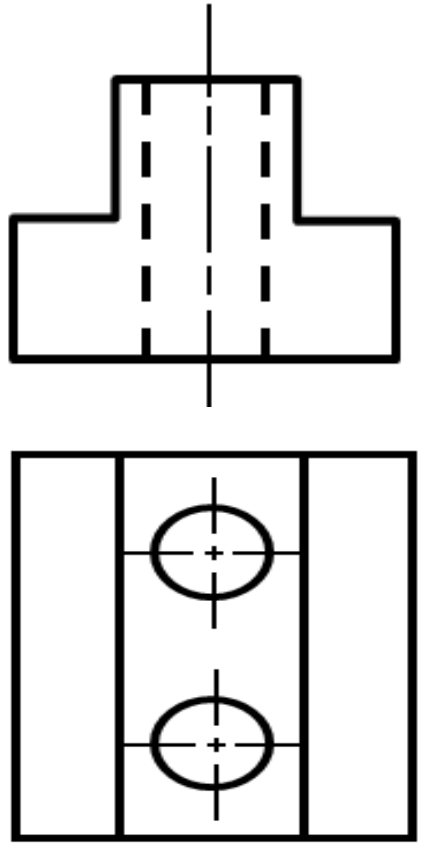




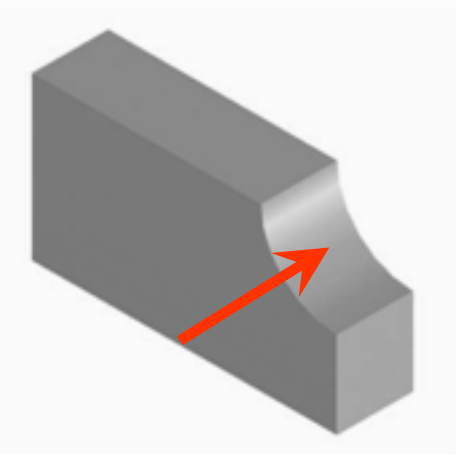


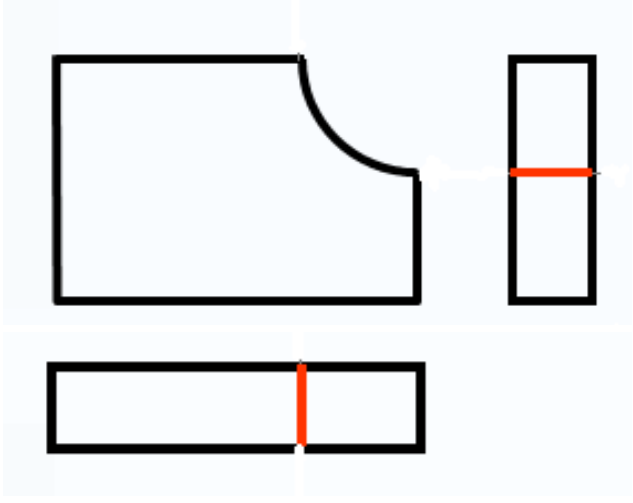
Representation of Holes

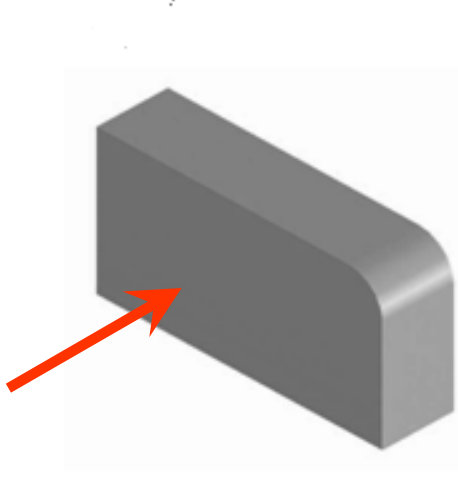


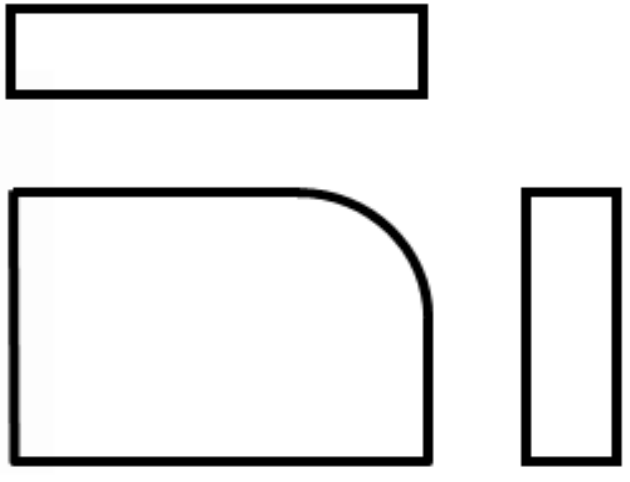


Representation of Edges and Fillets

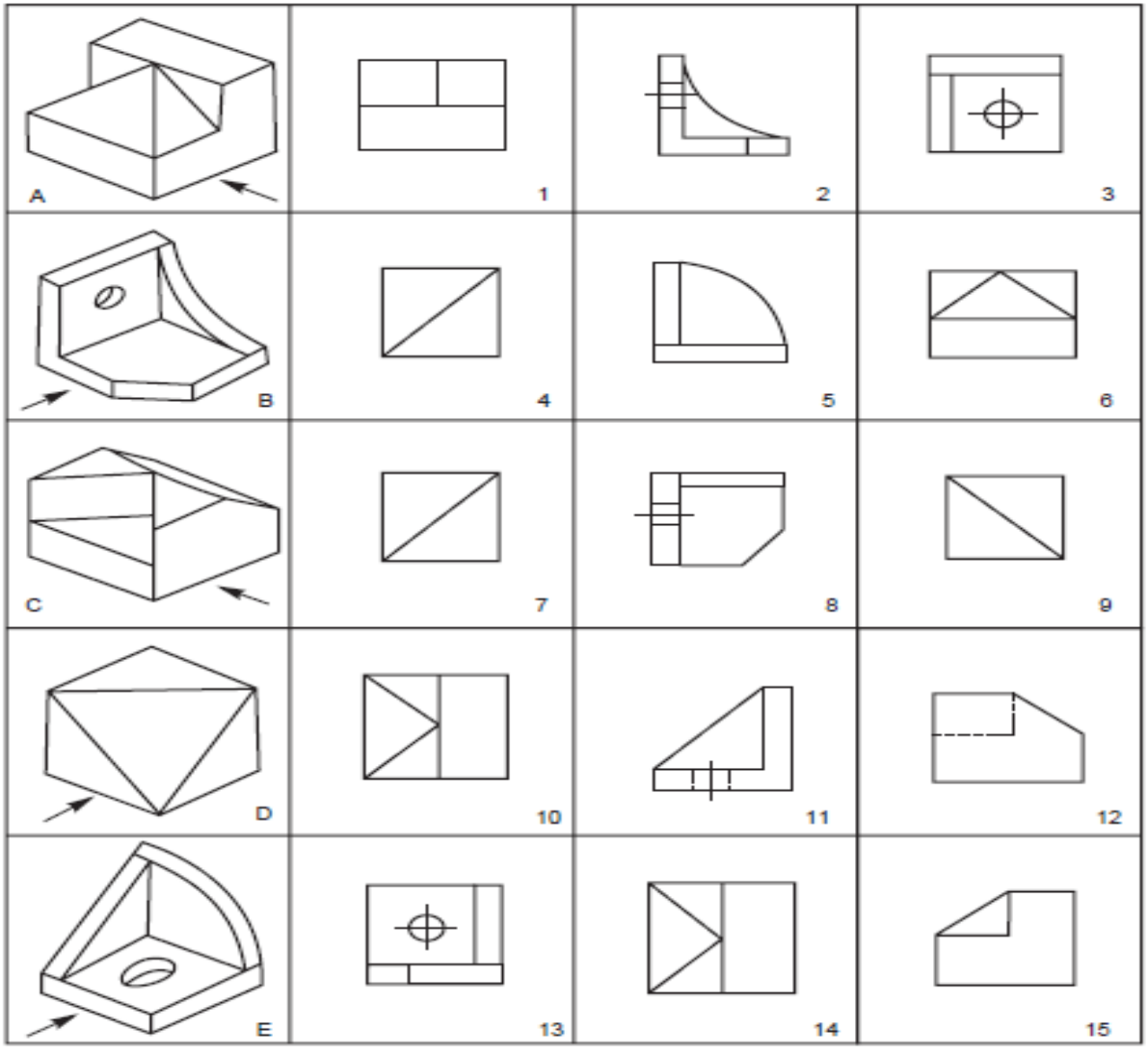






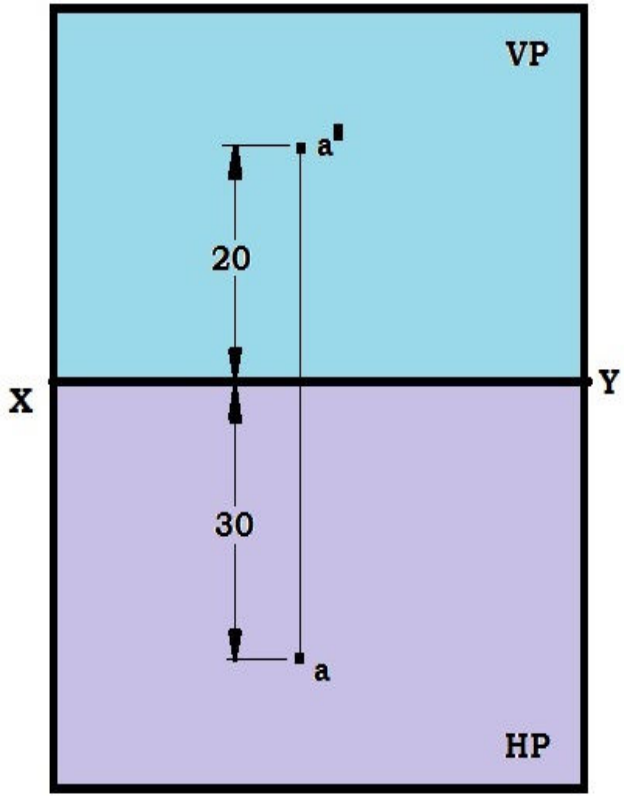


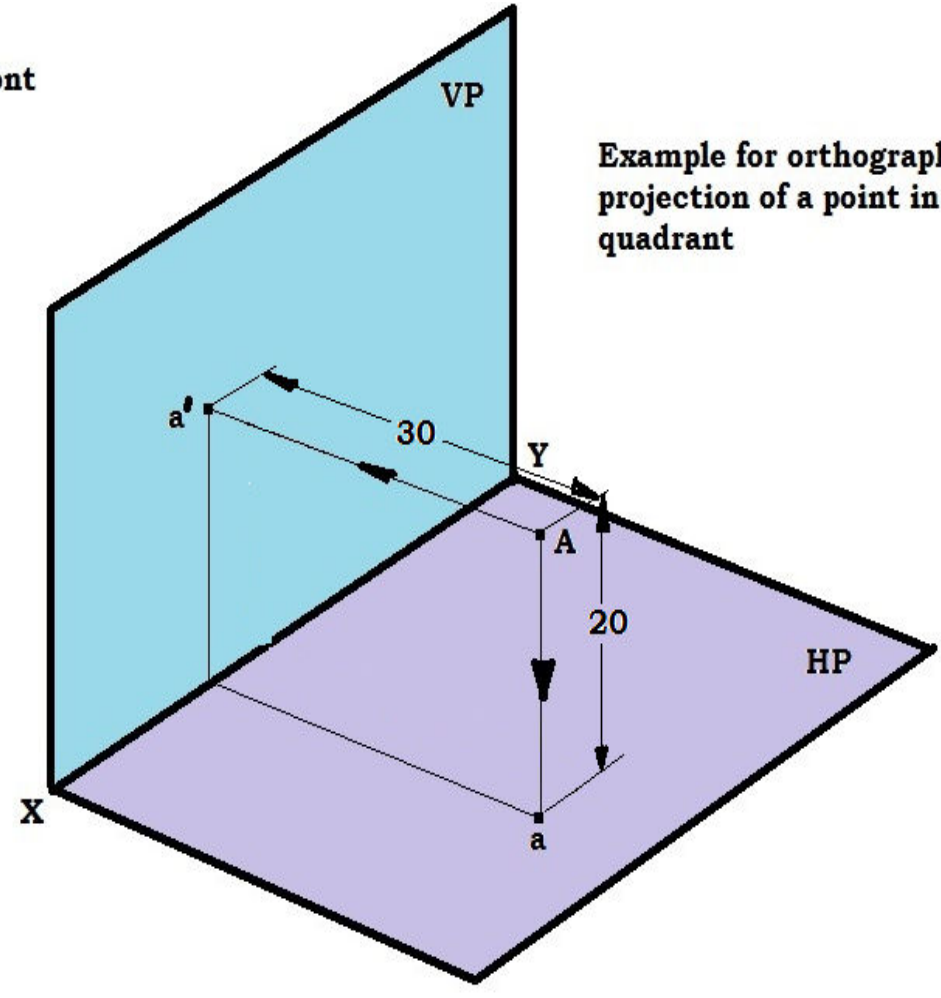
Identify the appropriate orthographic views



PROJECTION OF POINTS – Ist QUADRANT

point A, 20 mm above HP & 30 mm infront of VP

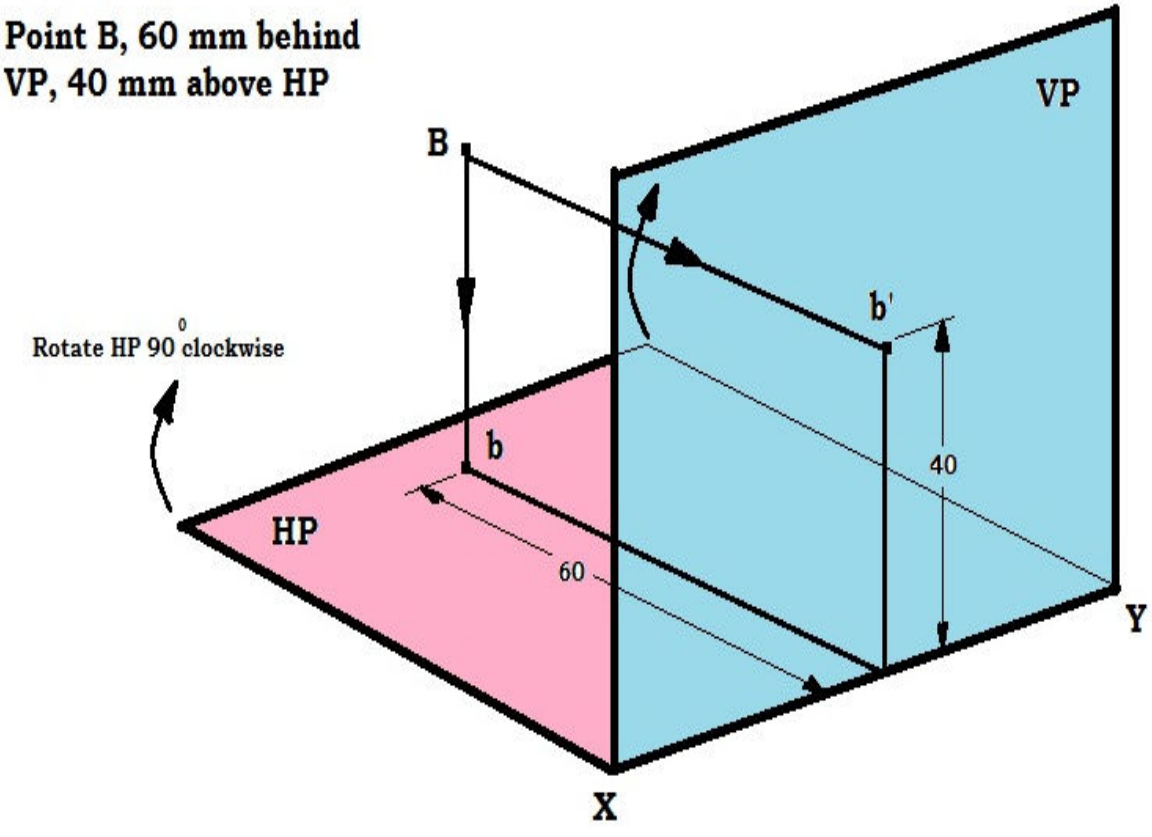




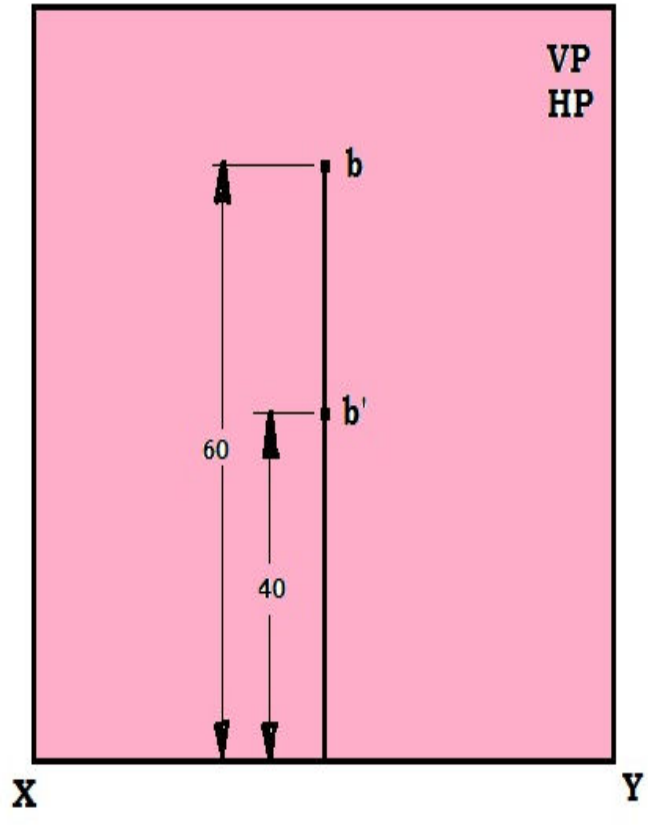
Example for orthographic projection of a point in I st quadrant

Projection Of Points – IInd QUADRANT

Point B, 60 mm behind
VP, 40 mm above HP



II nd QUADRANT

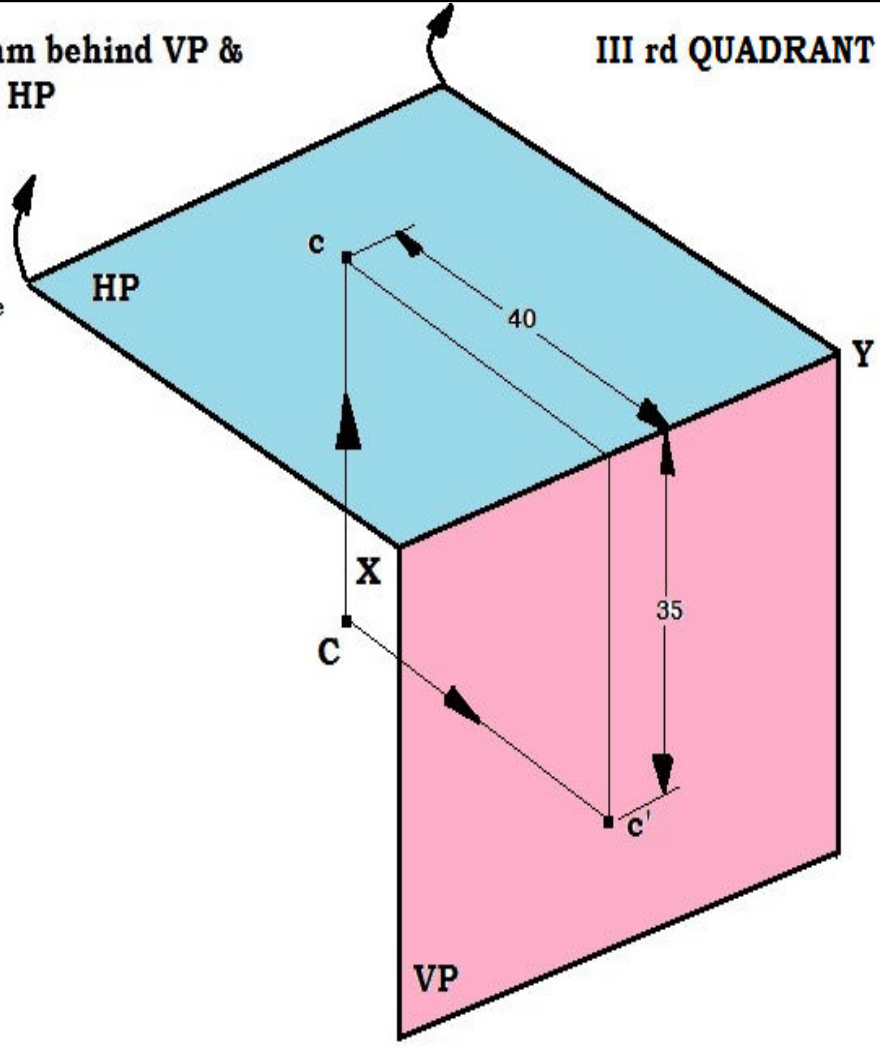


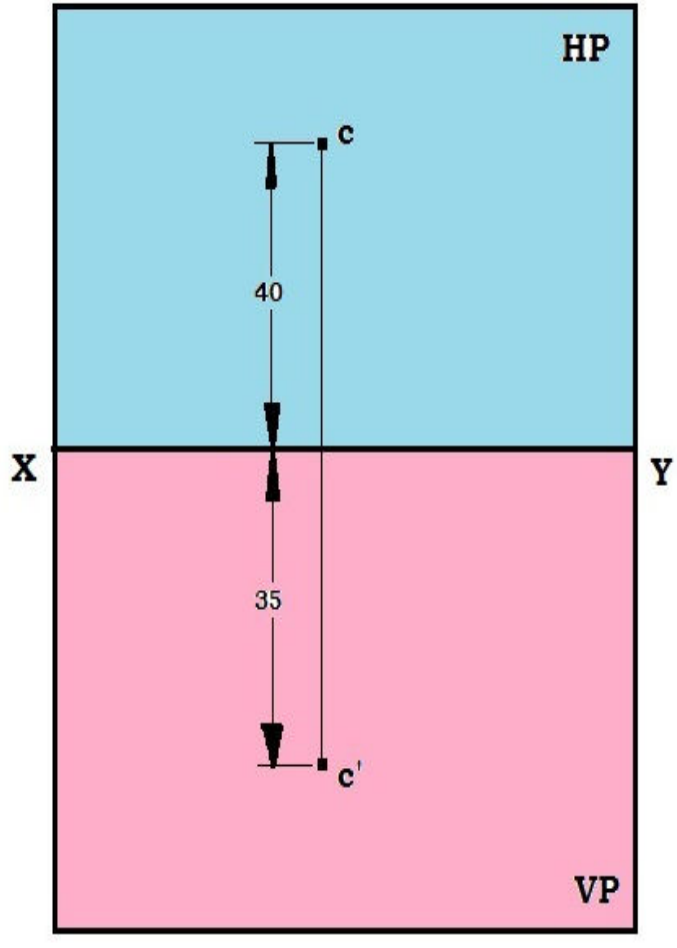
Projection Of Points – IIIrd QUADRANT

Point C, 40 mm behind VP &
35 mm below HP

III rd QUADRANT

Rotate HP 90° Clockwise

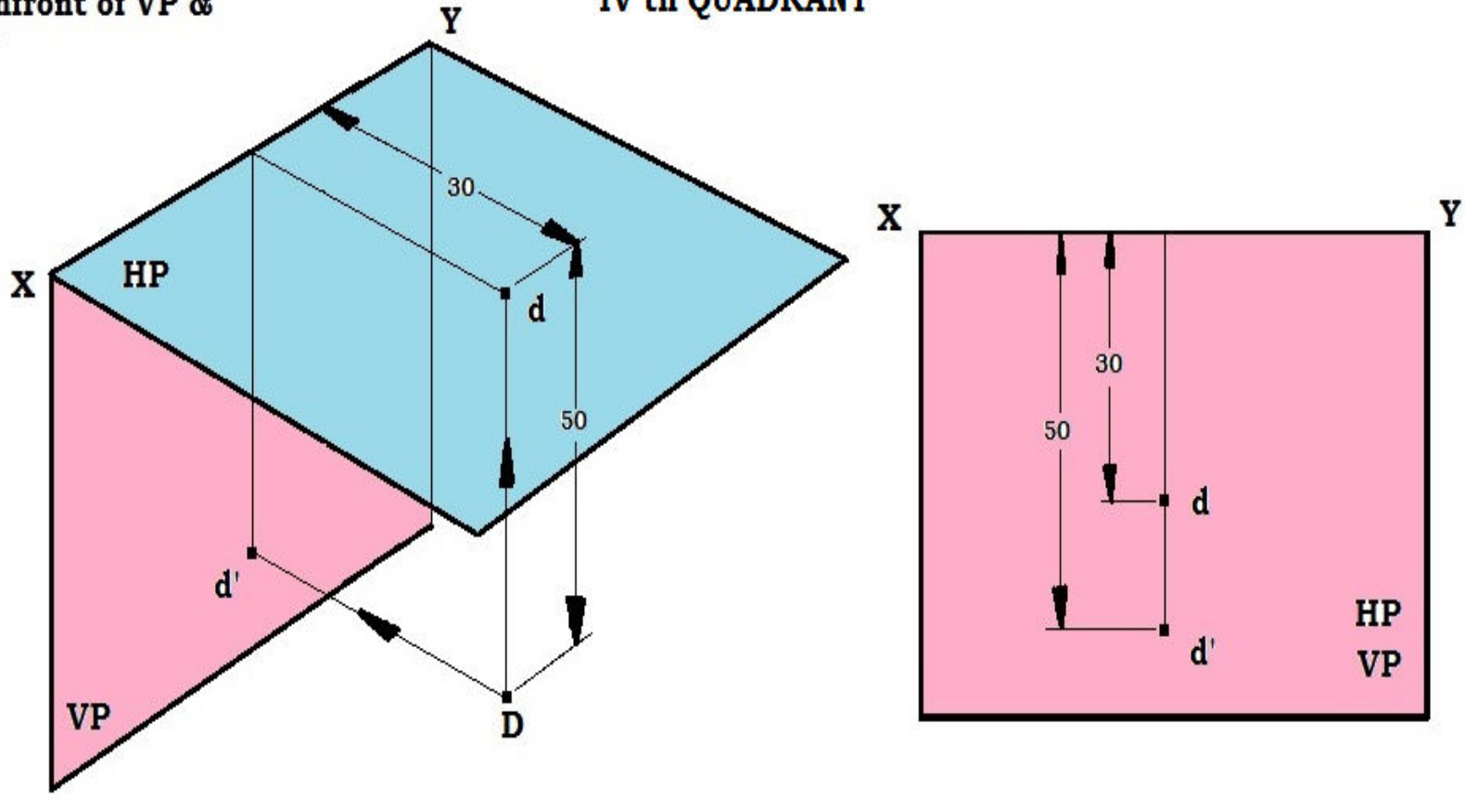




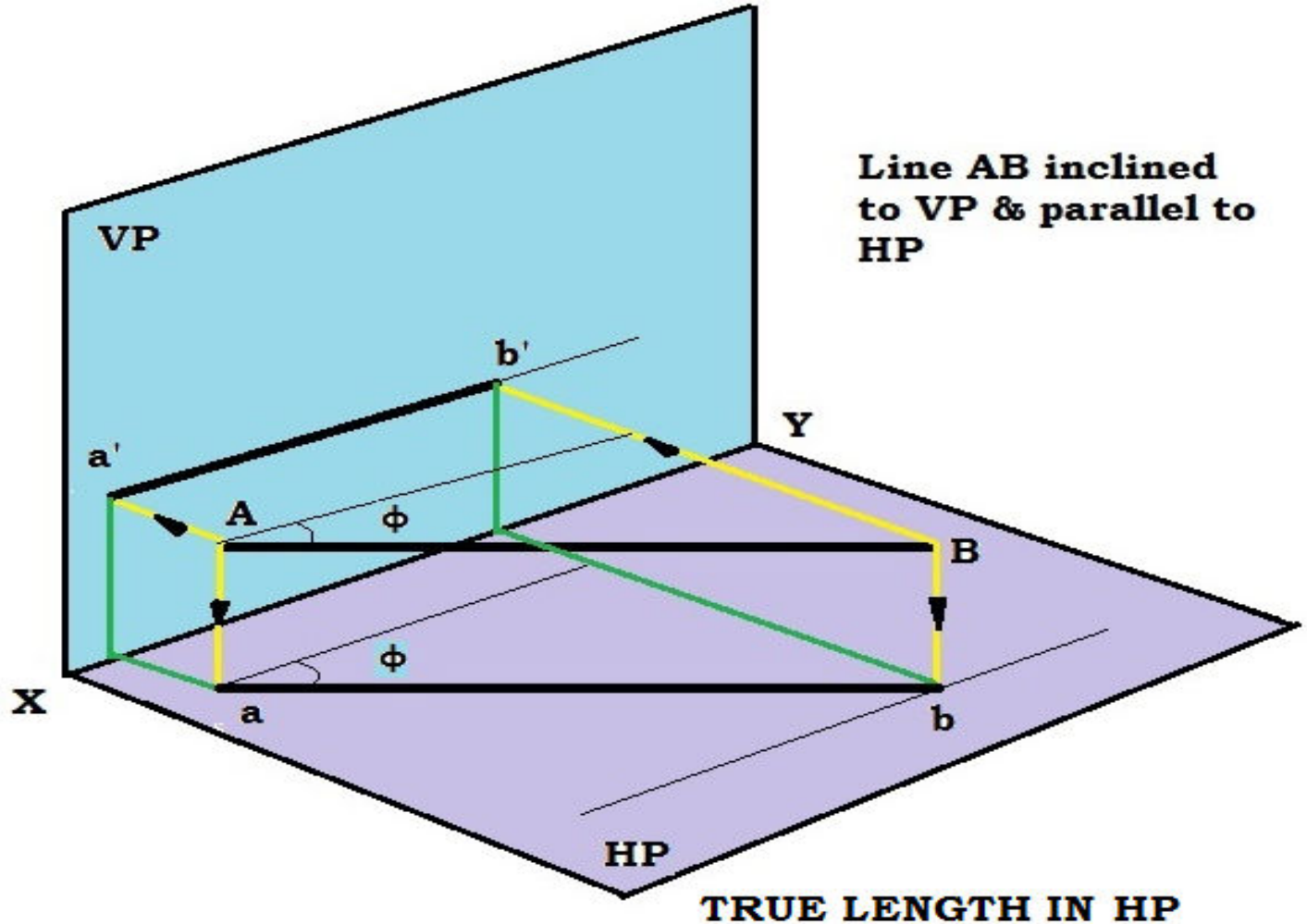
Projection Of Points – IVth QUADRANT

Point D, 30mm infront of VP &
50 mm below HP

IV th QUADRANT



Projection of Straight Line – Ist QUADRANT

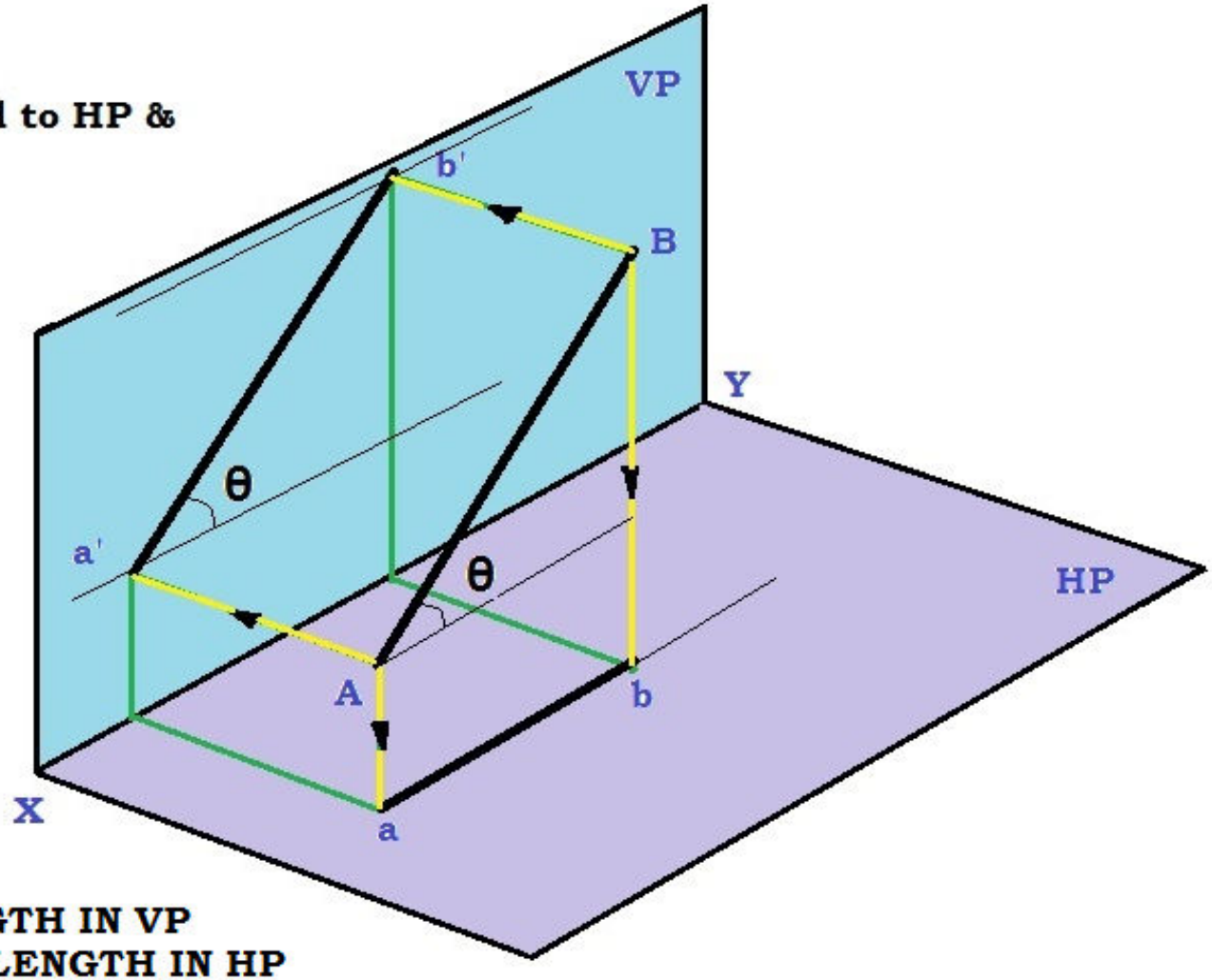


Line AB inclined to VP & parallel to HP

TRUE LENGTH IN HP
REDUCED LENGTH IN VP

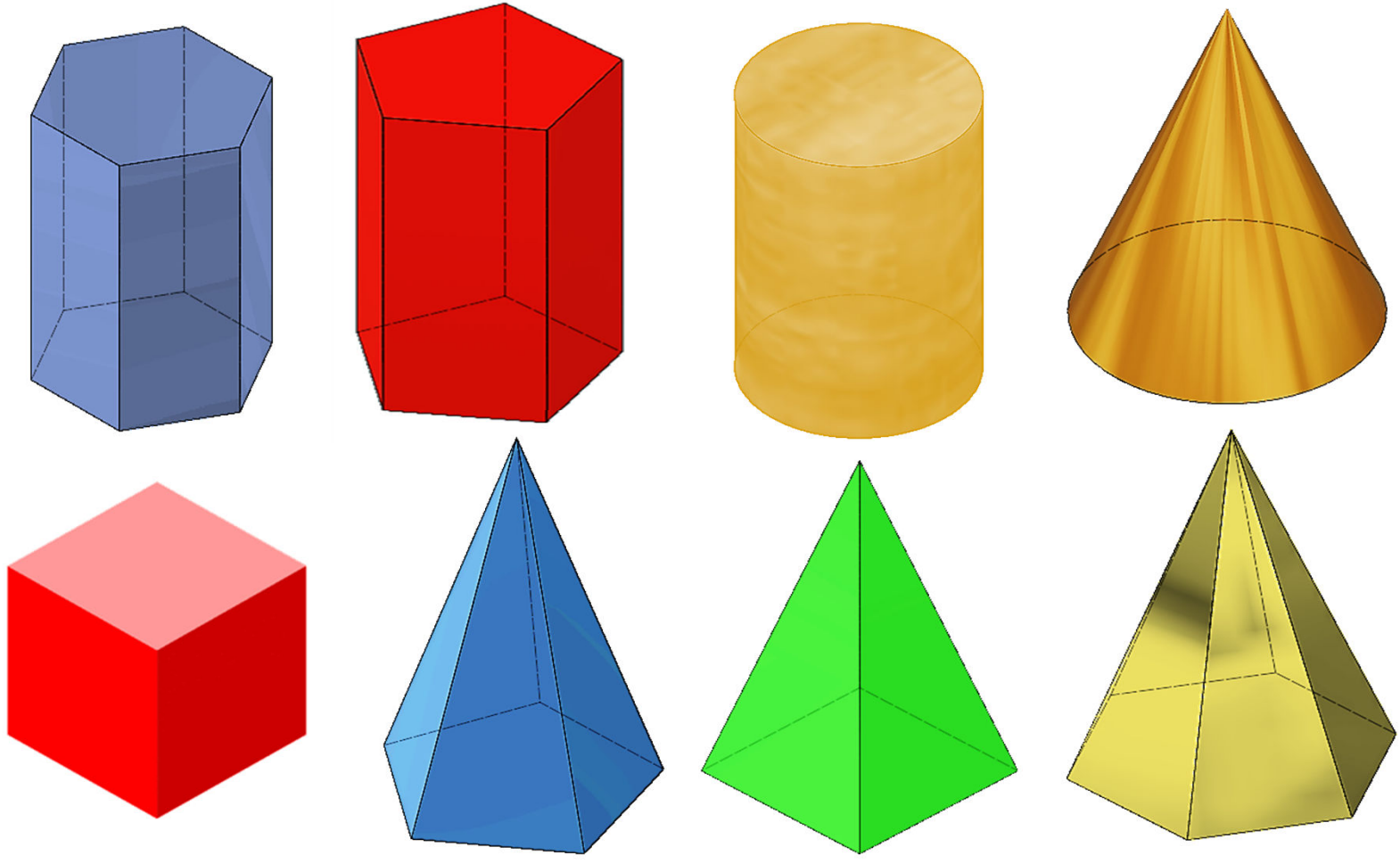
Projection of Straight Line – Ist QUADRANT

Line AB inclined to HP &
Parallel to VP



TRUE LENGTH IN VP
REDUCED LENGTH IN HP

Regular Solids



Types of Solids

Solids are divided into two main groups.

- **Polyhedra – A solid bounded by planes called faces.**

Examples: Prisms, Pyramids, Cube, Tetrahedron, octahedron etc.

- **Solids of Revolution – A solid generated by the revolution of rectangle or right angle triangle or semi-circle with respect to axis are known as solids of revolution. They are axisymmetric solids.**

Examples: Cylinder, Cone, Sphere.

Importance of Regular Solids in Engineering Drawing

- Regular solids are used in engineering drawing because their simple, symmetrical shapes make it easy to understand and practice drawing 3D objects accurately.

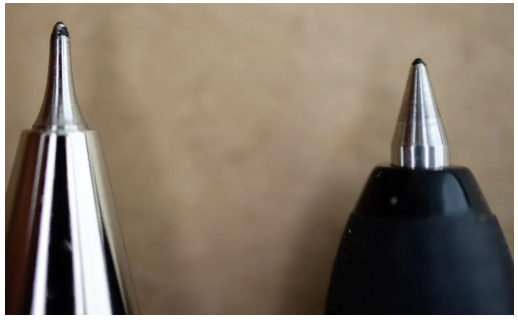
- They help teach visualization, projection, and standard drawing techniques clearly and consistently.

- Many complex mechanical parts and surfaces are based on or approximated using regular solids.

Using them in drawings helps:

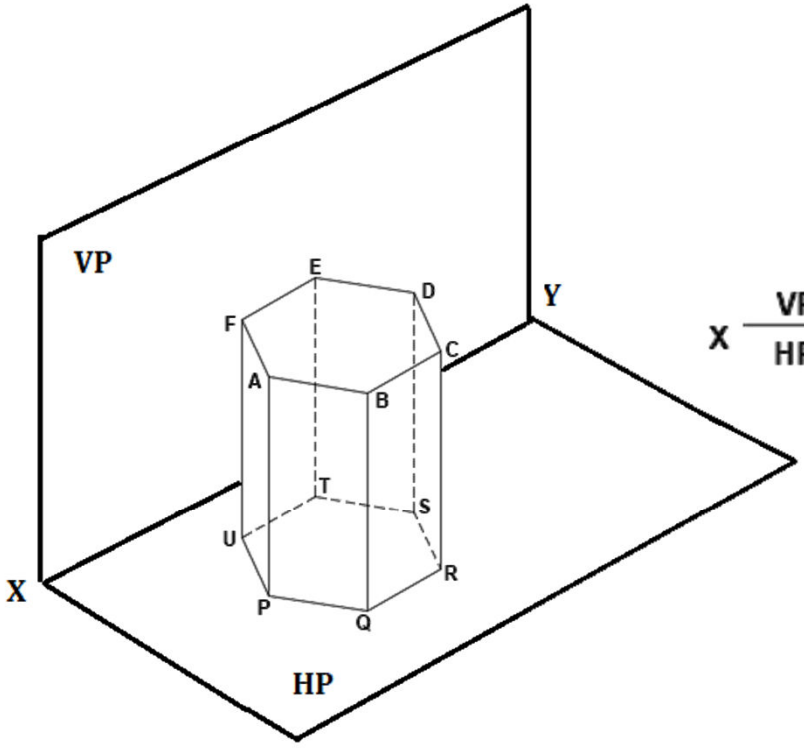
- Break down complex shapes into simpler elements
- Apply geometric transformations like rotation, translation, and scaling

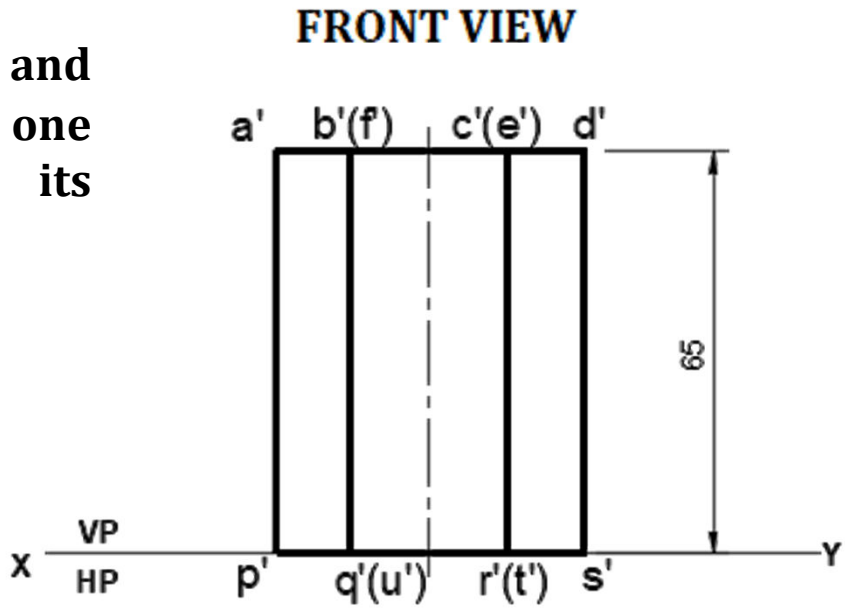
Regular Solid Approximations in real world applications

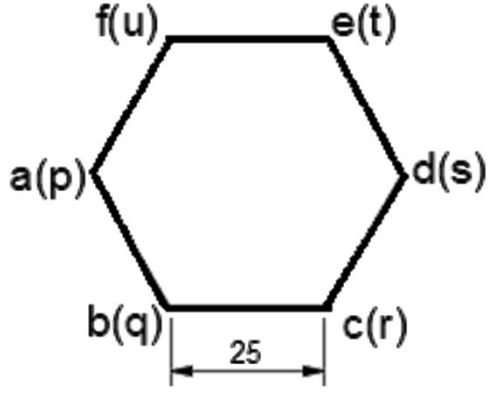


Numerical

Q. **A hexagonal prism of base side 25 mm and height 65 mm is resting on HP on its base with one of its base edges parallel to VP. Draw its projections.**

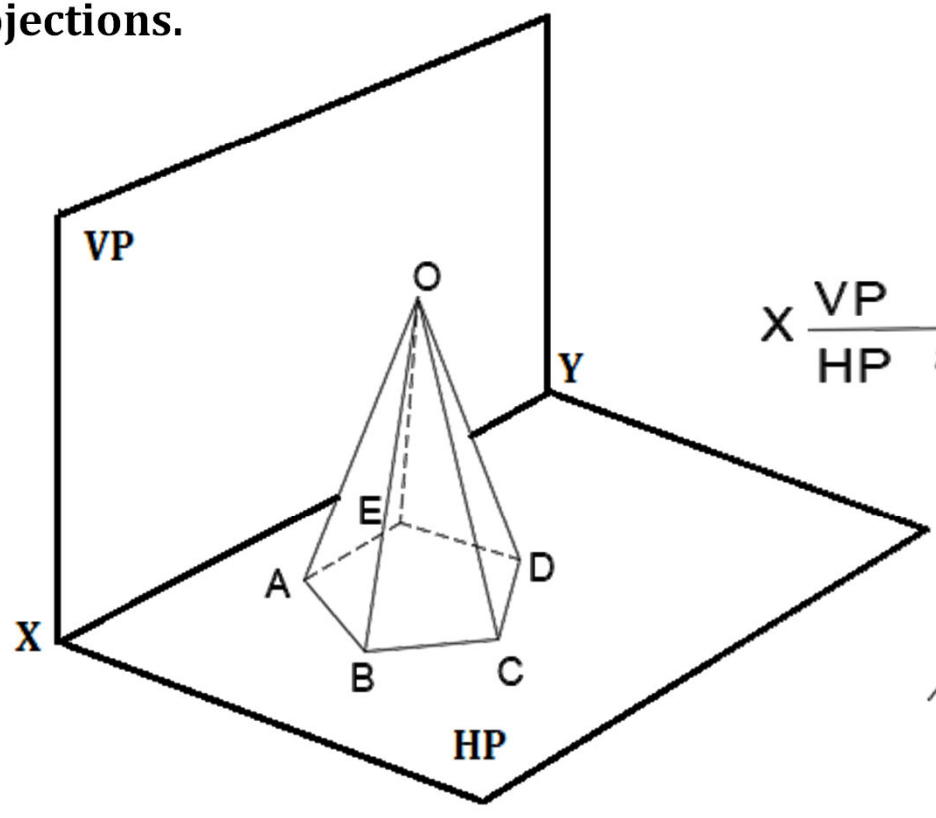


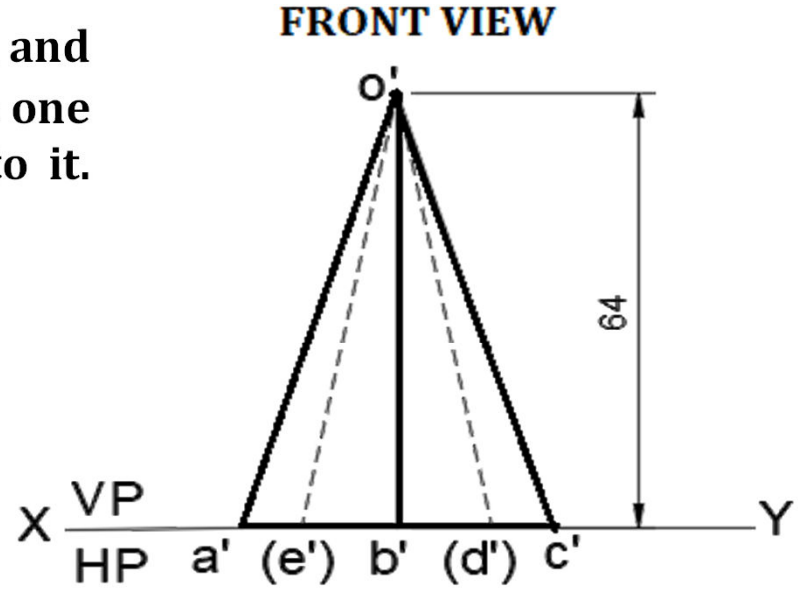


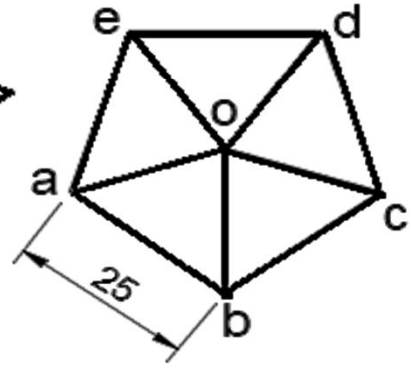


Numerical

Q. **A pentagonal pyramid of base side 25 mm and height 64 mm is resting on HP on its base with one of its base edges parallel to VP and nearer to it. Draw its projections.**

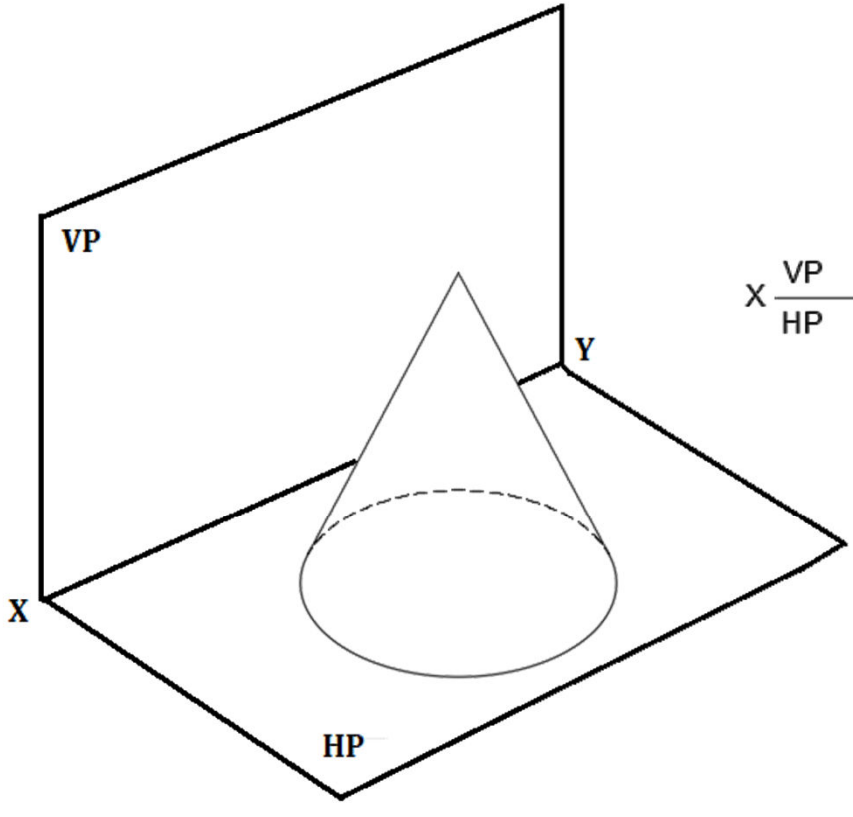


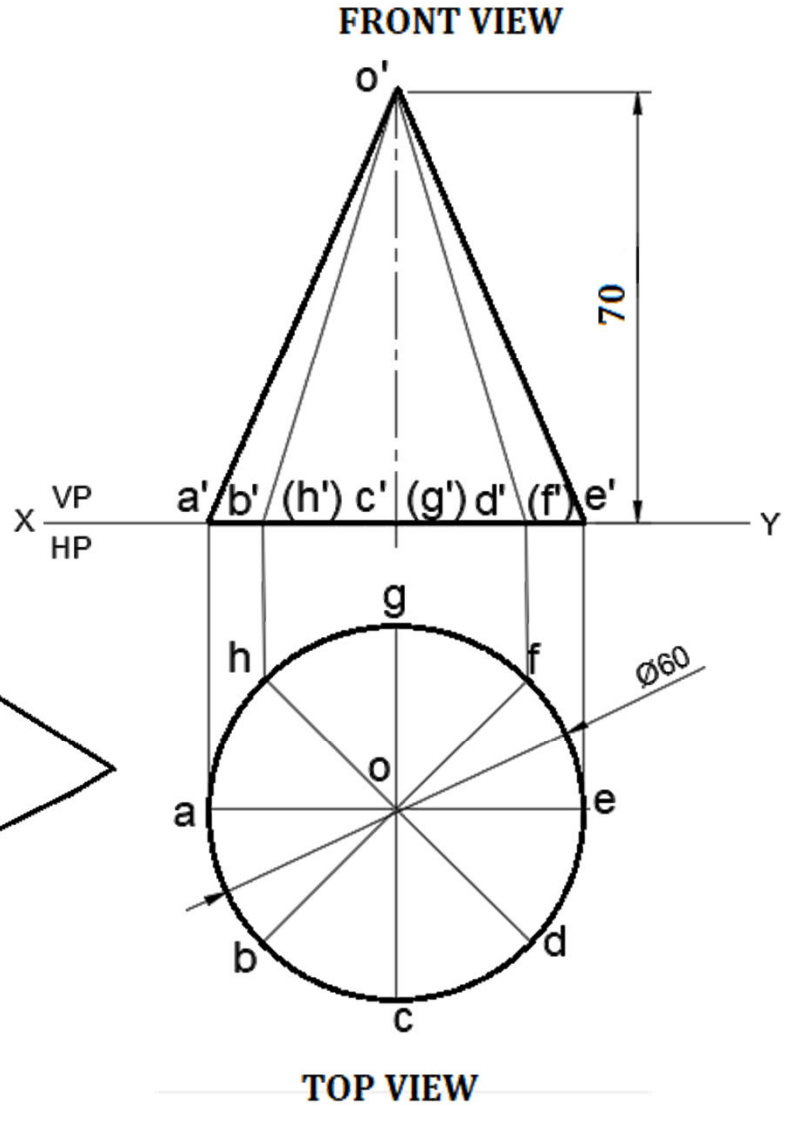




Numerical

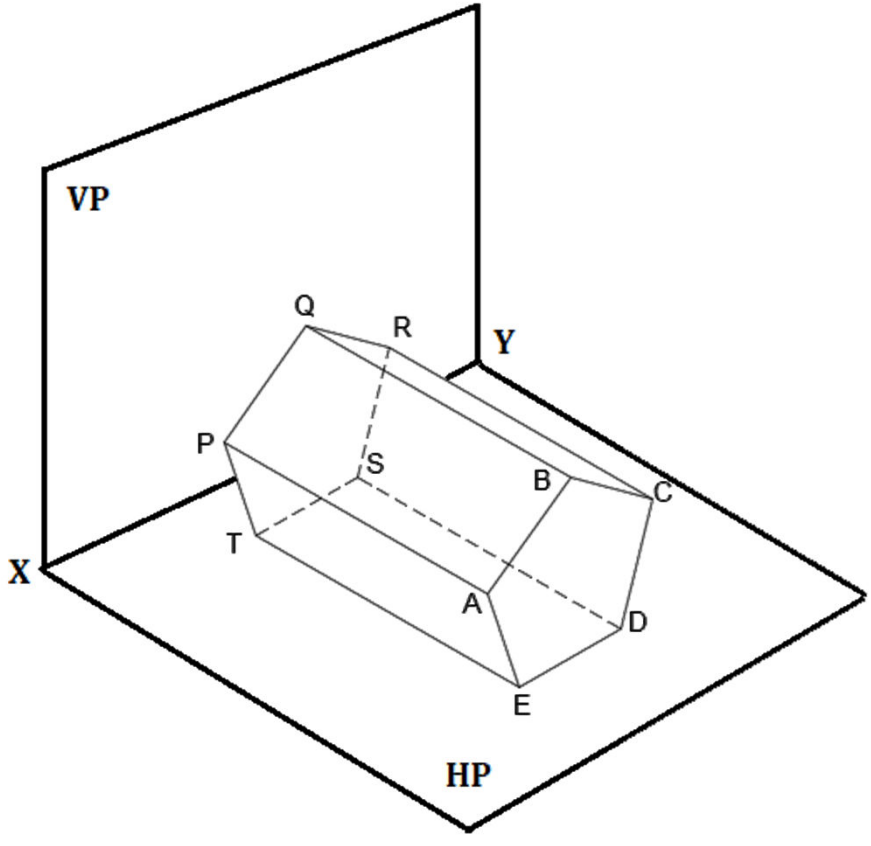
Q. **A Cone of base diameter 60 mm and height 70 mm is resting on HP on its base with its axis parallel to VP and perpendicular to HP. Draw its projections.**

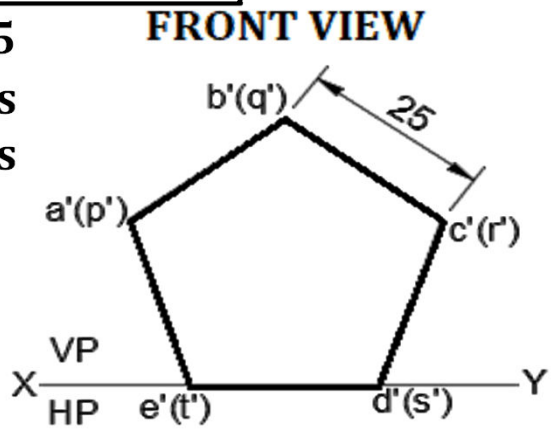


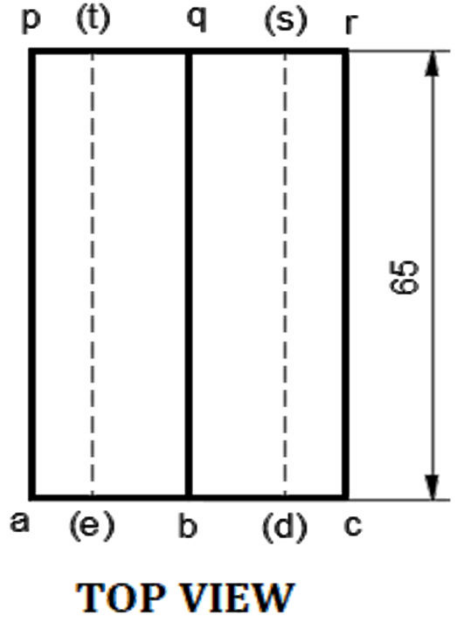


Numerical

Q. **A pentagonal prims of base side 25mm and height 65 mm is resting on HP on one of its rectangular faces with its axis parallel to HP and perpendicular to VP. Draw its projections.**







Projection of Solids – Exercise Problems

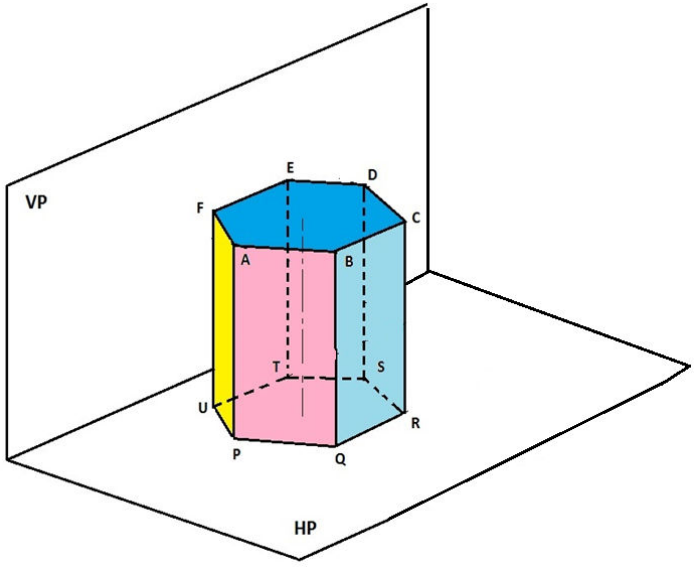
Q. A hexagonal pyramid of base side 20mm and height 65 mm is resting on H.P on its base with one of its base edges 30° inclined to V.P. The axis of the pyramid is parallel to V.P and perpendicular to H.P. Draw its projections.

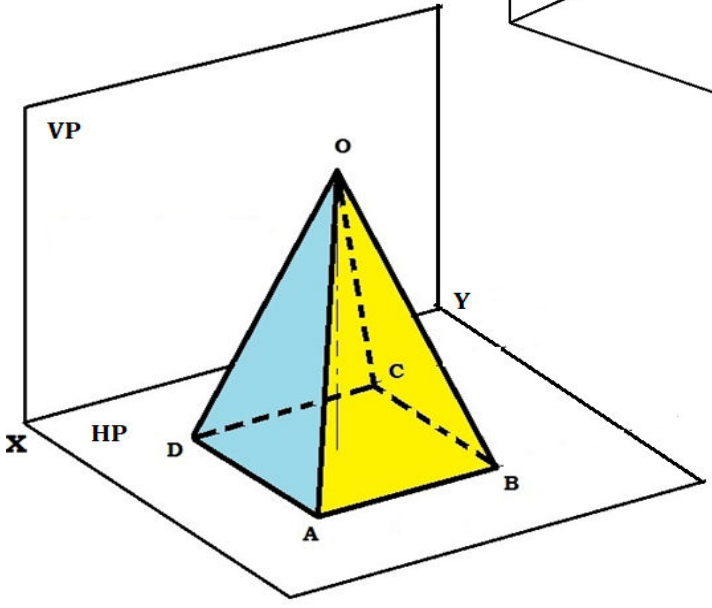
Q. A cylinder of diameter 65 mm and height 70 mm is resting on H.P on one of its generators with its axis parallel to H.P and perpendicular to V.P. Draw its projections.

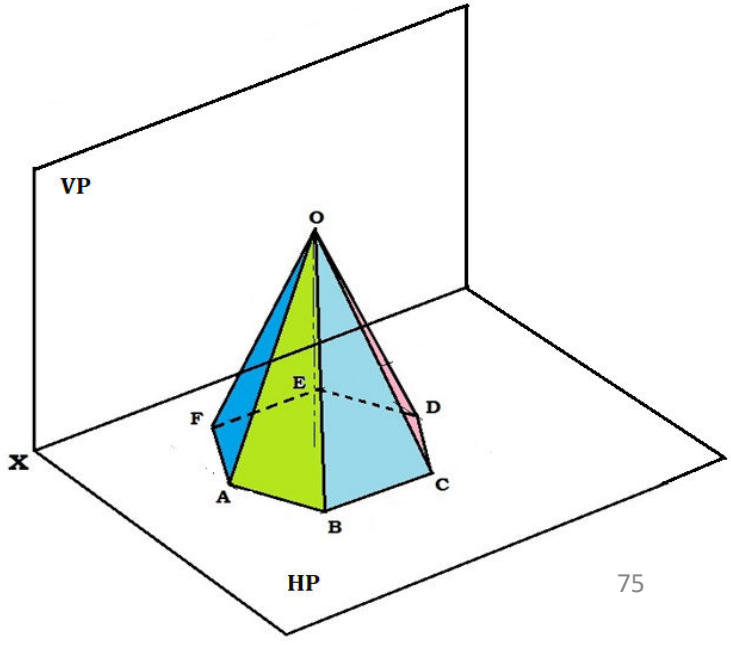
Q. A cube of side 40 mm is resting on HP on one of its square faces in such a way that two of its vertical faces are equally inclined to VP. The vertical edge nearer to VP is at a distance of 25 mm from it. Draw its projections.

Q. A square pyramid of base side 40 mm and height 60 mm is resting on HP one its base with one of its base edges 35° inclined to VP. The base corner nearer to VP is at a distance of 20 mm from it. Draw its projections.

Define the position of the solids resting in first quadrant.



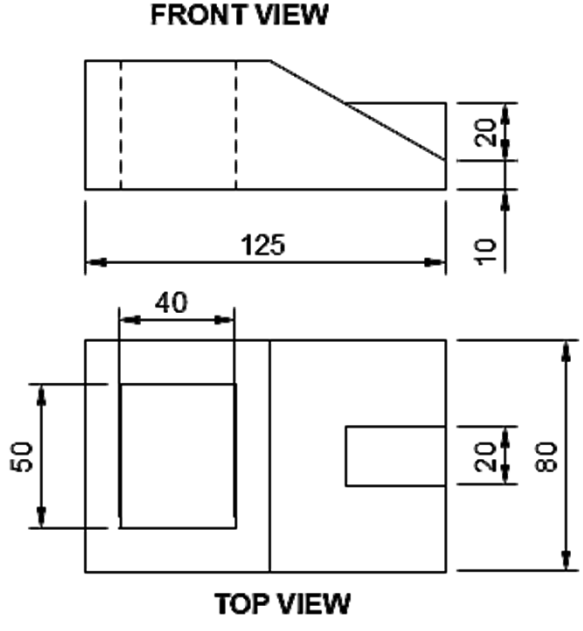


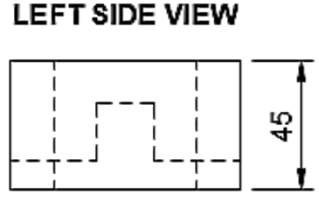


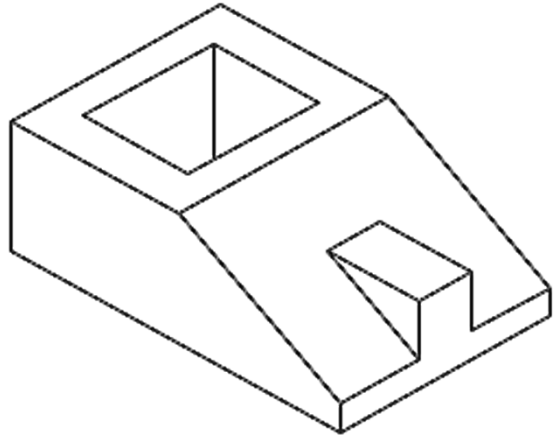
Isometric Projection

- Orthographic projection, including front, top, and side views, can be difficult to interpret as it requires good spatial imagination to visualize the object. However, it is essential for manufacturing, as it provides accurate dimensions and details for production.

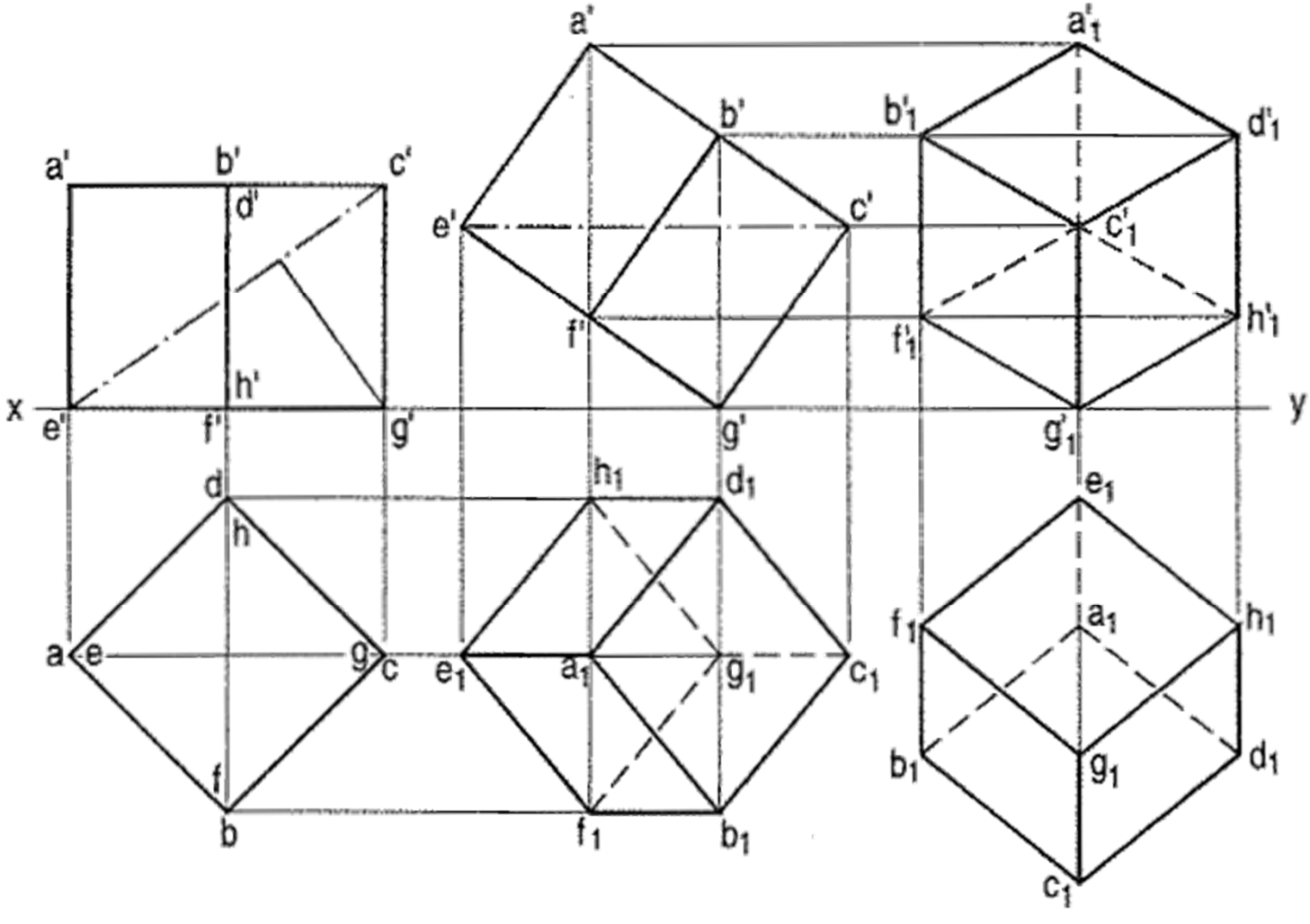
- In contrast, isometric projection is a three-dimensional pictorial view that shows all three dimensions in a single image. It helps in easily understanding the shape and structure of the object, making it useful for visualization.



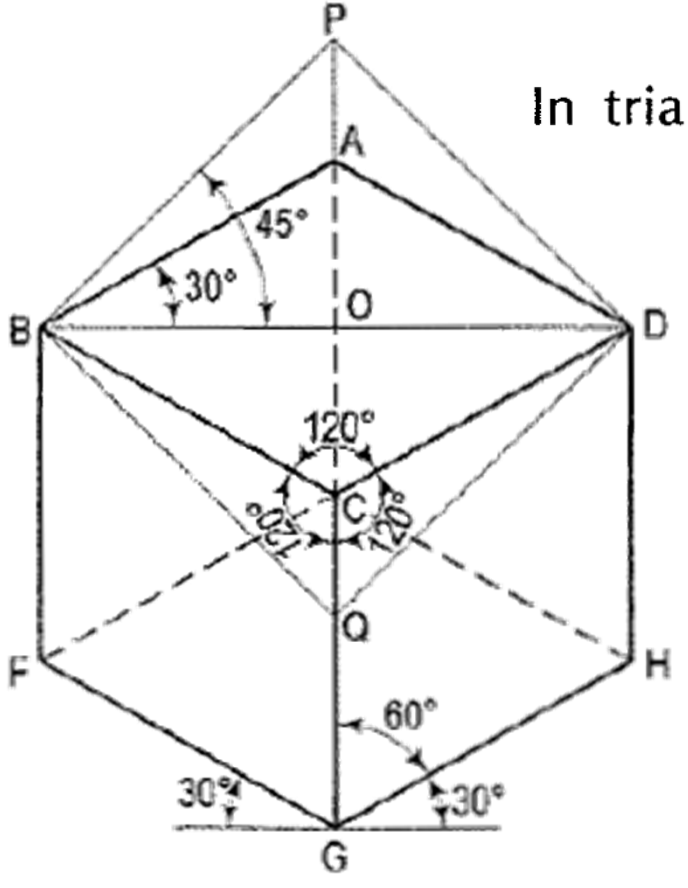




Isometric Projection of a Cube



Isometric Length & True Length Relation



In triangle ABO, $\frac{BA}{BO} = \frac{1}{\cos 30°} = \frac{2}{\sqrt{3}}$

In triangle PBO, $\frac{BP}{BO} = \frac{1}{\cos 45°} = \frac{\sqrt{2}}{1}$

$$\frac{BA}{BP} = \frac{2}{\sqrt{3}} \times \frac{1}{\sqrt{2}} = \frac{\sqrt{2}}{\sqrt{3}} = 0.815$$

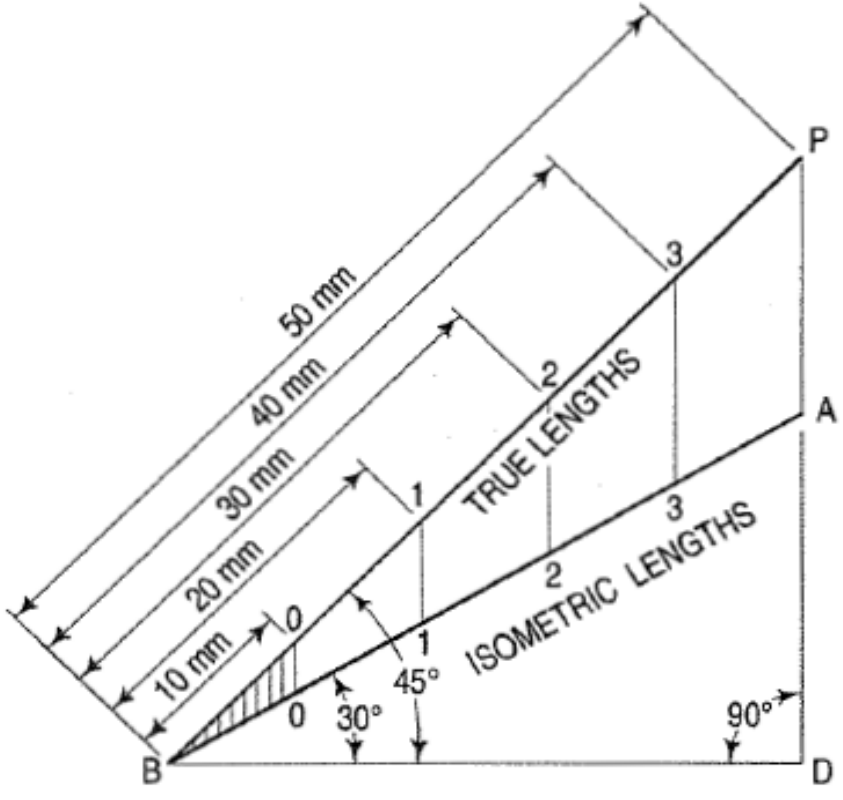
The ratio, $\frac{\text{isometric length}}{\text{true length}} = \frac{BA}{BP}$

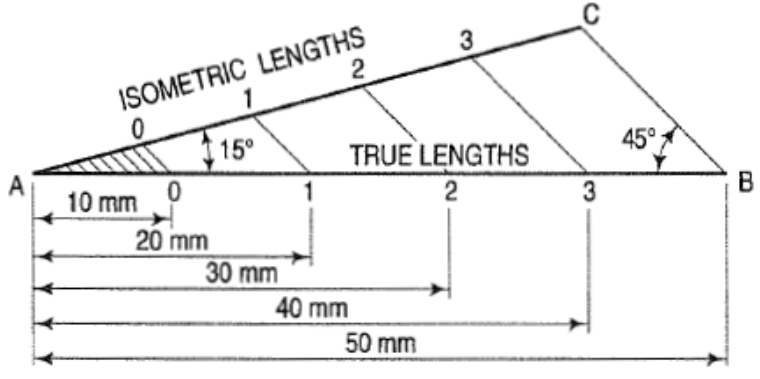
$$\frac{BA}{BP} = \frac{\sqrt{2}}{\sqrt{3}} = 0.815 \text{ or } \frac{9}{11}$$

Isometric Length & True Length Relation

- While drawing Isometric projection, it is necessary to convert true lengths into isometric lengths for measuring and marking the sizes.

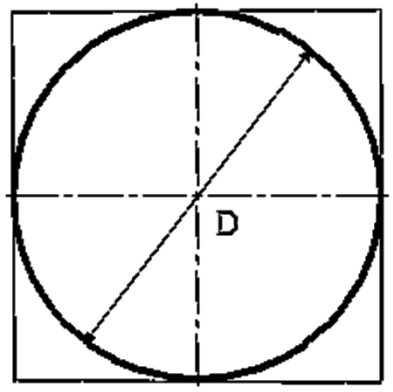
- This is conveniently done by constructing and make use of an isometric scale.



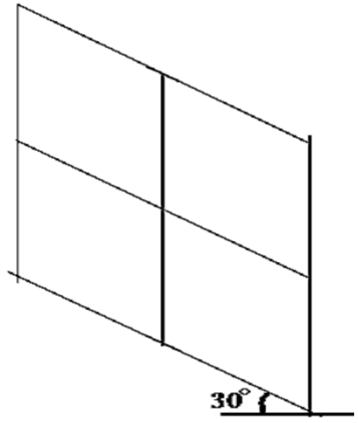


Isometric view of a circle

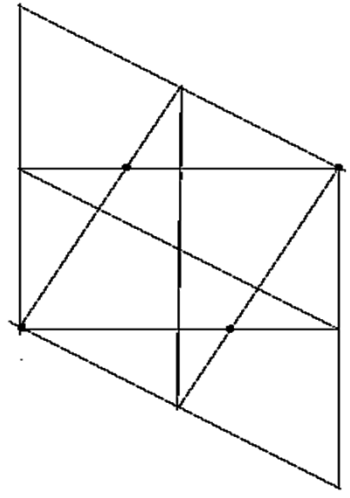
1



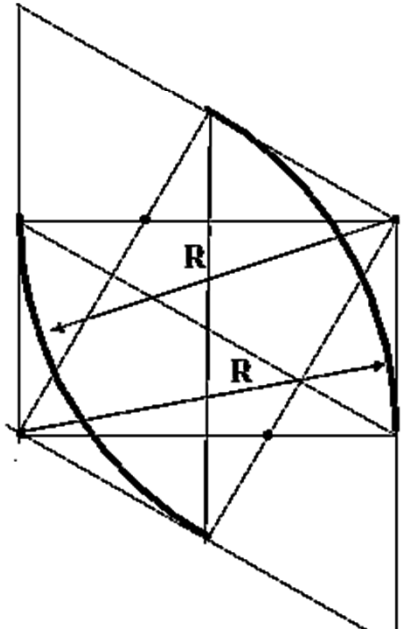
2



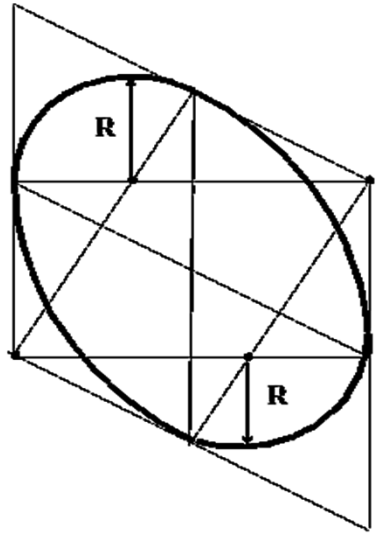
3



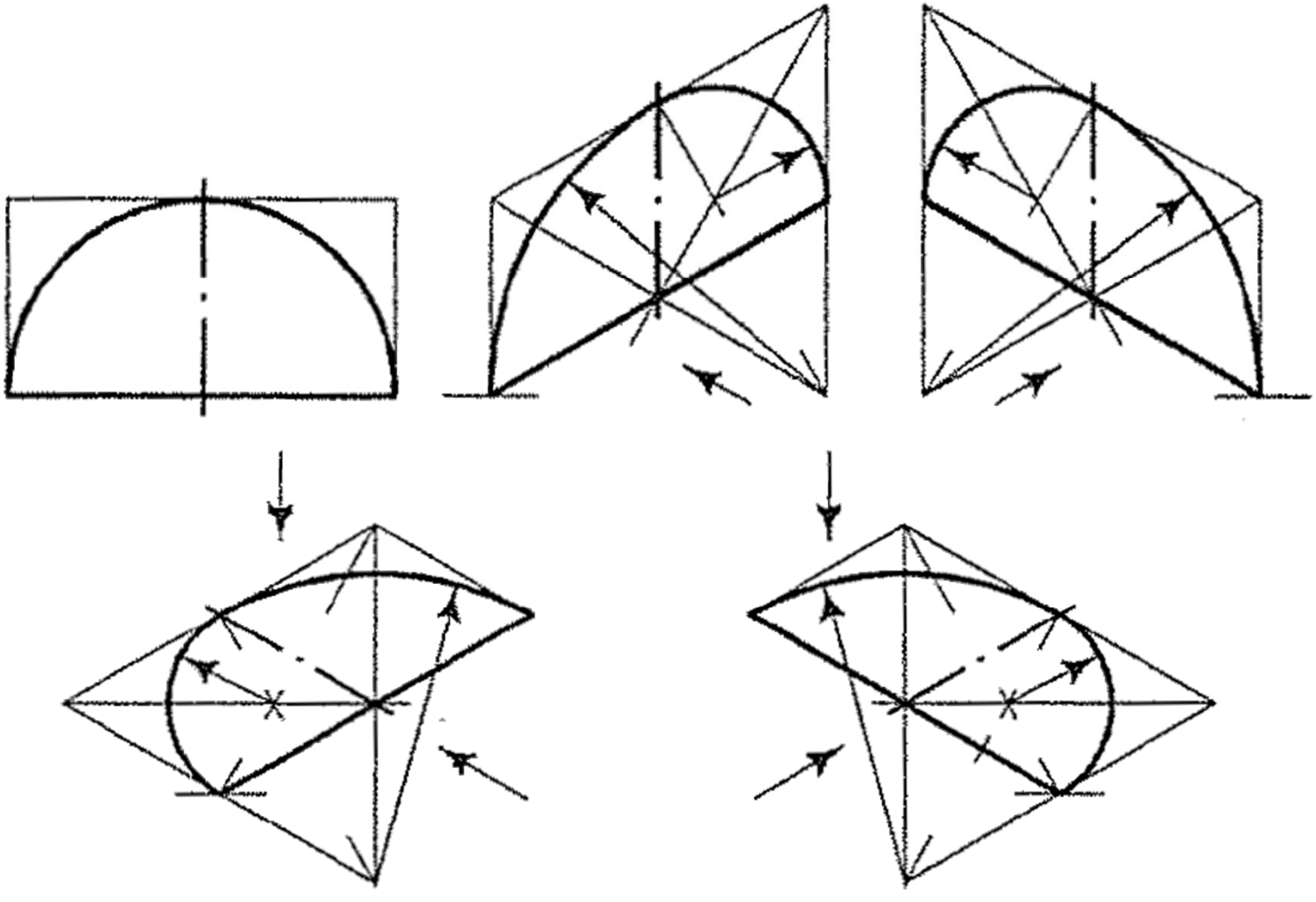
4



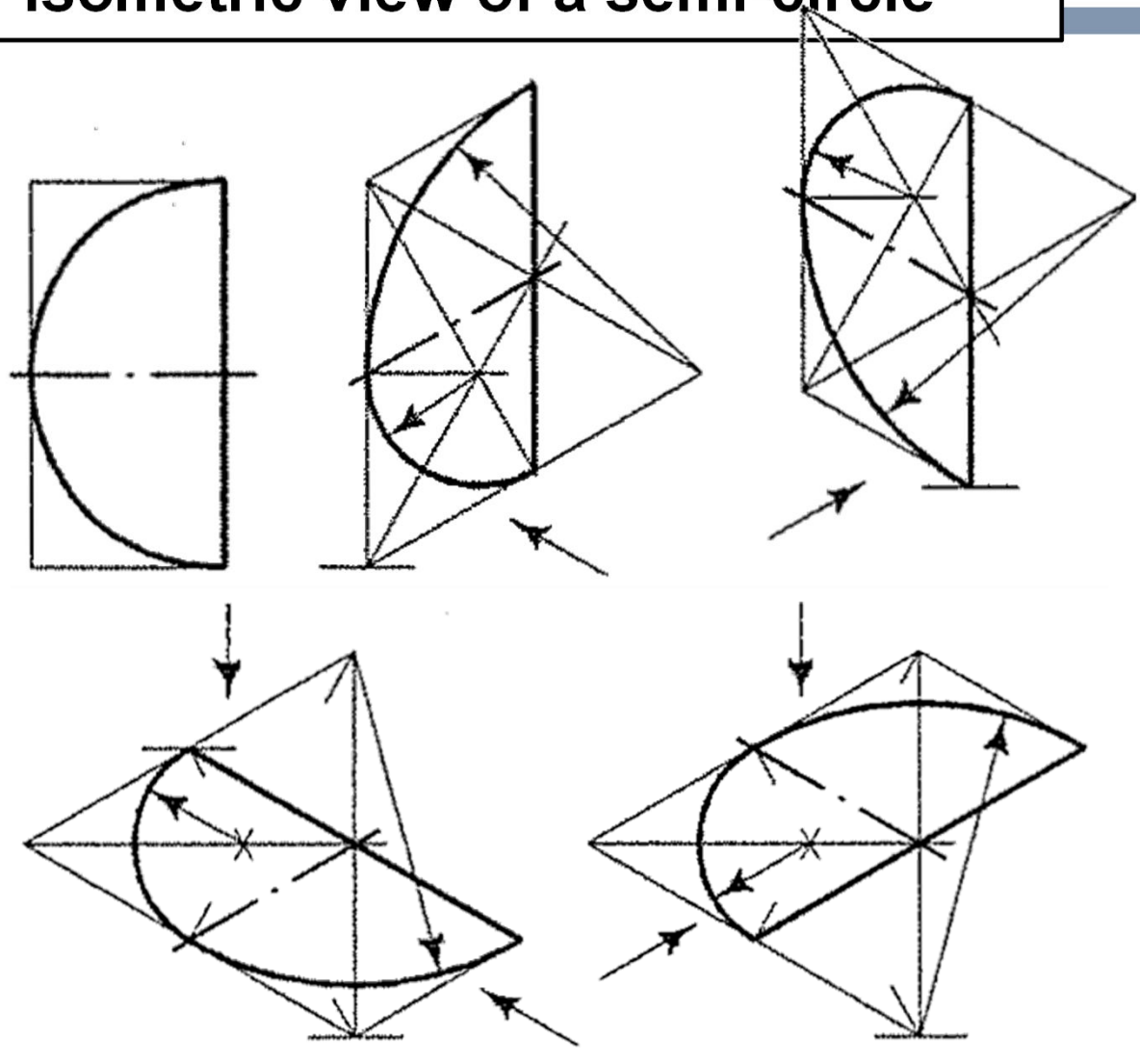
5



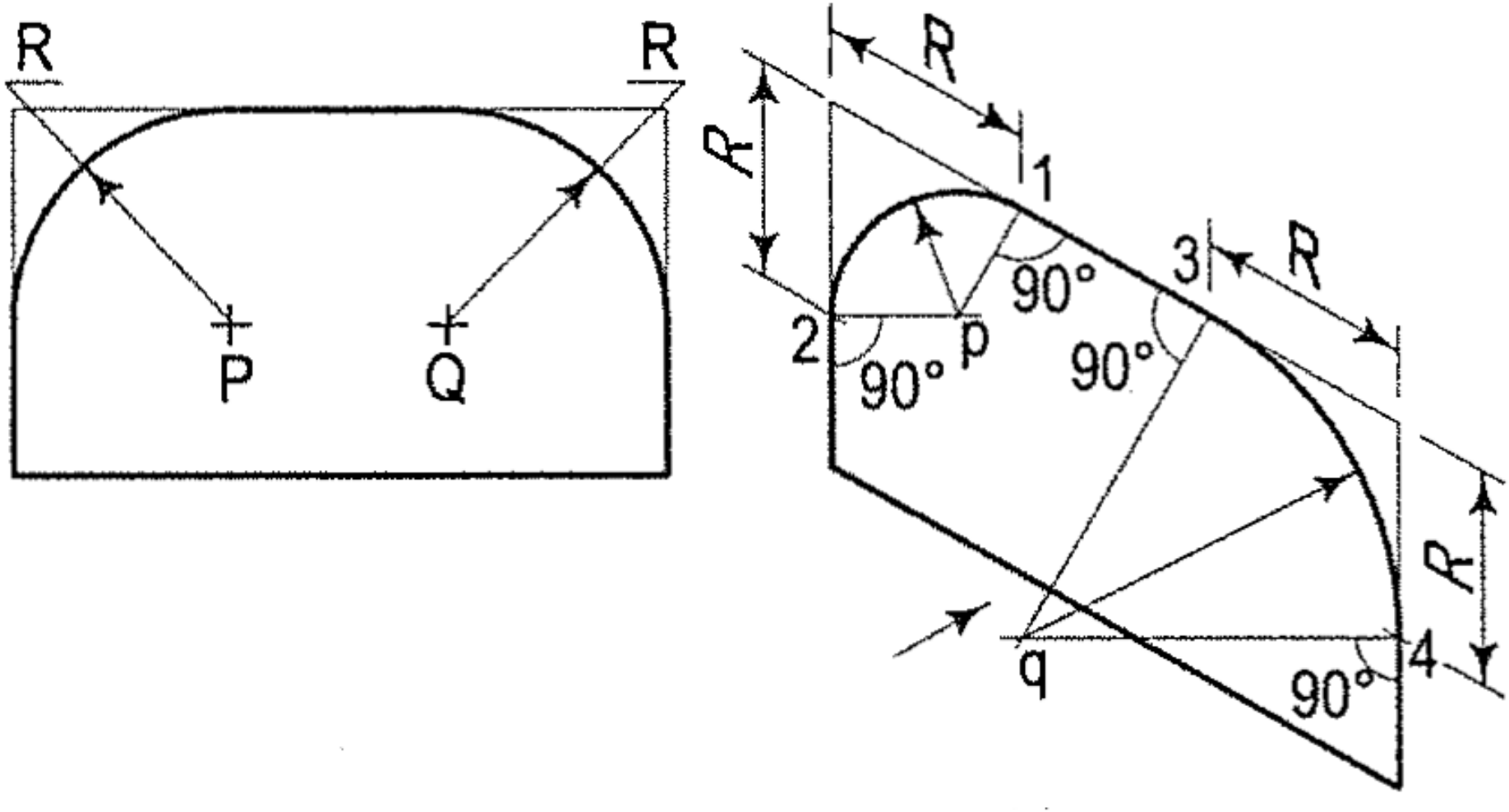
Isometric view of a semi-circle



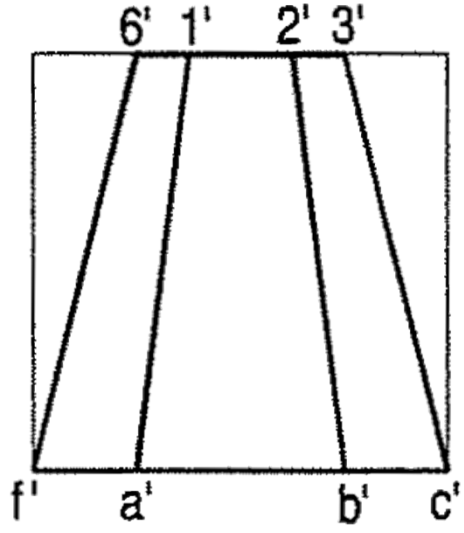
Isometric view of a semi-circle

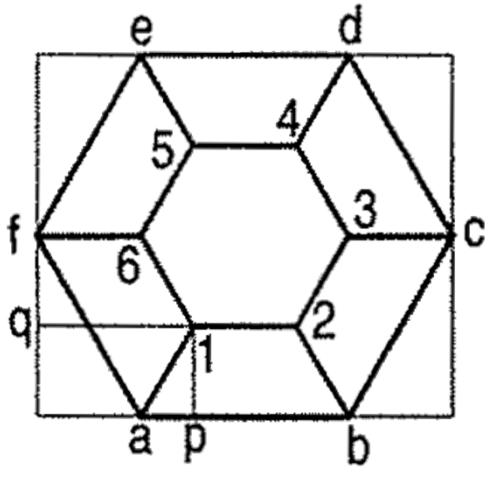


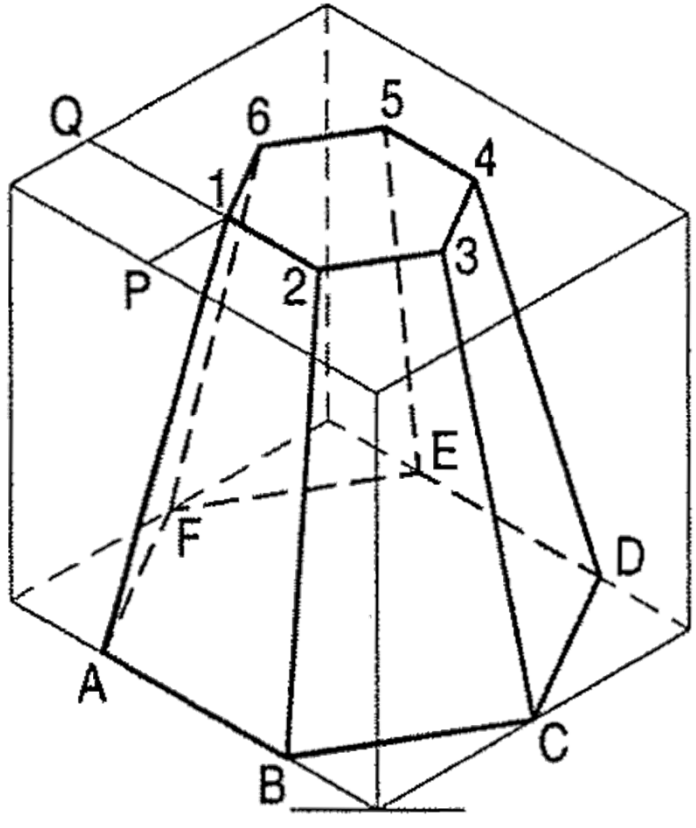
Isometric view of a semi-circle



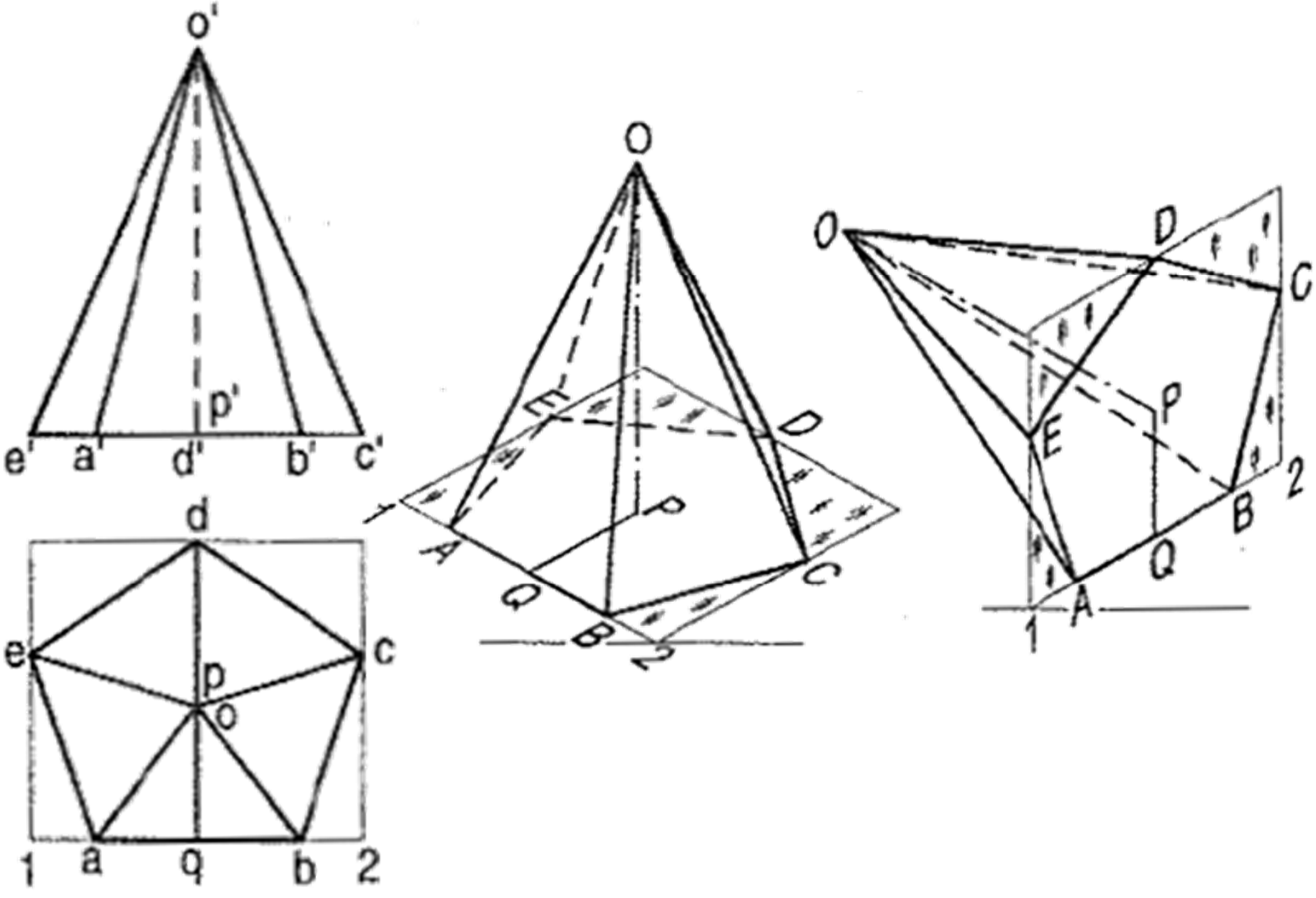
Isometric view of the frustum of a hexagonal pyramid



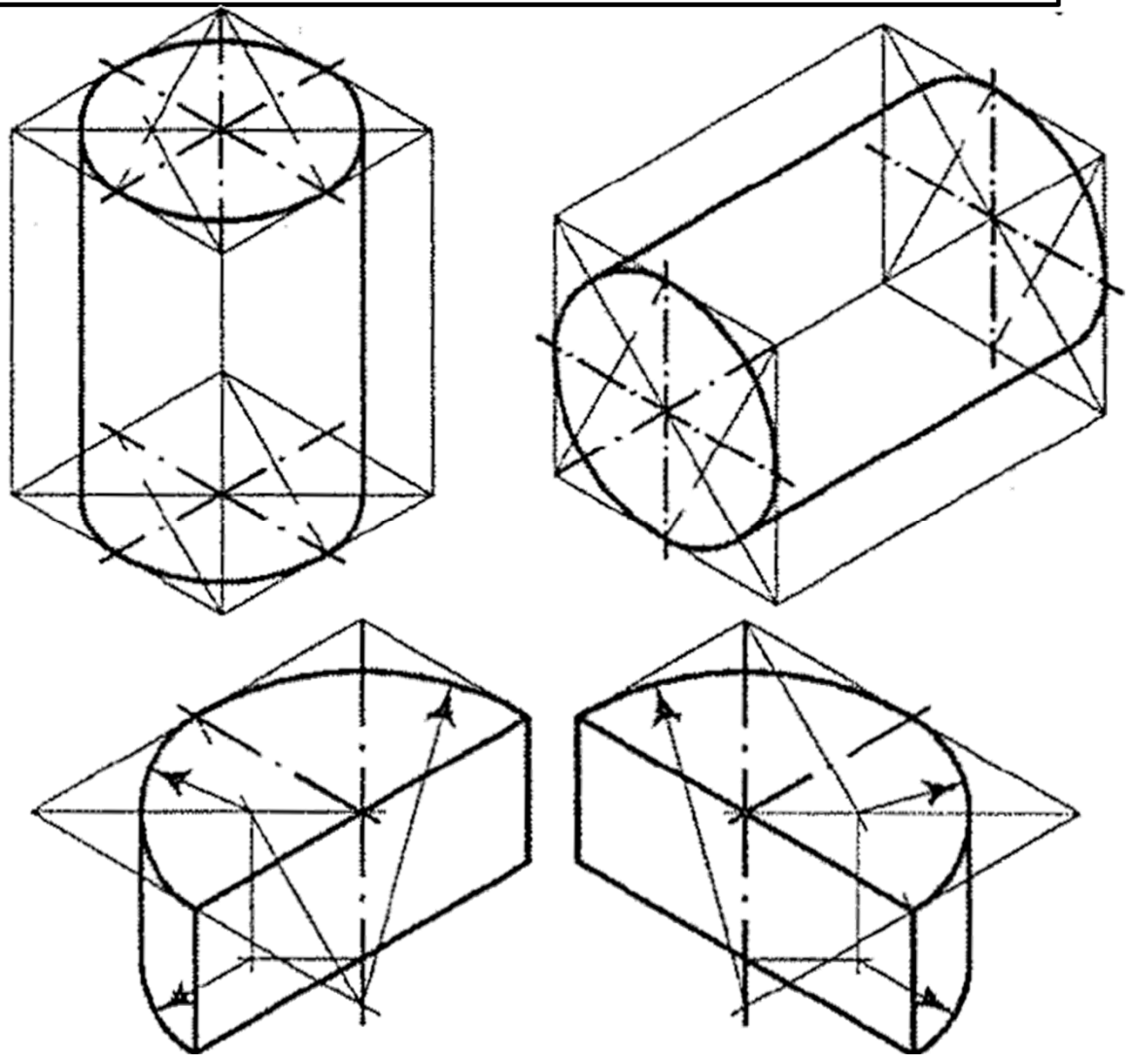




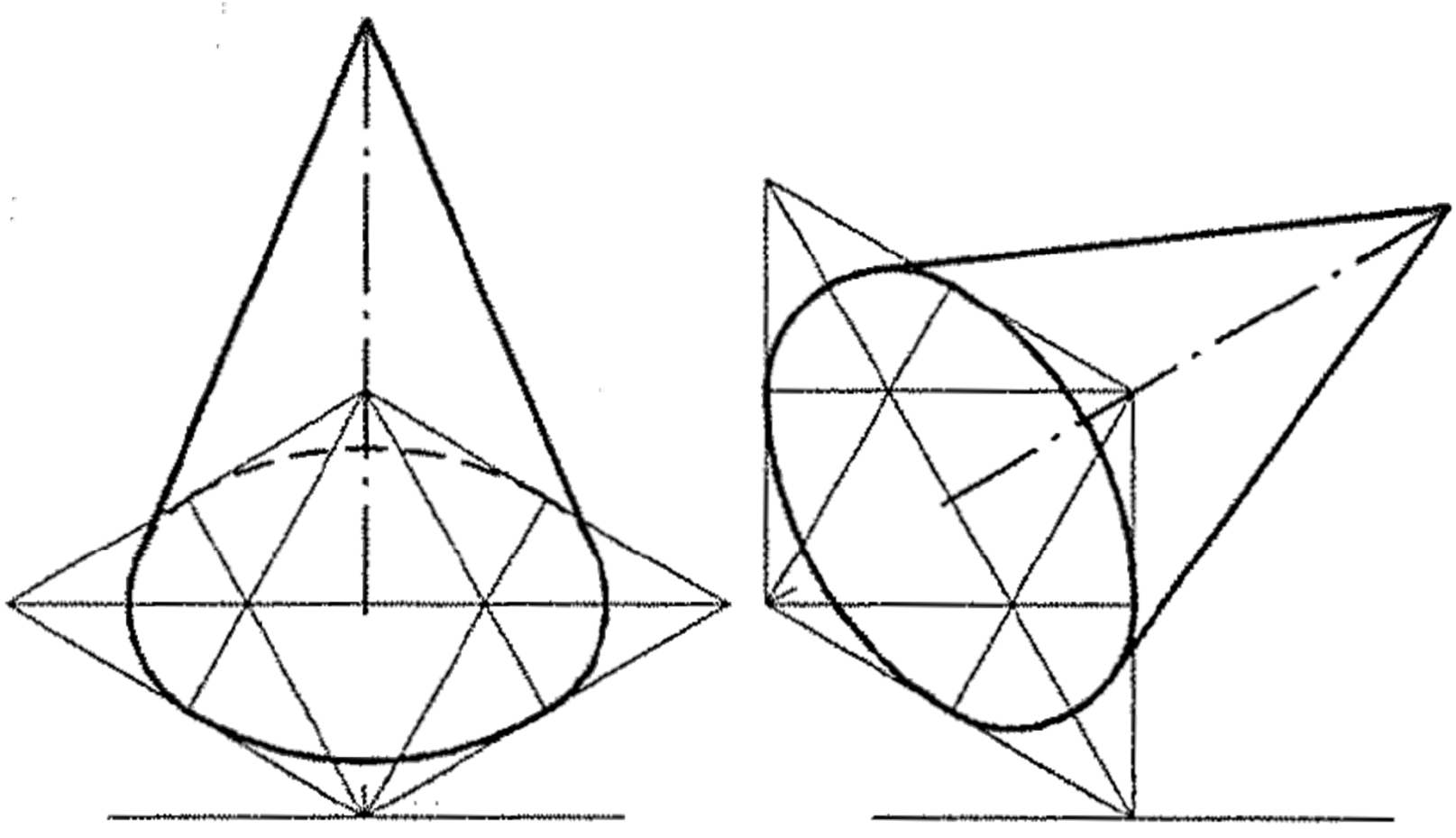
Isometric view of a pentagonal pyramid



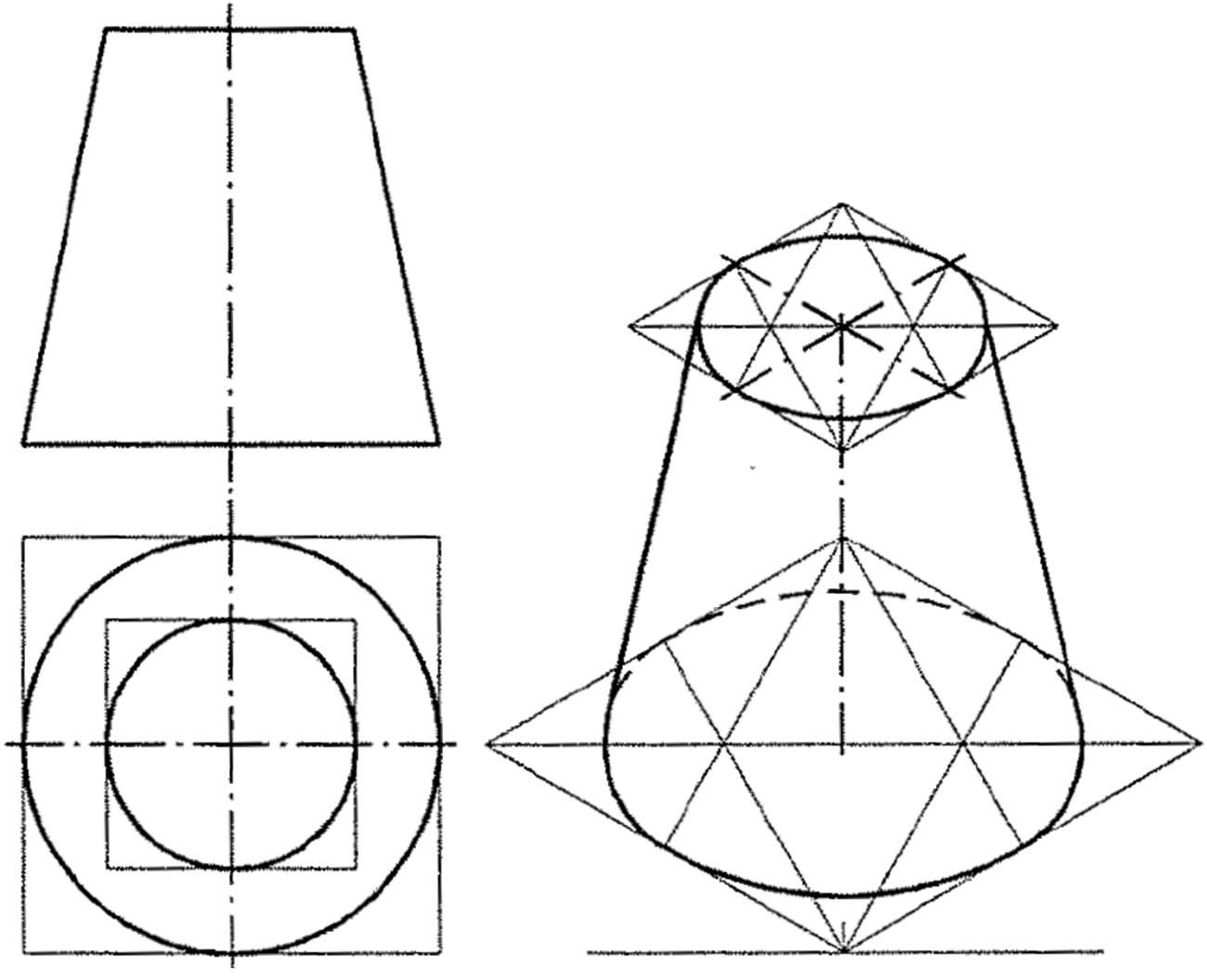
Isometric view of the cylinder and semi-circular disc



Isometric view of the cone



Isometric view of the frustum of a cone



Orthographic projection