S.RAMANATHAN ASST PROF MVSREC
Ph: 9989717732 rama_bhp@yahoo.com

CONCEPTS OF PLANES

Planes are 2-D closed figures. In our subject, planes are closed polygons like triangle, square, rhombus, pentagon, hexagon, circle and semi circle. **TV**

Projections of planes means drawing the front view, top views and sometimes, side views.

Always remember, in one view, the projection of plane is the true shape and in other view, it is a line.

1) **FV** $\rightarrow$ **True shape**
TV $\rightarrow$ **Line**

2) **TV** $\rightarrow$ **True shape**
FV $\rightarrow$ **Line**

Hence the problems on planes simply involves **FV** deciding where to draw the shape. If this is decided correctly, the other view is a line. Hence most important concept in planes is to decide where the shape is to be drawn.

There are 3 cases of planes problems. They are as follows:

1) Planes Parallel to HP or VP(1 stage)
2) Planes inclined to HP or VP (2 stages)
3) Planes inclined to both HP & VP (3 stages).

Planes are also called as surfaces or lamina.

Edge & Corner concept:

If an **edge** is in **HP** or **VP**, the **starting side** of the polygon is **vertical**.

If **corner** is in **HP** or **VP**, the **starting side** should be **horizontal**.

For a **Square**, **Corner** means **sides** at **45^0** to the x-y line.

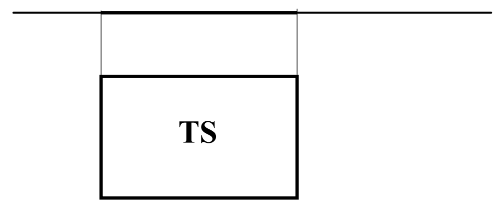
If edge is $\|$ to HP or VP, it is a horizontal

If edge is $\perp$ to HP or VP, it is vertical.

Case 1) Planes or surfaces $\|$ to HP/VP

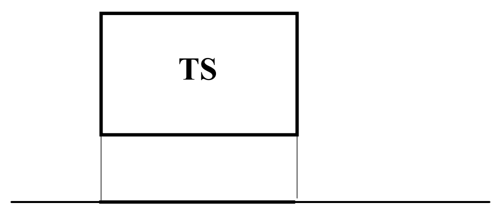
a) ***Planes $\|$ to HP ($\perp$ to VP)***

TV $\rightarrow$ **True shape**
FV $\rightarrow$ **Line**



b) ***Planes $\|$ to VP ($\perp$ to HP)***

FV $\rightarrow$ **True shape**
TV $\rightarrow$ **Line**



Simple rule

Plane $\|$ to HP $\rightarrow$ shape w.r.t VP (TV)

Plane $\|$ to VP $\rightarrow$ shape w.r.t HP (FV)

In this case, following data to be noted:

1) Shape of plane

2) Plane $\|$ to HP/VP (where to draw shape)

3) Edge(side)/ Corner in HP/VP or
Side inclined to HP/VP (for starting side)

S.RAMANATHAN ASST PROF MVSREC
Ph: 9989717732 rama_bhp@yahoo.com

12.2) An equilateral triangle of 50 mm sides has its plane parallel to HP and 25 mm above xy. Draw its projections if one of its sides is inclined at 45^0 to the VP.

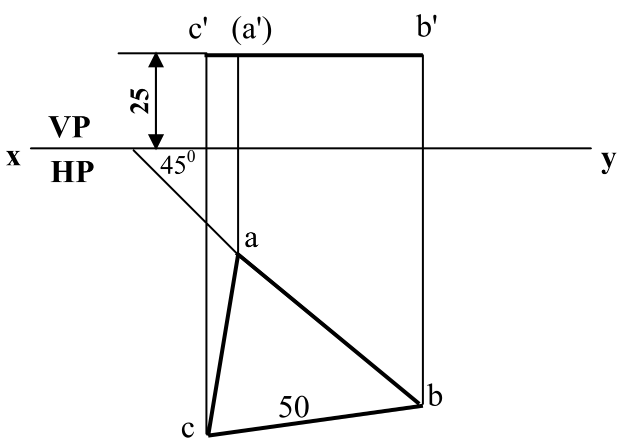
Ans) Given data:

Shape ⟶ triangle (all 50 mm sides)
Plane ⟶ ‖ to HP (**Shape** w.r.t.**VP**)
Side/ Corner ⟶ Side angle at 45^0

Logic: Since the plane is ‖ to HP, shape is w.r.t VP (Top View) and line is in FV.

Steps:

1) **Draw a side of ▲ at 45^0 below xy.**
2) **Cut arcs from a & b to get c. Join abc.**
3) **Project lines from a, b & c to get line a'b'c' (FV) at 25 mm above xy line.**



Note: *From Projection of Planes onwards, we have to show the position of reference planes (VP & HP) with respect to x-y line.*

Always note that VP is above x-y line and HP is shown below x-y for the First Angle Projection.

12.3) A square of 40 mm has a corner in HP and 20 mm in front of VP. All sides of the square are equally inclined to HP and ‖ to VP. Draw its projections.

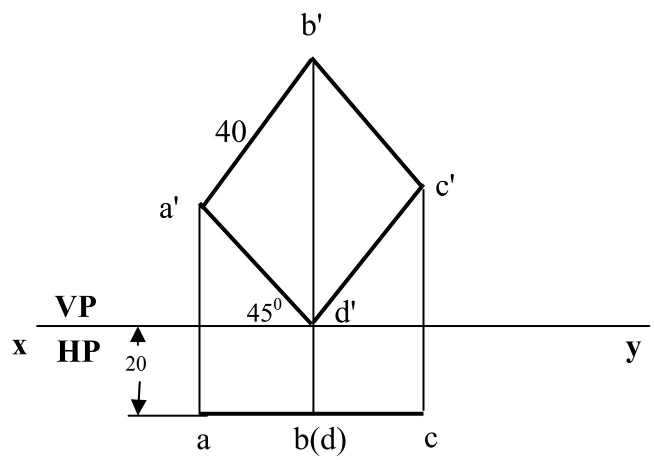
Ans) Given data**:**

Shape ⟶ Square of 40 mm
Plane ⟶ ‖ to VP (shape in TV)
Side/ Corner ⟶ Corner (45^0 sides)

Logic: Since the plane is ‖ to VP, shape is w.r.t HP (Front View) and line is in TV.

Steps:

1) Draw a square **a'b'c'd'** of 40 mm at 45^0 in FV, with a corner touching x-y.
2) Project lines from a'b'c'd' to get line abcd (TV) at 20 mm below x-y.



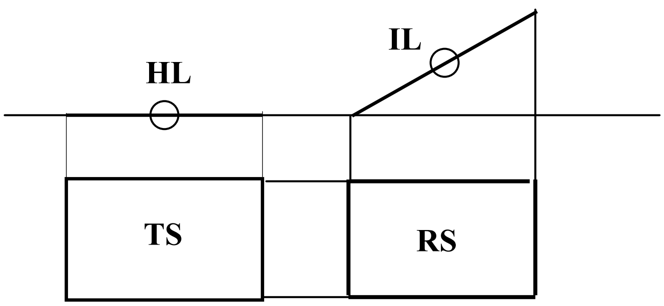
S.RAMANATHAN ASST PROF MVSREC
Ph: 9989717732 rama_bhp@yahoo.com

Case 2) Planes (surfaces) inclined to HP /VP

When planes are inclined to HP or VP, then its reduced shape will be seen in the opposite view.

a) *Planes (surfaces) inclined to HP (⊥ to VP)*

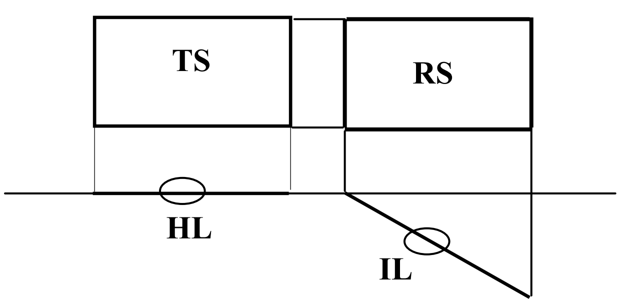
TV → Reduced shape (RS)
FV → Inclined Line (IL)



Note:
1) The **Inclined line (IL)** is of same length as the **Horizontal line (HL)**. Only angle changes in 2nd stage.
2) **Projectors** from **Inclined line (IL)** and **TS** gives the **Reduced Shape (RS)**

b) Planes (surfaces) inclined to VP (⊥ to HP)

FV → Reduced shape (RS)
TV → Inclined Line(IL)



Simple rule

Plane Inclined to HP → RS w.r.t VP (TV)

Plane Inclined to VP → RS w.r.t HP (FV)

In this case, following data to be noted:

1) Shape of plane

2) Plane ∠e to HP/VP (where to draw shape)

3) Edge(side)/ Corner in HP/VP
(For starting side)

Steps to solve problems on Inclined planes:

1) **Assume that plane is parallel & draw TS & HL in 1st stage.**
2) **Draw IL and then get RS in 2nd stage.**

Note: the following abbreviations will be used throughout the topic to make it easier for understanding.

TS: → True shape.
RS: → Reduced Shape.
HL: → Horizontal Line (Projection of TS)
IL: → Inclined Line (Plane angle; Length is same as HL).
FV: → Front View (Drawn above xy line)
TV: → Top View (Drawn below xy line).

S.RAMANATHAN ASST PROF MVSREC
Ph: 9989717732 rama_bhp@yahoo.com

12.4) A regular pentagon of 25 mm sides has a side on the ground. Its plane is inclined at 45^0 to HP & ⊥ to VP. Draw its projections.

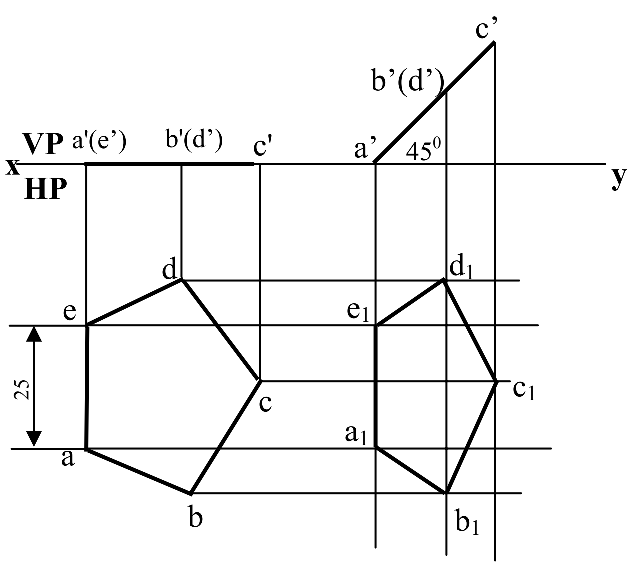
Ans) Given data:

Shape ⟶ Pentagon (25 mm sides/108^0)
Plane Angle ⟶ **HP**(**Red**' **Shape** w.r.t.**VP**)
Side/ Corner ⟶ Side (starting side vertical)

<u>Logic</u>: Since the plane is **inclined** to **HP**, **Reduced shape** (**RS**) is w.r.t **VP** (**Top View**) and **Inclined line** (**IL**) is w.r.t **HP** (**FV**).

Steps:

1) In **TV** , draw **pentagon** (**TS**) abcde of 25 mm with **starting side vertical** & **HL a'b'c'd'e'** on xy.
2) In **2nd stage**, at **45^0** draw **IL a'b'c'd'e'** of same length as **HL** and mark points at **same distances on IL** as **in HL**.
3) Project lines from **all points of IL** and **from TS** to get the **RS $a_1b_1c_1d_1e_1$**.



12.5) Draw the projections of a circle of 50 mm diameter having its plane vertical and inclined at 30^0 to VP. Its centre is 30 mm above HP and 20 mm in front of VP.

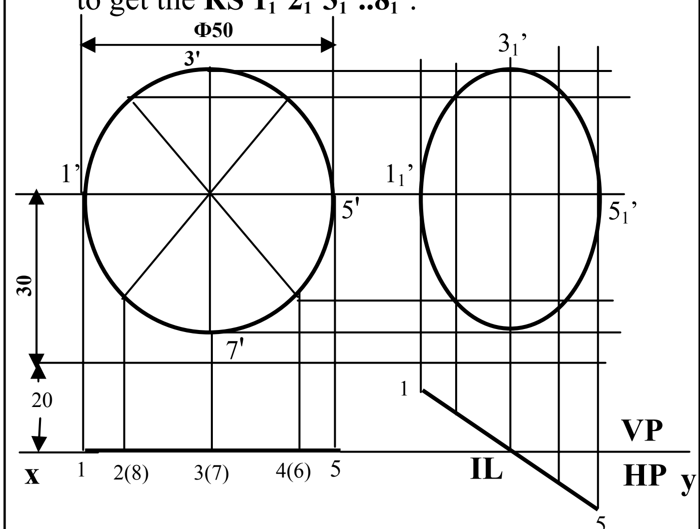
Ans) Given data**:**

Shape ⟶ Circle 50 mm diam.
Plane Angle ⟶ **VP** (**RS** w.r.t **HP**)
Side/ Corner ⟶ Not needed.

<u>Logic</u>: Since the plane is **inclined to VP, the RS is w.r.t HP (FV) and IL is w.r.t VP(TV).**

Steps:

1) In **FV**, draw a **circle** (**TS**) of 25 mm radius with **centre 30 mm above xy** and **HL at 20 mm below xy**. Divide circle into 8 parts 1',2',3'….8'
2) In **2nd stage**, at **30^0**, draw **IL** 1-2-3. of same length as **HL** and mark points at same **distances on IL** as **in HL.**
3) Project lines from **1-2-3-4**.. of **IL** and from **TS** to get the **RS 1_1'2_1'3_1'..8_1'**.



S.RAMANATHAN ASST PROF MVSREC
Ph: 9989717732 rama_bhp@yahoo.com

Case 3) **Inclined to both HP & VP.**

In this case, **Plane (surface)** is inclined to **HP/VP** and **Reduced Shape** (**Side/Diagonal/Diameter**) is inclined to **VP/HP** and vice versa.

These problems are solved in 3 stages.

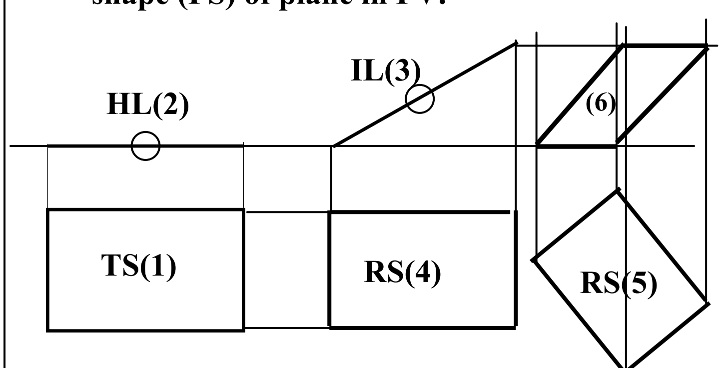
1) Solve the problem using **Plane angle** method and get the **1st & 2nd** stages.

2) In the **3rd** stage, turn the **Reduced shape** (by its **side/diagonal/diameter**) by the **given angle** and then its **projections** are **matched point to point** to get the **final shape** of the **plane**.

In total, there will be **6 figures** to be drawn, **3** in **FV** and **3** in **TV**.

a) ***Planes (surfaces) inclined to HP (⊥ to VP) & shape (side/ diagonal/ diameter) inclined to VP***

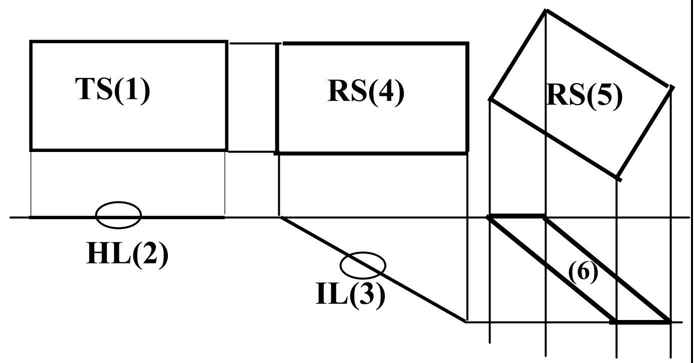
1) TV → Reduced shape (RS)
2) FV → Inclined Line (IL)
3) TV → Turn the RS at given angle and redraw it, using arcs.
4) FV → Draw projections now and match point to point from IL to get final shape (FS) of plane in FV.



Note:
The **RS (5)** should be turned about the side which **is vertical or horizontal.**

b) Planes (surfaces) inclined to VP (⊥ to HP) & shape (side/ diagonal/ diameter) inclined to HP

1) FV → Reduced shape (RS)
2) TV → Inclined Line (IL)
3) FV → Turn the RS at given angle and redraw it, using arcs.
4) TV → Draw projections now and match point to point from IL to get final shape (FS) of plane in FV.



Simple rule

Plane Inclined to HP → RS w.r.t VP (TV)
Plane Inclined to VP → RS w.r.t HP (FV)

In this case, following data to be noted:

1) Shape of plane
2) Plane ∠e to HP/VP (where to draw shape)
3) Edge (side) / Corner in HP/VP.
(1st and 2nd stage will be over here)
4) Shape angle VP/HP (side/diagonal/diam)

***Steps to solve problems on Inclined planes*:**

1) **Assume that plane is parallel & draw TS & HL in 1st stage.**
2) **Draw IL and then get RS in 2nd stage.**
3) **Turn the RS in the 3rd stage and match projections from IL to get Final shape.**

S.RAMANATHAN ASST PROF MVSREC
Ph: 9989717732 rama_bhp@yahoo.com

12.6) A square ABCD of 50 mm sides has its corner A in HP; its diagonal AC is inclined at 30^0 to HP & diagonal BD at 45^0 to VP & ║ to HP. Draw its projections.

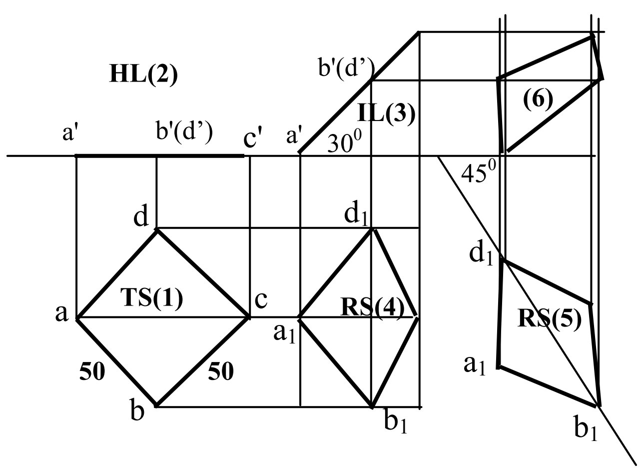
Ans) Given data:

Shape ⟶ Square (50 mm sides)
Plane Angle ⟶ 30^0 **to HP(AC**)
Side/ Corner ⟶ Corner (sides at 45^0)
Shape angle ⟶ Diagonal at 45^0 to **VP**(**BD**)

Logic: For squares and rhombus, if plane angles are not mentioned, then the diagonal angles are treated as plane angles and shape angles.
In this problem, **AC** is treated as **Plane angle** and **BD** is treated as shape angle. **Reduced shape** (**RS**) is w.r.t **VP** (**Top View**) and **Inclined line** (**IL**) is w.r.t **HP** (**FV**).

Steps:

1) In **1st stage**, in **TV** , draw square (**TS**) abcd of 50 mm with **starting side at 45 ^{0}** & **HL a'b'c'd'** on xy.
2) In **2nd stage**, at 30^0 draw **IL a'b'c'd'** of same length as **HL** and get the RS by projections.
3) In **3rd stage** Rotate **b_1d_1** at **45^0** to VP and draw **RS**. Take projections up and match point to point from **IL** to get Final Shape **a_1'b_1'c_1'd_1'**.



12.8) Draw the projections of a circle of 50 mm diameter having its plane angle at 45^0 to HP & its top view of diameter makes an angle of 30^0 to VP.

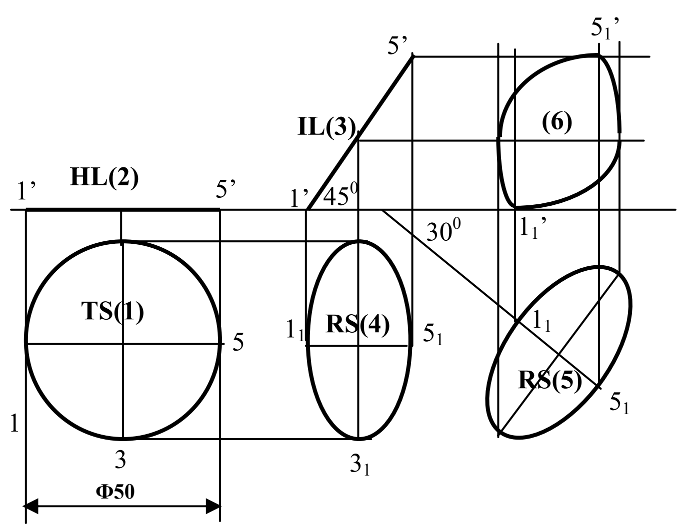
Ans) Given data**:**

Shape ⟶ Circle 50 mm diam.
Plane Angle ⟶ 45^0 **to HP (RS in TV**)
Side/ Corner ⟶ Not needed.
Shape angle ⟶ Diameter at 30^0 to **VP**

Logic: Since the plane is **inclined to HP, the RS is w.r.t VP (TV) and IL is w.r.t HP(FV). In the 3rd stage, turn the RS about diameter by 30^0 and match projections above to get final shape.**

Steps:

1) In **1st stage**, in **TV**, draw a **circle** (**TS**) of 25 mm radius below **xy** and **HL** 1'.2'..8' on xy. Divide circle into 8 parts 1,2…8.
2) In **2nd stage**, at **45^0**, draw **IL** 1'.2'..8' of same length as **HL** and get **RS** by projections.
3) In 3rd stage, rotate 1_1-5_1 by **45^0** to VP and draw **RS**. Take projections up and match point to point from **IL** to get Final Shape **1_1'2_1' .. 8_1'**.



S.RAMANATHAN ASST PROF MVSREC
Ph: 9989717732 rama_bhp@yahoo.com

***Exercise Problems*:**

2) A regular hexagon of 40mm sides has a corner on HP. Its surface is inclined at 45^0 to HP & the top view of the diagonal through the corner which is in HP makes an angle of 60^0 with VP. Draw its projections.

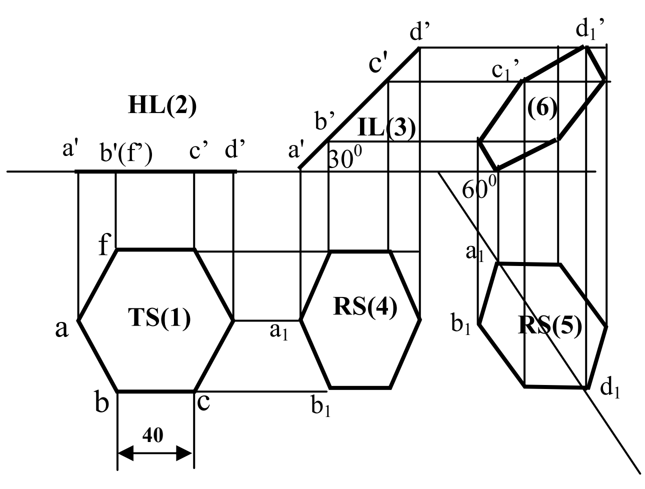
Ans) Given data:

Shape ⟶ Hexagon (40 mm/120^0 sides)
Plane Angle ⟶ 45^0 **to HP (RS in TV**)
Side/ Corner ⟶ Corner (side horizontal)
Shape angle ⟶ Diagonal at 60^0 to **VP**

Logic: Since the plane is **inclined to HP, the RS is w.r.t VP (TV) and IL is w.r.t HP (FV). In the 3rd stage, turn the RS about diagonal by 60^0 and match projections above to get final shape.**

Steps:

1) In **1st stage**, in **TV** , draw **hexagon** (**TS**) abcdef of 40 mm with **starting side horizontal** & **HL a'b'c'd'e'f'** on xy.
2) In **2nd stage**, at **45^0** draw **IL a'b..f'** of same length as **HL** and get the **RS** by projections.
3) In **3rd stage** Rotate **a_1d_1** at **60^0** to VP and draw **RS**. Take projections up and match point to point from **IL** to get Final Shape **a_1'b_1..f_1'**.



7) A semi circular plate of 80 mm diameter has its straight edge in the VP and inclined at 45^0 to HP. The surface of the plate makes an angle of 30^0 to VP. Draw its projections.

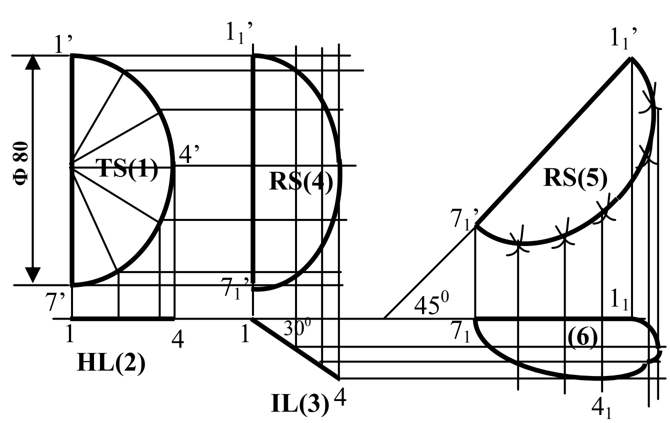
Ans) Given data**:**

Shape ⟶ Semi circle , 80 mm.
Plane Angle ⟶ 30^0 **to VP (RS in FV**)
Side/ Corner ⟶ Edge (side vertical)
Shape angle ⟶ Side at 45^0 to **HP**

Logic: Since the plane is **inclined to VP, the RS is w.r.t HP (FV) and IL is w.r.t VP (TV). In the 3rd stage, turn the RS about side by 45^0 and match projections below to get final shape.**

Steps:

1) In **1st stage**, in **FV**, draw a **semi circle** (**TS**) of 40 mm radius above **xy with starting side vertical** and **HL** 1.2..7 on xy. Divide semi circle into equal parts 1,2…7.(30^0 each).
2) In **2nd stage**, at **30^0**, draw **IL** 1.2..4 of same length as **HL** and get **RS** by projections.
3) In **3rd stage**, rotate **1'-7'** by **45^0** to HP and draw **RS**. Take projections below and match point to point from **IL** to get Final Shape **1_1 2_1..7_1**.



Exercise Problems:

9) A plate having the shape of an isosceles triangle has base 50 mm and altitude 80 mm. It is so placed that in the front view it is seen as an equilateral triangle of 50 mm sides and one side inclined at 45^0 to xy. Draw its top view.

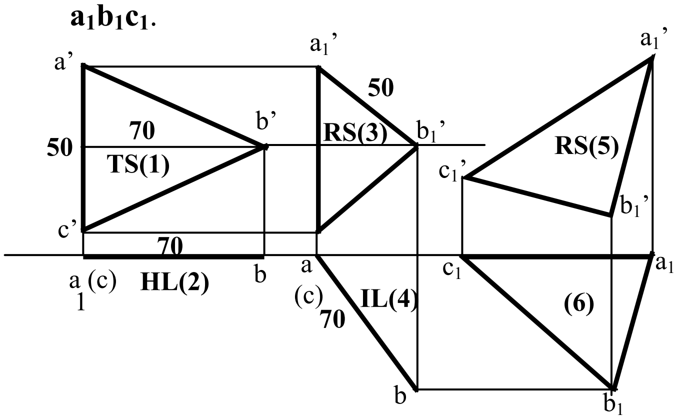
Ans) Given data:

True Shape ⟶ Isosceles ►(50/80)
Red Shape ⟶ Equilateral ►(50)
Side/ Corner ⟶ Side (**Start side Vertical**)
Shape angle ⟶ Side at 45^0 to **VP**
Shape change ⟶ **Front View**
⇨ **Plane Angle** ⟶ **Top View (w.r.t. VP)**

Logic: Since the **Shape changes** from **isosceles ►** to **Equilateral ►** in the **FV**, the **plane angle** is in the **TV**. Here plane angle is not given & hence we first draw **TS**, **HL**, **RS** and then **IL on the projectors of RS** & thus find **IL Angle** to **VP**.

Steps:

1) In 1^{st} **stage**, in **FV** , draw **Isosceles ►**(**TS**) **a'b'c'** of **base 50** & **altitude 70** at mid of **a'c'** with **starting side vertical** & **HL abc** on xy.
2) In 2^{nd} **stage**, draw **RS Equilateral ►** of 50 sides at same level as **TS**. Draw arc of **IL abc** of same length as **HL** and project **RS** to cut **IL and hence find the plane angle.**
3) In 3^{rd} **stage** Rotate **$a_1'c_1'$** at **45^0** to **HP** and draw **RS**. Take projections below & match point to point from **IL** to get Final Shape **$a_1b_1c_1$**.



10) Draw a rhombus of diagonals 100 & 60 mm with the longer diagonal horizontal. The figure is the top view of a square of 100 mm long diagonals with a corner on the ground. Draw its front view and find the angle its surface makes with the ground.

Ans) Given data**:**

True Shape ⟶ Square(d_1&d_2 100 mm)
Red Shape ⟶ Rhombus (**100X60)**
Side/ Corner ⟶ Corner (sides @ 45^0)
Shape angle ⟶ 90^0(d_2 is horizontal)
Shape Change ⟶ **Top View**
⇨ **Plane Angle** ⟶ **FV (w.r.t. HP)**

Logic: Since the **Shape changes** from **Square** to **Rhombus** in **TV**, the **plane angle** is in the **FV**. Here plane angle is not given and hence we first draw **TS**, **HL**, **RS** & then **IL** on the **projectors of RS** & thus find **IL angle** to **HP (ground)**.

Steps:

1) In 1^{st} **stage**, in **TV**, draw a **square of 100 mm diagonals (join corners of diagonals to get square) below xy & HL a'b'c'd'** on xy.
2) In 2^{nd} **stage**, draw **RS Rhombus of 100 & 60(vertical 100; horizontal 60 mm).**Draw arc of **IL a'c'** of same length as **HL** and project **RS** to cut **IL** in FV & hence find plane angle w.r.t HP (ground).
3) In 3^{rd} **stage**, rotate b-d by **90^0** to VP & draw **RS**. Take projections above and match point to point from **IL** to get Final Shape **$a_1'b_1'd_1'$**.