ENGINEERING GRAPHICS

UNIT III

PROJECTION OF SOLIDS

PROJECTION OF SOLIDS

1. Polyhedron (Prism (or) Pyramid)

(i) Triangular

(ii) Rectangular

(iii) Square

(iv) Pentagonal

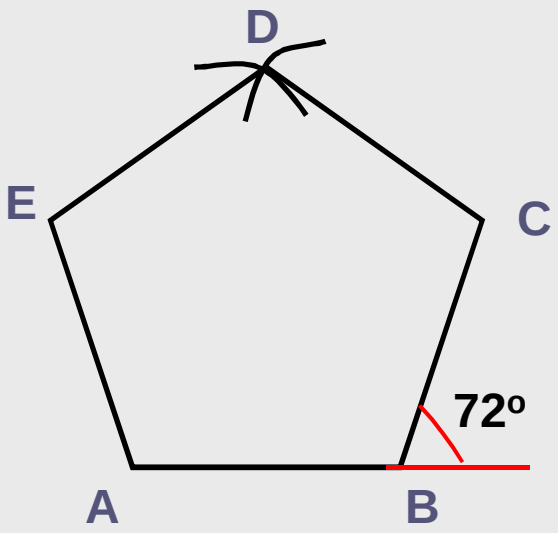
(v) Hexagonal

2. Solids of revolution

(i) Cylinder

(ii) Cone

How to construct a Pentagon



Total Angle = 360^o

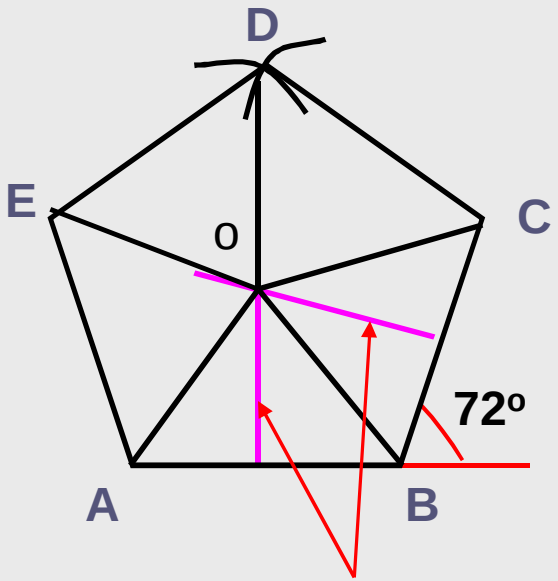
Number of sides = 5

Required Angle = $\frac{360^o}{5} = 72^o$

Procedure:

1. **Draw the line AB of given length**
2. **From A draw a line for an angle 72^o and for the given length**
3. **From B draw a line for angle of 72^o and for the given length**
4. **With C as centre draw an arc with the given length as radius**
5. **With E as centre, cut the arc with the same radius**

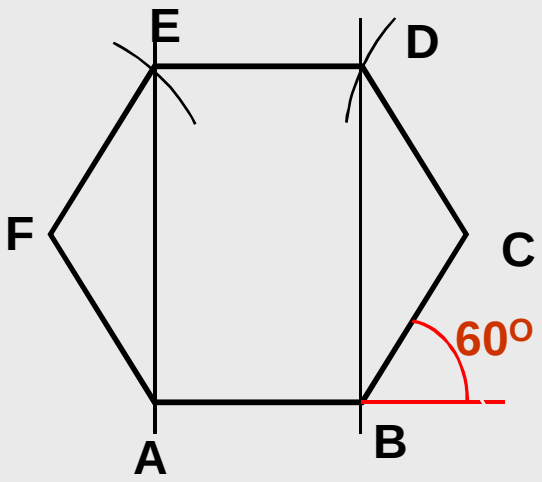
How to find mid point of a polygon having odd number of sides



Bisectors for sides AB and BC

1. Draw another bisector for the side BC
2. The cutting point of these two bisectors will be the mid point of the pentagon
3. Join the mid point with all the corners of the polygon.
4. The lines joining the corners and mid point actually represent the Longer Edges in the Plan or Elevation.

How to construct a Hexagon



Total Angle = 360°

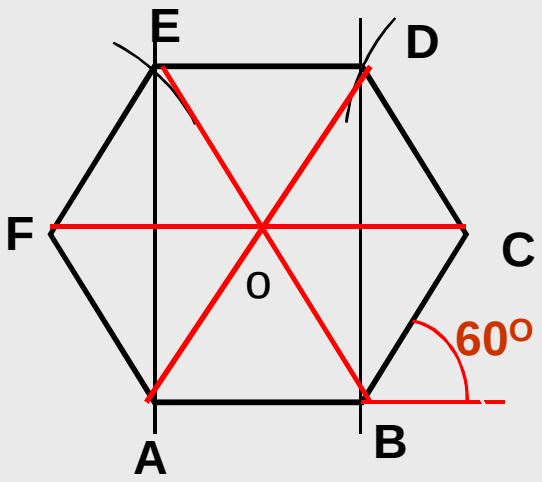
Number of sides = 6

Required Angle $= \frac{360^\circ}{6} = 60^\circ$

Procedure:

1. **Draw the line AB of given length**
2. **From A and B draw lines BC and AF for the angle 60° and for the given length**
3. **Draw two perpendicular lines from A and B**
4. **With C and F as centres draw arcs of radius given length two cut the perpendicular lines at E and D.**
5. **Join CD, DE and EF.**

How to find mid point of polygon having even number of sides



1. Join the diagonally opposite corners to get the longer edges.
2. Cutting point all these diagonal lines represent the Mid point of the polygon.
3. Actually the line joining opposite corners represent the longer edges of the solid.

Conditions

1. Axis of the solid perpendicular to HP and Parallel to VP
2. Axis of the solid perpendicular to VP and Parallel to HP
3. Axis of the solid Parallel to both HP and VP
4. Axis of the solid Parallel to VP and inclined to HP
5. Axis of the solid Parallel to HP and inclined to VP

Types of Problems

CASE 1: Inclined to HP

I. Axis inclined to HP

II. Base inclined to HP

III. Face inclined to HP

CASE 2: Inclined to VP

I. Rectangular face rest on HP

II. Longer edge (or) Slant edge rest on HP

III. Corner (or) base edge rest on VP

CASE 3: Corner lifting problem

Continue…

CASE 4: Freely suspended by string

CASE 5: Axis is parallel to VP

i. One of its triangular face on ground (HP)

ii. One of its generator (Sloping side) on ground (HP)

CASE 6:

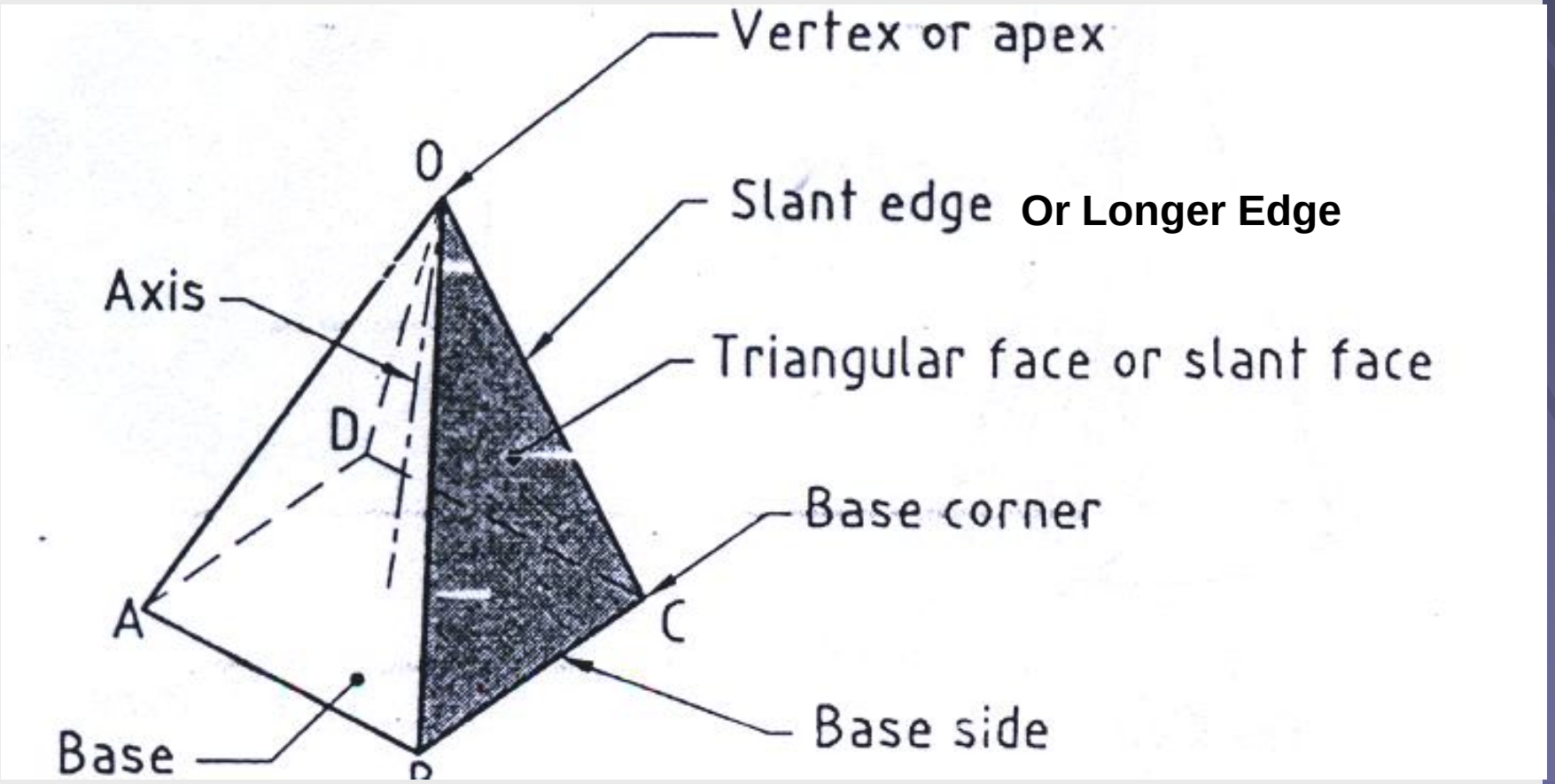
i. One of the triangular face is vertical

(or)

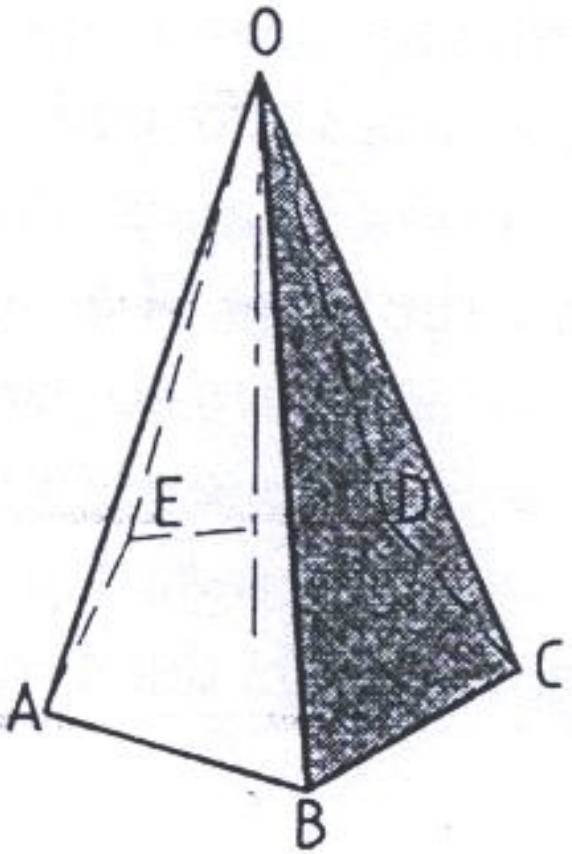
ii. One triangular face is perpendicular to both HP and VP

CASE 7: Solid diagonal is vertical

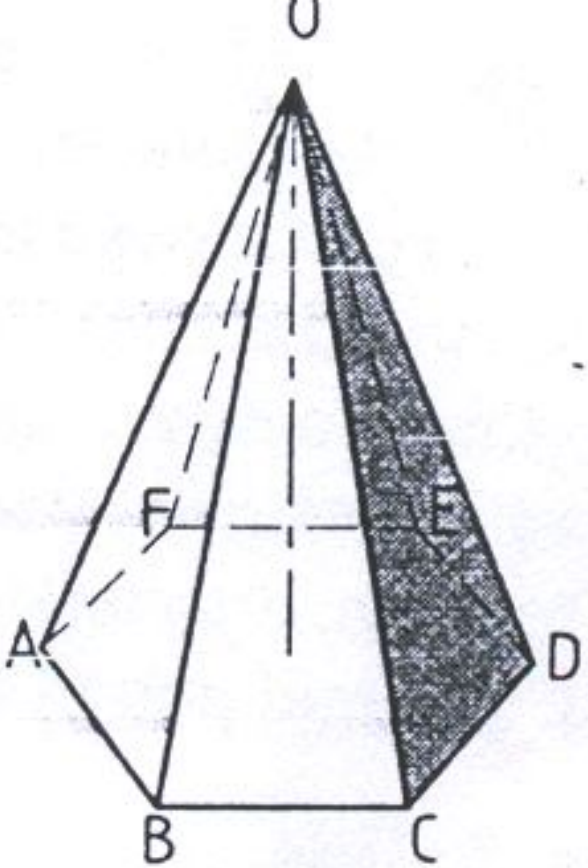
Pyramids


Vertex or apex
O
Slant edge
Or Longer Edge
Axis
Triangular face or slant face
D
Base corner
A
C
Base side
Base

Pentagonal & Hexagonal Pyramids

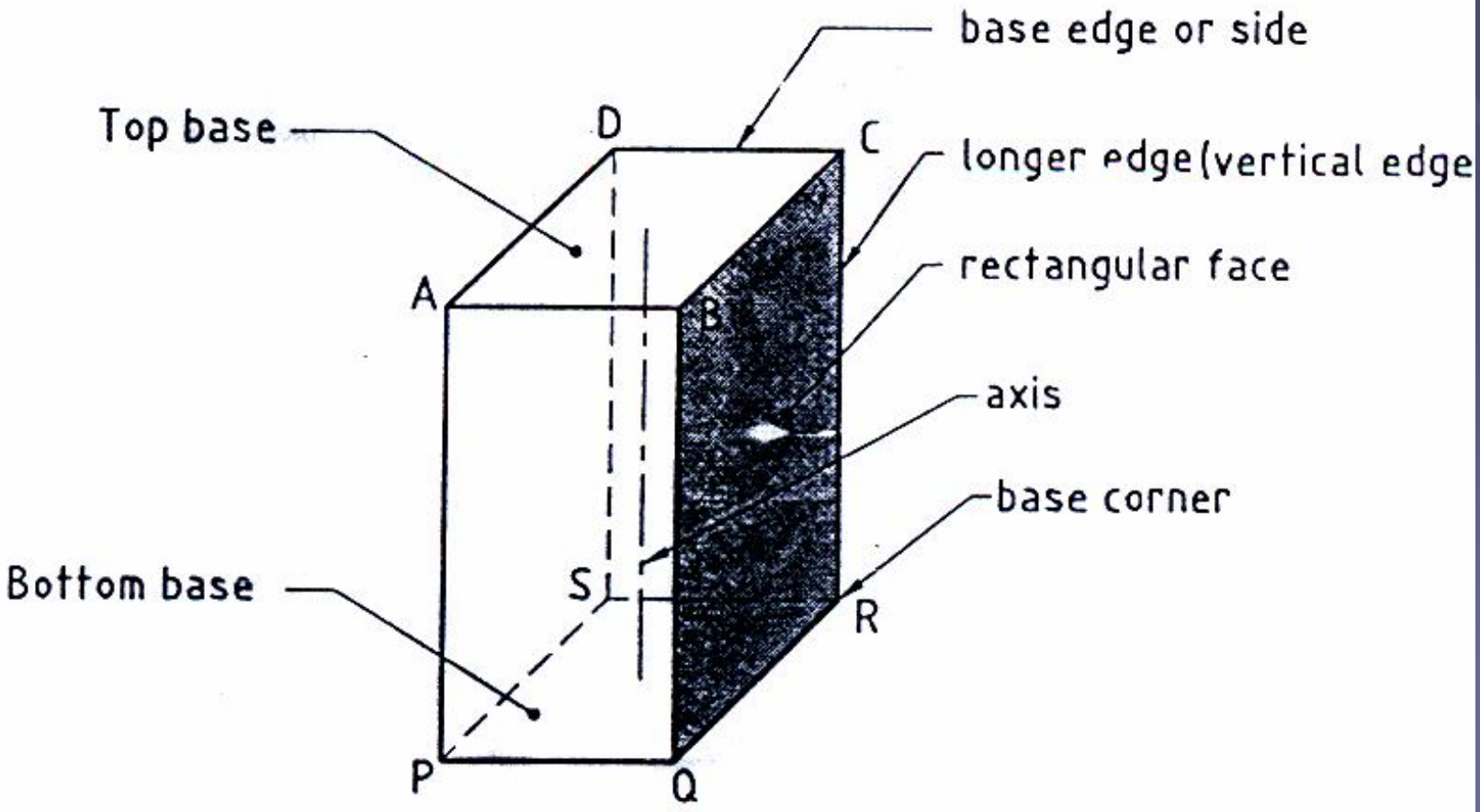


(iv) Pentagonal



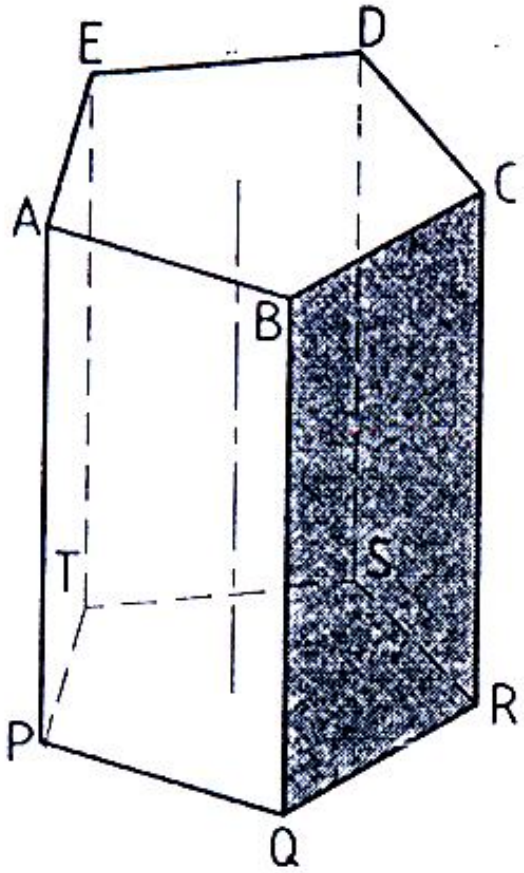
(v) Hexagonal

Prism

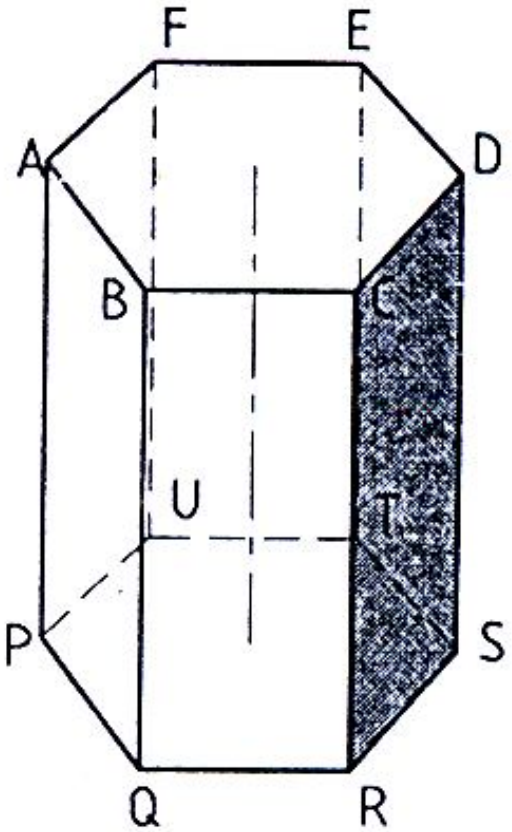


(i) Square prism

Pentagonal and Hexogonal Prisms.

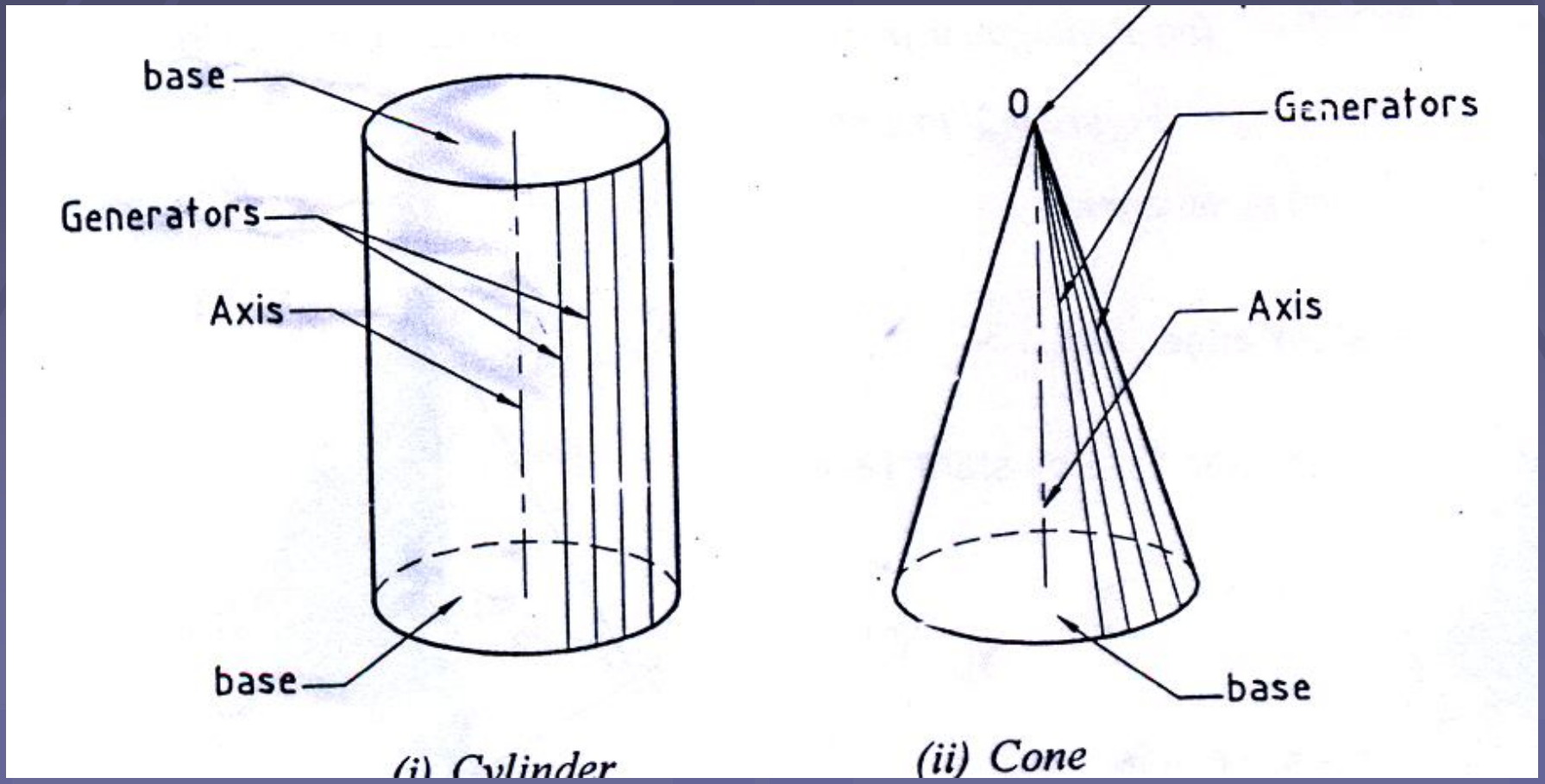


(iv) Pentagonal prism



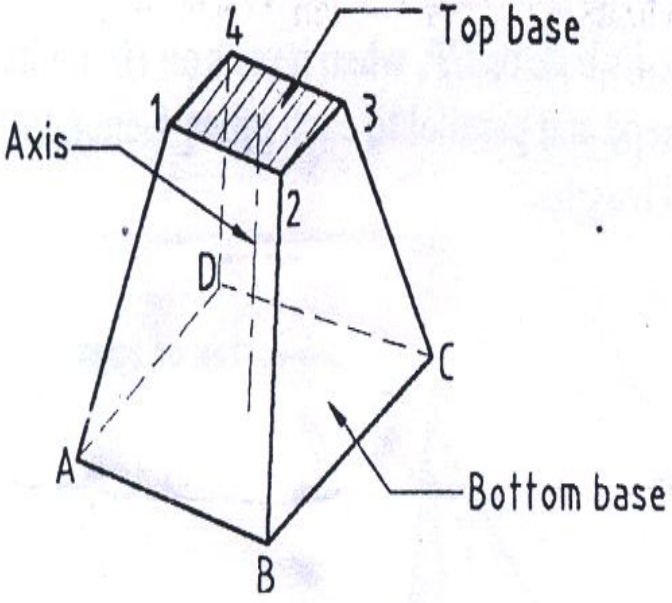
(v) Hexagonal prism

Solids of Revolution (Cylinder and Cone)

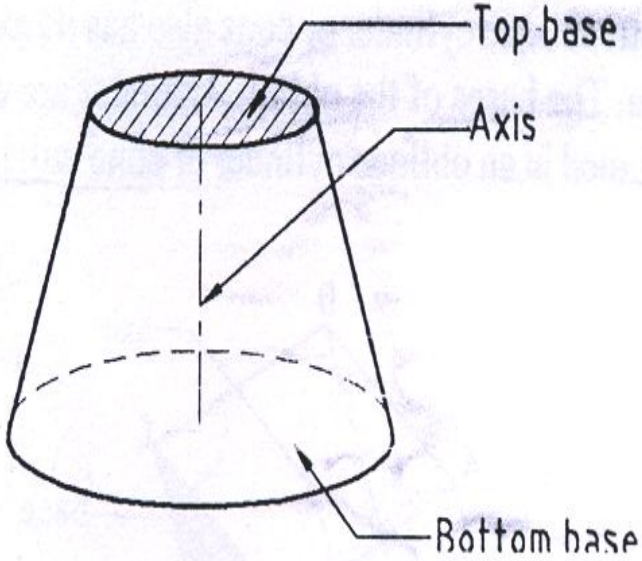


Frustum of solids

When any solid is cut by a plane which is parallel to the base, then it is called a frustum of a solid



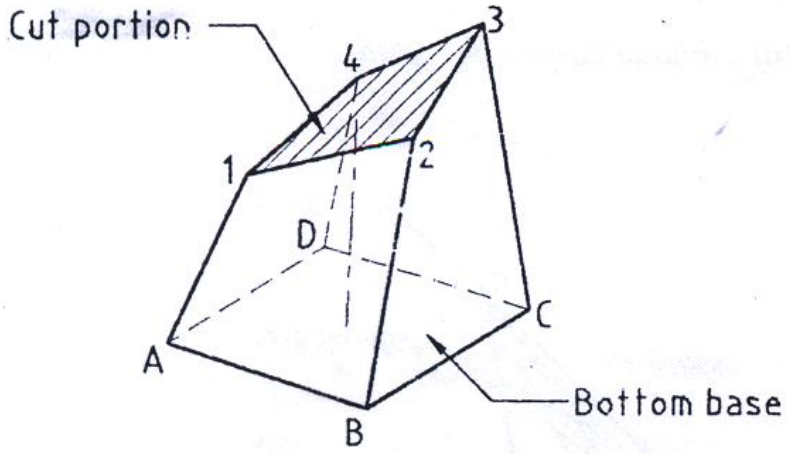
(i) Frustum of a square pyramid



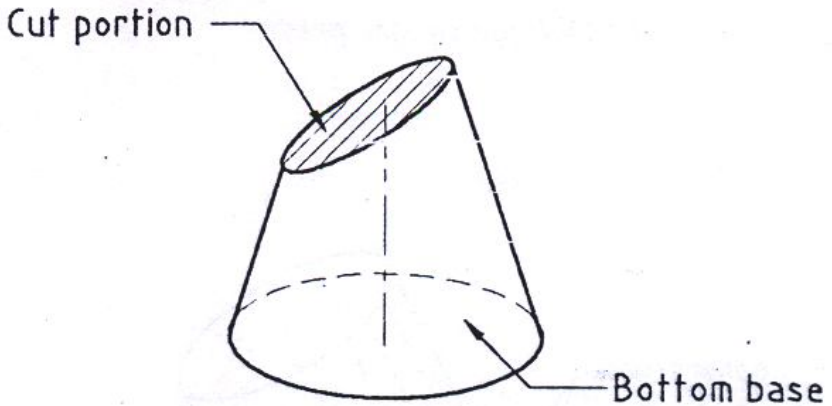
(ii) Frustum of a cone

Truncated Solids

When any solid is cut by a plane which is inclined to the base then it is called a truncated solid.



(i) Truncated pyramid



(ii) Truncated cone

Object Shape and its importance

- Object shape is nothing but the base shape of any solid
- In Projection solids the projection should be started with a view, in which the object shape of the solid appears.

Points to be remembered while drawing the object shape

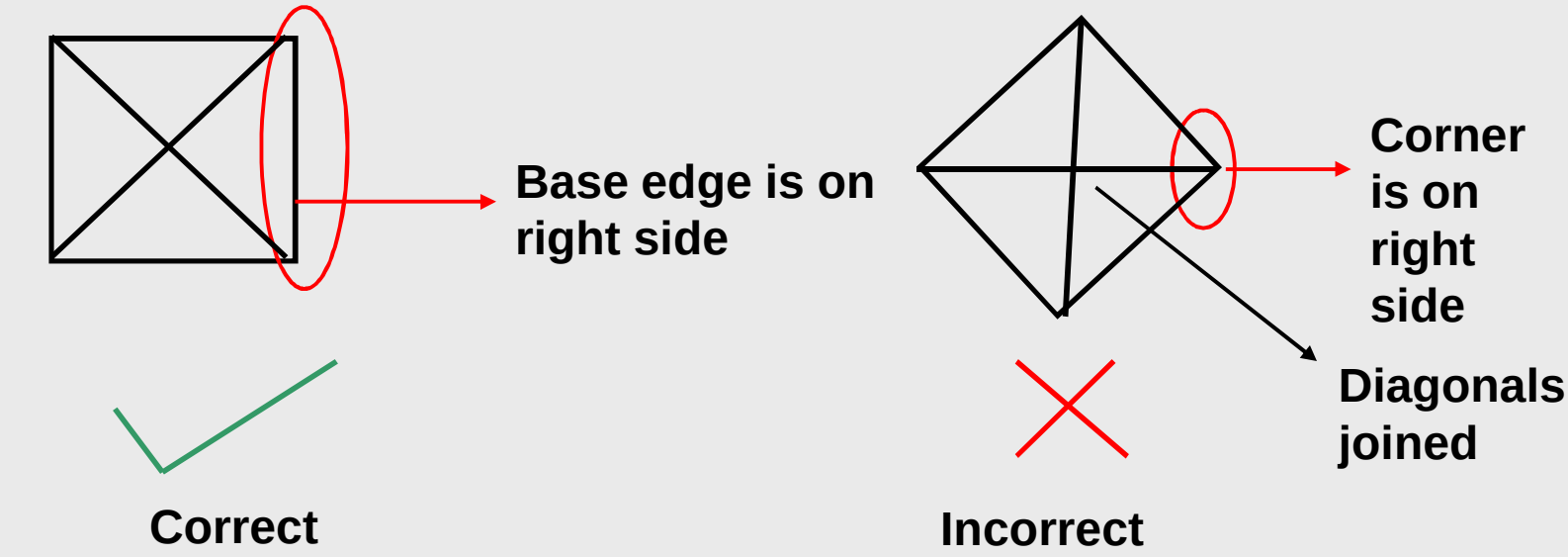
- Always the solid is tilted towards right side.
- Hence the resting part should be kept on the right side, when the object shape is drawn.
- For pyramids the diagonals should be joined (longer edges should be shown)
- For prisms diagonals should not be joined (longer edges will coincide with the corners in the top face)

Case 1: Axis inclined to HP

1. Draw the Object shape (Base shape of solid) in the plan
2. Draw the elevation
3. Tilt the elevation for the given angle
4. Redraw the top view.

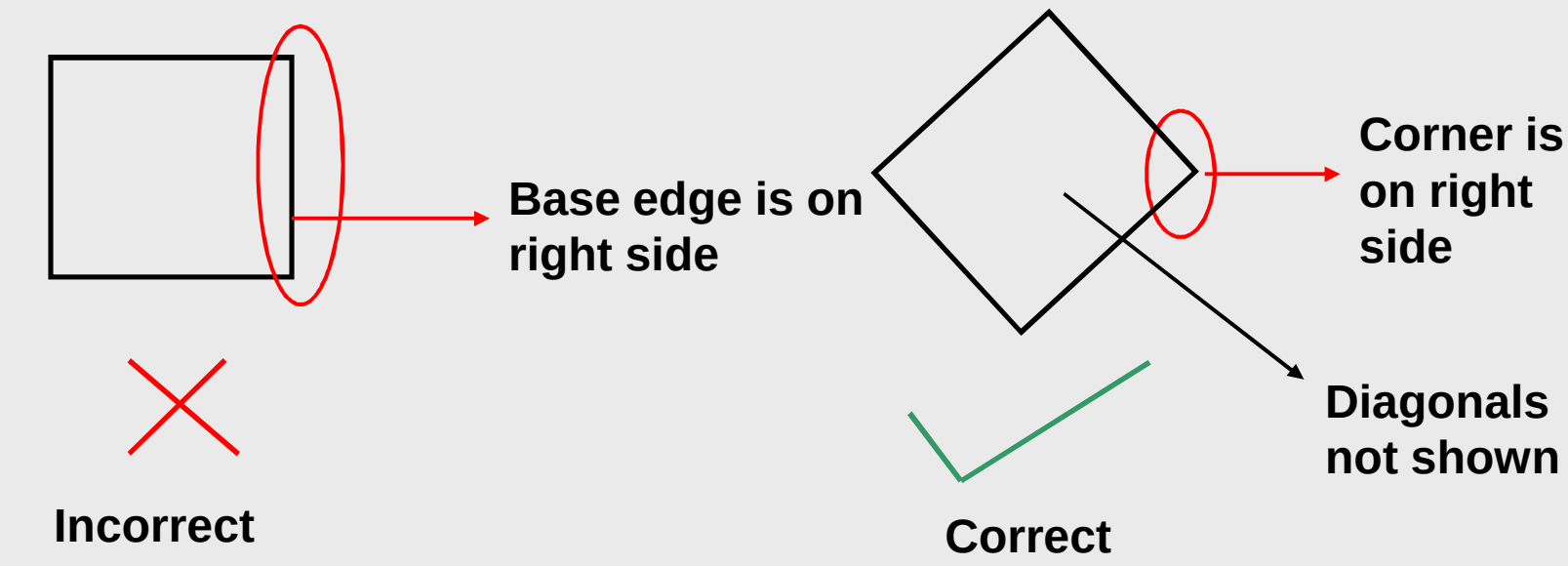
CASE 1:Resting part is on right side

E.g : **Square pyramid**, resting on HP with one of its base edges



Resting part is on right side

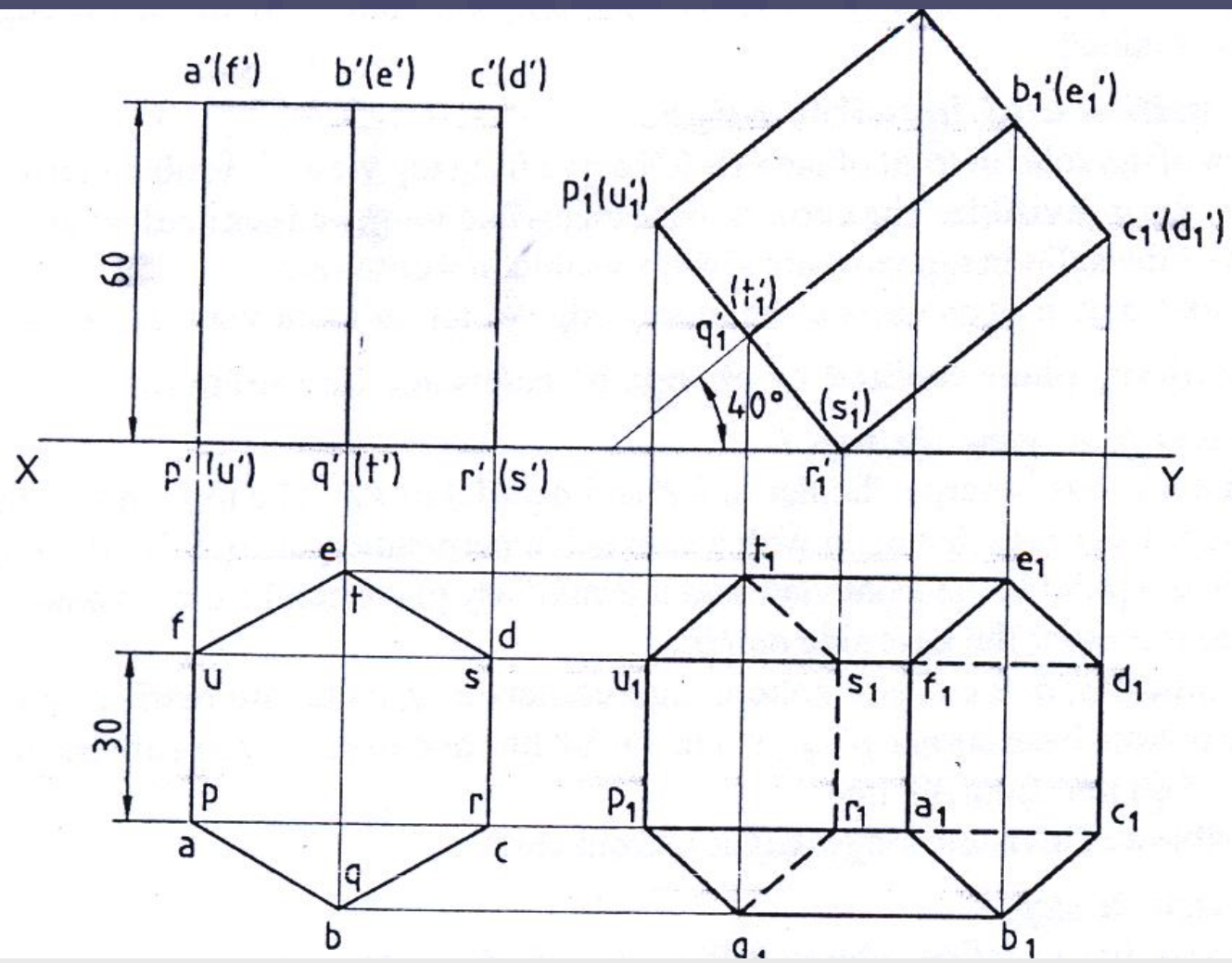
E.g : **Square prism**, resting on HP with one of its base corner



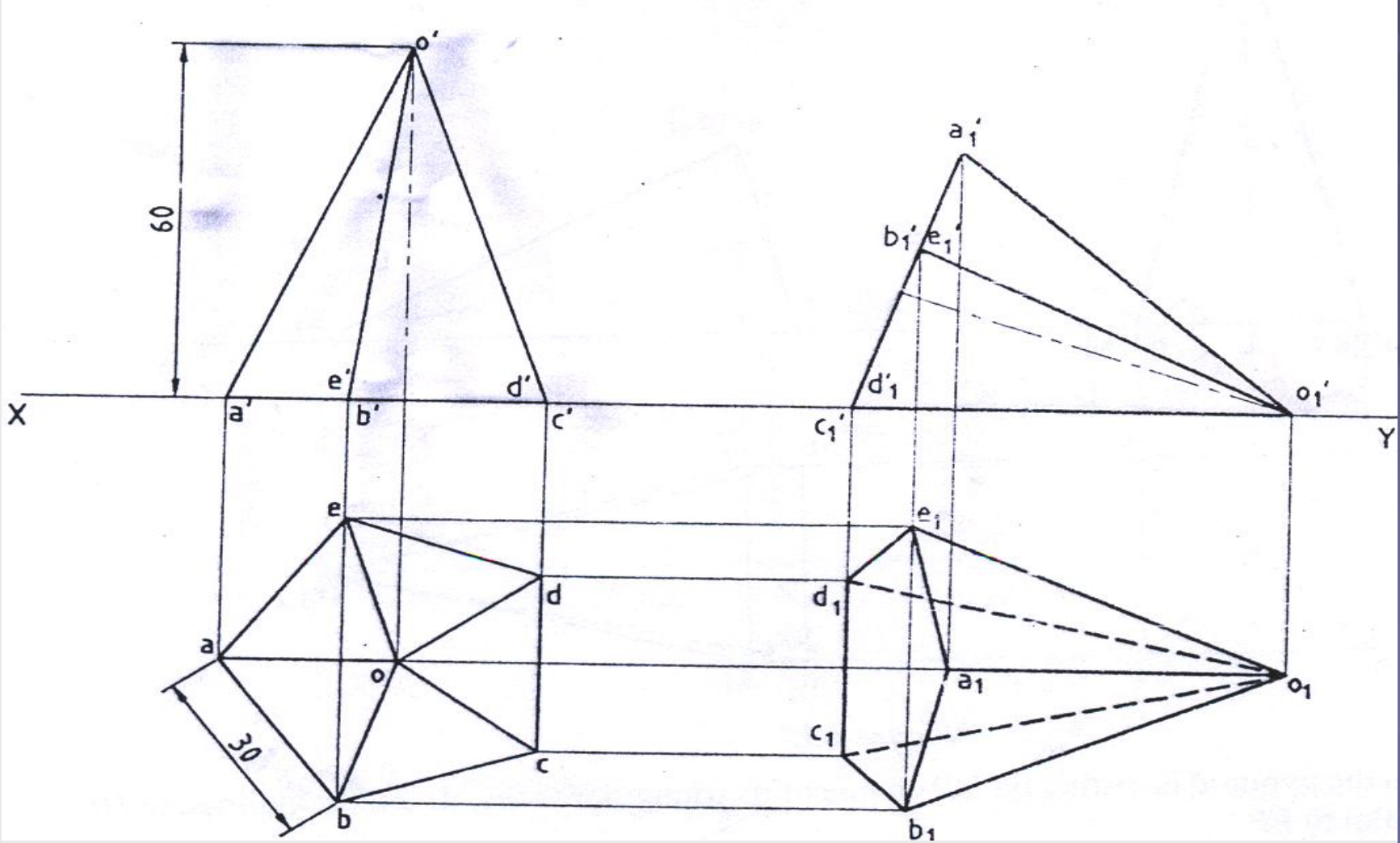
Inclined to HP

1. A hexagonal prism of base side 30mm axis length 60mm is resting on HP on one of its base sides with its axis inclined at 40º to HP and parallel to VP. Draw its projections.
2. A pentagonal pyramid of base side 30mm and axis length 60mm is resting on HP on one of its triangular faces with its axis is parallel to VP. Draw its projections.
3. Pentagonal pyramid, side of base 25mm and axis 55mm long, lies with one of its slant edges on HP such that its axis is parallel to VP. Draw its projections. (UQ)
4. A cylinder of base diameter 50mm and axis length 70mm is resting on HP on a point on the circumference of the base with its axis inclined at 50º to HP and parallel to VP. Draw its projections.
5. A cone of base diameter 50mm and axis length 60mm is resting on HP on a point on the circumference of the base. Its base is inclined at 50º to HP and perpendicular to VP. Draw its projections.

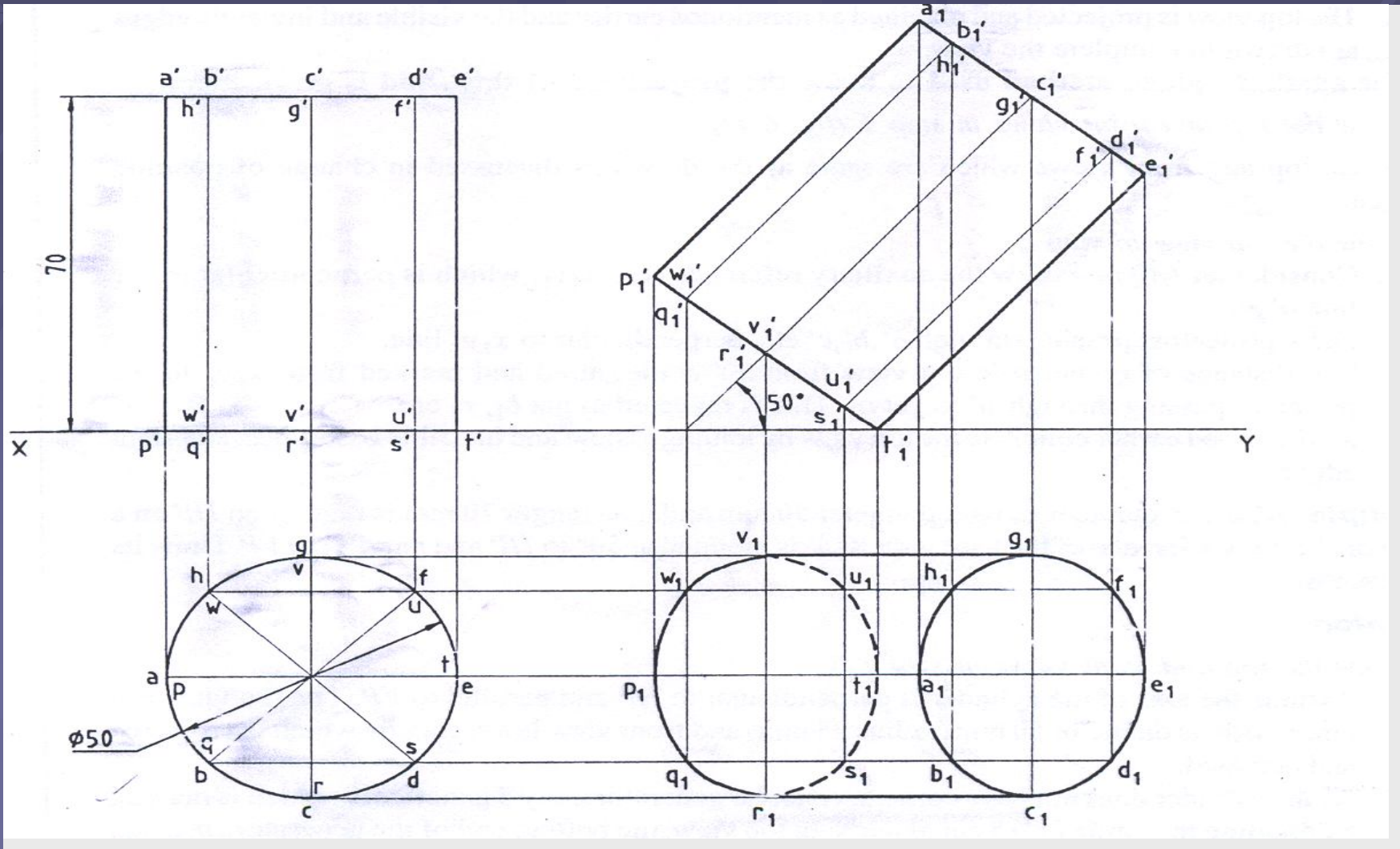
1.Projection of hexagonal prism with its axis inclined to HP



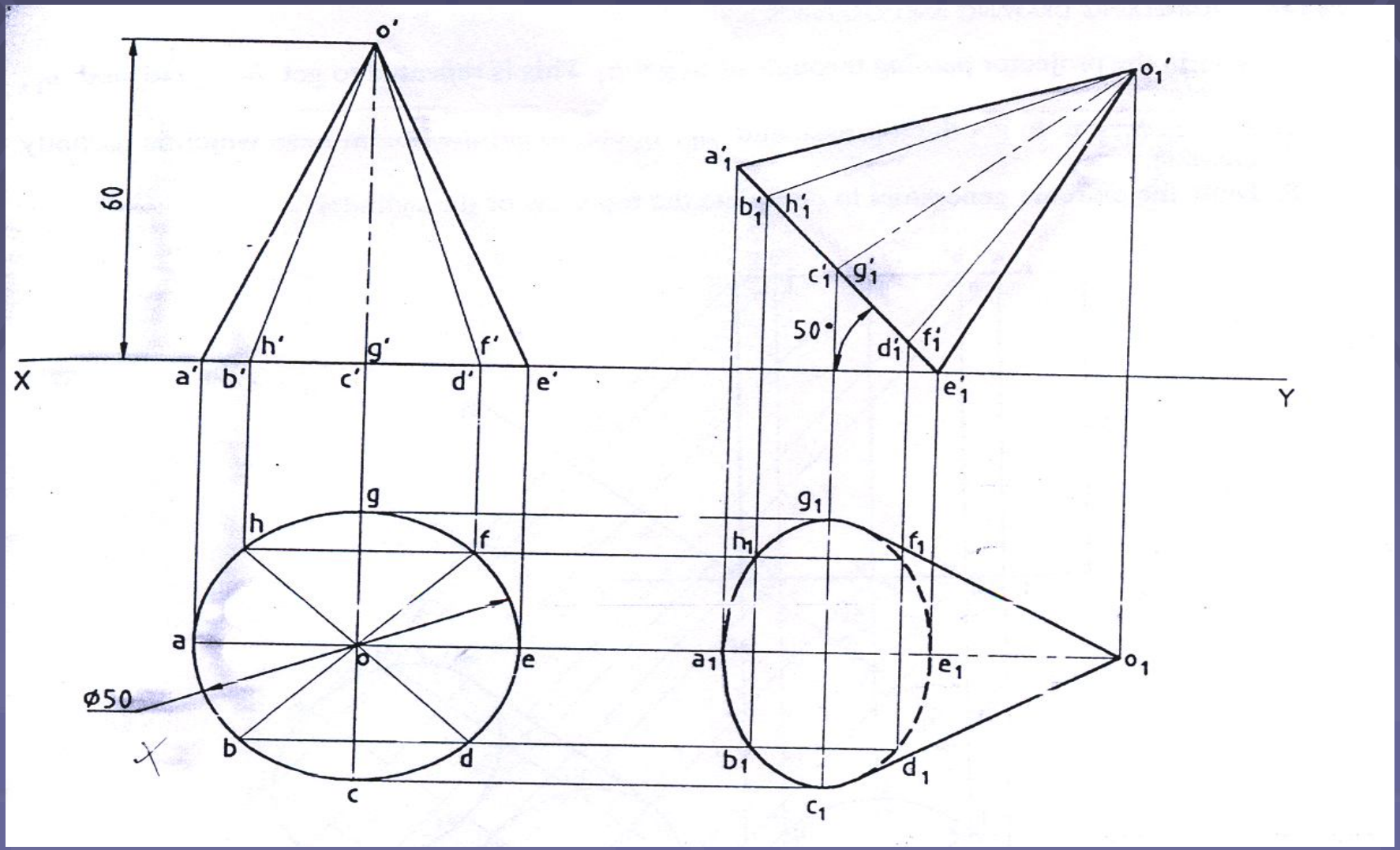
2.Pentagonal pyramid resting on HP on one of its triangular face with its axis parallel to VP



3.Projection of cylinder with its axis inclined to HP



5.Projection of cone with its base inclined to HP



Problems on CASE 1 – Prisms & Cylinder (Inclined to HP)

Axis Inclined:

1. A hexagonal prism of base side 30 mm axis length 60 mm resting on HP on one of its base sides with its axis inclined at 40º to HP and parallel to VP. Draw its projections.
2. Draw the projections of pentagonal prism of base side 20 mm and the axis length 50 mm when it rests on the ground (HP) on one of its corners of the base and the axis inclined 35º to the ground and parallel to VP.
3. A cylinder of base diameter 50 mm and axis length 70 mm is resting on HP on a point on the circumference of the base with its axis inclined at 50º to HP and parallel to VP. Draw the projections.

CASE 1 – Prism & Cylinder

4. A rectangular prism of size 30 mm × 40 mm and altitude 60 mm rest on HP and one of its longer edge (longer side) is of the base on HP. Its axis is inclined at 40º to HP and parallel to VP. Draw its projections. (H.W)
5. Draw the projections of a triangular prism of base side 25 mm and axis 60 mm resting on HP on one of its base sides with the axis inclined at 40º to HP and parallel to VP. (H.W)

Base Inclined:

1. A hexagonal prism side of base 25 mm & axis 50 mm long rests with one of its base corners on HP such that its base makes an angle of 60º to HP and its axis is parallel to VP. Draw its projections.

CASE I – Pyramids & Cone

Axis Inclined:

1. A hexagonal pyramid side of base 25 mm and axis 50 mm long, rest with one of the edges of its base on HP and its axis is inclined at 30º to HP and parallel to VP. Draw its projections
2. Draw the projections of a pentagonal pyramid of base 25 mm side & axis 60 mm long when it is lying on HP on one of its base edges, such that the axis is parallel to VP and inclined at 30º to HP. **(H.W)**
3. Draw the projections of a cone, base 30 mm diameter and axis 50 mm long, resting on HP on a point of its base circle with the axis making an angle of 45º with HP and parallel to VP.

CASE 1 – Pyramids & Cone

Base Inclined:

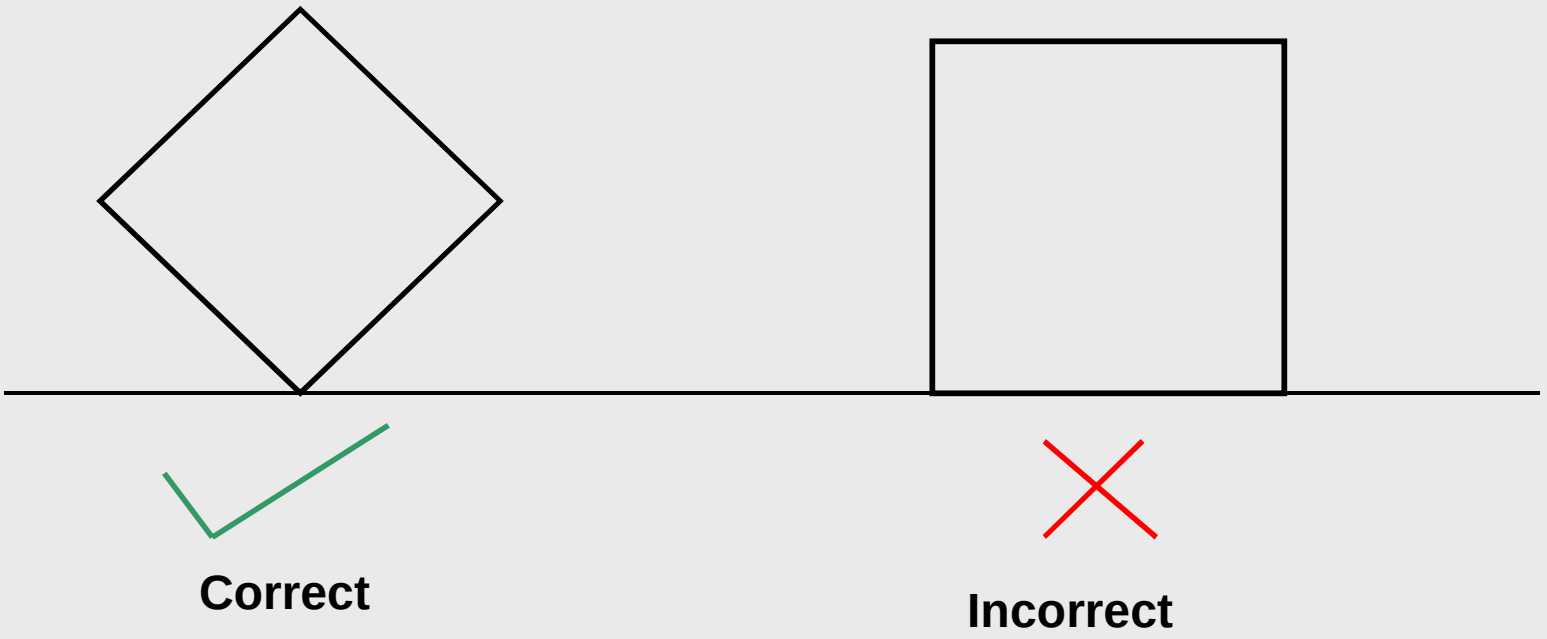
1. A pentagonal pyramid side of base 20 mm and axis 45 mm long rests with one of its corners on HP such that the base is inclined at an angle of 60º to HP and one side of base is perpendicular to VP. Draw its projections.
2. A tetrahedron of 40 mm side rests with one of its edges on HP and perpendicular to VP. The triangular face containing that edge is inclined at 30º to HP. Draw its projections.

Case 2: Axis Inclined to VP

1. Draw the Object shape in Elevation
2. Draw the plan
3. Tilt the plan to the given angle
4. Redraw the elevation

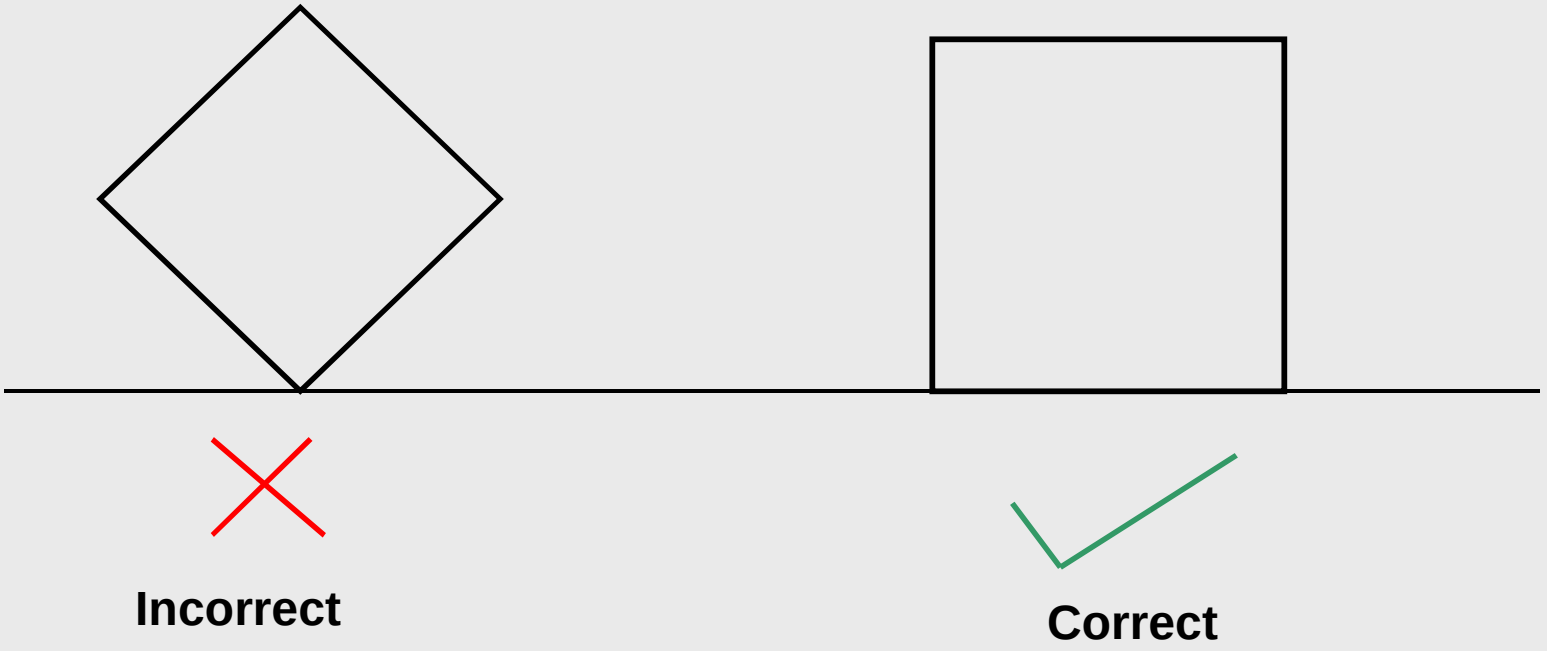
Points to be remembered while drawing object shape in CASE 2 - **Prism**

Condition: Square Prism, resting on HP with one of its longer edges



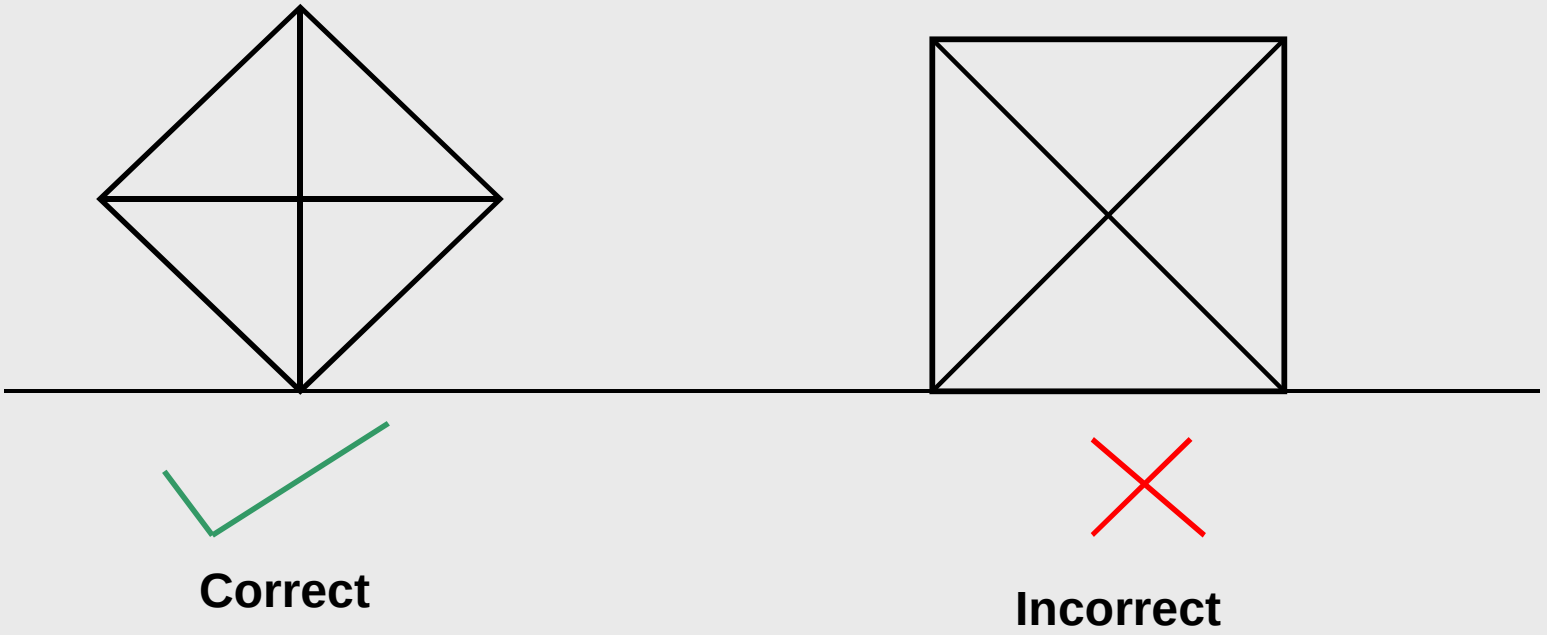
Points to be remembered while drawing object shape in CASE 2 - **Prism**

Condition: Square Prism, resting on HP with one of its rectangular faces



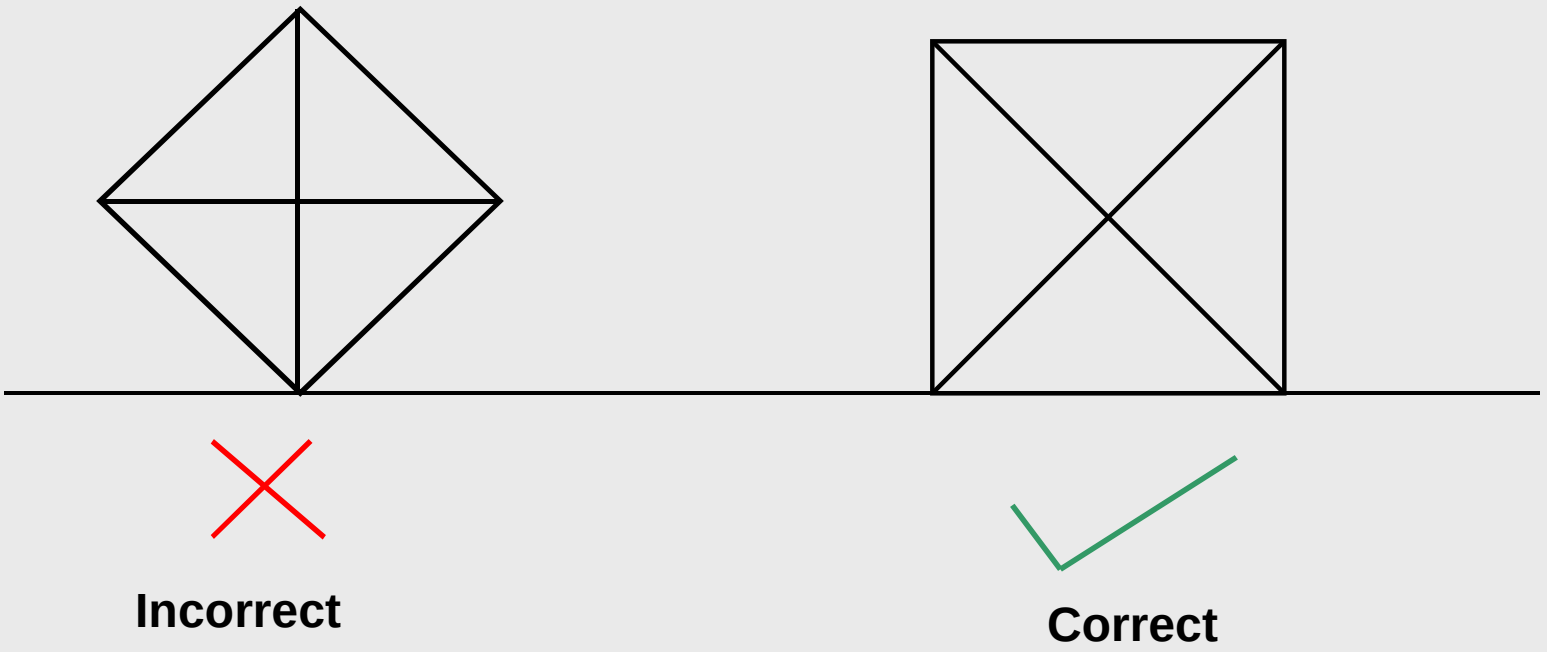
Points to be remembered while drawing object shape in CASE 2 - **Pyramid**

Condition: Square Pyramid, resting on HP with one of its corners



Points to be remembered while drawing object shape in CASE 2 - **Pyramid**

Condition: Square Pyramid, resting on HP with one of its Edges



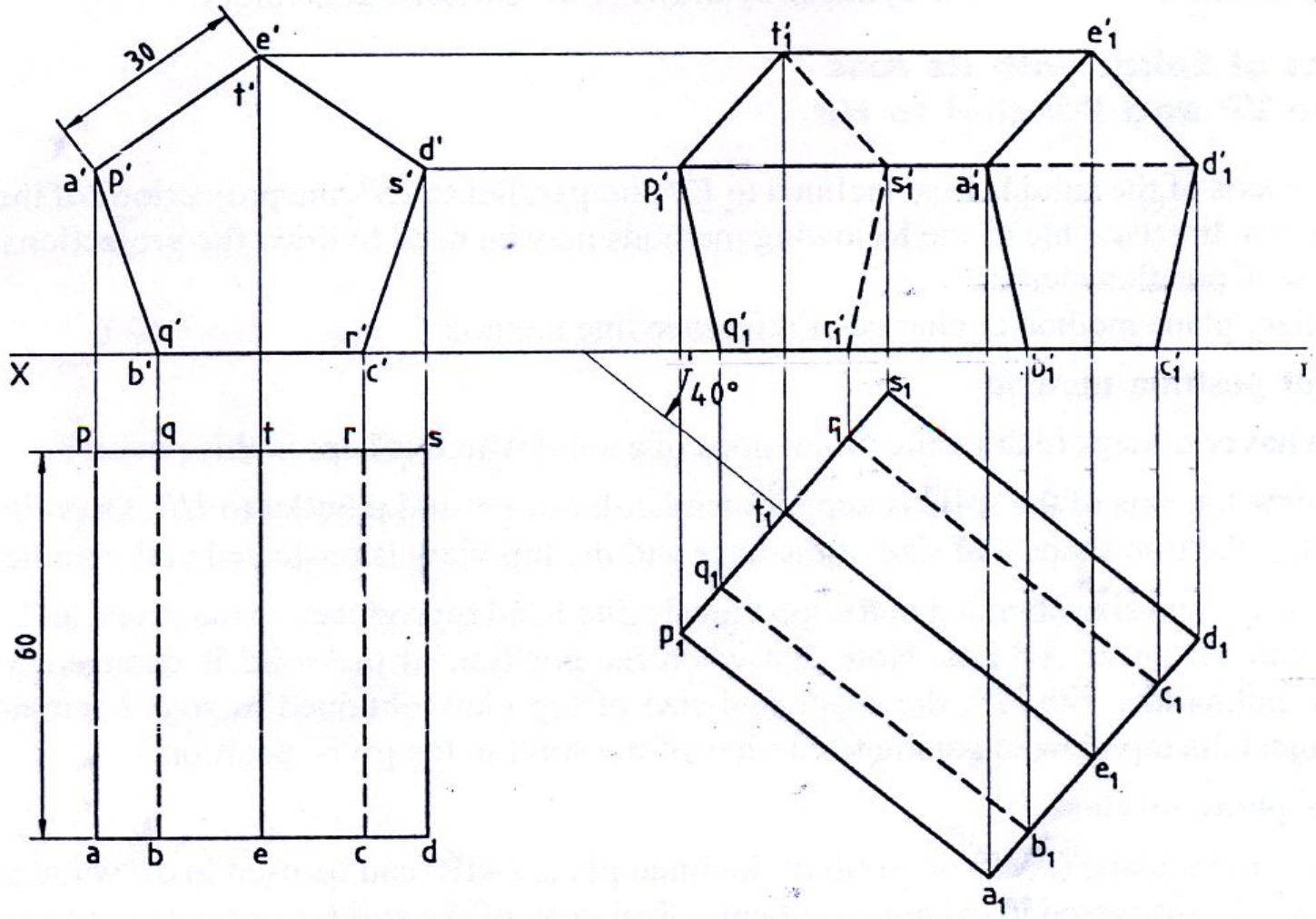
CASE 2: Prisms & Cylinder (Inclined to VP

1. A square prism of base side 35 mm and axis length 60 mm lies on HP on one of its longer edges with its face equally inclined to HP. Draw its projections when its axis inclined at 30º to VP.
2. A square prism of base side 35 mm and axis length 60 mm is resting on HP on one of its longer edges with its axis inclined at 25º to VP. One of the face containing resting edge inclined 25º to HP. Draw the projections.
3. A pentagonal prism of base side 35 mm & axis length 65 mm is resting on HP on one of its rectangular faces with axis is inclined at 40º to VP. Draw the projections.

Inclined to VP

3. A pentagonal prism of base side 30mm and axis length 60mm is resting on HP on one of its rectangular faces with its axis is inclined at 40º to VP. Draw its projections.

Projection of Pentagonal prism with its axis inclined to VP and parallel to HP



CASE 2: Prisms & Cylinder (Inclined to VP

4. Draw the projections of a pentagonal prism of 30 mm side of base and 65 mm long. It is lying on one of its longer edges on HP with the rectangular face perpendicular to HP such that the axis makes 60º with VP.
5. A cylinder of base diameter 40 mm & axis length 60 mm resting on one of its generator on HP with its axis inclined at 45º to VP. Draw the projections.
6. A hexagonal prism, side of base 25 mm & axis 60 mm long lies with one of its rectangular face on HP, such that the axis is inclined at 45º to VP. Draw the projections.

CASE 3: Corner lifting problem

A right pentagonal pyramid side of base 30 mm & altitude 60 mm rests on one of its edges of the base in HP, the base being lifted up until the highest corner, in it is 40 mm above HP. Draw its projection when the edge in which it rests is made perpendicular to VP.

Case 4:Freely Suspended by String

Formula to find centre gravity when the solid is freely suspended by string:

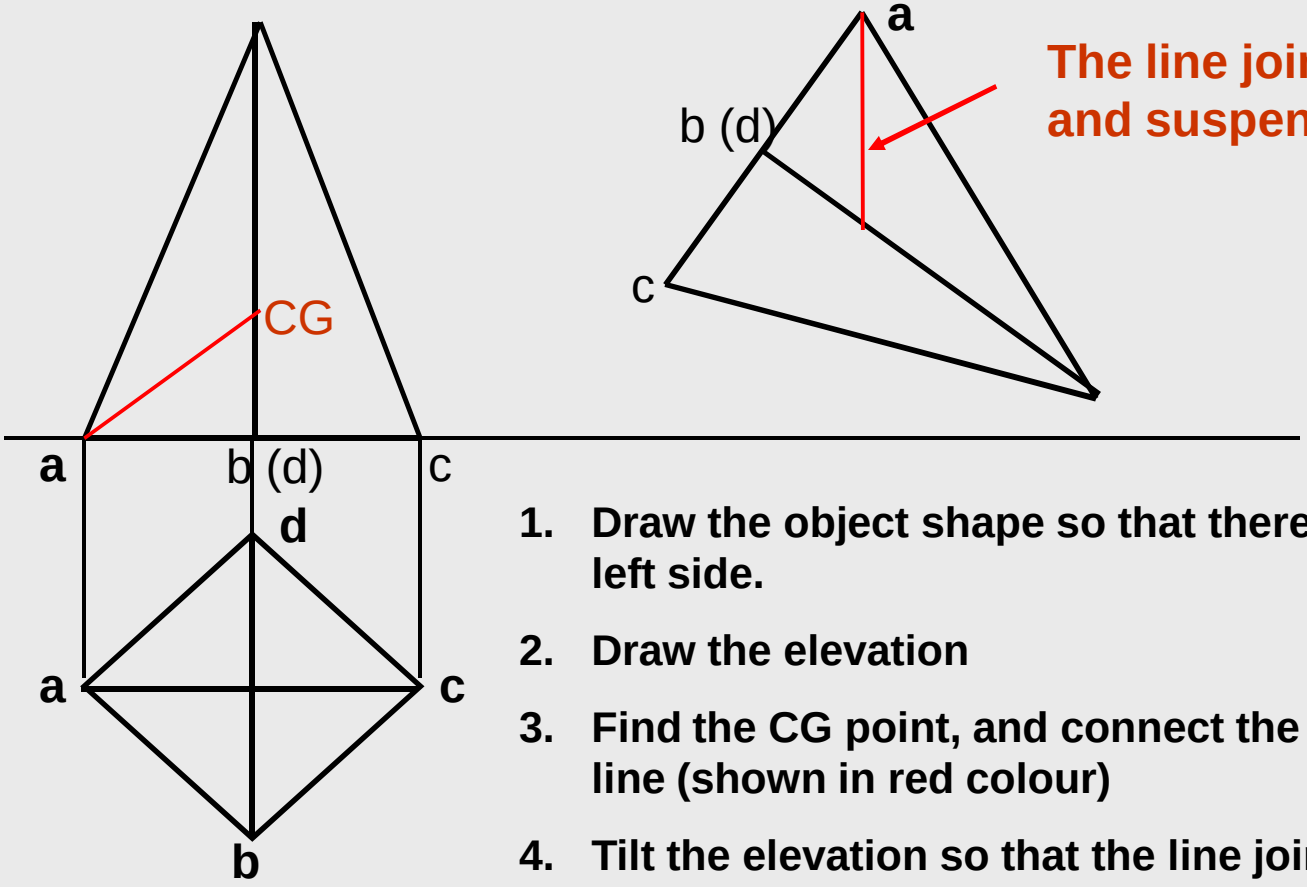
1. For Pyramids,cone CG = 1/4th of the Axis length
2. For Prisms, cylinder CG = Half of the Axis length

Freely suspended by a string

Conditions to draw the views:

1. Draw the object shape in the plan, so that a corner is placed on the left side.
2. The line connecting the suspended corner (corner on right side), and the CG point should be perpendicular to reference axis.

Freely Suspended by a string



The line joining the CG and suspended corner

1. **Draw the object shape so that there is a corner on left side.**
2. **Draw the elevation**
3. **Find the CG point, and connect the a and CG by a line (shown in red colour)**
4. **Tilt the elevation so that the line joining the point a and CG should be vertical to reference axis**

Freely suspended by a string

1. A square pyramid base 32 mm side & axis 60 mm long is freely suspended from one of the corners of its base with the axis parallel to VP. Draw its projections.
2. A pentagonal pyramid of side of base 30 mm and altitude 65 mm is suspended freely from a string attached to one corner of the base of the pyramid. The string is held such that the apex of the pyramid is touching. The axis of the pyramid is parallel to VP. Draw the projections.
3. A cone of diameter 40 mm and height 60 mm is freely suspended from one of its base points such that the axis is parallel to VP. Draw its front & top views.

Freely suspended by a string

4. A hexagonal prism of side 30 mm and axis length 60 mm is freely suspended by a string from one of its base corners with its axis parallel to VP. Draw its projections.

5. A cylinder of base diameter 40 mm & axis length 60 mm is freely suspended from one of its base pointer such that the axis is parallel to VP. Draw its front & top view.

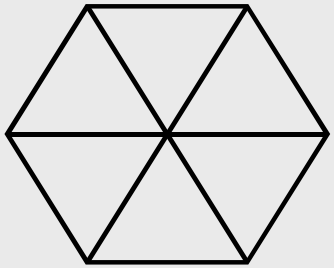
CASE 5

One of its triangular face on ground (HP) or one of the slant edge on HP (or) one of its generators (sloping side) on ground (Axis parallel to VP)

1. Draw the object shape in plan
2. Draw the elevation
3. Tilt the elevation completely
4. Redraw the plan

One of the triangular faces on ground, sloping sides on ground, generators on ground **(Axis parallel to VP)**

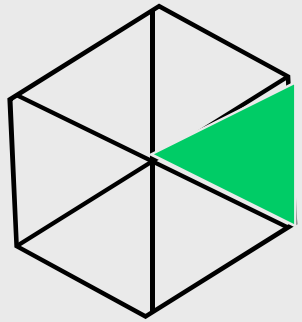
Hexagonal pyramid resting on HP with one of its triangular faces with its axis parallel to VP



Incorrect

Reason:

When we tilt the longer edge (sloping edge) will rest on ground



Correct

Reason:

Since tilting is done towards right, when we tilt the solid, the shaded triangular face will rest on ground

CASE 5

Conditions: One of its triangular face on ground, one of the slant edge on ground, one of its generators on ground

1. A hexagonal pyramid of side of base 25 mm, axis 50 mm long lies with one of its triangular faces on the HP and its axis, is parallel to VP. Draw the projection.
2. A pentagonal pyramid, side of base 30 mm and axis 60 mm long is lying with one of its triangular faces on the HP and axis parallel to the VP. Draw its projections.
3. A pentagonal pyramid, side of base 25 mm and axis 55 mm long, lies with one of its slant edges on HP such that its axis is parallel to VP. Draw its projections.

CASE 5

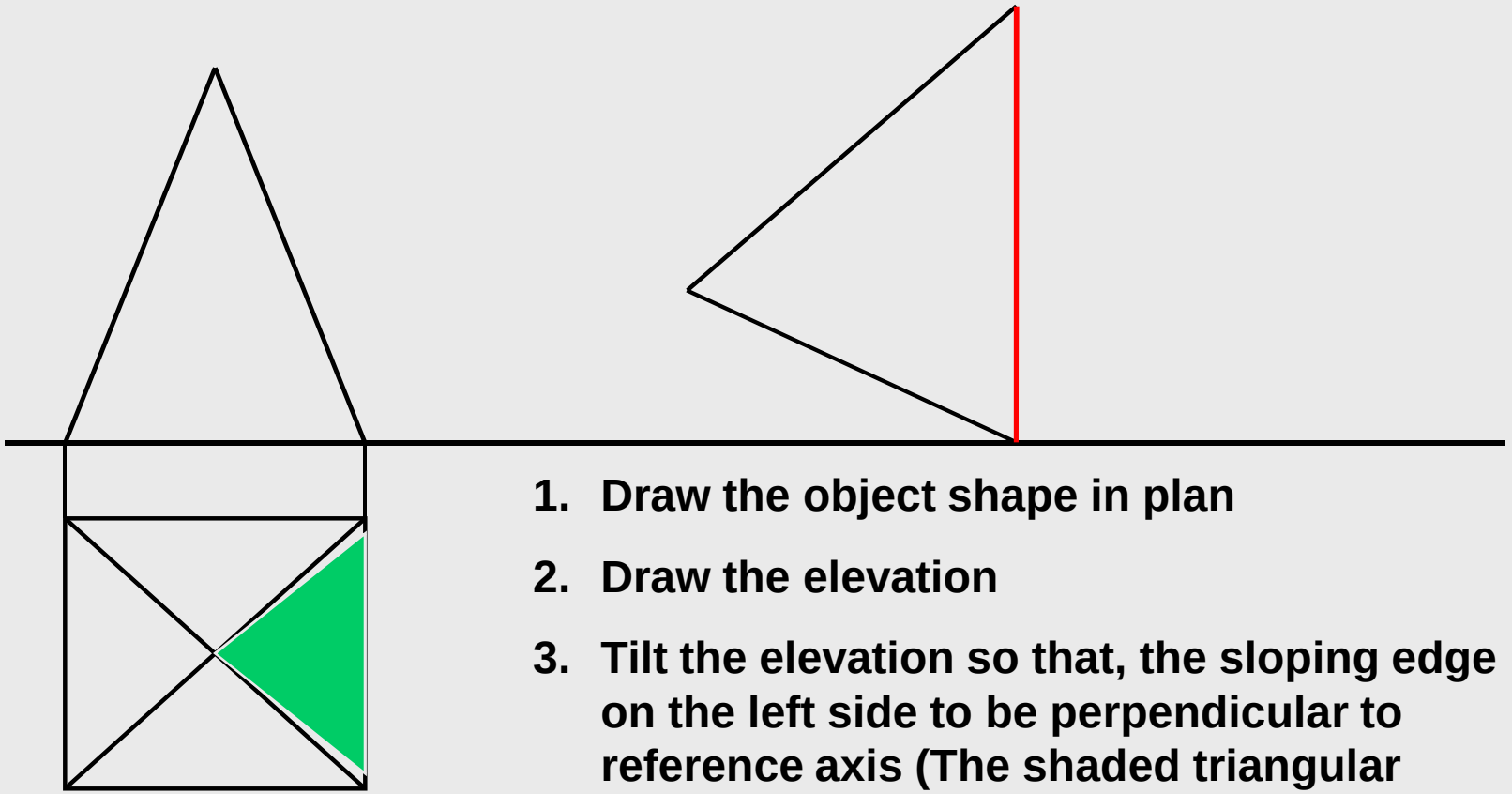
Conditions: One of its triangular face on ground, one of the slant edge on ground, one of its generators on ground

4. A cone of base diameter 50 mm and axis length 60 mm is resting on HP on one of its generators with its axis parallel to VP. Draw its projections.
5. A square pyramid of base side 35 mm & axis length 65 mm is resting on HP on one of its triangular faces with its axis parallel to VP. Draw its projections.

One of the triangular face on VP (or) one of slant edge on VP (or) one of the generator on VP.

1. A square pyramid of base side 35 mm & axis length 65 mm is resting on VP on one of it triangular face with its axis parallel t HP. Draw the projections.

CASE 6: One triangular face is vertical (or perpendicular to both HP and VP)



1. **Draw the object shape in plan**
2. **Draw the elevation**
3. **Tilt the elevation so that, the sloping edge on the left side to be perpendicular to reference axis (The shaded triangular face becomes perpendicular to both HP and VP)**
4. **Complete the plan**

Special Case 6: One triangular face is vertical (or perpendicular to both HP and VP)

1. A hexagonal pyramid of base side 30 mm and axis length 60 mm is resting on HP on one of its base edges with the face containing the resting edge perpendicular to both HP and VP. Draw its projections.
2. A pentagonal pyramid of base side 30 mm and axis length 60 mm is resting on HP on one of its base corner with its axis parallel to VP. Draw its projections when the slant edge containing the resting corner is vertical.
3. Draw the projections of a cone of diameter 40 mm & height 70 mm lying on the ground on one of its base point with a generator perpendicular to HP.

Case 7: solid diagonal is vertical

1. Draw the projections of a cube of side 40mm when it rests on one of its corners with a diagonal of the solid vertical.
2. A hexagonal prism of base side 30 mm and axis length 60 mm is resting on HP on one of its base corners with a solid diagonal through that corner is perpendicular to HP. Draw its projections and print the length of the diagonal **(UQ)**

AUXILLIARY PROJECTIONS OF SOLIDS

(i) **Axis inclined to one plane and parallel to other:**

When the axis of the solid is inclined to one plane and parallel to other. Draw its projections in two stages.

Stage – 1: (simple position)

In the first stage assume the solid to be simple position that is its axis perpendicular to one of its planes (i.e) if the axis is inclined to HP, assume the solid to be perpendicular to HP. Similarly if the axis is inclined to VP. Assume the solid to be perpendicular to VP.

AUXILIARY PROJECTIONS OF SOLIDS

Stage – 2: (change of position (or) change of reference line (or) auxiliary projection method)

In this method introduce an auxiliary plane according to the required condition project the final views.

Auxiliary plane method (or) change of reference line method(Inclined to HP):

1. A hexagonal prism of base side 30 mm axis length 60 mm is resting on HP on one of its base sides with its axis inclined at 40º to HP and parallel to VP. Draw its projections by auxiliary projection method.

AUXILLIARY PROJECTIONS OF SOLIDS

2. A hexagonal pyramid side of base 25 mm and axis 50 mm long and rest on one of its corners of its base on HP. The axis is inclined at 30º to HP and parallel to VP. Draw its projection by auxiliary projection method.
3. A cone of base diameter 40 mm and altitude 65 mm rest on HP with one of its points on its circumference of base. Its axis is inclined at 40º to HP and parallel to VP. Draw its projections by auxiliary projection method.

AUXILLIARY PROJECTIONS OF SOLIDS

Inclined to VP:

1. A hexagonal prism, side of base 25 mm and axis 60 mm long, lies with one of its rectangular faces on HP, such that the axis is inclined at 45º to VP. Draw its projection by auxiliary inclined plane method.

END

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