Engineering Drawing – Projection of Lines

5.1 Straight Line:

A straight line is defined as the shortest distance between two points. It is one dimensional entity. A line represents the locus of point moving along a fixed path in space.

5.2 Terms used in Projection of Planes:

1. **True length (TL):**
    The actual length of the line is called true length.

2. **Plane Length (PL) / Top View Length (TVL):**
    The apparent length of the line seen in top view is known as plane length/top view length.

3. **Elevation Length (EL)/ Front View Length (FVL):**
    The apparent length of the line seen in front view is known as elevation length/front view length.

4. **Side View Length (SVL):**
    The apparent length of the line seen in side view is known as side view length.

5. **Inclination with HP (θ):**
    It is the true angle that a line makes with its projection on HP. It is measured along the plane containing the line & perpendicular to HP.

6. **Inclination with VP ($\emptyset$):**
    It is the true angle that a line makes with its projection on VP. It is measured along the plane containing the line & perpendicular to VP.

7. **Inclination with PP (Ψ):**
    It is the true angle that a line makes with its projection on PP. It is measured along the plane containing the line & perpendicular to PP.

8. **Apparent angle with the HP (α):**
    It is the angle between front view & XY line. α correspond to θ & is always $> \theta$.

9. **Apparent angle with the VP (β):**
    It is the angle between top view & XY line. β correspond to $\emptyset$ & is always $> \emptyset$.

10. **Trace:**
    The point of intersection of a line (or its extension) with the reference planes is known as trace.

11. **Horizontal Trace (HT):**
    The point of intersection of a line (or its extension) with the HP is known as horizontal trace.

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12. Vertical Trace (VT):

The point of intersection of a line (or its extension) with the VP is known as vertical trace.

13. Point View:

The view of a line seen as a point (i.e. when the views of two ends coincide) is called the pint view.

5.3 Positions of straight lines based on Principal Planes:

A straight line may be located in space either by specifying the location of the end points/by specifying the location of end point & the direction. The following are the positions of straight lines w.r.t planes of projection.

1. Line parallel to both the planes,
2. Line perpendicular to one plane & parallel to other plane,
3. Line inclined to one plane & parallel to other plane,
4. Line inclined to both the planes,
5. Line contained by a plane, perpendicular to both the planes.

Note:

1. PL ≤ TL,
2. EL ≤ TL,
3. EL ≤ TL,
4. $(\theta + \emptyset) \leq 90^0$,
5. $\alpha > \theta$,
6. $\beta > \emptyset$,
7. If $\theta = \emptyset$ then $\alpha = \beta$.

5.4 Straight line parallel to both the planes:

When a line is parallel to any plane, its projection on that plane is a straight line of the same length. Because in orthographic projection, the line is imagined to be viewed from infinity. Hence the rays of sight are parallel to each other. When they pass through the end points of the straight line, they will meet the plane of projection at two points. The distance between them is equal to the length of the projected line.

Q) A line CD 30 mm long is parallel to both the planes. The line is 40 mm above the HP & 25 mm infornt of VP. Draw the projections of the line.

1. Draw the reference line XY.
2. Draw the projections at any point on it.
3. Mark c' at a distance of 40 mm above XY, which represnts front view of C.
4. Mark c at a distance of 25 mm below XY on the same projector, which represent the top view of C
5. Since the line parallel to both the planes, FVL = TVL = TL & parallel to XY.
6. Draw c'd' = 30 mm parallel to XY, which represents front view of the line.
7. Through d' draw a line erpendicular to XY & extend beyond it.
8. Through c draw a line parallel to XY to intersect the perpendicular line at d.
9. cd represents top view of the line.

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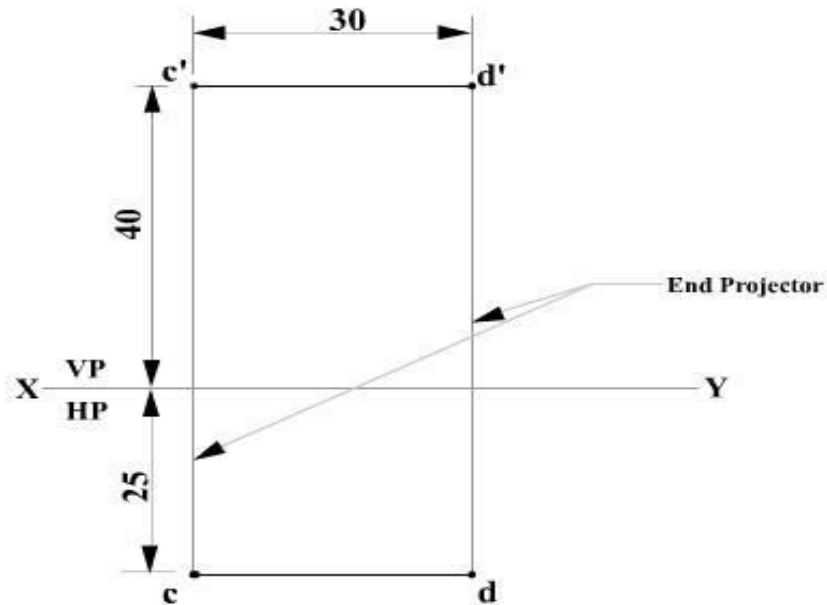
5.4 Straight line perpendicular to one plane & parallel to other plane:

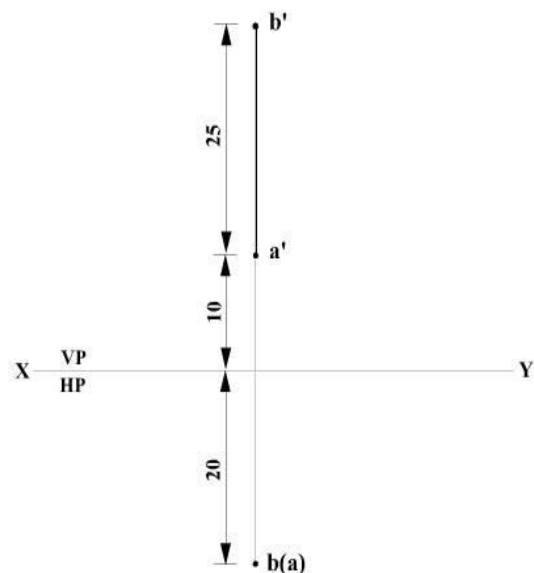When a line perpendicular to one plane & parallel to other plane, one of the views gives the true length & the other view gives the point view.

5.4.1 Line perpendicular to HP & parallel to VP.

When a line perpendicular to HP & parallel to VP, the true length of the line is seen in front view & the top view is a point view.

Q) A line AB, 25 mm long is parallel to VP & perpendicular to HP. Point A is 10 mm above HP & 20 mm in front of VP. Draw the projections of the straight line?

1. Draw the reference line XY.
2. Draw the projections at any point on it.
3. Mark a' at a distance of 10 mm above XY, which represnts front view of A.
4. Through a' draw a'b' = TL
5. Mark a at a distance of 20 mm below XY on the same projector, which represent the top view of A&B.
6. Join a'b' in thick, which represents TL of the line.

5.4.2 Line perpendicular to VP & parallel to HP.

When a line perpendicular to VP & parallel to HP, the true length of the line is seen in top view & the front view is a point view.

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Q) A line AB of length 25 mm is perpendicular to VP & parallel to HP. Point A is 20 mm above HP & 10 mm in front of VP. Draw the projections of the straight line?

1. Draw the reference line XY.
2. Draw the projections at any point on it.
3. Mark a' at a distance of 20 mm above XY, which represnts front view of AB.
4. Mark a at a distance of 10 mm below XY on the same projector, which represent the top view of A.
5. Through a draw ab = TL
6. Join ab in thick, which represents TL of the line.

5.5 Straight line inclined to one plane & parallel to other plane:

When a line inclined to one plane & parallel to other plane, one of the views gives the true length & the other view will be less than its true length. The view which gives the true length must be drawn first.

5.5.1 Line inclined to HP & parallel to VP.

When a line inclined to HP & parallel to VP, its front view gives the true length & true inclination of the line. The top view length will be less than its true length. So front view of the line should be drawn first.

Q) Draw the projections of the line PQ of length 40 mm is inclined at an angle of 30^0 to HP & parallel to VP. The end P is 25 mm above HP & 20 mm in front of VP.

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1. Draw the reference line XY.
2. Draw the projections at any point on it.
3. Mark p' at a distance of 15 mm above XY, which represnts front view of P.
4. Mark p at a distance of 20 mm below XY on the same projector, which represent the top view of P.
5. Through p' draw a line parallel to XY.
6. Through p' draw a line making an angle of 30^0 with the reference line
7. With p' as centre & radius = TL, draw an arc on the inclined line & name the point as q'.
8. p'q' represents the front view of the line PQ.
9. Through p draw a line parallel to XY.
10. Through q' draw a line perpendicuar to XY & extend it to intersect the line drawn through p at q.
11. Join pq in thick, which represents Top view of the line.

5.5.2 Line inclined to VP & parallel to HP.

When a line inclined to VP & parallel to HP, its top view gives the true length & true inclination of the line. The front view length will be less than its true length. So top view of the line should be drawn first.

Q) Draw the projections of the line PQ of length 40 mm is inclined at an angle of 35^0 to VP & parallel to HP. The end P is 20 mm above HP & 15 mm in front of VP.

Engineering Drawing – Projection of Lines

1. Draw the reference line XY.
2. Draw the projections at any point on it.
3. Mark p' at a distance of 20 mm above XY, which represnts front view of P.
4. Mark p at a distance of 15 mm below XY on the same projector, which represent the top view of P.
5. Through p draw a line parallel to XY.
6. Through p draw a line making an angle of 35^0 with the reference line
7. With p as centre & radius = TL, draw an arc on the inclined line & name the point as q.
8. pq represents the top view of the line PQ.
9. Through p' draw a line parallel to XY.
10. Through q draw a line perpendicuar to XY & extend it to intersect the line drawn through p' at q'.
11. Join p'q' in thick, which represents front view of the line.

Assignment Problems

1Q) draw the projections of a straight line PQ, 75 mm long in the following positions.

A. Parallel to both HP & VP & 25 from each.
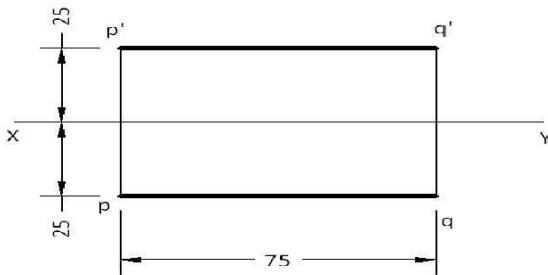
B. Parallel to & 40 in front of VP & on HP.
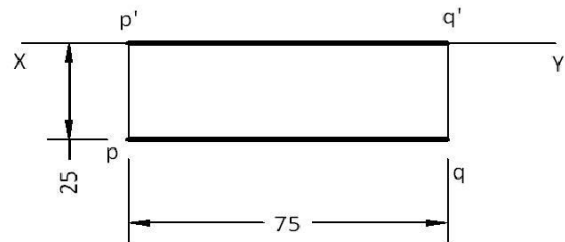
C. Parallel to & 25 above HP & on VP.
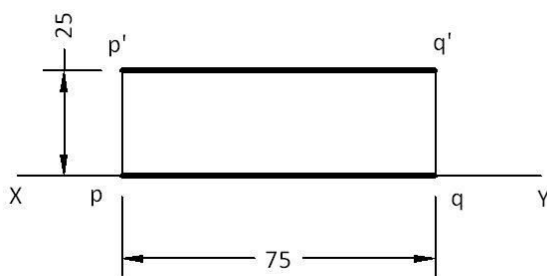
D. Perpendicular to HP, 25 in front of VP & one end 25 above HP.

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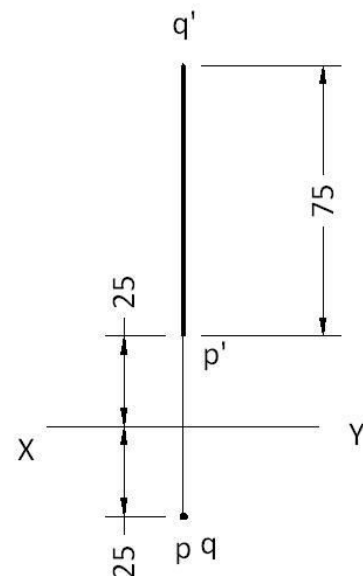
E. Perpendicular to HP 25 in front of VP & one end on HP.

q'

75

X   p'   Y

25   p q
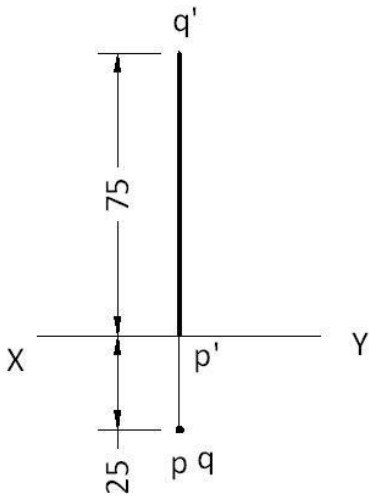
F. Perpendicular to HP & in VP & one end on HP.

q'

75

p'

X   p q   Y
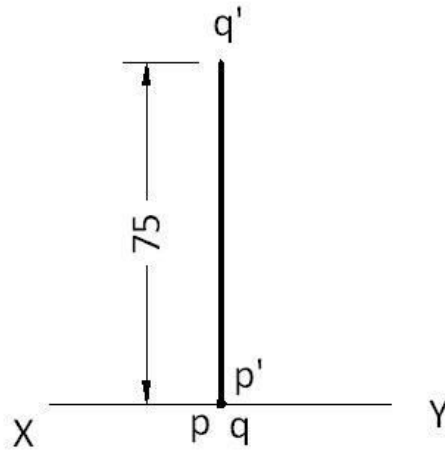
G. Inclined at 60^0 to VP, in HP & one end on VP
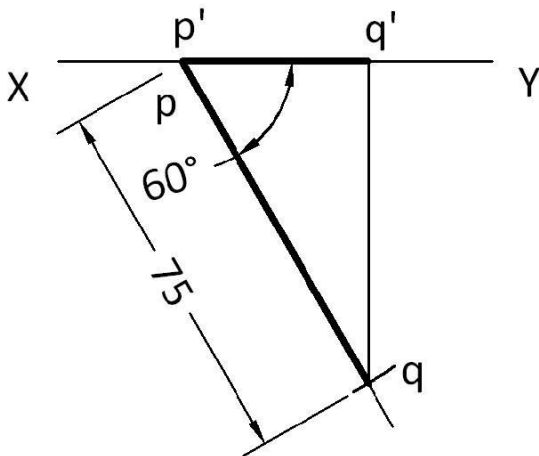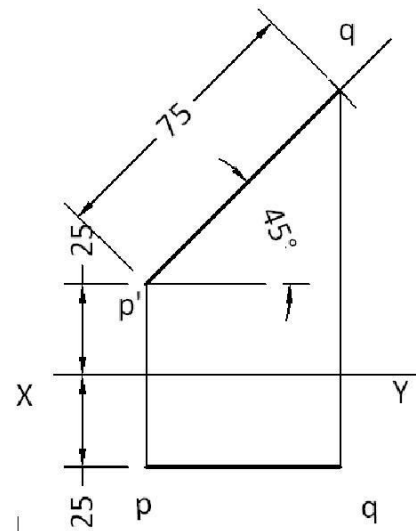
p'   q'

X   Y

p

60°

75

q

H. Inclined at 45^0 to HP, one end 20 above HP & parallel to & 25 in front of VP.

q

75

45°

25

p'

X   Y

25   p   q

I. Inclined at 30^0 to VP one end 25 in front of VP & parallel to and 25 above HP.

25

p'   q'

X   Y

25   p

30°

75   q
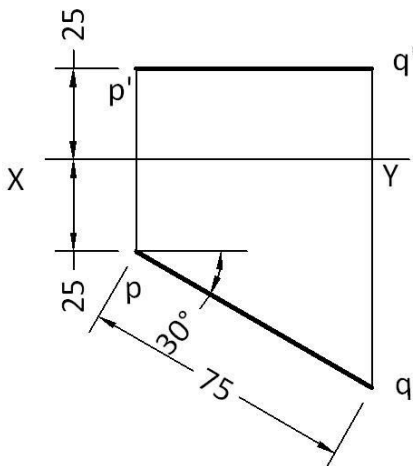
2Q) A line AB 70 long is parallel to & 40 above HP. Its two ends are 25 & 50 in front of VP respectively. Draw the projections & find its inclinations with the HP.

TL = 70,

a' = 40 above XY,

a = 25 below XY,

b' = 40 above XY,

b = 50 below XY.

INCLINATION WITH HP, $\theta = 21^0$.
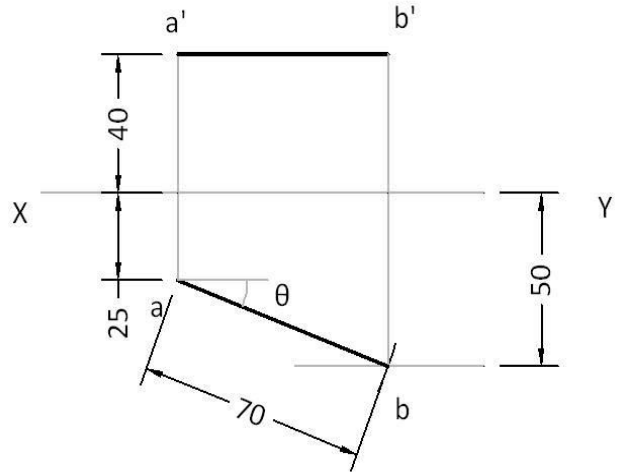
3Q) The top view of a line PQ 75 long measures 50. The line is in VP. Its one end P 25above HP. Draw its projections.

TL = 75,

TVL = 50,

P = on XY,

q = on XY,

p' = 25 above XY.
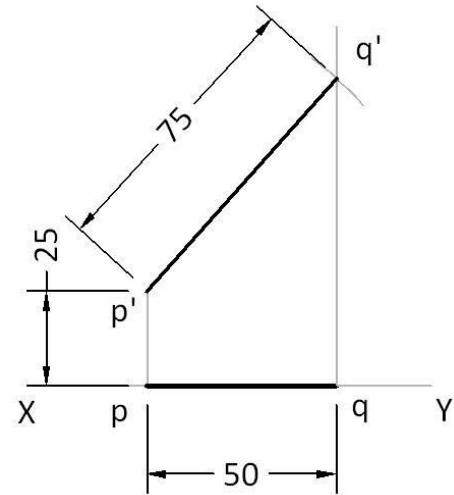
4Q) The front view of a line, which is inclined at 30^0 to VP is 65 long. Draw the projections of the line when it is parallel to & 35 above HP. Its one end being 30 in front of VP.

$\emptyset = 30^0$,

FVL = 65,

a' = 35 above XY,

a = 30 below XY.

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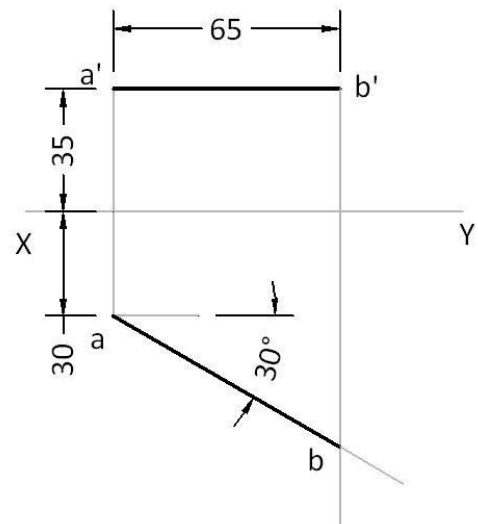
5Q) A 100 long line is parallel to and 25 in front of the VP. Its one end is in the HP while the other is 50 above HP. Draw its projections and find its inclination with the HP.

TL = 100,

a = 25 below XY,

a' = on XY,

b' = 50 above XY.
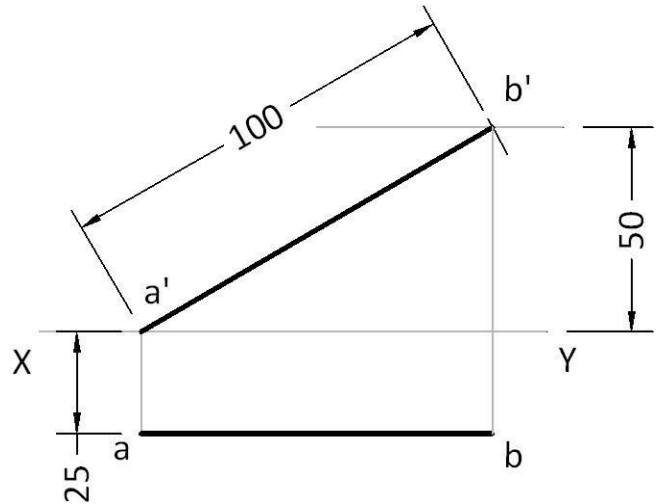
6.a Q) what is the true length of a line whose top view measures 75 and whose inclination to the HP is 45^0.
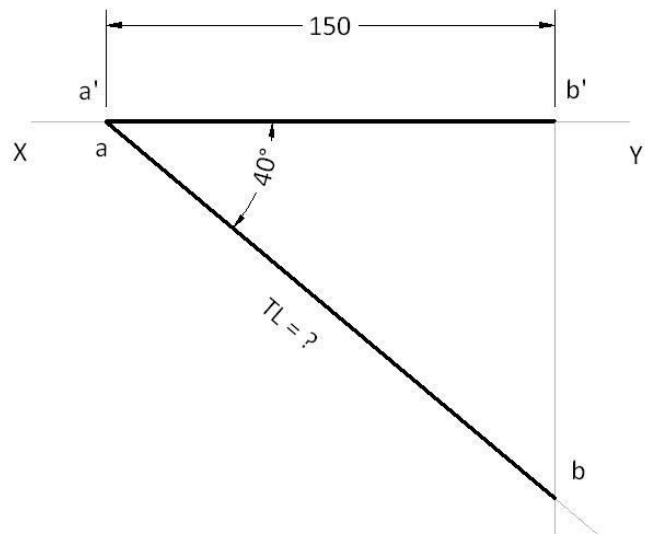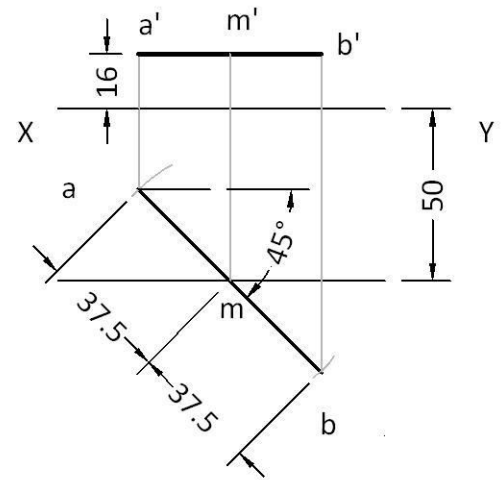
TL = ?

TVL = 75,

$\theta = 45^0$.
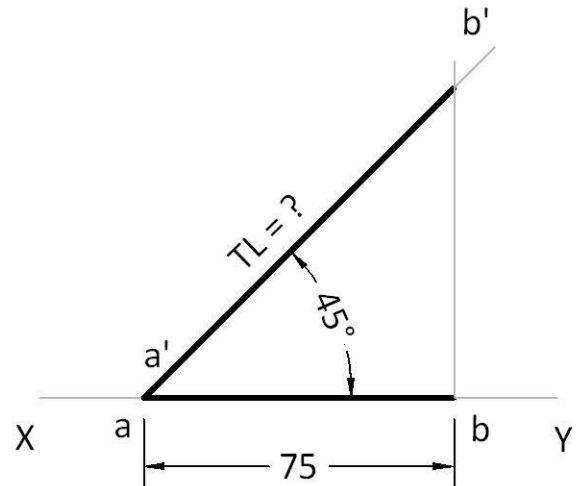
TRUE LENGTH = 106 mm.

6.b Q) what is the true length of a line whose front view measures 150 and whose inclination to the VP is 40^0.

TL = ?

FVL = 150,

$\emptyset = 40^0$.

TRUE LENGTH = 195 mm.

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**7Q) A line 75 long is parallel to HP & 16 below it & inclined at 45^0 to VP. The midpoint of the line is 50 in front of VP. Draw its projections.**

TL = 75,

a' = 16 above XY,

m = 50 below XY.

8Q) Two pegs on a wall are 4.5 meters apart. The distance between the pegs measured parallel to the floor is 3.6 meters. If one peg is 1.2 meters above the floor, find the height of the second peg & inclination of the line joining the two pegs with the floor.

TL = 4.5 m,
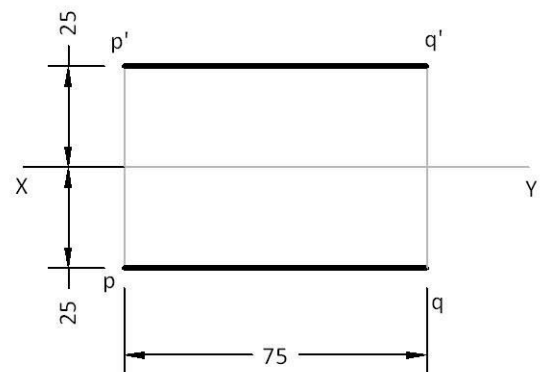
aa' – bb' = 3.6 m, a' = 1.2 m,

b' = ?

θ = ?
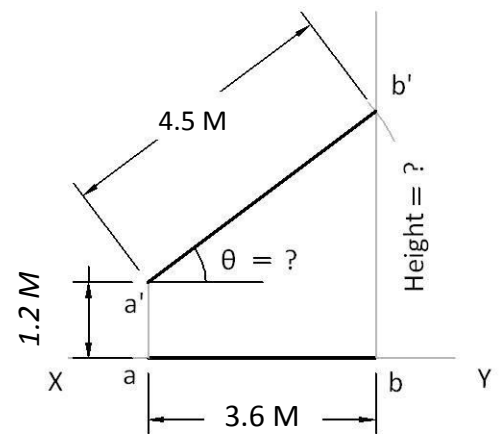
THE SECOND PEG IS 3.9 m FROM THE FLOOR,

THE SECOND PEG IS INCLINED AT 37^0 WITH THE FLOOR.

SCALE 1: 2

Problems on Traces

1Q) Draw the projections of a line of 75 long Parallel to both HP & VP & 25 from each. Draw its traces.

Since a straight line is parallel to both HP & VP, the line will not meet the planes of projection even when it is extended. Therefore, no HT & VT.
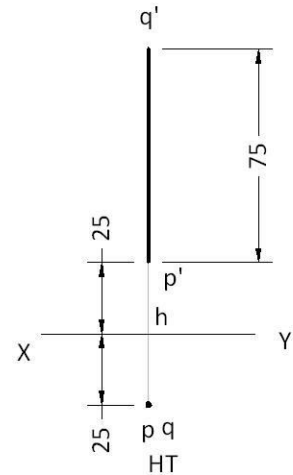
2Q) Draw the projections of a line of 75 long Perpendicular to HP, 25 in front of VP & one end 25 above HP. Draw its traces.

If a line is perpendicular to HP & parallel to VP, when it is extended it intersects with the HP. Therefore we have only HT & No VT.
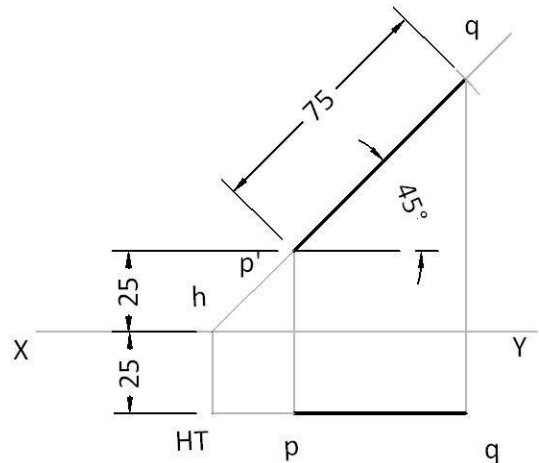
1. Extend the line p'q' (FV) to intersect XY & name it as h.
2. Through h draw a line perpendicular to XY to intersect the top view extension line at HT.

3Q) Draw the projections of a line of length 75 Inclined at 45^0 to HP, one end 20 above HP parallel to & 25 in front of VP.

If a line is inclined to HP & parallel to VP, when it is extended it intersects with the HP. Therefore we have only HT & No VT.

3. Extend the line p'q' (FV) to intersect XY & name it as h.
4. Through h draw a line perpendicular to XY to intersect the top view extension line at HT.

4Q) Draw the projections of a line of length 75 Inclined at 30^0 to VP one end 25 in front of VP & parallel to and 25 above HP.

If a line is inclined to VP & parallel to HP, when it is extended it intersects with the VP. Therefore we have only VT & No HT.

1. Extend the line pq (TV) to intersect XY & name it as v.
2. Through v draw a line perpendicular to XY to intersect the front view extension line at VT.

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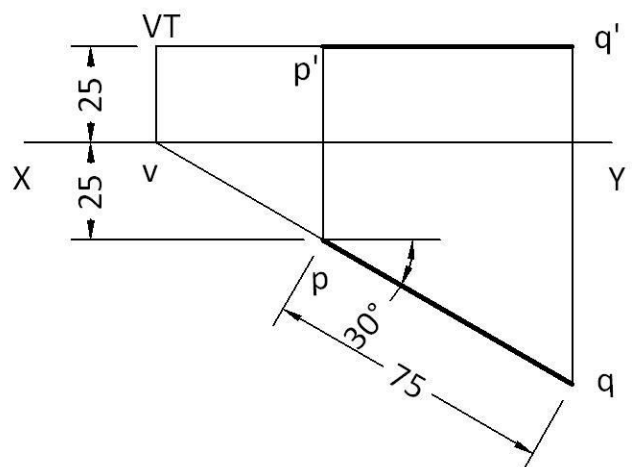
5.6 Line inclined to both HP & VP.

A line inclined to both the planes is known as an Oblique line. When a line inclined to both HP & VP, none of the views gives its true shape. This type of problems are solved in three stages.

Stage – 1: Assume the line inclined to one plane & parallel to other plane & projections are drawn.

Stage – 2: Assume the line inclined to second plane & parallel to other plane & projections are drawn.

Stage – 3: Combine stage – I & II & draw the projections.

5.7 True Length & True Inclinations:

When a line is parallel to a plane, its projection on that plane will show its true length & true inclination with the other plane.

When projections of a line drawn, its true length & true inclinations with HP & VP are determined by the following methods.

1. Rotating Line Method,
2. Trapezoidal Method,
3. Auxiliary Plane Method.

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