Rao Badhur Y Mahabaleshwarappa Engineering College (RYMEC)

(Formerly , Vijayanagara Engineering College (VEC), Ballari)

WELCOME

To

CHITRIKI ACADEMY

On

ENGINEERING DRAWING

By

Dr. Chitriki Thotappa.

Professor, Department of Mechanical Engineering.

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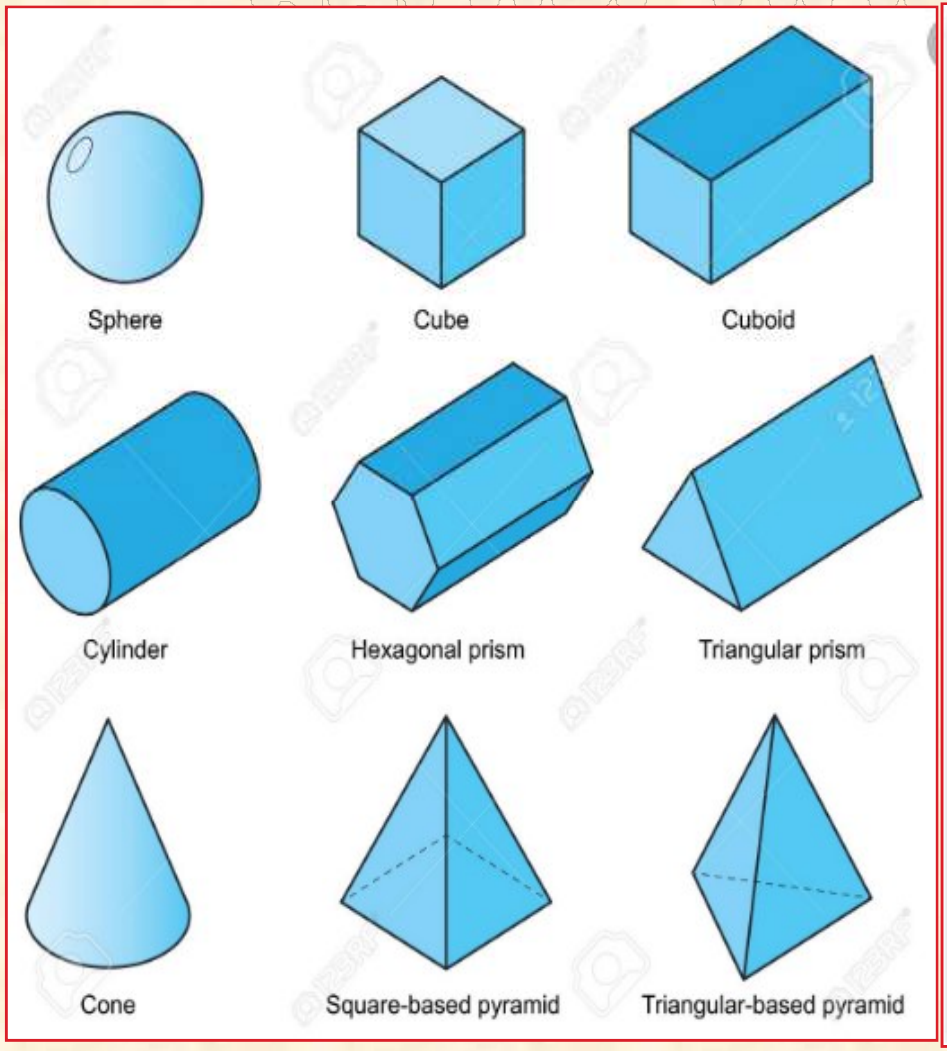
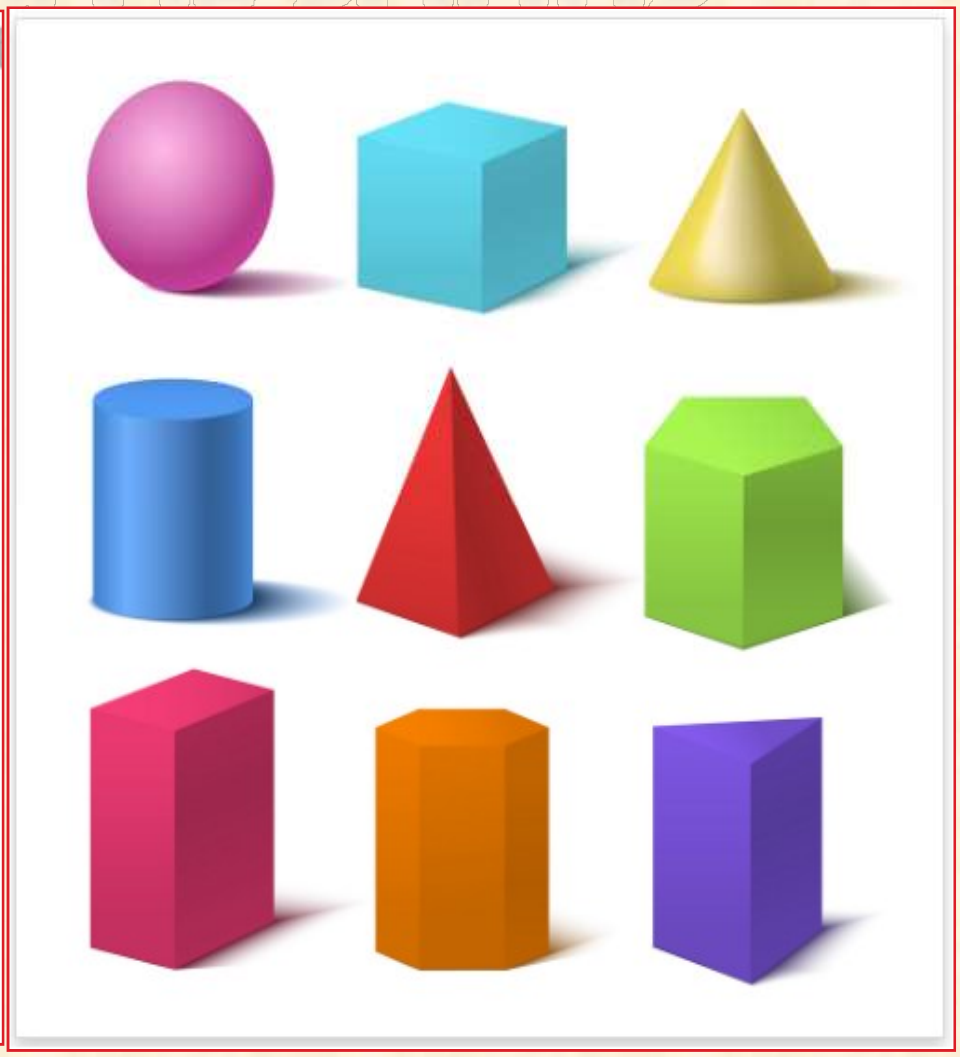
PROJECTION OF SOLIDS





INTRODUCTION TO SOLIDS

SOLID is a 3 dimensional (3D) object having all the 3 - dimensions like length, breadth and height / Thickness.

Solid is bounded by either flat/plane surfaces, curved surfaces and combination of curved and flat surface (Both).

Example

1. Bounded by flat surfaces – Eg. Prism and pyramid

2. Bounded by curved surfaces – Eg. Sphere

3. Bounded by both curved and flat surfaces – Eg. Cone and Cylinder

Types of geometrical solids.

1. Polyhedron – a) Regular Polyhedron b) Other Polyhedron

2. Solids of revolution/Rotation.

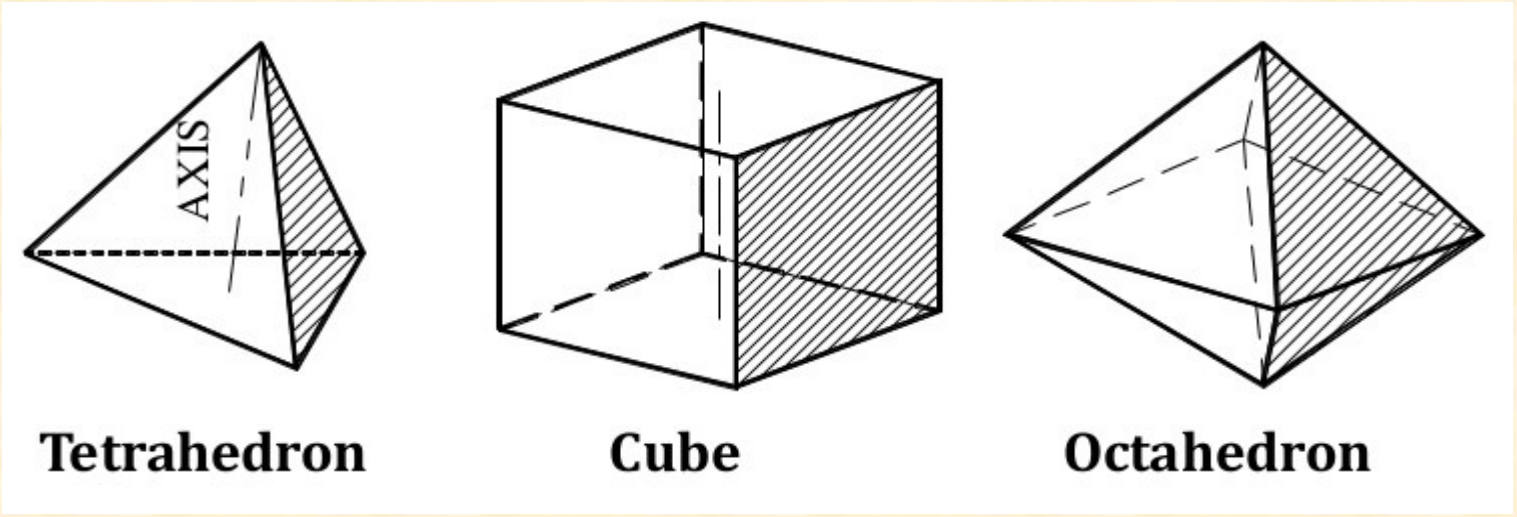
Polyhedrons – Polyhedrons are solids bounded by only flat surfaces.

Polyhedrons are of 2 types :

a) **Regular Polyhedron:** Is a type of polyhedron bounded by only flat surfaces with identical / same shape and size flat surfaces.

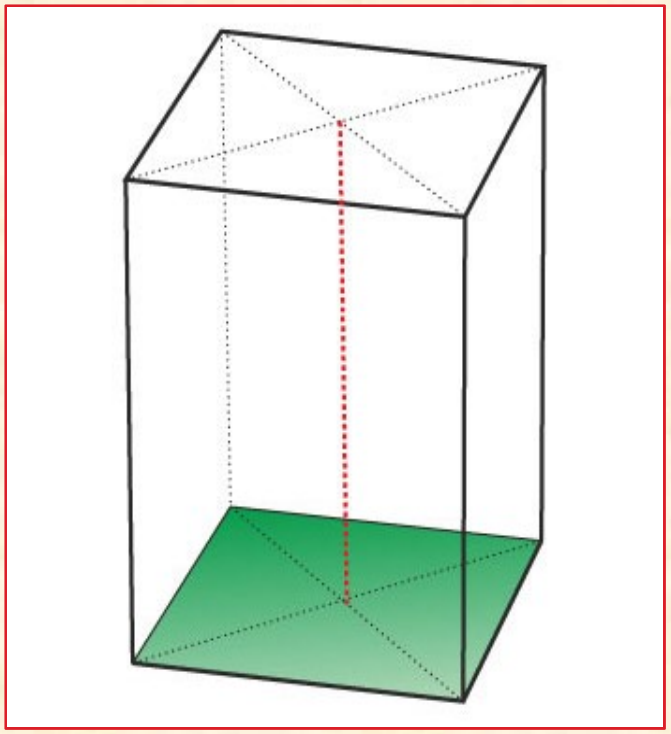
Example for Regular Polyhedron :

1. Tetrahedron - 4 equilateral triangular surfaces / faces of same size.
2. Hexahedron or Cube - 6 square faces of same size.
3. Octahedron – 8 equilateral triangular faces of same size.

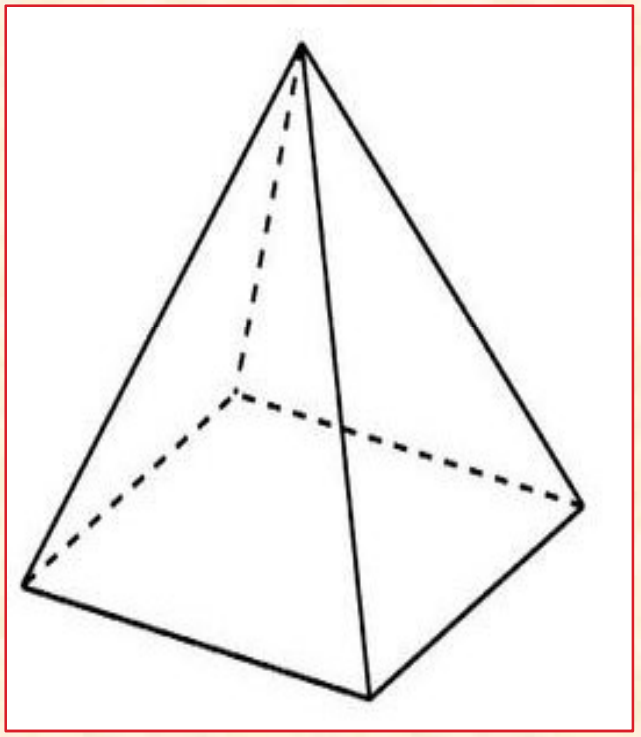


b) Other Polyhedrons: **Is a type of polyhedron bounded by only flat surfaces.**

Example for Other Polyhedron: **1. Prisms** **2. Pyramids.**



Square Prism



Square Pyramid

PRISMS: It is a Polyhedron bounded by only flat surfaces and it consists of 2 parallel and identical end surfaces/faces. And sides/edges of these end faces/surfaces are connected by rectangular surfaces (lateral surfaces).

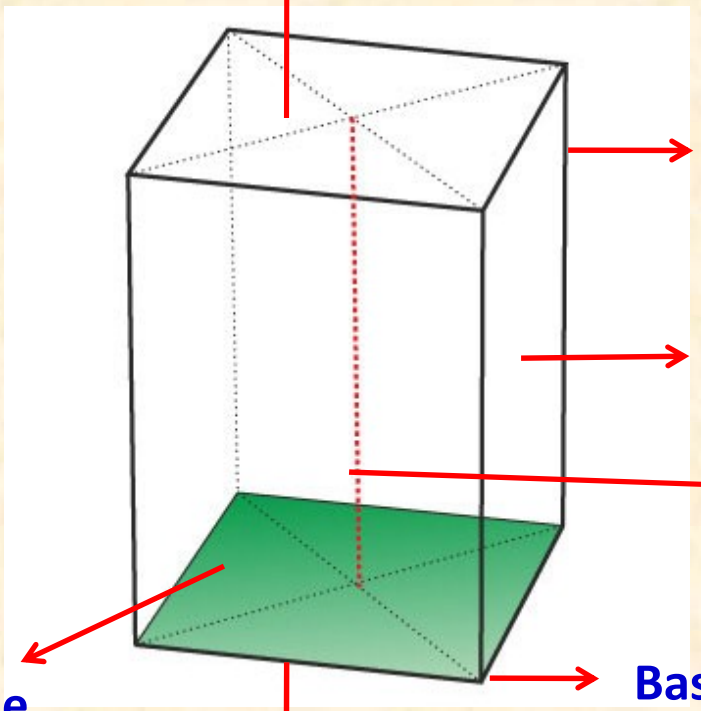
Parts of the Prism:

- **Lateral edges:** Longer edges of rectangular surface in the Prisms are called Lateral Edges.
- **Lateral surfaces/Faces:** They are the Rectangular surface connecting the base edge and opposite top face edge.
- **Base edges/sides.**
- **Base and Top face.**
- **Base corners and Top face corners.**
- **Axis :** It is a imaginary line passing through the centre of the two end faces.

SQUARE PRISM

Square Prism consists of following parts like - Square Face, Edges/Sides, Corners, Lateral Edges, Lateral Rectangular face, Axis.

- 2- Square Faces
- 4 - Rectangular Faces
- 4 – Lateral Edges/Sides
- 4 - Base Edges/Sides
- 4 – Base Corners
- 4 – Top Face Edges/Sides
- 4 – Top Face Corners
- 1 - Axis

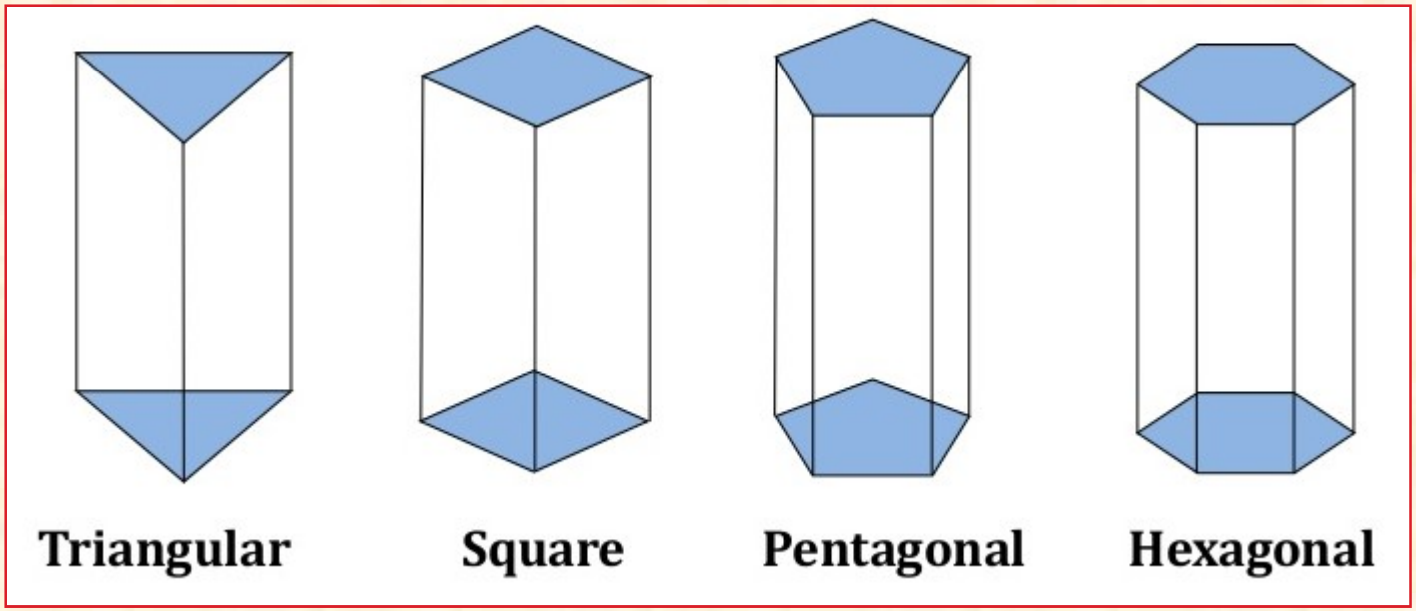


- **Axis of the Prism is always perpendicular to base or end faces and parallel to lateral edges.**

Types of Prisms:

Based on the shape of the prism base, Prisms are of different types.

1. Triangular Prism 2. Square Prism 3. Rectangular Prism 4. Pentagonal Prism.
5. Hexagonal Prism.



Solids having top and base of same shape

PYRAMIDS: **It is also a type of Polyhedron bounded by only flat surface, it consists of a base and a Apex (Vertex), each base edge/side and Apex are connected by triangular face called Slant triangular face.**

Parts of the Pyramid:

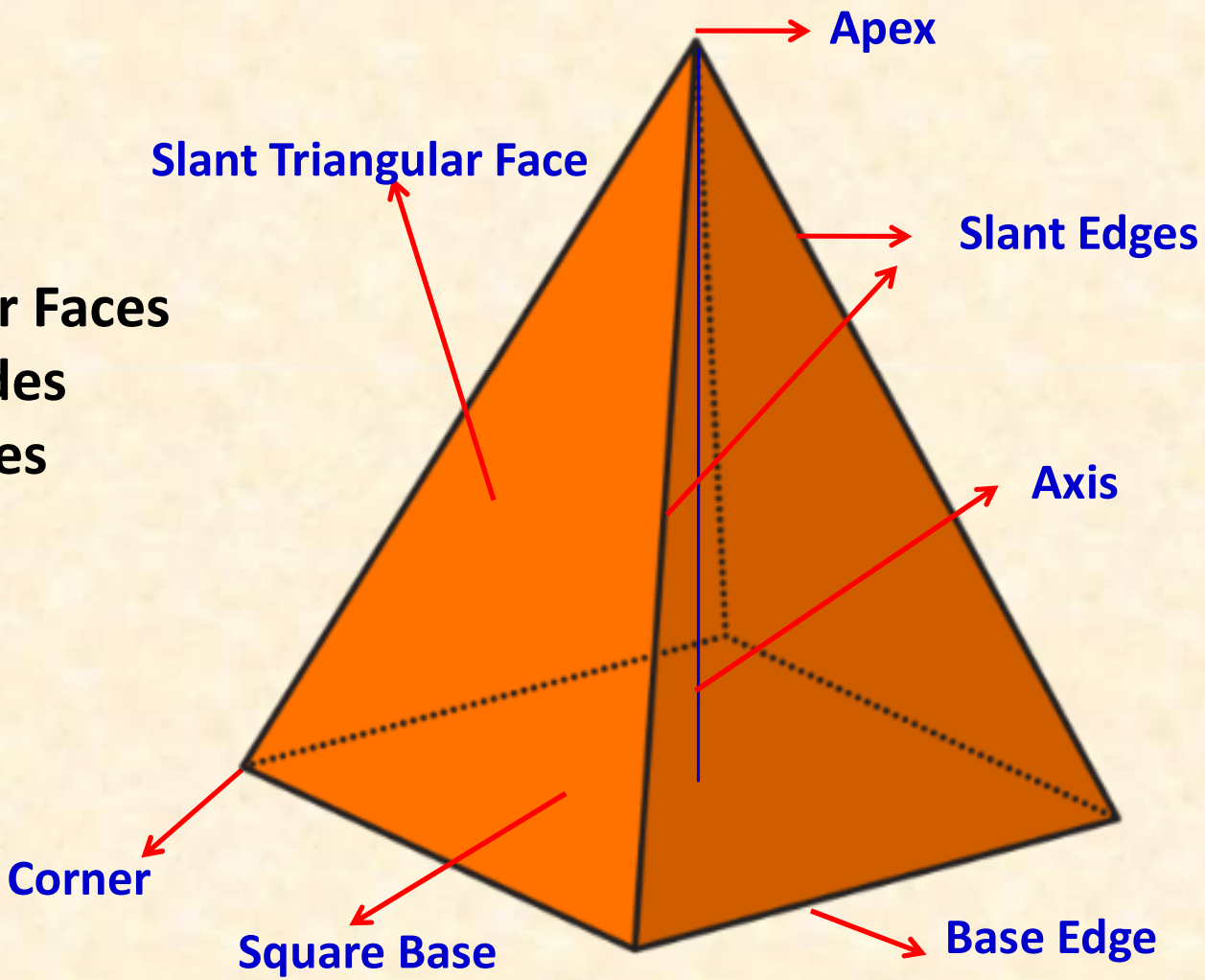
- **Slant edge:** Line joining the base corner and Apex are called Slant Edges.
- **Slant surface/Face:** They are the Slant triangular face/surface connecting the base edge and the Apex.
- **Base.**
- **Base edges/sides.**
- **Base corners.**
- **Apex :** All slant edges from various base corners touches at one point at the top the pyramid called Apex.
- **Axis :** It is a imaginary line passing through the centre of the base and the Apex.

Axis of the Pyramid is always perpendicular to base and inclined to slant edges.

SQUARE PYRAMID

SQUARE PYRAMID consists of following parts like - Square Base, Base Edges/Sides, Base Corners, Slant Edges, Slant triangular face, Apex & Axis.

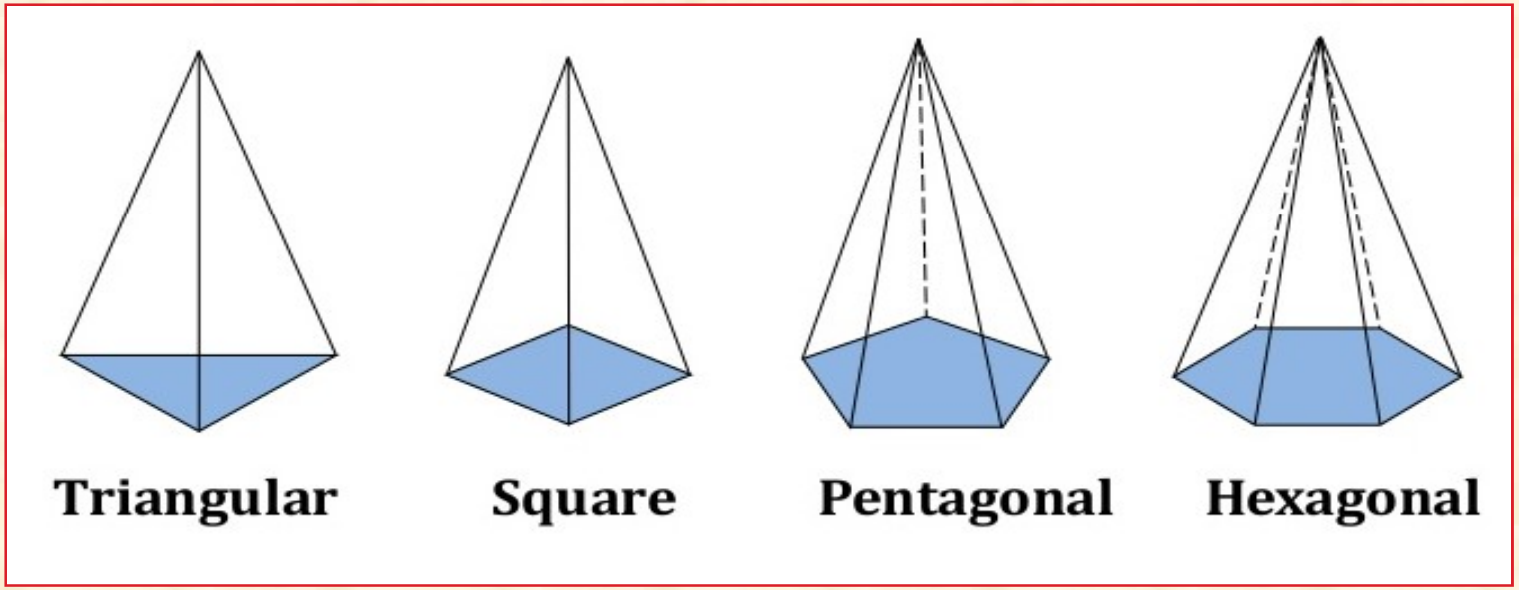
1- Square Base
4 – Slant Triangular Faces
4 – Slant Edges/Sides
4 - Base Edges/Sides
4 – Base Corners
1– Apex
1 - Axis



Types of Pyramids:

Based on the shape of the pyramid base, Pyramids are of different types.

1. Triangular Pyramid. 2. Square Pyramid. 3. Rectangular Pyramid.
4. Pentagonal Pyramid. 5. Hexagonal Pyramid.



Solids having base of some shape and just a point as a top, called apex.

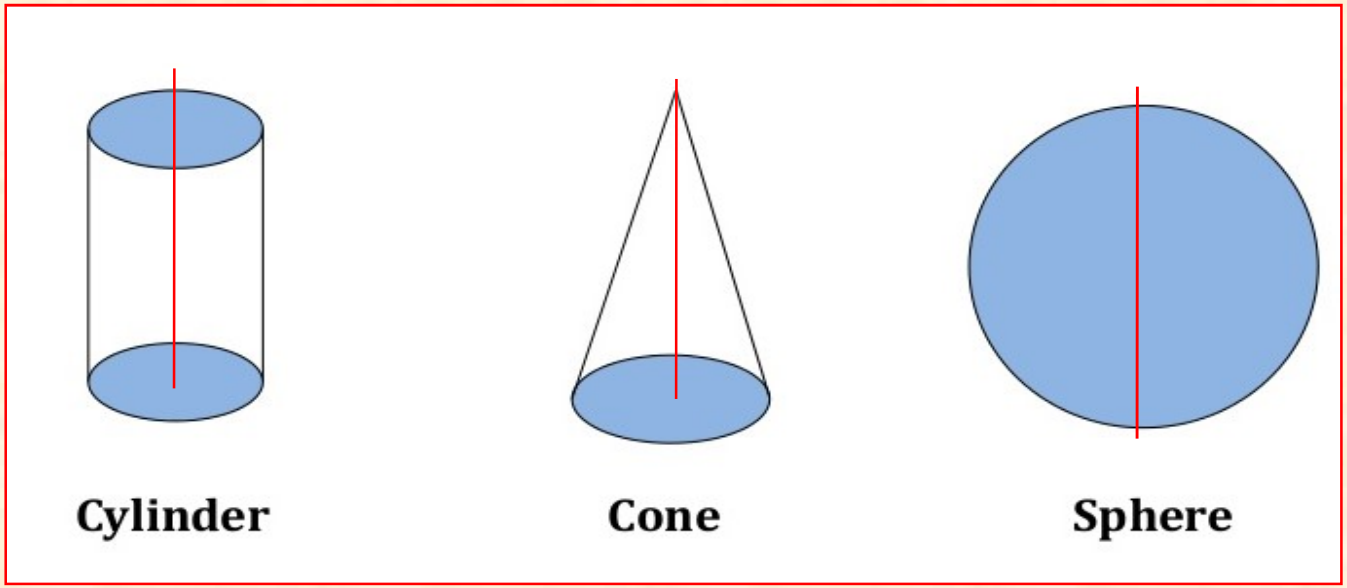
Solids of Rotation / Revolution :

Solids formed or generated by revolving / rotating plane surfaces /Laminas

About a fixed line (Axis) are called Solids of Rotation / Revolution.

Example for Solids of Rotation.

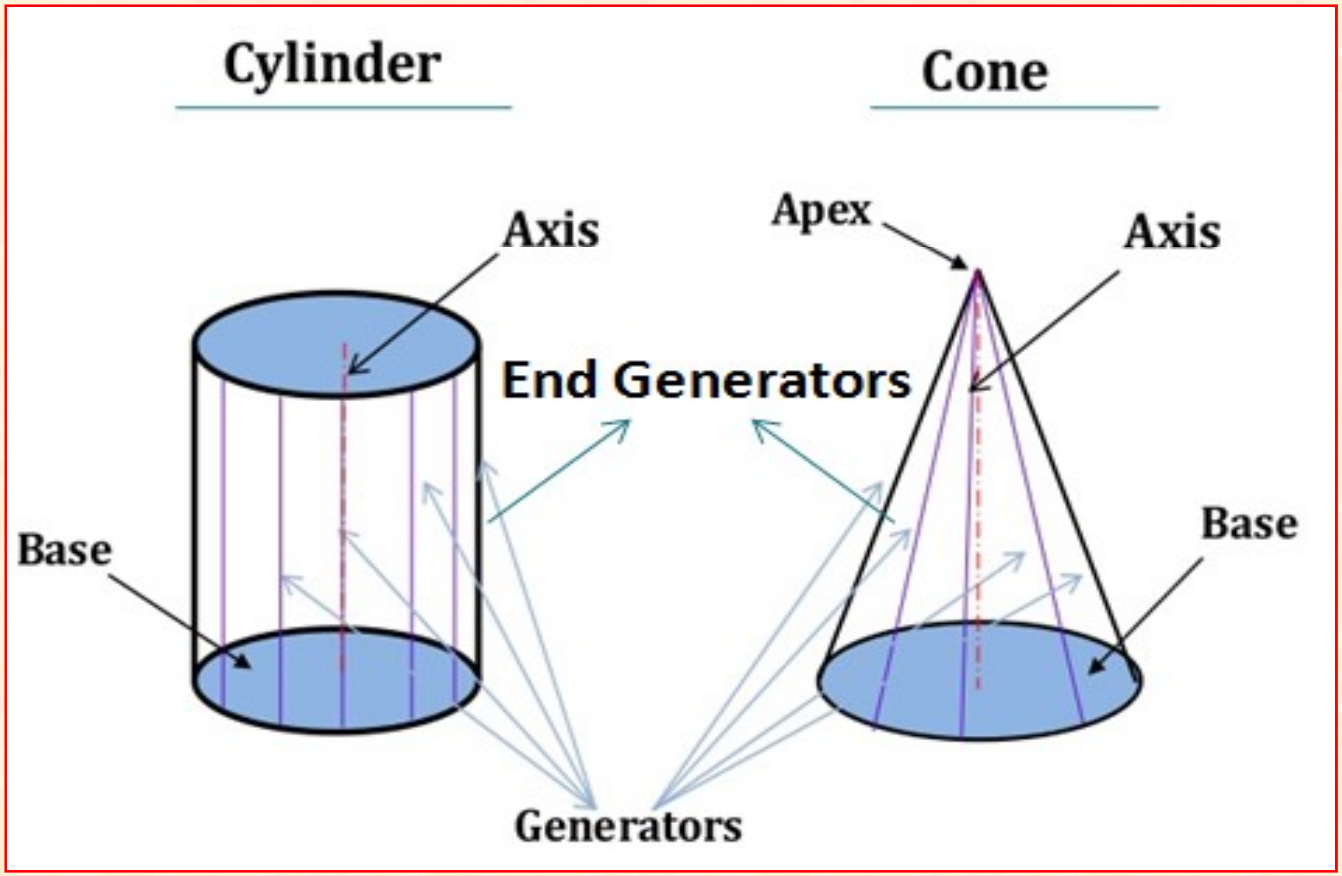
1. **Cone - Generated by rotating Triangular (Right triangular) plane surface.**
2. **Cylinder – Generated by rotating Rectangular lamina / Plane surface.**
3. **Sphere – Generated by rotating Circular or Semi-circular lamina.**



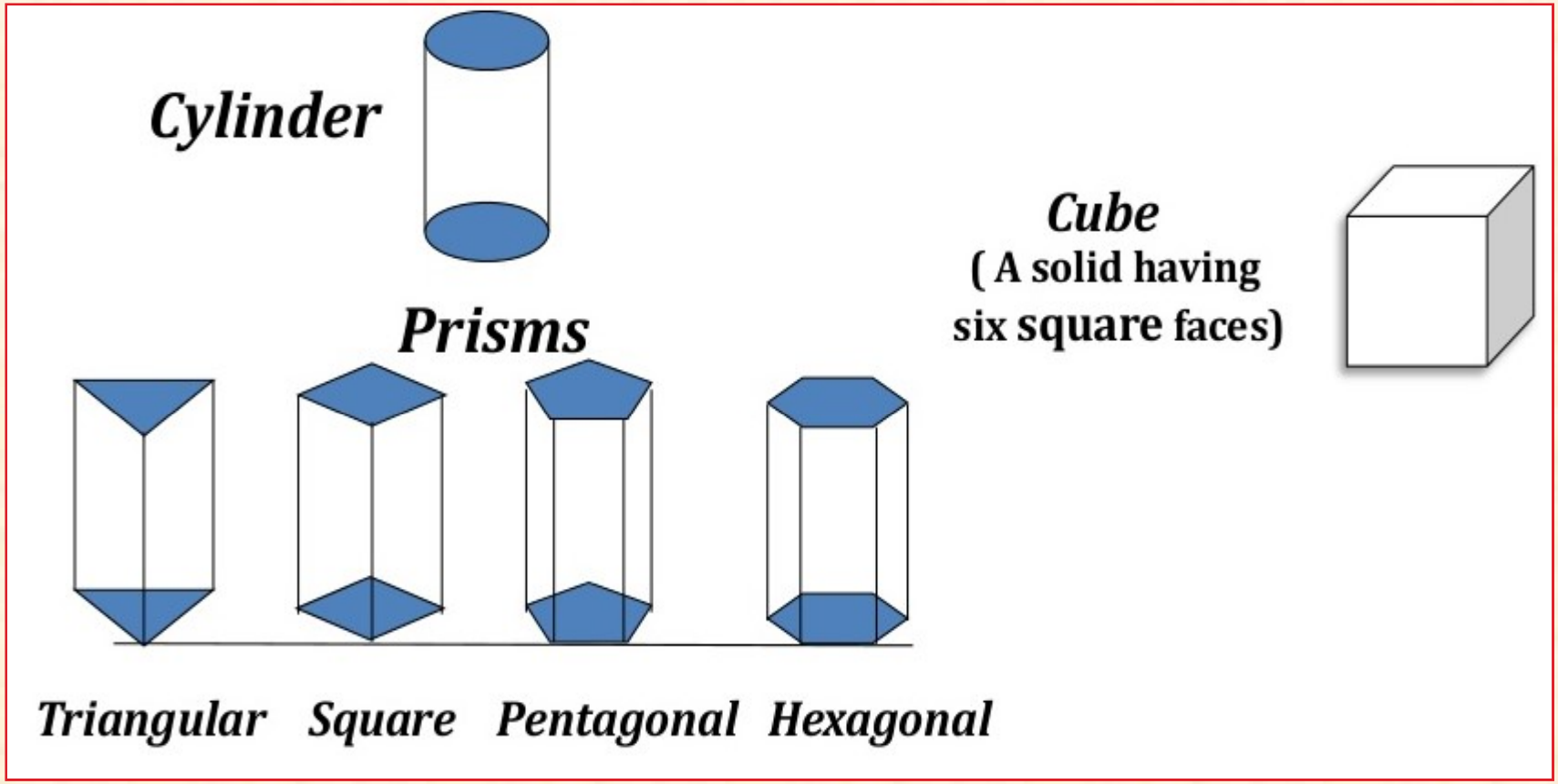
Parts of Solids of Rotation.

1. **Cone** – Apex, Generators, Base and Axis.
2. **Cylinder** - Generators, Base, Top face, Axis.
3. **Sphere** - Generators, Axis.

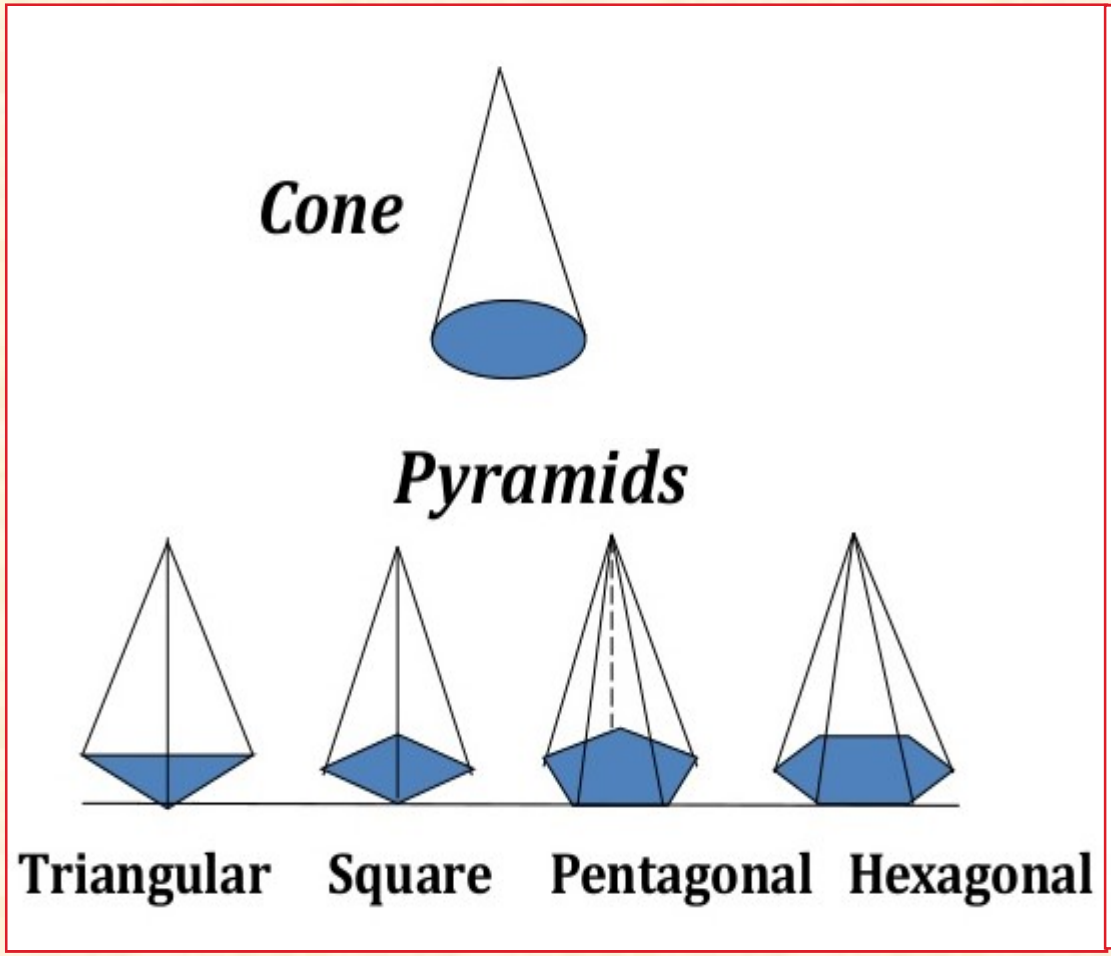
Generators: Imaginary lines generating curved surface of the Cylinder, Cone and Sphere.

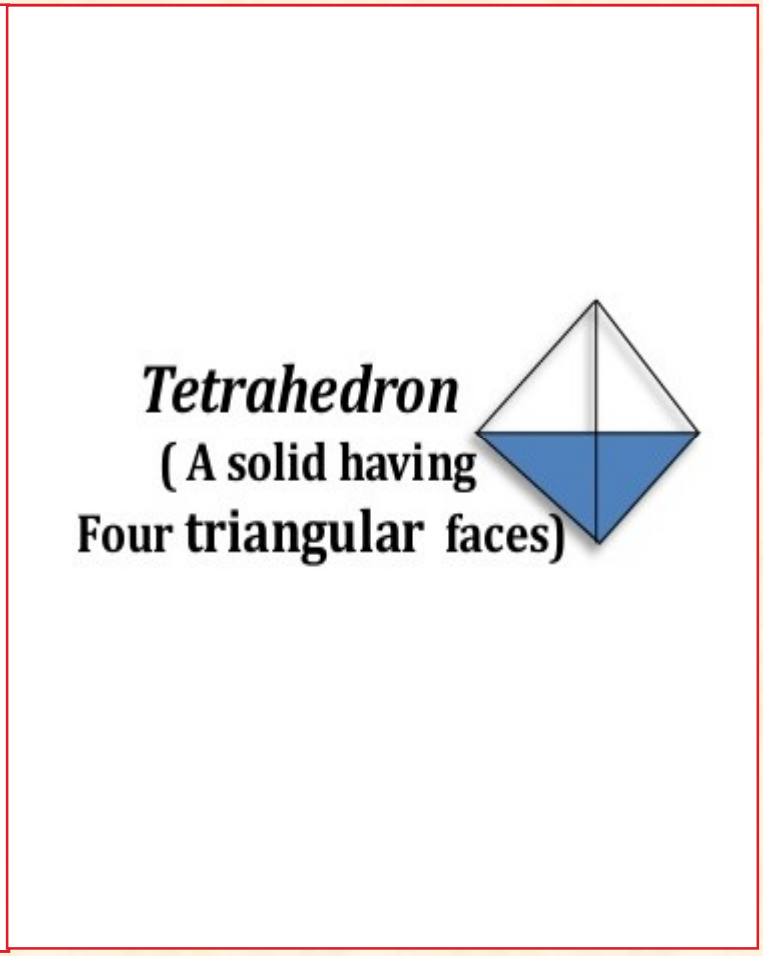


The following Solids have top face and base of same shape.



The following Solids have base of some shape and Just as a point on its Top called Apex.





PROJECTION OF SOLIDS

Projection of solids: **It is defined as the process of obtaining or drawing views of the solid (Object) on different planes of projection (POPs) using the principles of orthographic projection.**

Position of Solid: (In 1st Quadrant)

Solid can be positioned in the first quadrant in infinite number of ways and these infinite positions can be classified into following three groups or cases based on how the axis of the solid is held with reference to planes of projection (POP) or Reference planes.

Based on Axis of the solid and the Reference planes (HP & VP) the 3 Cases are:

CASE -1 : Axis of the solid is perpendicular to one POP and parallel to other POP.
(It is also called as Simple Position of the Solid)

i.e. Axis of the solid is perpendicular to HP and parallel to VP. And also vice versa.

CASE – 2 : Axis of the solid is inclined to one POP and parallel to other POP.

i.e. Axis inclined to HP and Parallel to VP. And Vice versa.

CASE – 3 : Axis of the solid is inclined to both the POP's (i.e. HP and VP).
Then it is also inclined to PP.

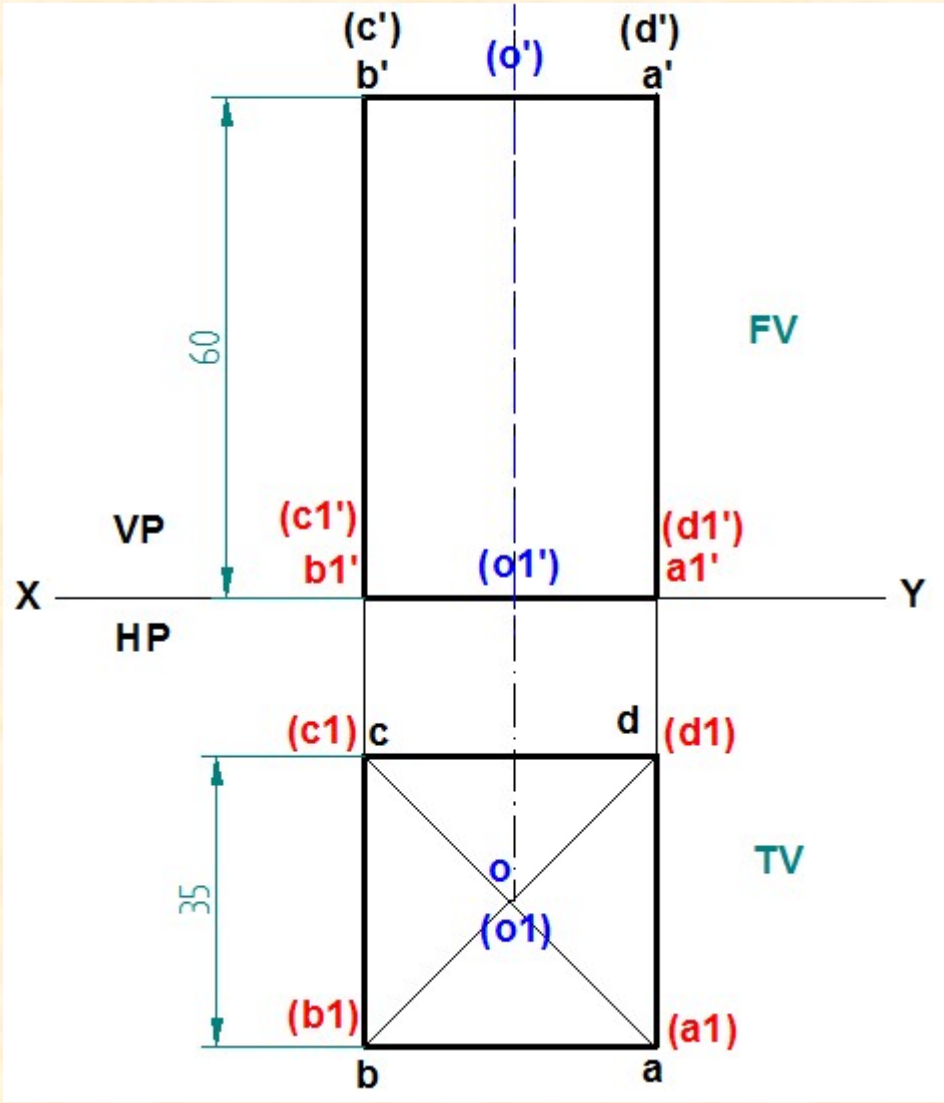
CASE - 3 (special case in Case - 3): Axis of the solid is inclined to both HP and VP, But parallel to VP. This is possible only when summation of θ and ϕ is 90 (i.e. $\theta + \phi = 90$).

CASE-1 A **Square prism of side 35 mm** and **axis length 60 mm** is resting on base **on HP**, where **axis Is perpendicular to HP** and **Parallel to VP**. Draw the Projections.

Hint: Since, Base is **resting on HP** and Parallel to HP, in the TV only true shape and size of the square is seen. So first TV Should be drawn.

Since no condition is given either edge or corner resting on HP, So any position (Edge or Corner) can be drawn.

Here Edge position is drawn.

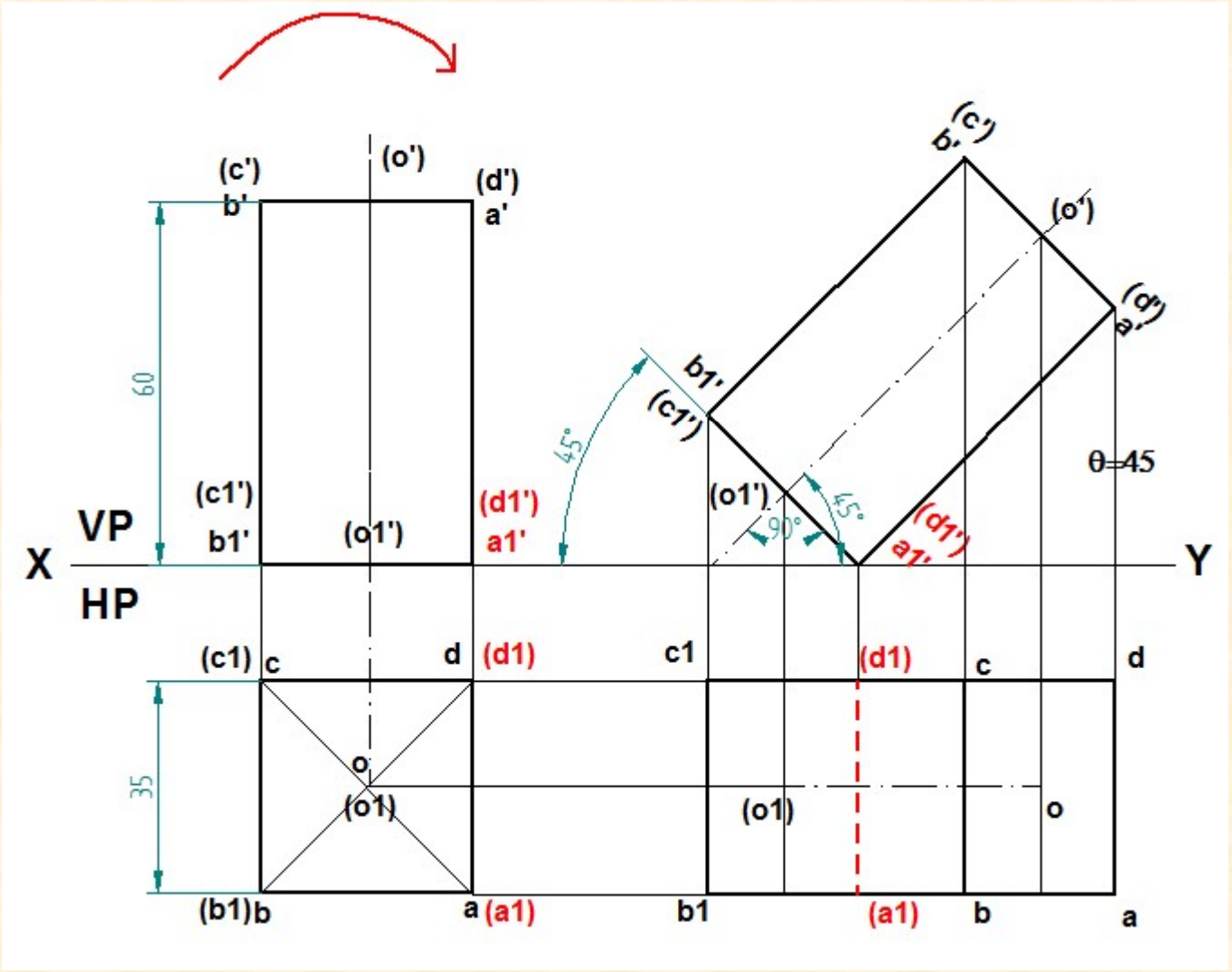


CASE-2 A Square Prism 35 mm sides of base and 60 mm axis length rests on HP on one of its edges of the base and the axis is inclined to HP at 45*, Draw the projections of the Prism.

Hint: Case 2 is converted to Case1. As Axis is inclined to HP, make it Perpendicular to HP and Parallel to VP.

Base edge a1d1 Is resting on HP.
First draw the TV, Edge Position i.e. Base edge a1d1 should be perpendicular to XY line.

Draw the 1st set of views (i.e. TV & FV).
Next draw the final 2nd set of views with the help of 1st set of views.



CASE-3. A Square Prism 35 mm sides of base and 60 mm axis length rests on HP on one of its edges of the base which is inclined to VP at 30*. Draw the projections of the Prism when the axis is inclined to HP at 45*.

Standard Procedure to solve Case 3 Problems using change of Position method.

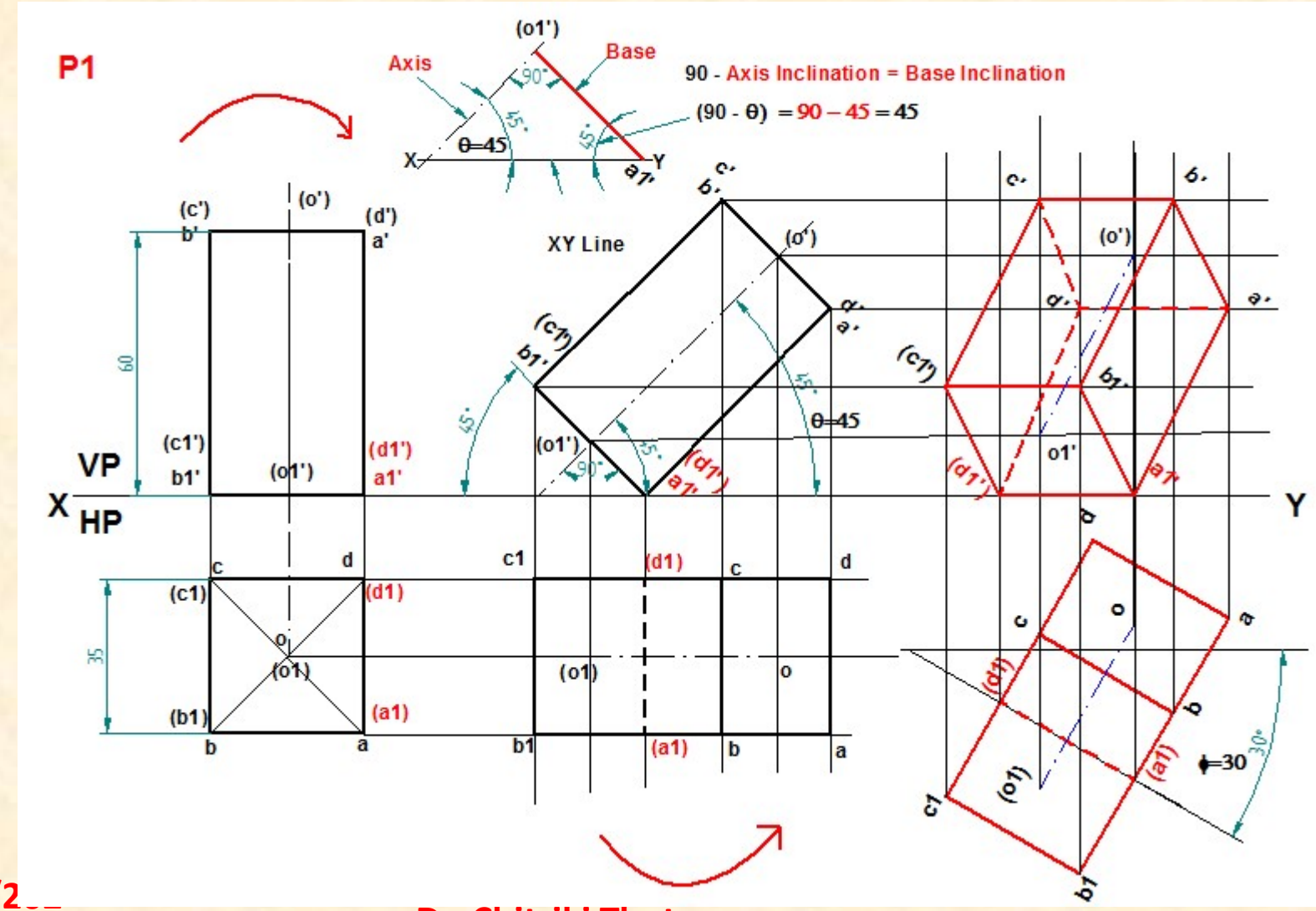
STEP 1: Convert Case 3 to Case 2 and Case 2 to Case 1 (Simple position) and draw the 1st set of views.

STEP 2: After drawing 1st set of views of Case 1 (Simple position), convert Case 1 to Case 2 according to the condition (Data) given in the problem, then draw the 2nd set of views with the help of 1st set of views.

STEP 3: After drawing 2nd set of views, convert Case 2 to Case 3 position according to condition (Data) given in the problem, then draw the final 3rd set of views with the help of 2nd set of views.

P1. A **Square Prism 35 mm sides** of base and **60 mm axis length** rests on HP on one of its edges of the base which is inclined to VP at 30*. Draw the projections of the Prism when the axis is inclined to HP at 45*.

Base Edge resting on HP – A1D1



General guidelines to solve the problems

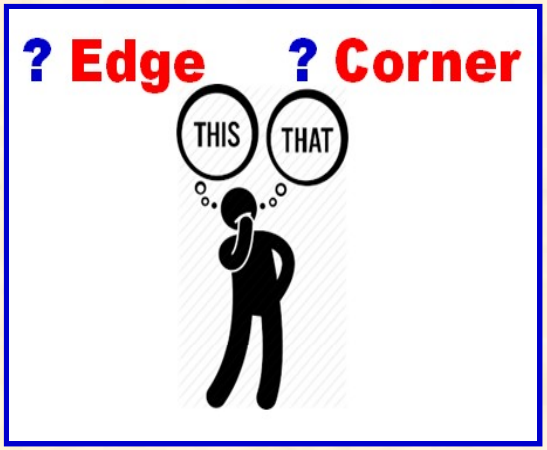
- **CAREFUL READING:** One should read the problem carefully once or twice, analyze and understand the problem correctly.
- **SOLID IDENTIFICATION:** Identify which solid is given in the problem, what are its dimensions and properties.
- **ANALYZE ANGLES/INCLINATIONS:** Analyze, what all the Angles / Inclinations given the problem (i.e. whether true inclination is given or Apparent inclination is given). And Write down the correct data given in the problem .
- **FIRST VIEW & POSITION:** Analyze which view should be drawn first (i.e. TV or FV) and also analyze which position should be drawn (i.e. Edge position or Corner position).

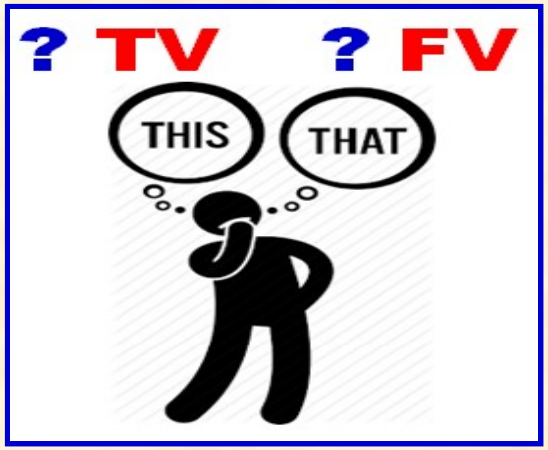
General guidelines to solve the problems

- **STANDARD PROCEDURE:** Follow the standard procedure/steps in sequence order.
- **DRAWING RULES:** Follow all rules and regulations of Engineering drawing while drawing (i.e. Dark lines, light lines, very light lines, dotted lines, Dimensioning etc.).
- **IDENTIFICATION OF VISIBLE AND INVISIBLE PARTS OF THE SOLID:** Apply the conditions correctly in sequence order carefully to identify, which portion/part of the solid is seen/visible and which portion/part of the solid is Unseen / Invisible.
- **DIMENSIONING :** All dimensions given in the problem and asked to find out in the problem should be mentioned in the drawing.

General guidelines to solve the problems

- *Always students will have a confusion.*





- **Initially, which VIEW should be drawn first (i.e., Top View or Front View).**
- **And which POSITION should be drawn (i.e. Edge or Corner position).**

1. Which view should be drawn first ?

- Always that view should be drawn first, in which true shape and true size of the solid base is seen.
- If Base EDGE or Base CORNER is resting on HP, then TV should be drawn first (Because in this view only true size and true shape of the solid base is seen).
- If it is resting on VP, then FV should be drawn first (Because in this view only true size and true shape of the solid base is seen).

Solid resting on HP – TV first

Solid resting on VP – FV first

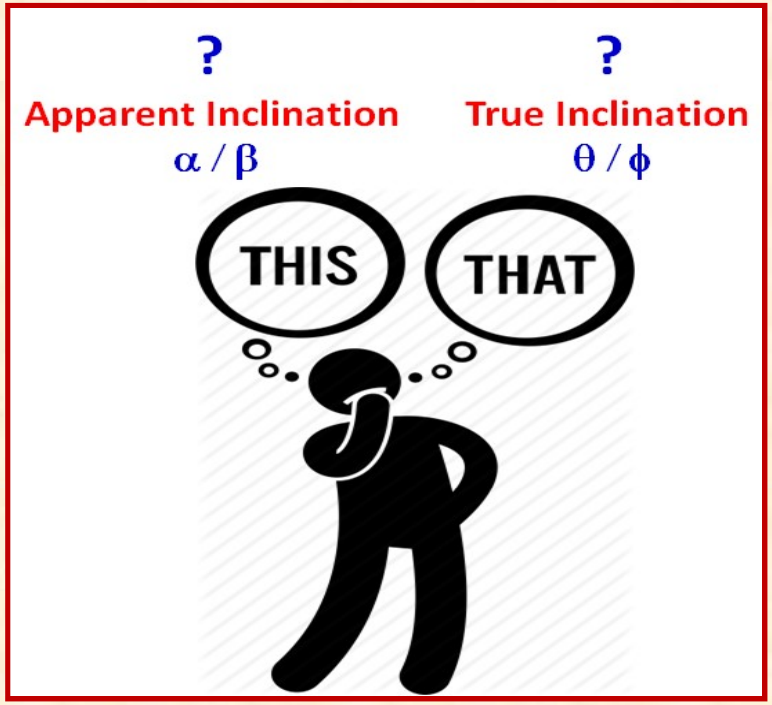
2. Whether Initial position should be EDGE position or CORNER position ?

- In the problem, if it is Referring to base EDGE, then initial position should be EDGE POSITION.
- If it is Referring to base CORNER/DIAGONAL then the initial position should be CORNER POSITION.

- Always Apparent inclinations $\alpha, \beta >$ True inclinations θ, ϕ.
- Always Apparent length < True length.
- HP inclinations are seen in VP and VP inclinations are seen in HP.
- HP dimensions are seen in VP and VP dimensions are seen in HP.
- Always FV and TV lies in the same projection lines.
- Always True length should be represented on True Inclination.
- Always Apparent length should be represented on Apparent Inclination.

TRUE INCLINATION & APPARENT INCLINATION

Always,
APPARENT INCLINATION
Should be for
APPARENT LENGTH



And,
TRUE INCLINATION
Should be for
TRUE LENGTH

How to identify / understand that the inclination given in the problem is True Inclination or Apparent Inclination.

- If statement is like Base edge / Diagonal / Median or Perpendicular bisector / Axis is inclined to HP / VP, then the inclination should be considered as TRUE INCLINATION (Θ / Φ).

- If the statement is like Top view of the Base edge / Diagonal / Median or Perpendicular bisector / Axis is inclined to HP/ VP, then the inclination is not a true inclination, it should to be considered as APPARENT INCLINATION (α /β).

- If the statement is like Base edge / Diagonal / Median or Perpendicular bisector / Axis appears to be inclined to HP / VP, then the inclination is not true inclination, it should to be considered as APPARENT INCLINATION (α /β).

IDENTIFICATION OF VISIBLE / SEEN & INVISIBLE / UNSEEN PORTION OF SOLID

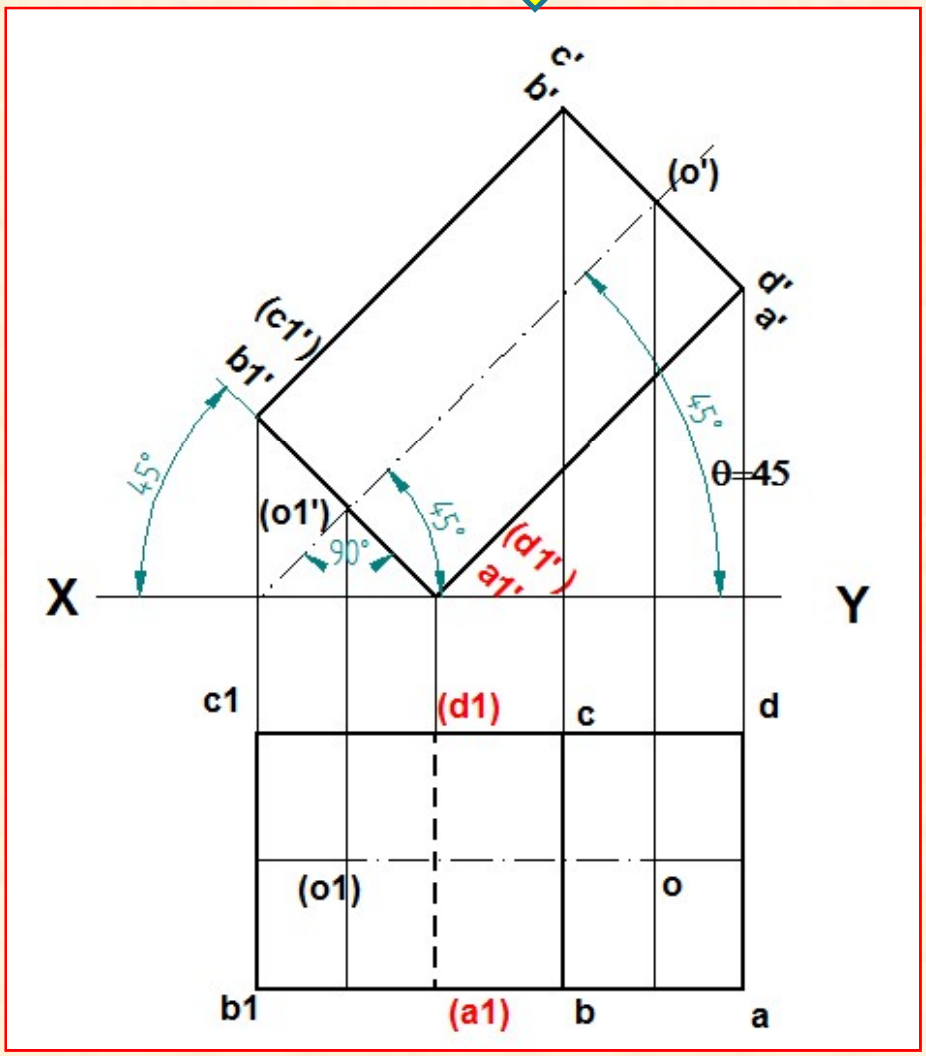
GENERAL HINT: To Identify the VISIBLE and INVISIBLE parts of the solid.

- **Portion / Part of the Solid which is near to the observer is VISIBLE / SEEN.**
- **Portion / Part of the Solid which is faraway from the observer is INVISIBLE / UNSEEN. (Partly seen and Partly Unseen)**
- **All Boundaries / Extreme parts of the solid in the views are VISIBLE / SEEN.**
- **All parts of the solid behind the VISIBLE / SEEN portion are INVISIBLE / UNSEEN, if they are not falling boundary / Extreme in the view.**

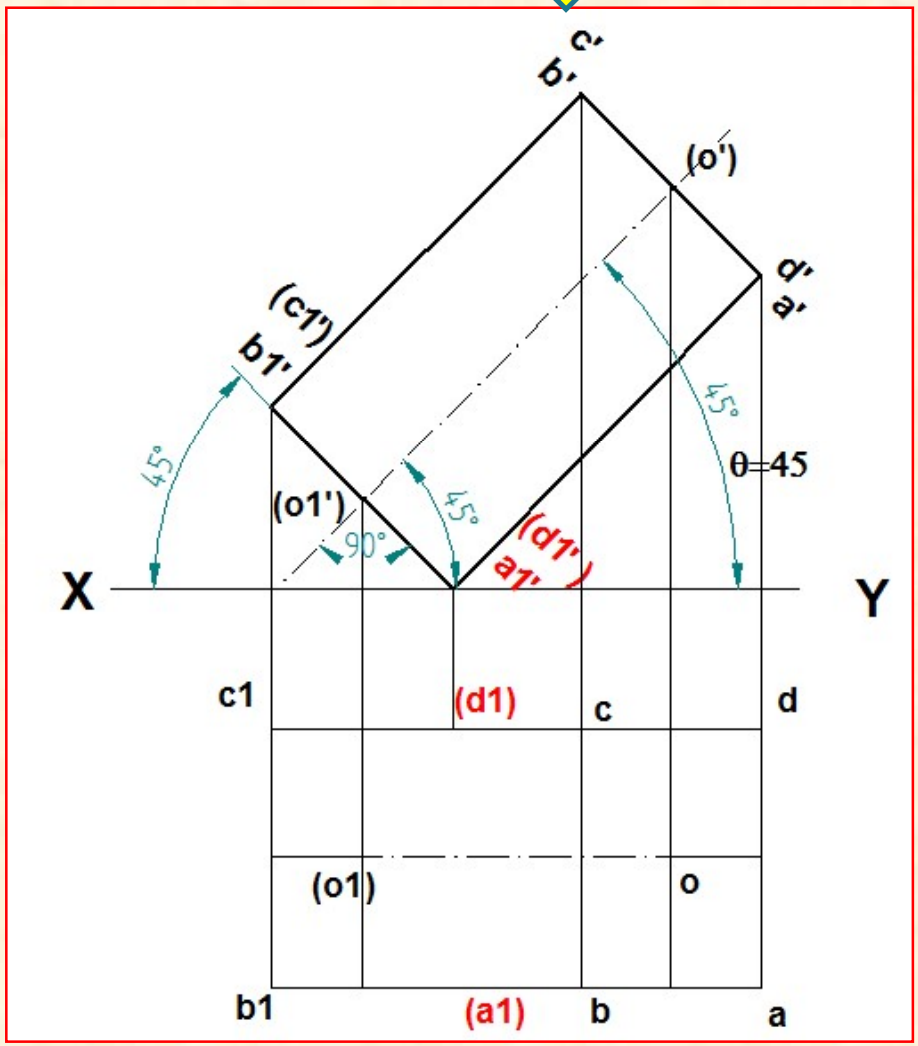
- **Parts (Lines / Edges) passing through / inside seen face / base are INVISIBLE / UNSEEN , all those edges should be drawn with dotted lines.**

Identification of VISIBLE & INVISIBLE Parts of the Solid in the TV with the help of FV

Observer

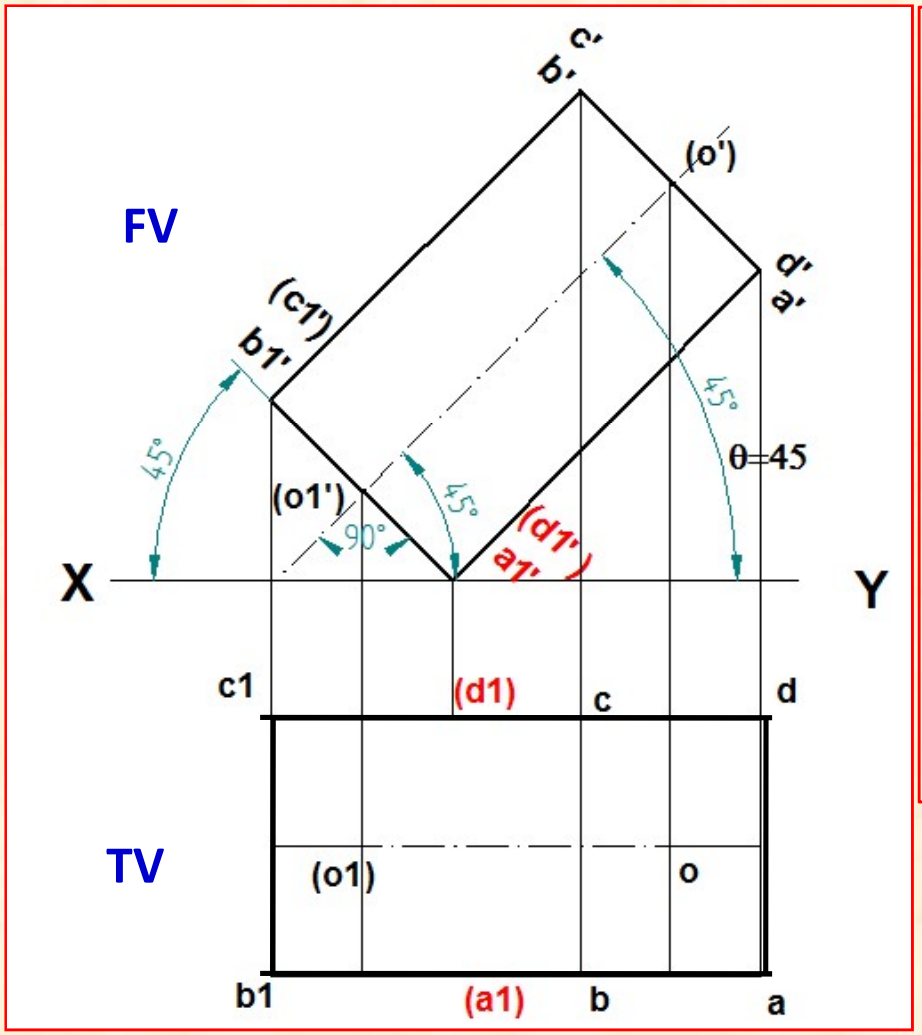


Observer



Identification of VISIBLE & INVISIBLE Parts of the Solid in the TV with the help of FV

Observer

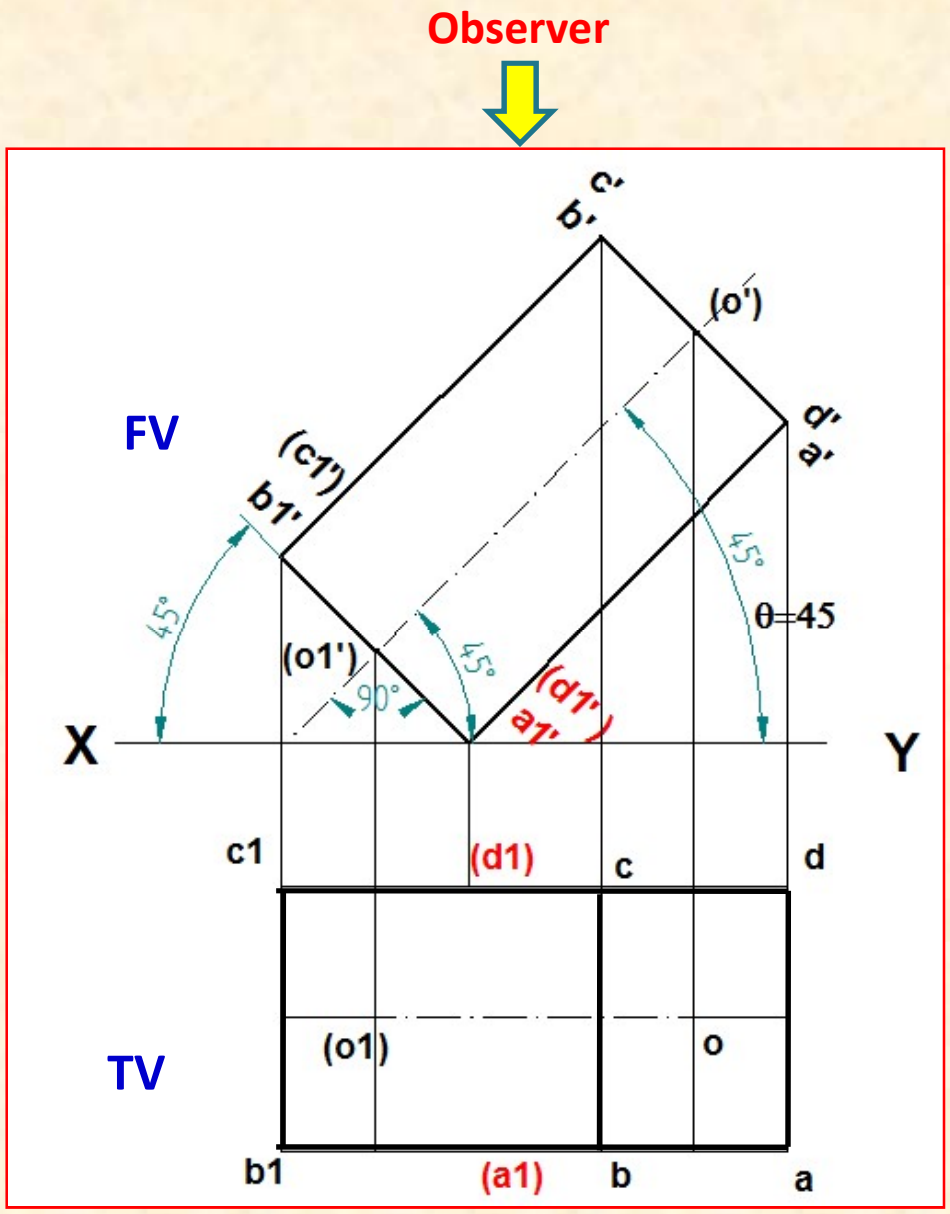


Step-1 (TV) : (Identifying the Boundaries)

All parts of the solids which falls in Boundaries are seen, so make it dark.

i.e. In TV (ab,bb1,b1c1,c1c,cd,da) are the parts which falls in boundary are seen, so make it dark.

Identification of VISIBLE & INVISIBLE Parts of the Solid in the TV with the help of FV

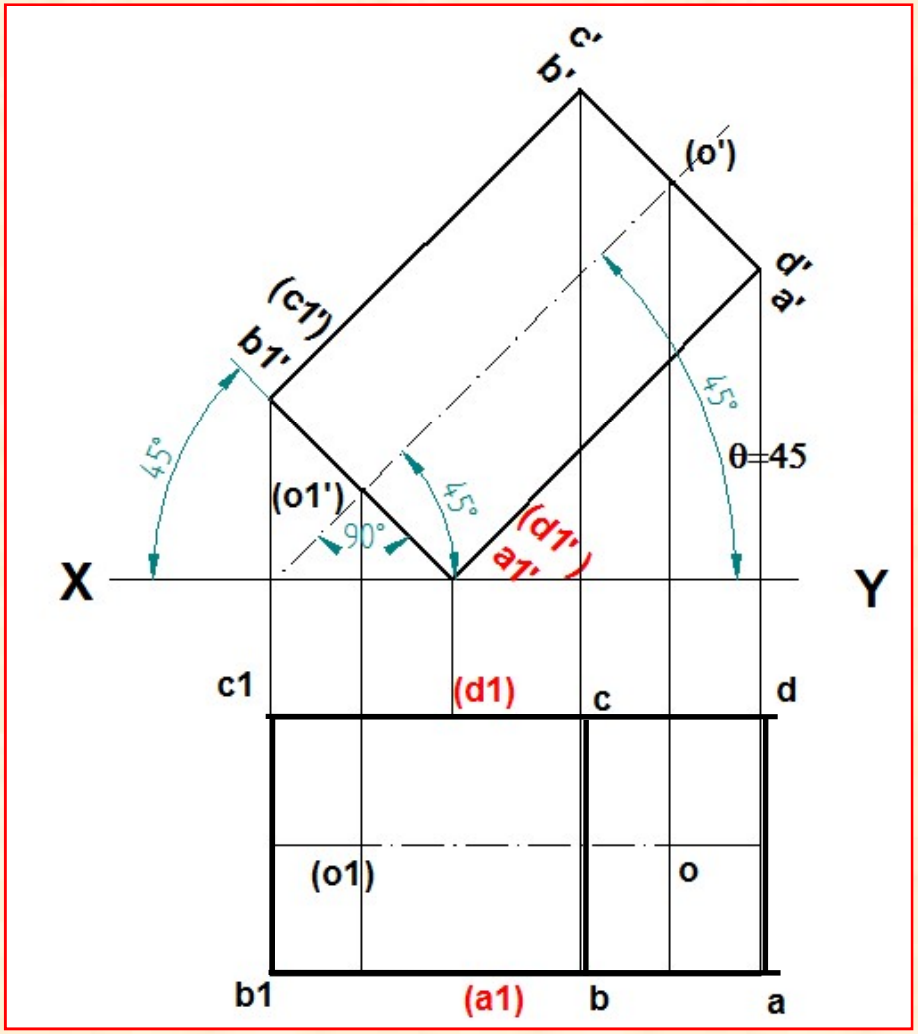


Step-2 (FV): (Face nearer to Observer)

- **Observe the FV and identify the Face (Part) nearer to the observer, that face is completely seen in the TV, so make it dark.**
- **i.e. in FV (a'b'c'd') face is nearer to observer, so in the TV (abcd) face is completely seen, so make it dark.**

Identification of VISIBLE & INVISIBLE Parts of the Solid in the TV with the help of FV

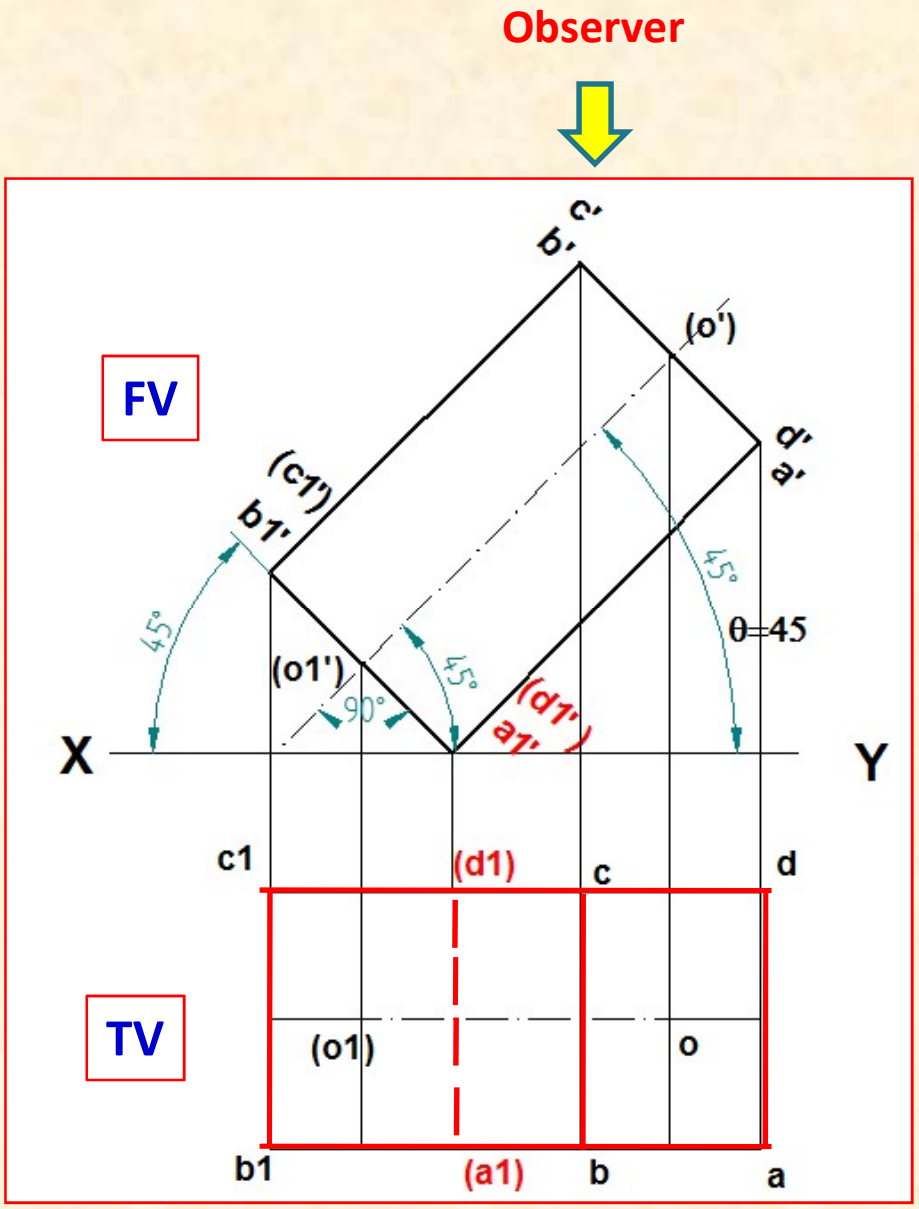
Observer



Step-3 (FV) : (Lateral/Slant Edges)

- All the lateral edges/slant edges falling above the Axis are seen and below the axis are unseen.
- Here, a'a1',d'd1' are below the axis they (aa1,dd1) are unseen in the TV, But since they are falling in boundary and coincide with seen lateral edges, they are not made dotted.
- b'b1', c'c1' are above the axis they (bb1,cc1) are seen in the TV and also they fall in boundary.
- (Apply this step only for the parts (Lateral/Slant edges), which are still incomplete.)

Identification of VISIBLE & INVISIBLE Parts of the Solid in the TV with the help of FV

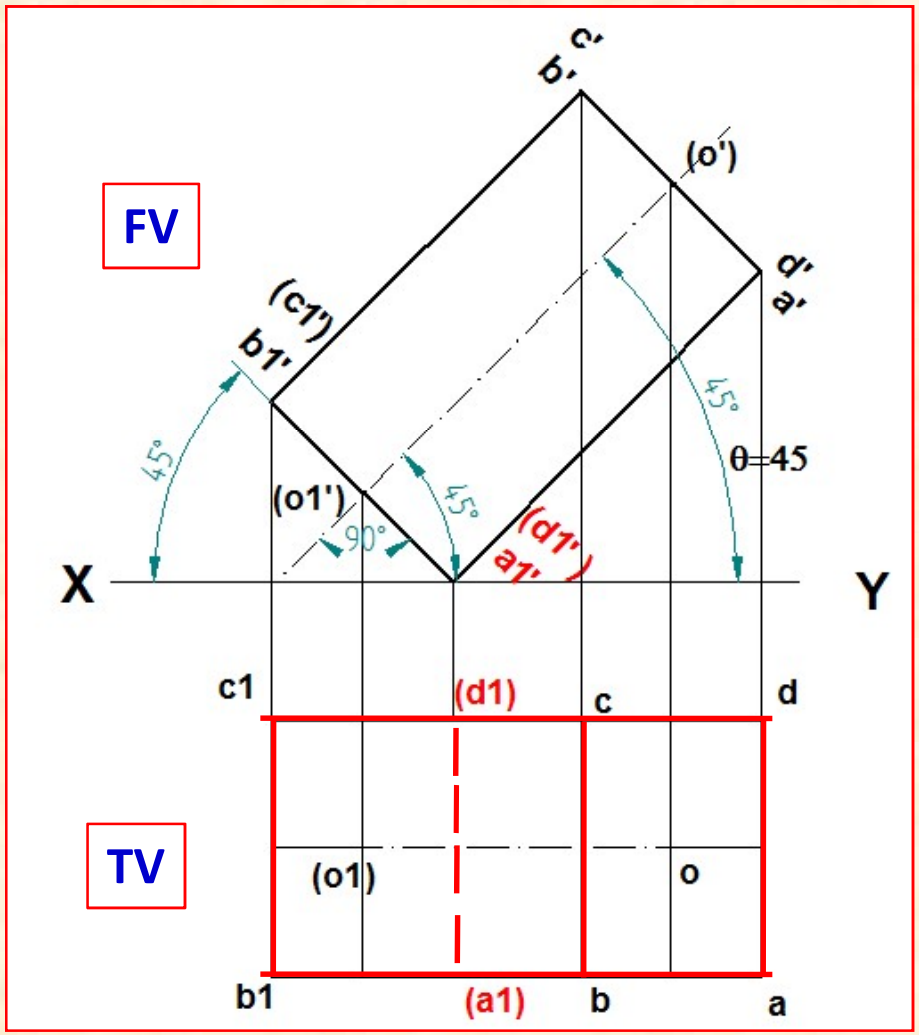


Step-4 (FV) : (Face faraway from the observer)

- Face faraway from the observer is partly seen and partly unseen.
- Any Face edges contains 2 end points.
- If 2 points of the edge falls on or above the Axis , then that edge is seen.
- If 1 point or 2 points of the edge falls below the axis, then that edge is unseen, if it is not extreme/boundary.
- Here, a1'd1' falls below the axis, so it is UNSEEN in the TV (So dotted line).

Identification of VISIBLE & INVISIBLE Parts of the Solid in the TV with the help of FV

Observer

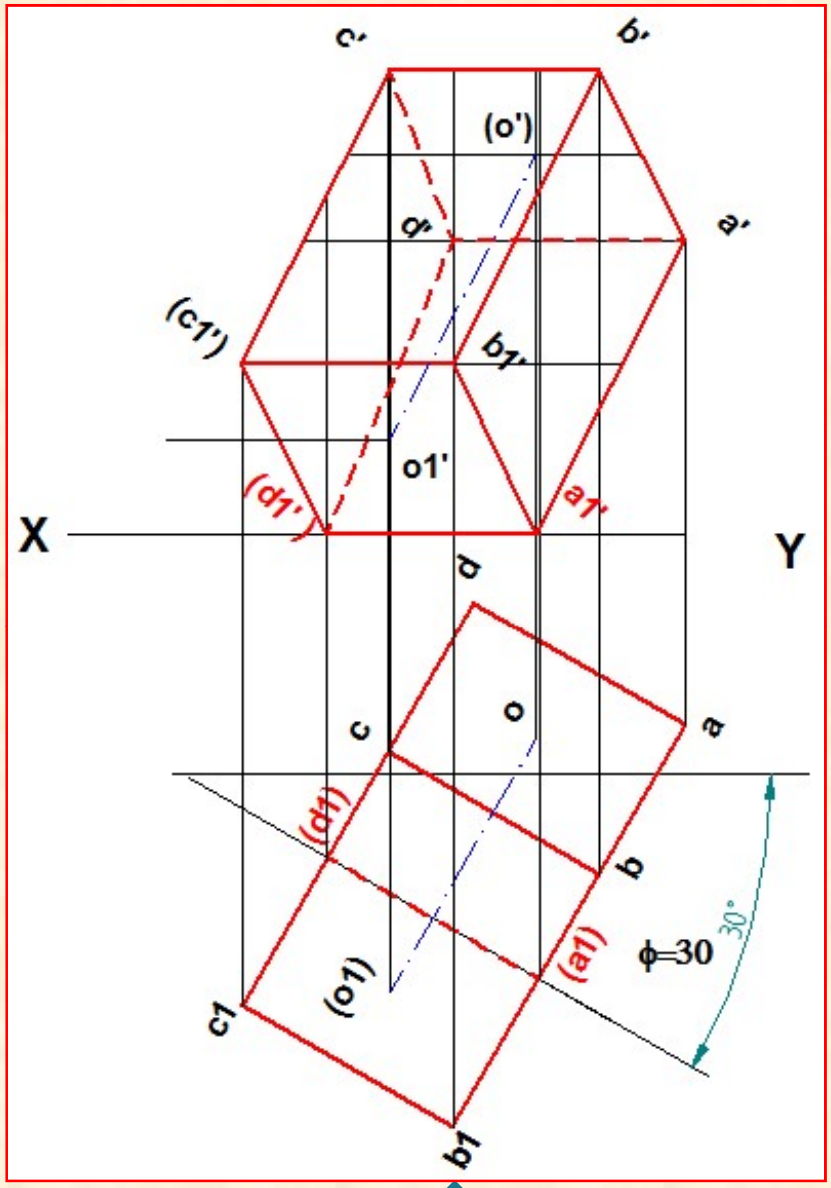


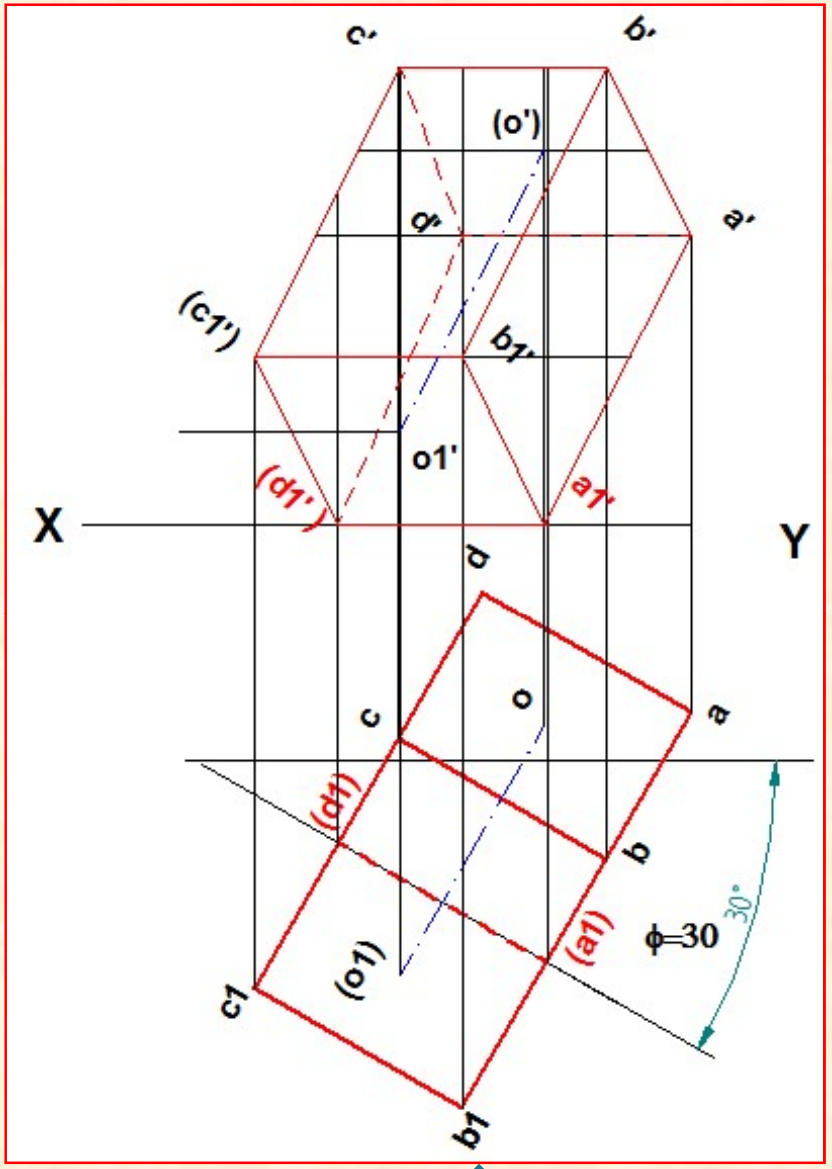
Step – 5 (TV) :

- Any part of the solid passing through / inside the seen portion (Lateral face (Rectangular face)/Slant face/any face/base) of the solid is unseen, so make it dotted.

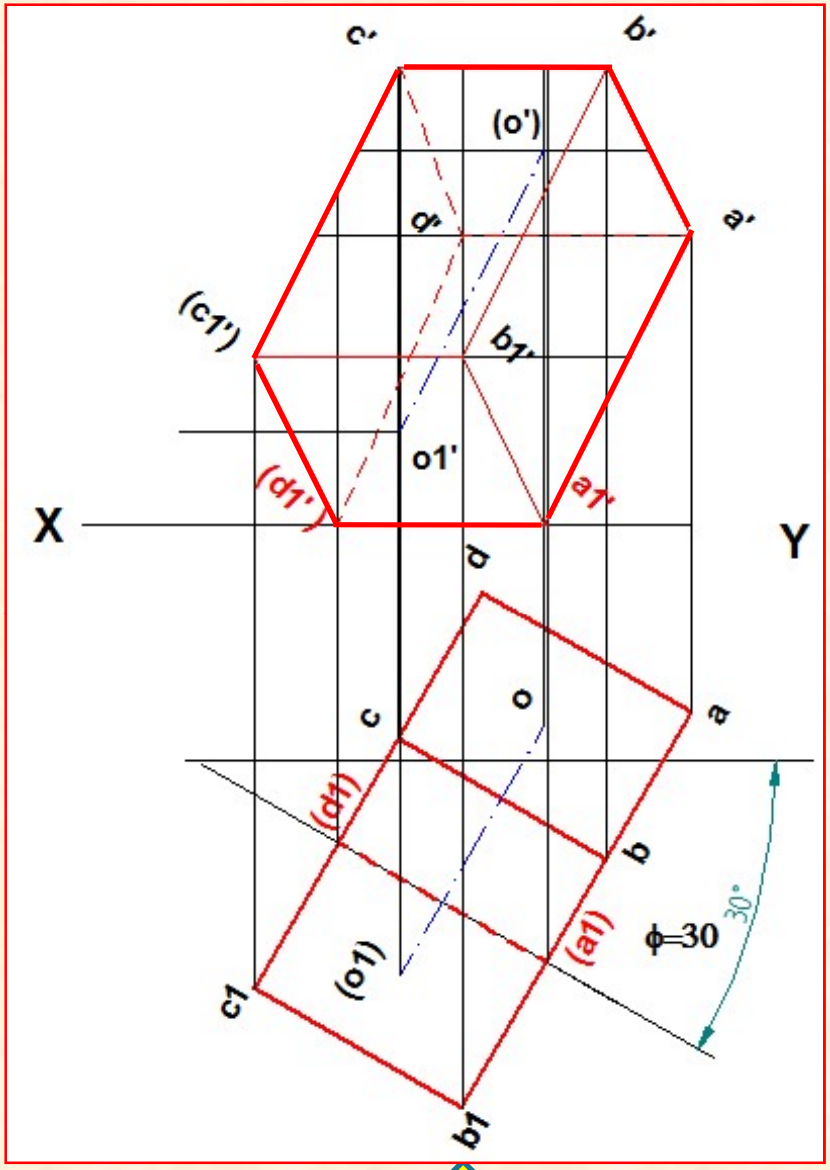
- Here, a1d1 is the base edge passing through the seen Lateral face bcc1b1, so it is Unseen (Dotted)

Identification of VISIBLE & INVISIBLE Parts of the Solid in the FV with the help of TV





Identification of VISIBLE & INVISIBLE Parts of the Solid in the TV with the help of FV

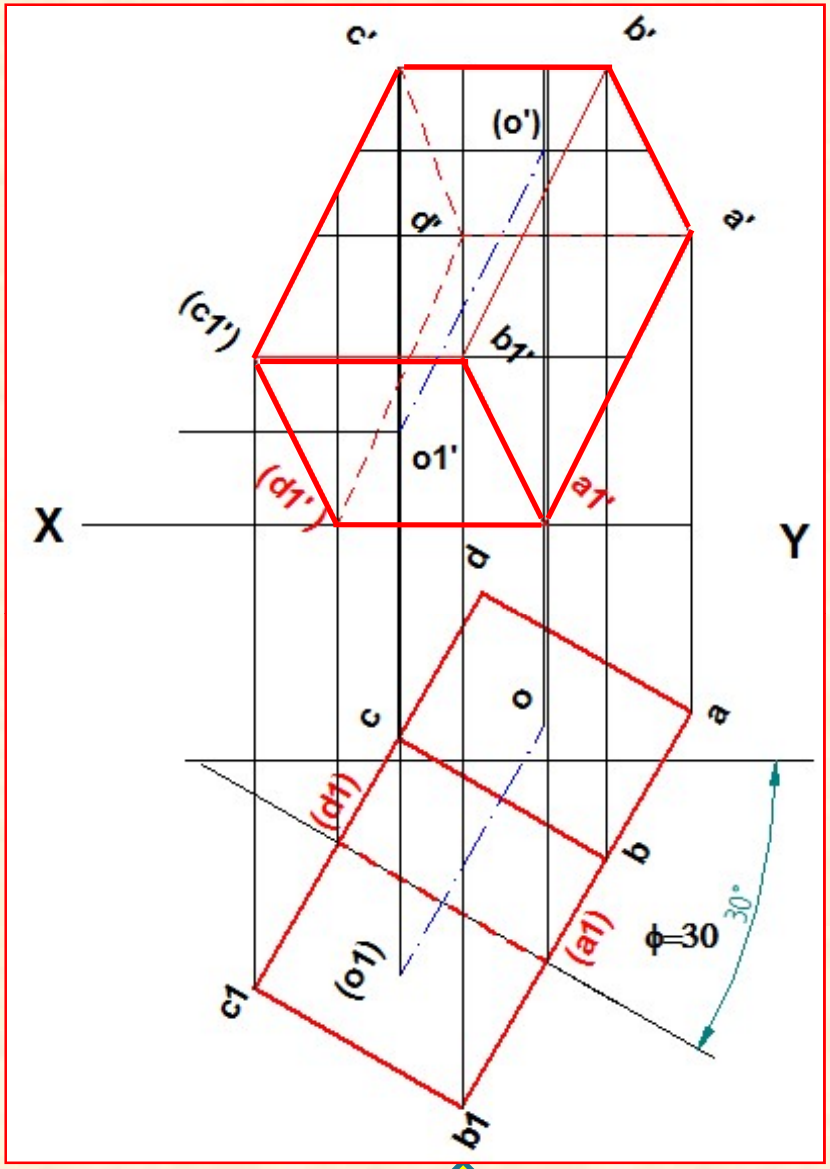


Same sequence of steps to be followed. (But, here below the Axis are seen and above the Axis are unseen)

Step-1 (FV) : (Identifying the Boundaries)

- All parts of the solids which falls in Boundary are seen, so make it dark.
- i.e. In FV (a1'a',a'b',b'c',c'c1',c1'd1',d1'a1') are the parts which falls in boundary are seen, so make it dark.

Identification of VISIBLE & INVISIBLE Parts of the Solid in the TV with the help of FV

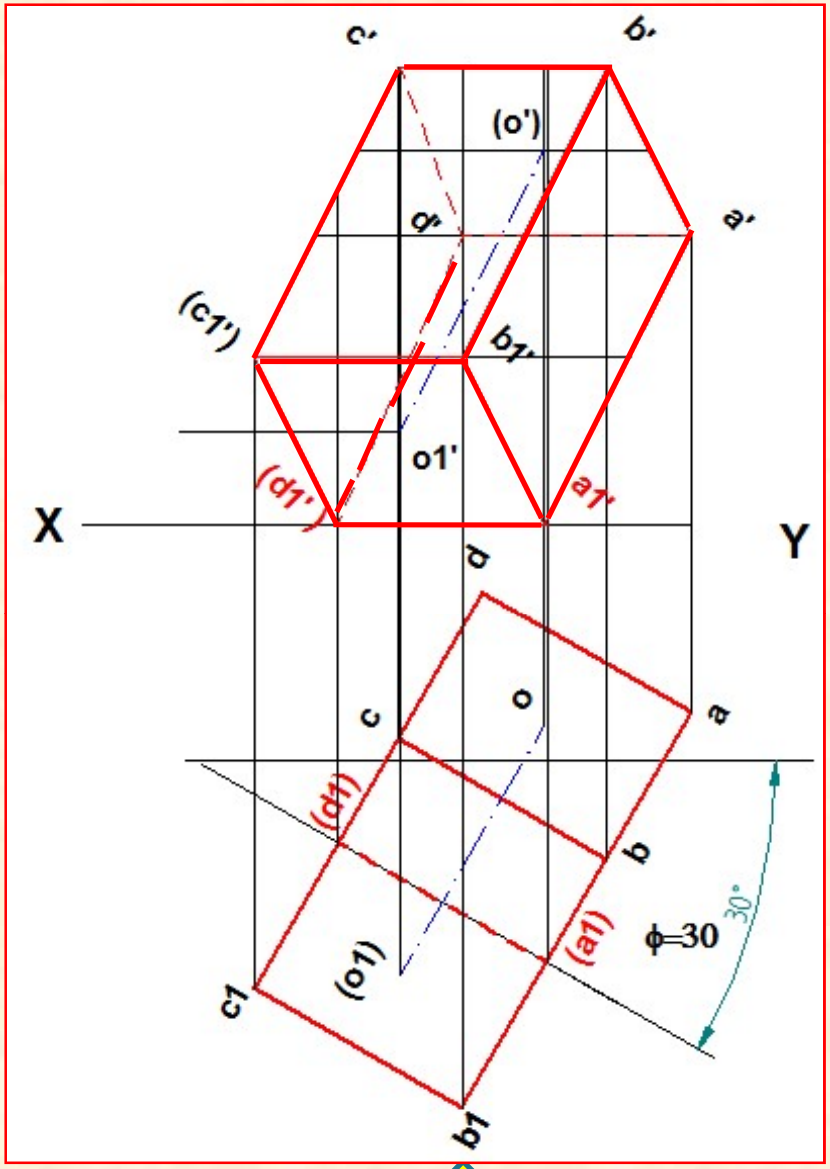


Observer

Step-2 (TV): (Face nearer to Observer)

- **Observe the TV** and identify the **Face (Part) nearer to the observer,** that face is completely **seen in the FV**, so make it dark.
- **i.e.** in TV **(a1b1c1d1)** face is nearer to observer, so in the FV **(a1'b1'c1'd1')** face is completely seen, so make it dark.

Identification of VISIBLE & INVISIBLE Parts of the Solid in the TV with the help of FV

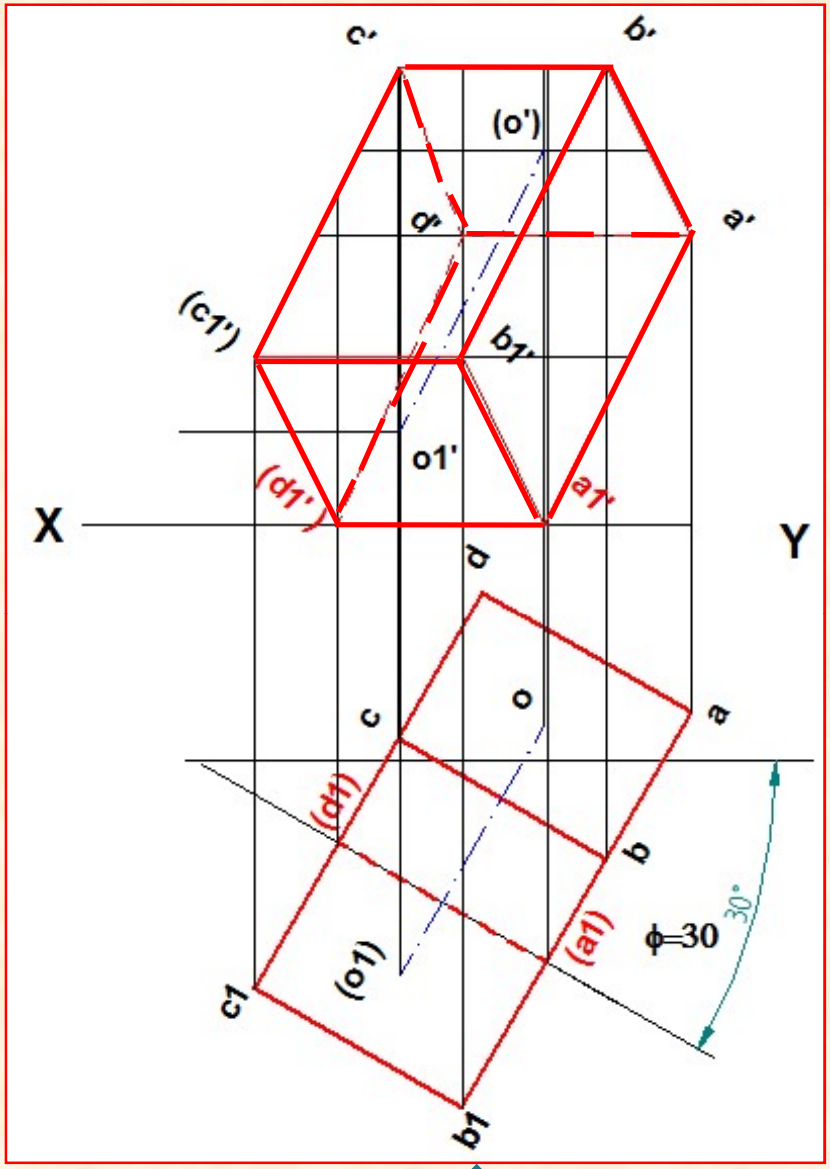


Observer

Step-3 (TV) : (Lateral/Slant Edges)

- All the lateral edges/slant edges falling below the Axis (near to the observer) are seen and above the axis (faraway from the observer) are unseen.
- Here, aa1,bb1 are below the axis (nearer to the observer), so they (a'a1',b'b1') are seen in the FV, so make them dark.
- cc1,dd1, are above the axis (faraway from the observer) they (c'c1',d'd1') are unseen the FV, so make them dotted, but if they are falling in boundary, then they are already made dark, then leave it.
- (Apply this step only for the parts (Lateral/Slant edges), which are still incomplete.

Identification of VISIBLE & INVISIBLE Parts of the Solid in the TV with the help of FV

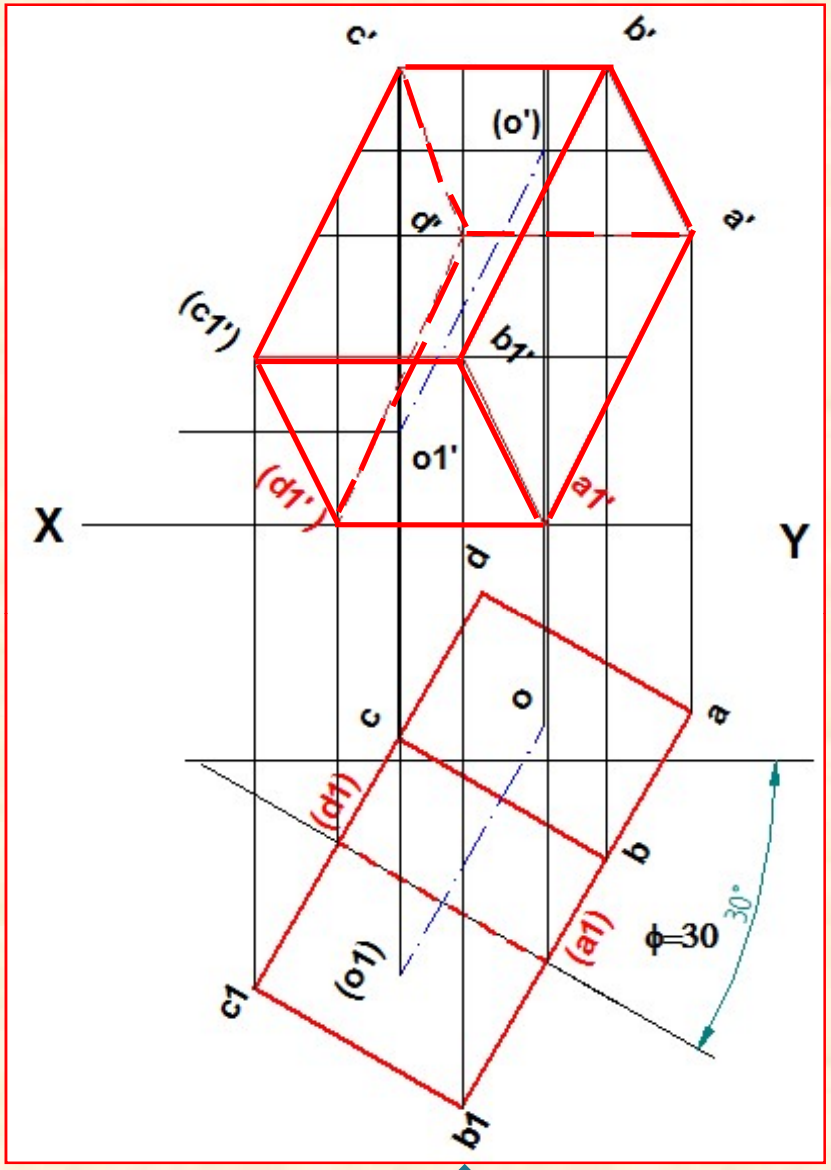


Observer

Step-4 (TV) : (Face faraway from the observer)

- Face faraway from the observer is partly seen and partly unseen.
- Any Face edges contains 2 end points.
- If 2 points of the edge falls below the Axis , then that edge is seen.
- If 1 point or 2 points of the edge falls above the axis, then that edge is unseen, if it is not extreme/boundary.
- Here, in edge cd both points falls above the axis it is Unseen. And in edge ad, one point a falls below the axis and another point d falls above the axis it is also unseen, if they are not extreme/boundary, so in the FV both edges c'd' and a'd' are UNSEEN (So dotted line).

Identification of VISIBLE & INVISIBLE Parts of the Solid in the TV with the help of FV



Observer

Step – 5 (FV) : Any part of the solid passing through / inside the seen portion (Lateral face (Rectangular face)/Slant face/any face/base) of the solid is unseen, so make it dotted.

- **Here, lateral edge d1'd' passes through seen base a1'b1'c1'd1' , so it is Unseen (make it dotted)**
- **NOTE: Any edge connecting the dotted edge is also dotted or Unseen.**
- **For Eg. Here edges a'd' and d'c' are connecting the dotted lateral edge d1'd', so they are also unseen (make it dotted).**

Problems on Projection of Solids

(Case -3 Problems)

P1. A Square Prism 35 mm sides of base and 60 mm axis length rests on HP on one of its edges of the base which is inclined to VP at 30*. Draw the projections of the Prism when the axis is inclined to HP at 45*.

Hint: Resting on HP – Draw TV first.

Refers to Base edge – Draw Edge position.

Axis inclined to HP = $\theta = 45*$ (True Inclination)

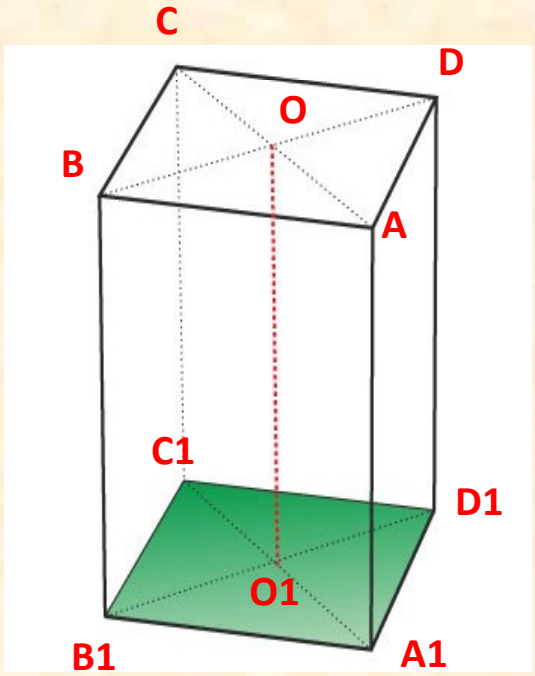
Base Edges resting on HP is inclined to VP = $\phi = 30*$ (True Inclination)

Follow the standard procedure / Steps to solve the Case 3 Problem using Change of Position method by drawing following 3 set of views.

1st Set of views – Case 1

2nd Set of views – Case 2

3rd Set of views – Case 3 (Final views)



SQUARE PRISM

Naming of Prism parts Ref. Fig.

- A1B1C1D1 - Base

- A1B1, B1C1, C1D1,D1A1 – Base Edges

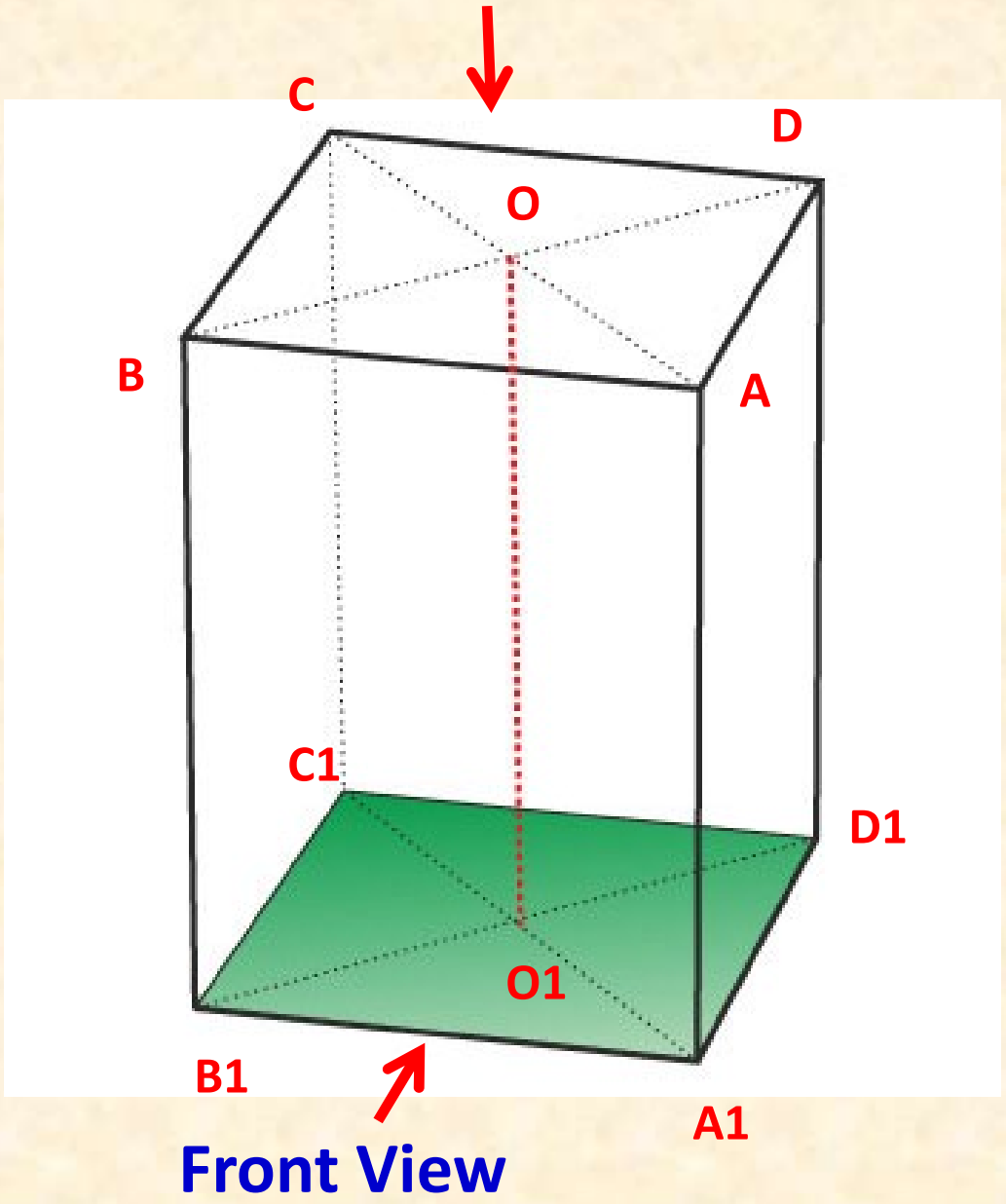
- ABCD - Top face

- OO1 - Axis

- AA1, BB1, CC1, DD1 – Lateral Edges

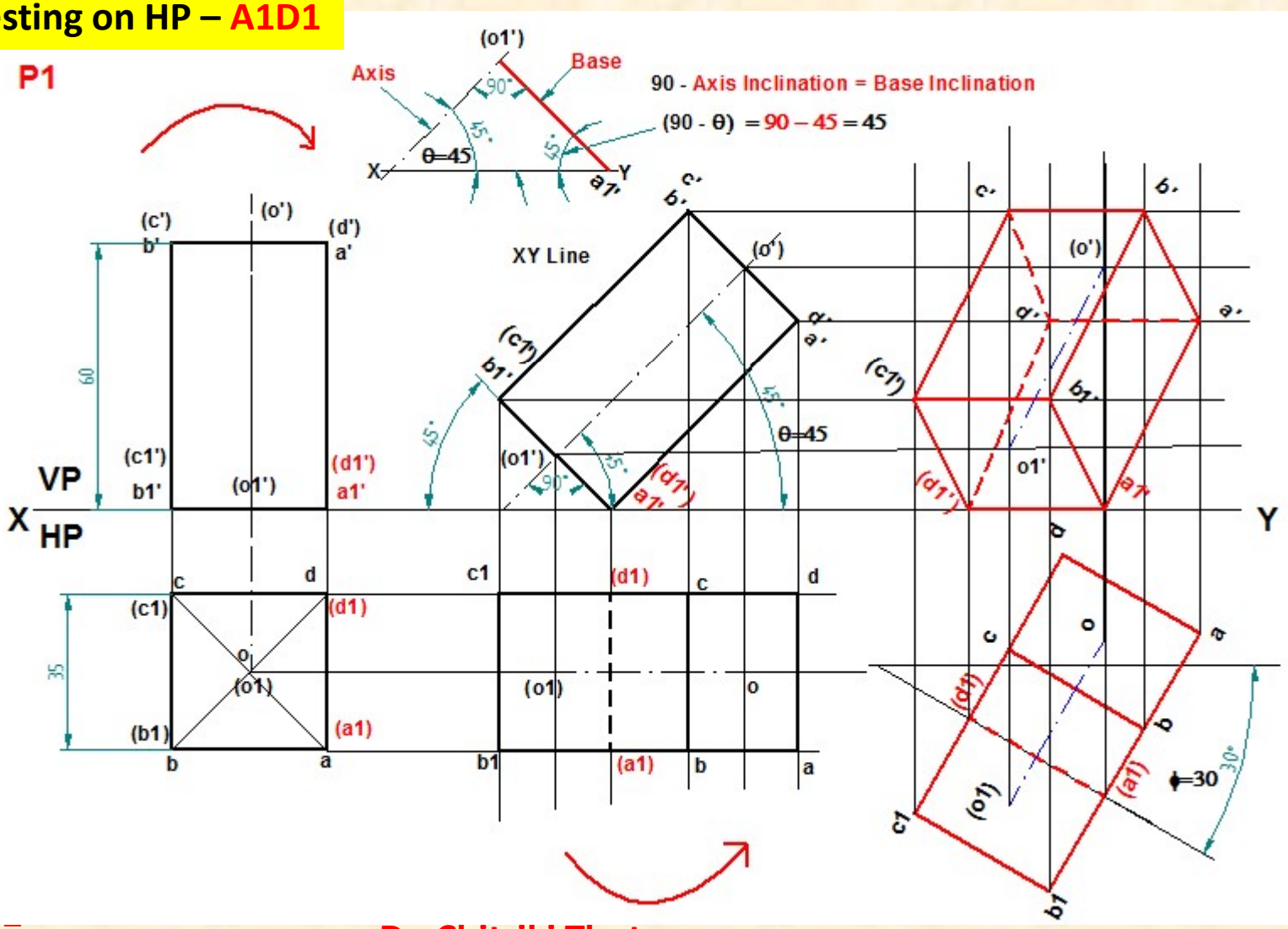
RECTANGULAR FACES

- AA1B1B – 1
- AA1D1D - 2
- DD1C1C - 3
- C1CBB1 - 4



P1. A **Square Prism 35 mm sides** of base and **60 mm axis length** rests on HP on one of its edges of the base which is inclined to VP at 30*. Draw the projections of the Prism when the axis is inclined to HP at 45*.

Base Edge resting on HP – A1D1



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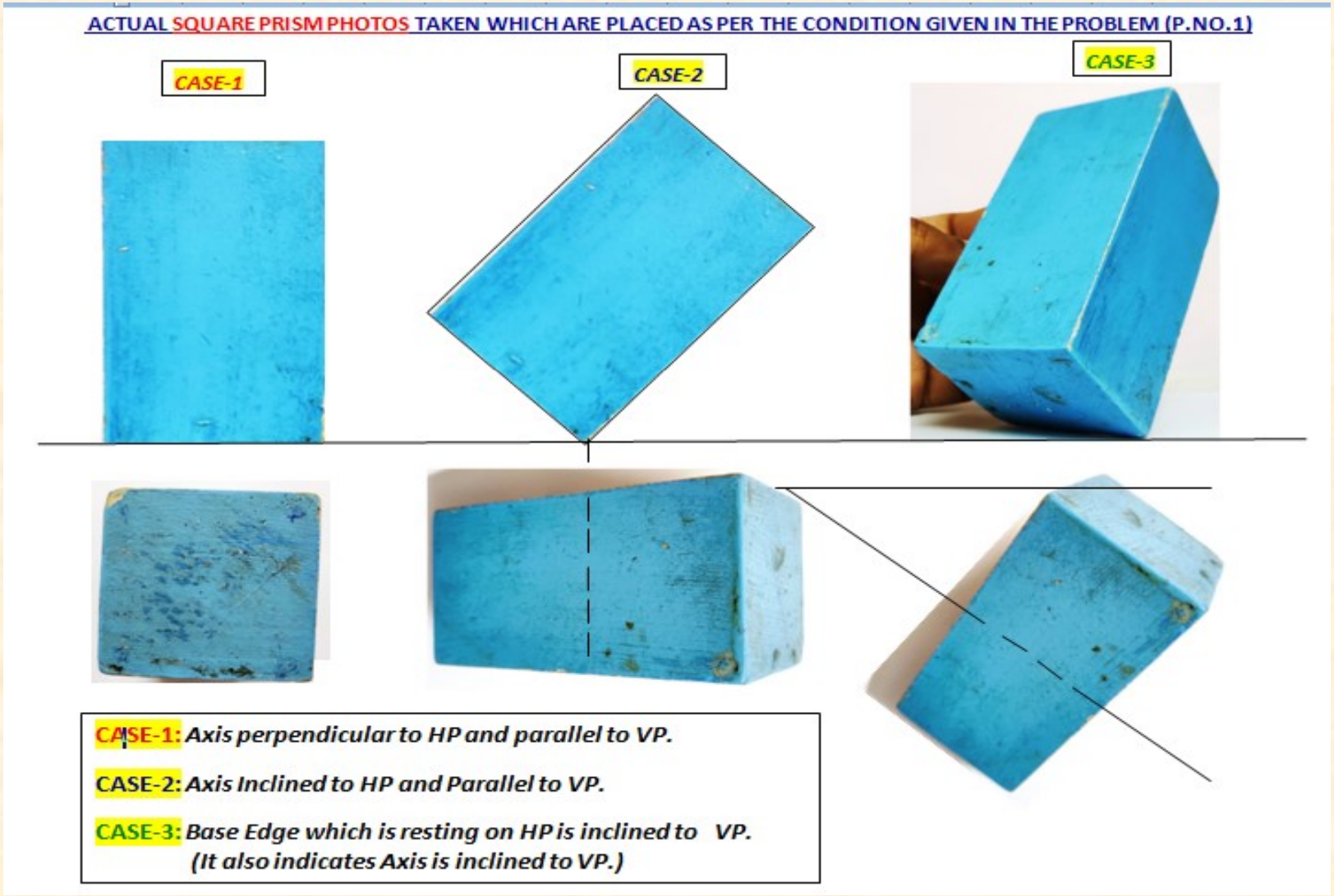


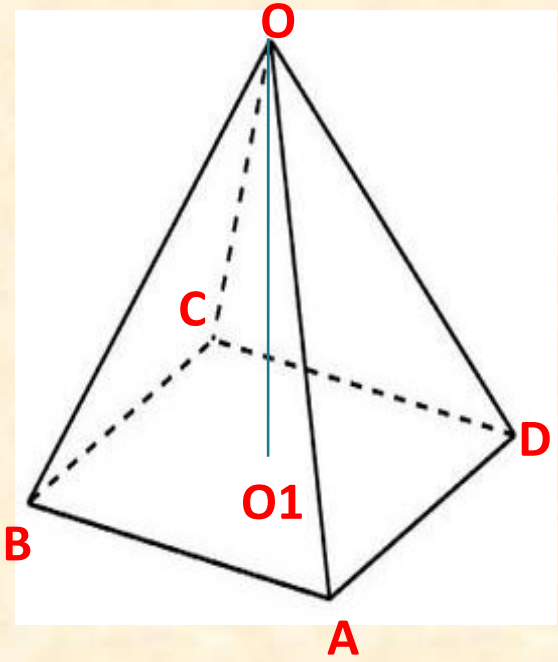
P.18 A Square Pyramid 35 mm sides of base and 60 mm axis length rests on HP on one of its corners of the base. Draw the projections of the Pyramid when the axis the pyramid is inclined to HP at 40*and to VP at 30*.

Hint: Resting on HP – Draw TV first.

Refers to Base Corner – Draw Corner position.

Axis inclined to HP = $\theta = 40*$ (True Inclination)

Axis inclined to VP = $\phi = 30*$ (True Inclination)



Follow the standard procedure / Steps to solve the

Case 3 Problem using Change of Position method

by drawing following 3 set of views.

1st Set of views – Case 1

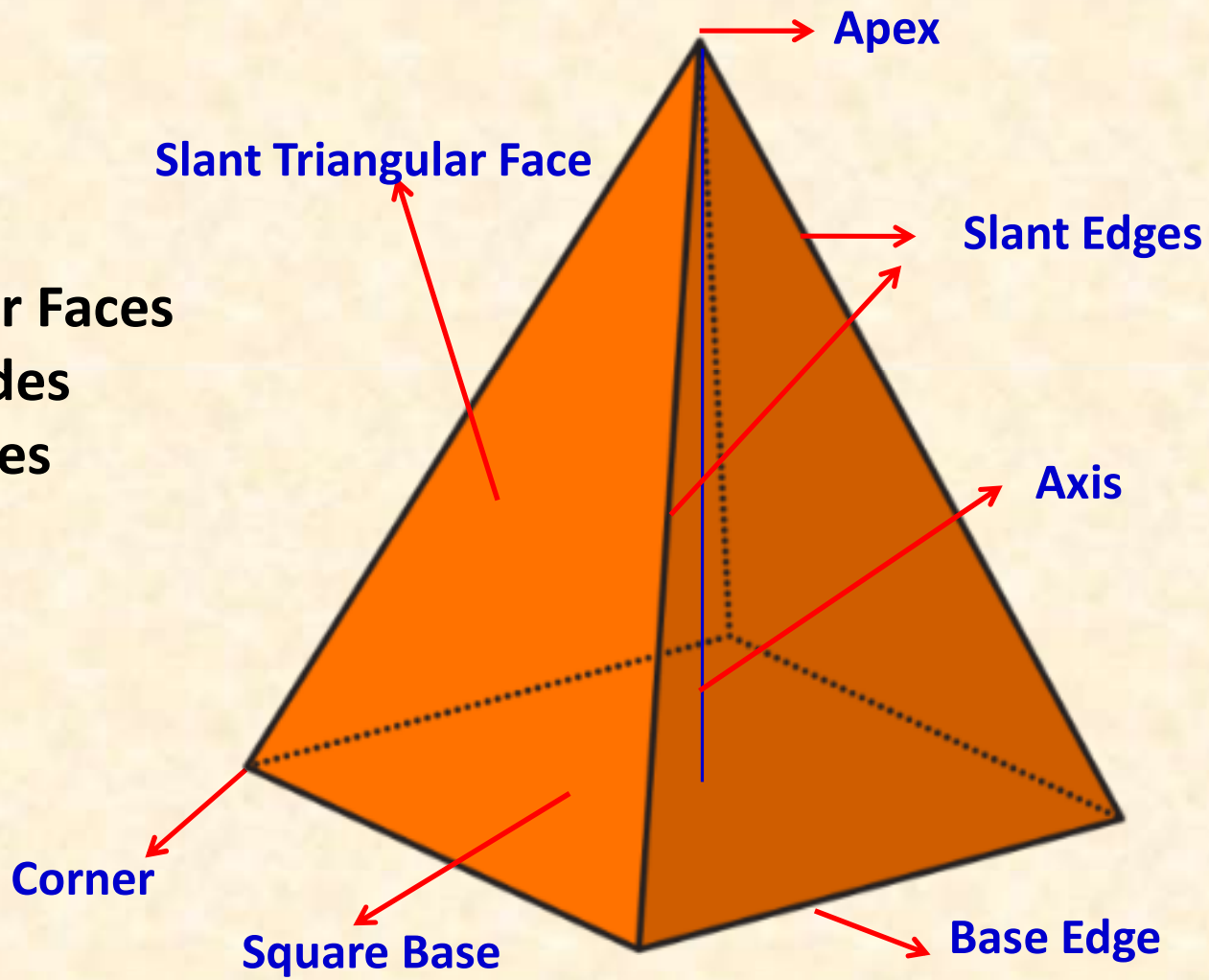
2nd Set of views – Case 2

3rd Set of views – Case 3 (Final views)

SQUARE PYRAMID

SQUARE PYRAMID consists of following parts like - Square Base, Base Edges/Sides, Base Corners, Slant Edges, Slant triangular face, Apex & Axis.

1- Square Base
4 – Slant Triangular Faces
4 – Slant Edges/Sides
4 - Base Edges/Sides
4 – Base Corners
1– Apex
1 - Axis



SQUARE PYRAMID

Naming of Pyramid parts Ref. Fig.

ABCD – Square Base

O - Apex

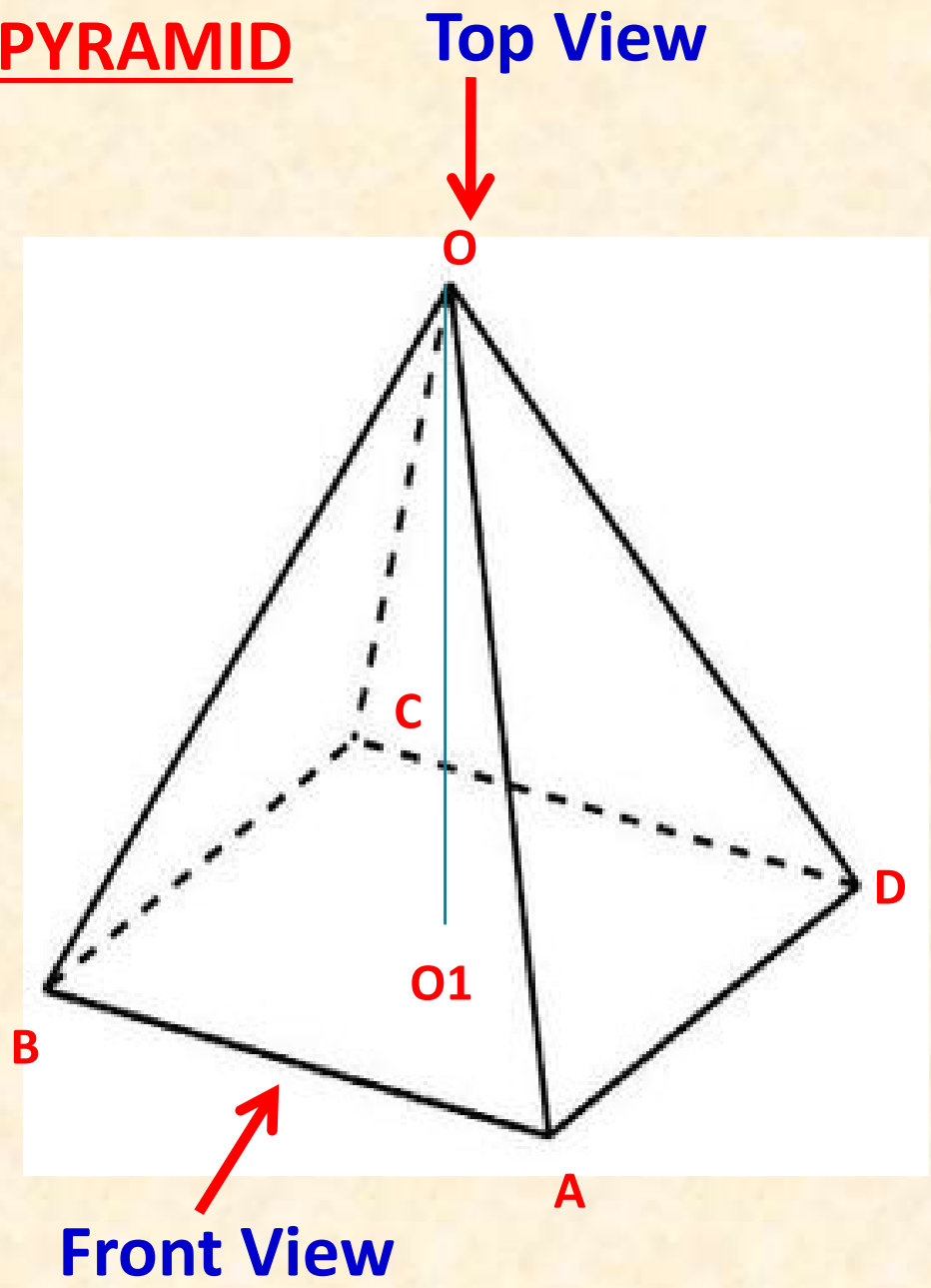
OO1 - Axis

AO, BO,CO,DO - Slant Edges

AB, BC, CD, AD – Base Edges

4 - SLANT TRIANGULAR FACES

- AOD– 1
- DOC - 2
- COB - 3
- BOA - 4



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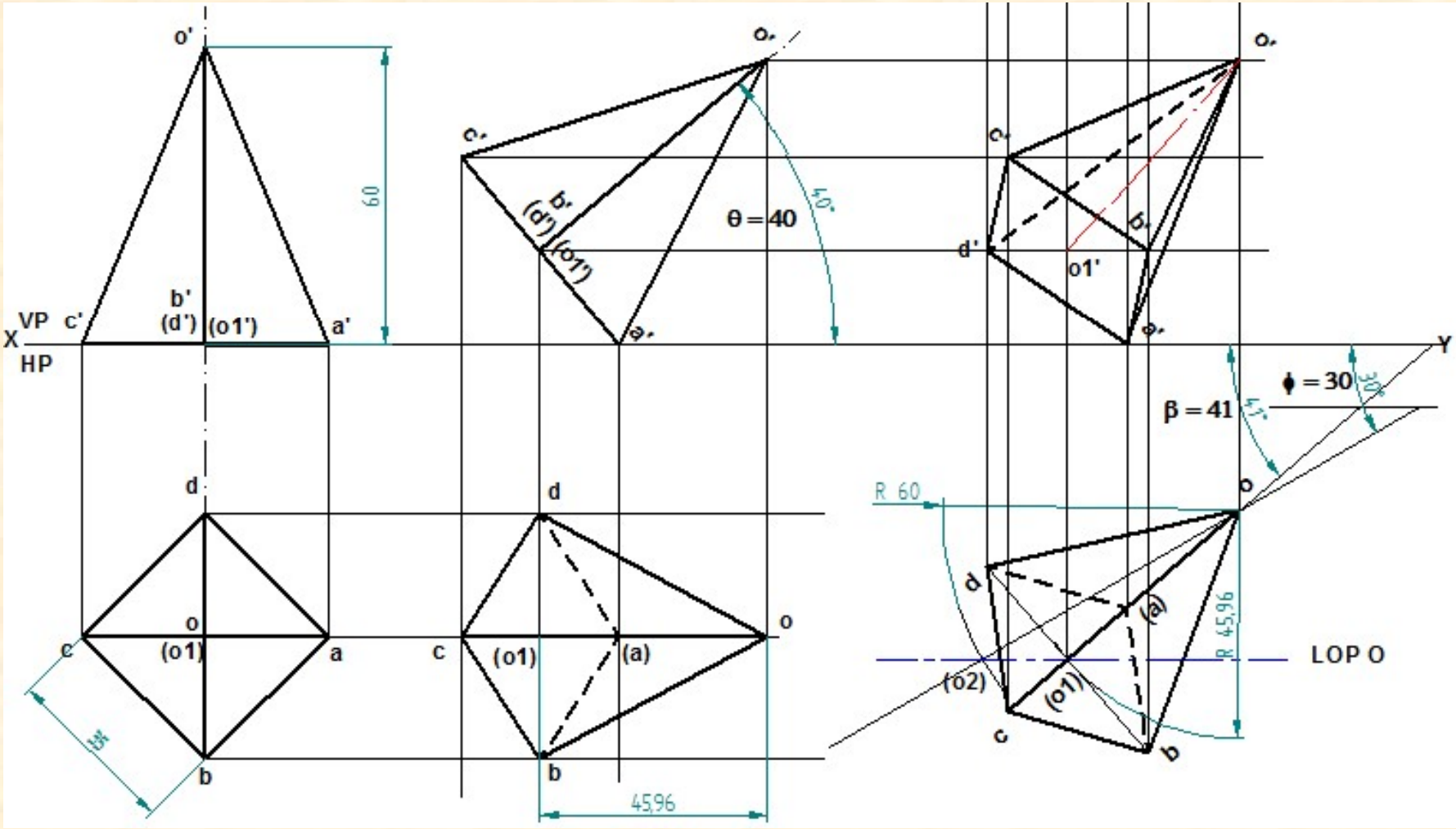

Thank You

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- Your prompt Feedback will always helps for improvement. (+ ve or – ve)
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