KSU CET UNIT

FIRST YEAR NOTES

CET UNIT

1
Introduction

1.1. Introduction to technical drawing and its language.

Engineering graphics is a graphical language mainly used by technicians for communicating technical ideas. Different types of lines and curves are the alphabets of this language. Plane figures such as circle, square, triangle, etc. and some special symbols are the words of this universal language. Certain rules to be followed while preparing the drawing are the grammar of this language. Since it is a technical language some common standard practice should be followed in the drawing. For this purpose, the Bureau of Indian Standards [BIS] has formulated certain rules for this drawing. A drawing prepared according to these rules is called technical drawing.

1.2. Lines.

Various types of lines are used in the technical drawing. These lines differ in appearance, thickness and darkness such as continuous line, broken line, thick line, thin line etc. Table 1.1 shows some of the lines used in engineering graphics.

Table 1.1.

Line.	Description.	Application.
———————	Continuous thick.	Visible edges.
———————	Continuous thin.	Projection lines. Hatching lines. Dimension lines.
— — — — — —	Dashed line.	Hidden edges.
— - — - — - —	Chain line.	Central line, axis.
▬ - — - — - ▬	Chain line with thick end segments.	Cutting plane.

1.3. Lettering.

Writing dimensions, titles, notes and other important particulars on a drawing is called lettering. Important requirements for lettering in technical drawing are legibility, uniformity and ease of execution.

BIS recommends single stroke lettering for engineering drawing. Single stroke means that the thickness of line of letter is obtained in one stroke of the pencil. Single stroke letters are of two types, vertical and inclined. In vertical type of lettering, letters are kept within a rectangle of standard size. In inclined type of lettering, letters are kept within a parallelogram of included angle of 75°.

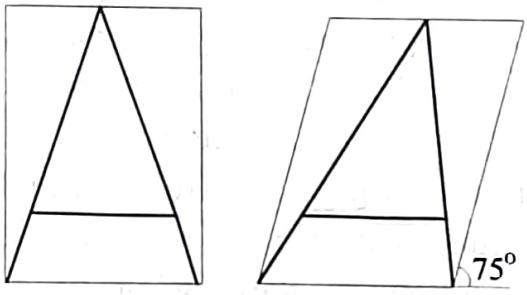


Fig. 1.1. Vertical and inclined stroke letters.

Based on the ratio of height of letter to thickness of letter, the letters are classified as type A letters and type B letters.

In type A letter the thickness of letter is equal to the height of letter divided by 14. In type B letter the thickness of letter is equal to the height of letter divided by 10.

When h is the height of letter and d is the thickness of letter, then,

For type A letter, $d = \frac{h}{14}$ and for type B letter, $d = \frac{h}{10}$. Other measurements of the letters are expressed in terms of h.

Single stroke, vertical, type B letters are widely used in engineering drawing. The height of letters and numerals depends on the size of the drawing and can be selected from the standard heights of 2.5, 3.5, 5, 7, 10, 14 and 20mm. Table 1.2 shows the characteristics of type B capital letters, lower case letters and numerals.

Table 1.2.

(i) For capital letters.

Characteristics.	Ratio.	For h = 10 mm
Height	$\frac{10}{10}$ h	10 mm
Thickness of stroke	$\frac{1}{10}$ h	1 mm
Spacing between characters	$\frac{2}{10}$ h	2 mm
Minimum spacing between words	$\frac{6}{10}$ h	6 mm
Width for I	$\frac{1}{10}$ h	1 mm
Width for J	$\frac{4}{10}$ h	4 mm
Width for C, E, F and L	$\frac{5}{10}$ h	5 mm
Width for A, M, Q, V, X and Y	$\frac{7}{10}$ h	7 mm
Width for W	$\frac{9}{10}$ h	9 mm
Width for all other capitals	$\frac{6}{10}$ h	6 mm

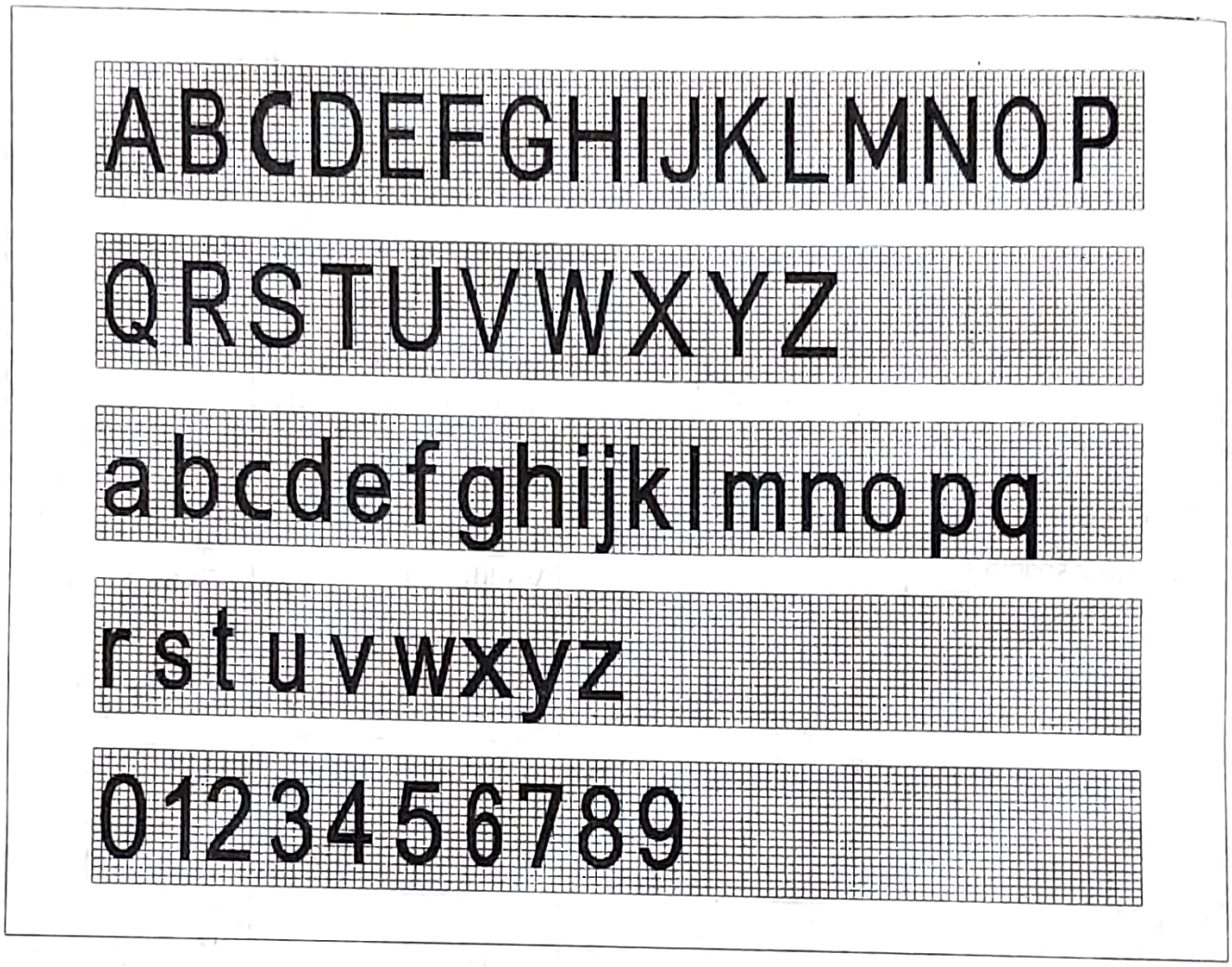
(ii) For lower case letters and numerals.

Characteristics.	Ratio.	For h = 10 mm
Height of letters with stem or tail	$\frac{10}{10}$ h	10 mm
Height of letters without stem or tail	$\frac{7}{10}$ h	7 mm
Width for i	$\frac{1}{10}$ h	1 mm
Width for l	$\frac{2}{10}$ h	2 mm
Width for j	$\frac{3}{10}$ h	3 mm
Width of m and w	$\frac{7}{10}$ h	7 mm
Width of all other letters	$\frac{5}{10}$ h	5 mm
Height of numeral 0 to 9	$\frac{10}{10}$ h	10mm
Width of numerals 0 to 9	$\frac{5}{10}$ h	5 mm
Width of numeral 1	$\frac{3}{10}$ h	3 mm

Example 1.1.

Write capital letters and lower case letters from A to Z and numerals from 0 to 9. Use type B, vertical letters with height, h = 20 mm.

Solution.



1.4. Dimensioning.

Showing the various information regarding the length, breadth and height of an object and some other details regarding the size and position of a hole in the object etc. on a drawing is called dimensioning. Lines, numbers, symbols etc. are used for this purpose.

The elements of dimensioning include projection lines, dimension lines, leader lines etc. Projection line or extension line is a thin continuous line extending beyond the outline of the object. Dimension line is a thin continuous line drawn in between the extension lines. The projection line should be extended about 3 mm beyond the dimension line. Arrow heads are put at the ends of dimension line. The width to length ratio of an arrow head should be 1:3. As far as possible the dimensions should be placed outside the view. Dimensions should not be kept very near to the drawing and crossing of dimension lines should be avoided. Dimensions should be expressed in one unit only, preferably in millimetres.

A leader line is a line referring to a feature in the drawing, It is drawn at an angle greater than 30°. A leader line should terminate with a dot if it ends within the outline of the drawing, with an arrow head if it ends on the outline of the drawing and without dot or arrow head if it ends on a dimension line.

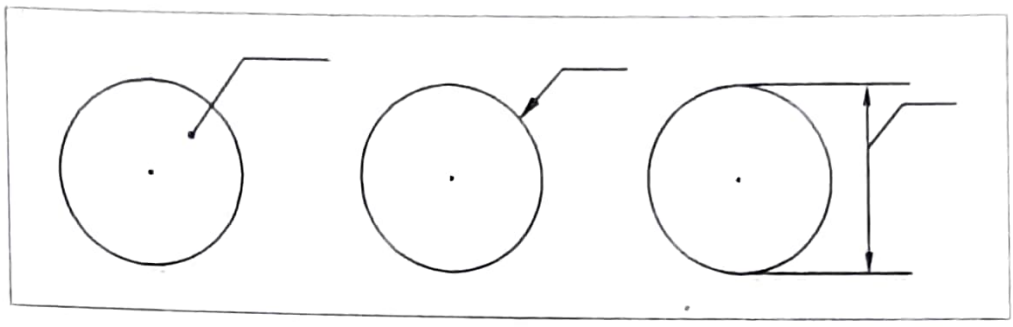


Fig. 1.2. Leader lines.

System of dimensioning.

There are two main systems of dimensioning. These are,

i) Aligned system and

ii) Unidirectional system.

In the aligned system, the dimensions are written parallel, above and at the middle of the dimension line and readable either from bottom or from the right hand side of the drawing. Fig. 1.3 shows the dimensioning in aligned system.

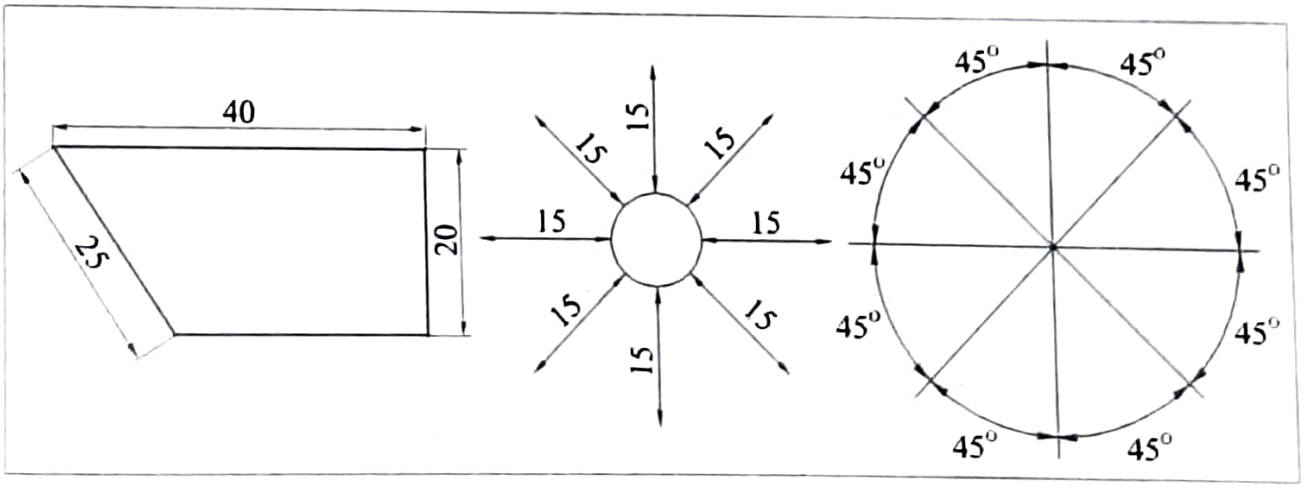


Fig 1.3. Aligned system of dimensioning.

In unidirectional system of dimensioning, all the dimensions are written in such a way that they are readable from bottom of the drawing. Non-horizontal lines are broken at the middle to insert the dimension as shown in Fig.1.4.

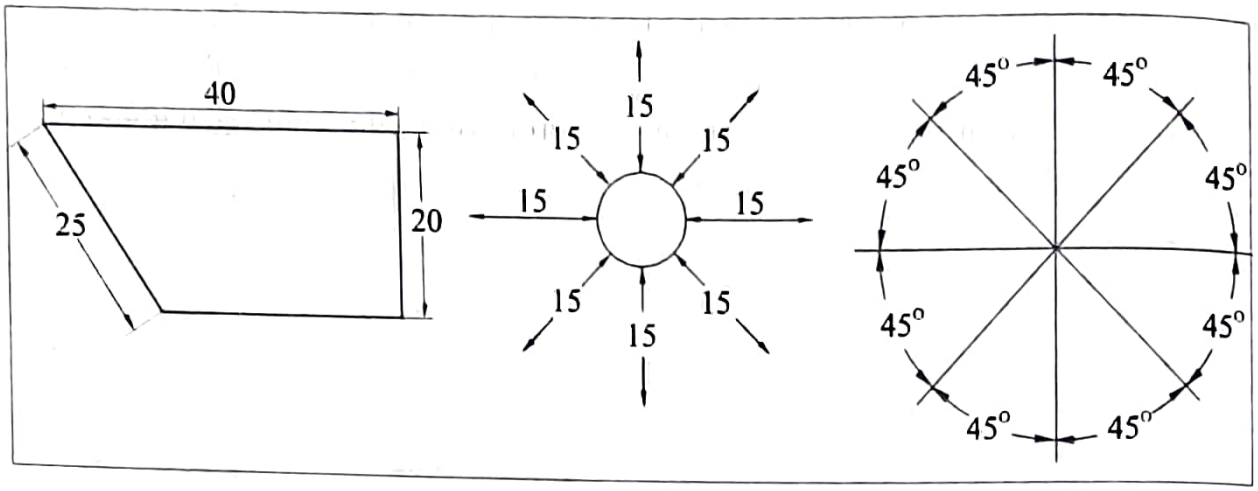


Fig. 1.4. Unidirectional system of dimensioning.

1.5 . Scaling of figures.

In engineering drawing, the size of drawing paper is limited. Hence often it is not possible to represent an object in a sheet of paper with its actual dimensions. In such case, the size of drawing is reduced or enlarged in proportion with the actual size of the object. The proportion by which the actual dimension is enlarged or reduced is called scale of drawing and this process is called scaling of figures.

Commonly used scales for engineering drawing are,

i) For full size drawing, the scale is 1:1

ii) For reduced drawing, the scale is 1: x

iii) For enlarged drawing, the scale is x :1

The standard values of x are 2, 5, 10, 20, 50 etc.

1.6. Drawing instruments.

The accuracy and neatness of engineering drawing depends on the quality of the instruments used for the drawing. Many instruments and drawing materials are used to facilitate drawing more easy and more accurate. Some of these are,

i) Drawing board. ii) Minidrafter. iii) Instrument box. iv) Set squares.

v) Protractor. vi) Scale. vii) Pencil. viii) Eraser. ix) Drawing sheet.

i) Drawing board.

Drawing boards are usually made of well seasoned soft wood. To prevent warping, strips of wood are glued together. The standard size of drawing board, according to BIS are shown in table 1.3.

Table 1.3.

Designation	Size in mm		
	Length	Width	Thickness
D_0	1500	1000	25
D_1	1000	700	25
D_2	700	500	15
D_3	500	350	15

ii) Minidrafter.

It is an instrument designed to combine the functions of scale, set squares and protractor. It has an angle, formed by two scales set exactly at right angles to each other. In the normal position one of the two arms of the angle is horizontal and the other is vertical. The arms can be set and clamped at any desired position by means of an adjusting head which has a protractor. The mechanism of minidrafter is such that by clamping one end of it at the top left end of the drawing board, the angle consisting the arms can be moved over the drawing sheet.

iii) Instrument box.

It is a box containing compus, divider etc. The compus is used for drawing circles and arc of circles. Divider is used to divide straight lines or circular arcs into a number of equal parts. It is also used to transfer measurements from one part of the drawing to another part of the drawing.

iv) Set squares.

Set squares, generally two in number, are used to draw inclined lines, to measure angle etc. The common types are 30°-60° set square and 45°-45° set square. These angles are the angles at the corners of set square. The set squares are used in combination to draw a line paralled to any given line, to draw a line perpendicular to any given line either from a point in the line or from a point outside the line.

v) Protractor.

Protractor which is flat and semicircular in shape is used to measure angle. The circumferencial edge is graduated to 1° divisions and is numbered at every 10° interval. The diameter of the semicircle that is the straight line 0°-180°, is called base of the protractor. The center of the base is marked as O.

vi) Scale.

Scales are made of wood, steel, plastic or card board. The edges of the scales are marked with divisions of centimetres which are sub divided into millimetres. Scale is used to draw straight lines and to measure distance between two points on a drawing.

vii) Pencil.

Special quality pencils are used in engineering drawing. Pencils with different degrees of hardness are available. The grade of the lead in the pencil is shown by a number and a letter marked at one and of the pencil, such as 2H, 3B etc. The increase in hardness is shown by the number put in front of the letter H. The increase in softness is shown by the number put in front of the letter B. HB grade is medium hard and is suitable for lettering and dimensioning. 2 H is used to start the drawing and H is used to finish by darkening the drawing.

viii) Eraser.

An eraser is used to remove unnecessary pencil marks from the drawing sheet. Soft rubber is the most suitable kind of eraser for engineering drawing.

ix) Drawing sheet.

Drawing sheets are available in six standard size, as specified by BIS. The sheet should be tough and strong and when an eraser is used on it, its fibers should not get integrated. Size of drawing sheets are based on A0 size with an area of one square metre, having a length to width ratio of $\sqrt{2}:1$. The area of each succeeding smaller size is half of the preceding one, the ratio being $\sqrt{2}:1$ itself. Table 1.4 shows the designation and corresponding size of different drawing sheets.

Table 1.4.

Designation	Size in mm	
	Length	Width
A0	1189	841
A1	841	594
A2	594	420
A3	420	297
A4	297	210
A5	210	148

1.7. Drawing sheet layout for class work.

The layout of a drawing sheet should facilitate easy reading and understanding of the drawing presented therein. It is recommended that the margin should have a minimum width of 20mm for the sizes A0 and A1 and a minimum margin of 10mm for A2, A3, A4 and A5 sheet. A margin of 20mm on the left hand side has to be provided irrespective of the size of the sheet. The drawing sheet layout should also provide a title block which is an important feature in a drawing. The drawing sheet layout should also provide a title block which is an important feature in a drawing. The size of the title block for class work is 150mm x 50mm which is provided at the bottom right hand corner of the sheet. Fig.1.5 shows the layout of a drawing sheet and Fig. 1.6 shows the layout of title block for class work.

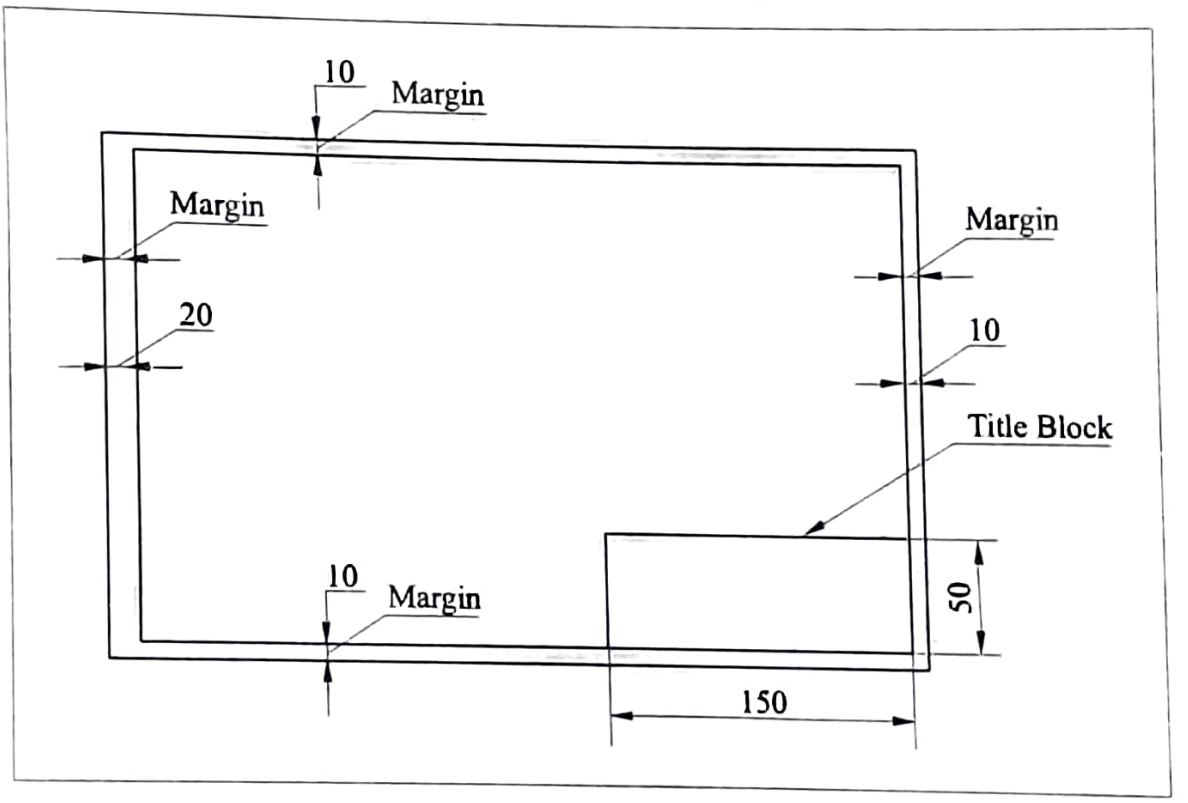


Fig 1.5. Layout of drawing sheet.

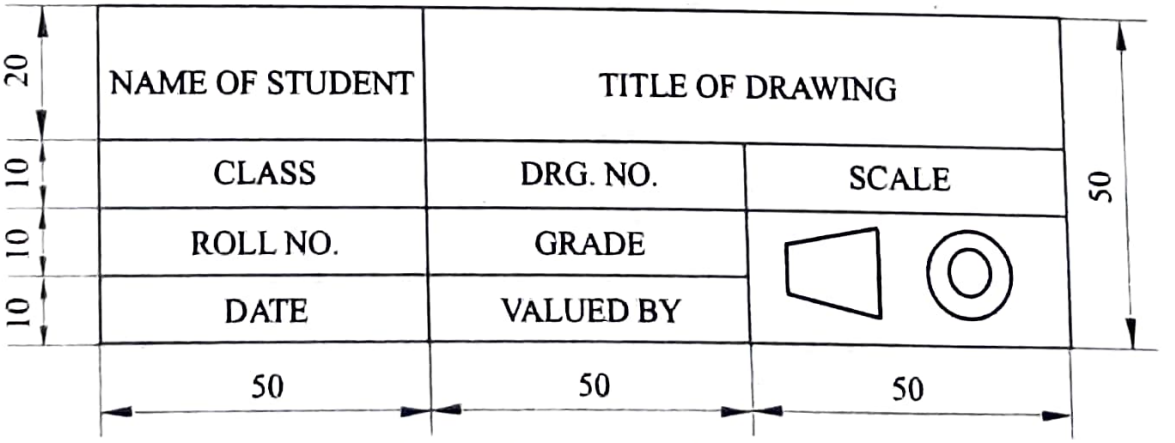


Fig.1.6. Layout of title block.

2

Projections of points and lines

2.1. Introduction.

A point is a geometrical concept. It has no dimensions and hence it is denoted by a dot. The four quadrants of reference, Ist, IInd, IIIrd and IVth quadrants are separated by two reference planes (surfaces), horizontal plane (HP) and vertical plane (VP). Horizontal plane is parallel to the surface of earth and vertical plane is perpendicular to the surface of earth. The line of intersection of HP and VP is called reference line or XY line. Refer Fig. 2.1.

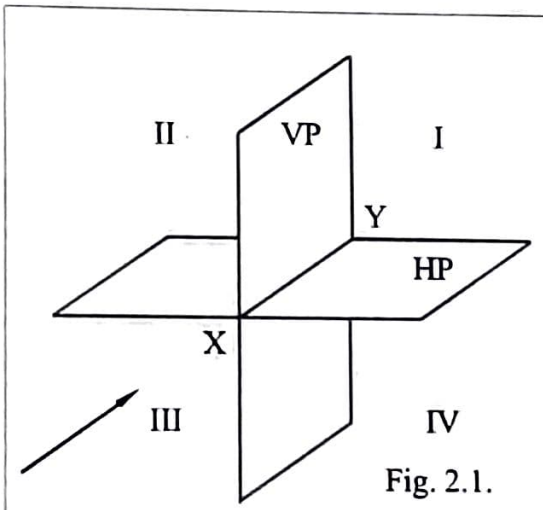


Fig. 2.1.

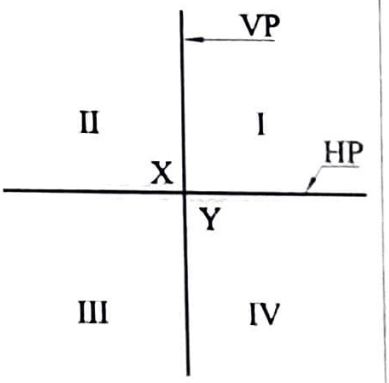


Fig. 2.2.

When these planes are viewed in the direction shown by the arrow in Fig. 2.1, the horizontal and vertical planes are seen as two lines perpendicular to each other as shown in Fig. 2.2.

A point may be situated in space in any one of the quadrants, in one of the reference planes or in the line of intersection of reference planes. The following are the various positions at which a point can be situated.

(i). Above HP and in front of VP.[In the first quadrant].

(ii). Above HP and behind VP. [In the second quadrant].

(iii). Below HP and behind VP. [In the third quadrant].

(iv). Below HP and in front of VP. [In the fourth quadrant].

(v). On HP and in front of VP.

(vi). On HP and behind VP.

(vii). Above HP and on VP.

(viii). Below HP and on VP.

(ix). On HP and on VP. [on XY line].

Refer Fig. 2.3.

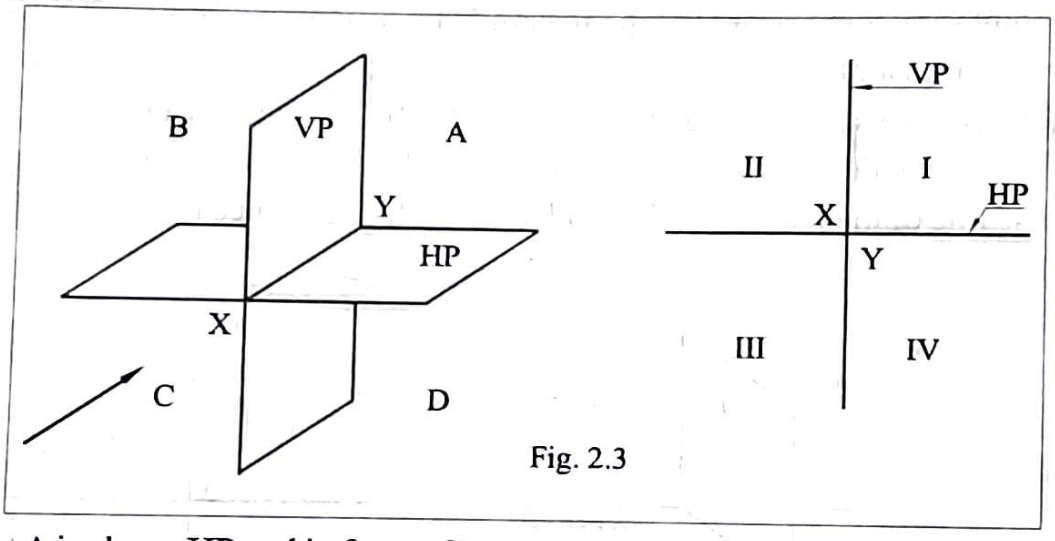


Fig. 2.3

Point A is above HP and in front of VP.

Point B is above HP and behind VP.

Point C is below HP and behind VP.

Point D is below HP and in front of VP.

Point E is on HP and in front of VP.

Point F is on HP and behind VP.

Point G is above HP and on VP.

Point H is below HP and on VP.

Point I is on HP and on VP.

The projection (view) of a point on HP is called top view or plan of the point and the projection (view) of a point on VP is called front view or elevation of the point. The top view of points A,B,C,D etc are denoted by a,b,c,d etc. respectively. Similarly the front view of points A,B,C,D etc. are denoted by a′,b′,c′,d′ etc. respectively.

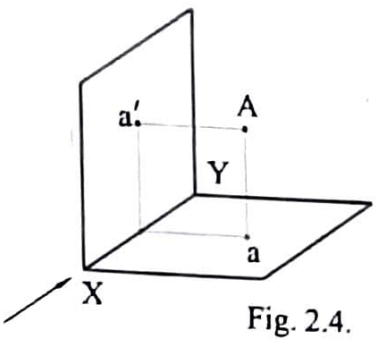


Fig. 2.4.

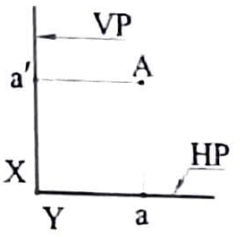


Fig. 2.5.

Fig. 2.4 shows the position of a point A which is in the first quadrant and its projections on HP and VP, a and a′. When viewed in the direction shown by arrow in Fig. 2.4, the planes, point A, a and a′ are as shown in Fig. 2.5.

2.2. Position of plan and elevation of points with respect to XY line, when the points are in different positions.

The position of plan and elevation of a point with respect to XY line depends on the position of the point with respect to the reference planes. The plan as well as the elevation of a point may be above XY line, on XY line or below XY line.

After marking the plan and elevation, as shown in Fig.2.6, rotate the horizontal plane about the XY line through 90° in the clockwise direction. Then turn the entire plane through 90° about a vertical axis. After this the HP, VP, XY line, a and a′ are as shown in Fig. 2.6.

The line joining plan and elevation of a point is called projector and a projector is always perpendicular to the XY line. Refer Fig. 2.6. The plan and elevation of a point are always on the same line drawn perpendicular to XY line.

Case (i) When a point A is in the first quadrant.

When a point A is in the first quadrant, its elevation a′ will be above XY line and its plan a will be below XY line as shown in Fig. 2.6.

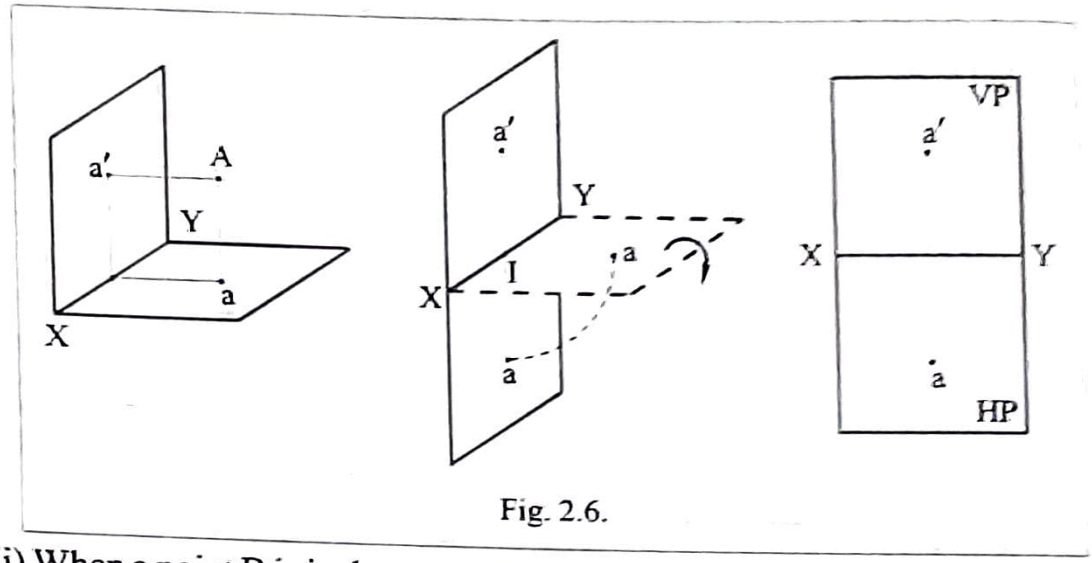


Fig. 2.6.

Case (ii) When a point B is in the second quadrant.

When a point B is in the second quadrant its elevation, b′ and plan b, both are above XY line. Refer Fig. 2.7.

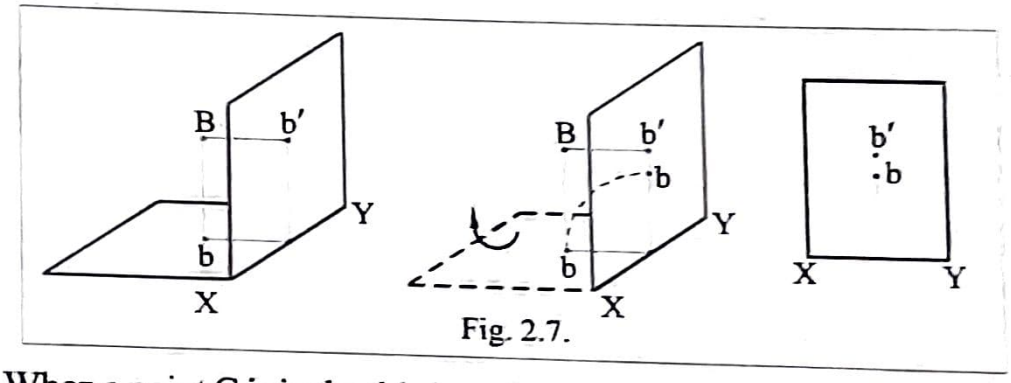


Fig. 2.7.

Case (iii) When a point C is in the third quadrant.

When a point C is in the third quadrant, its elevation c′ will be below XY line and plan c will be above XY line as shown in Fig.2.8.

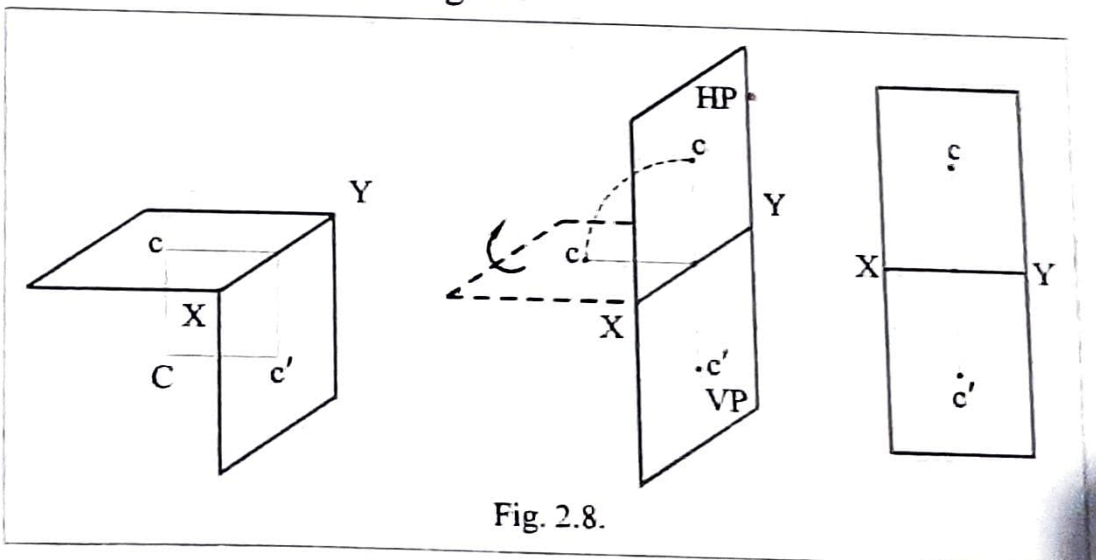


Fig. 2.8.

Case (iv). When a point D is in the fourth quadrant.

When a point D is in the fourth quadrant, its elevation d'and plan d, both are below XY line. Refer Fig.2.9.

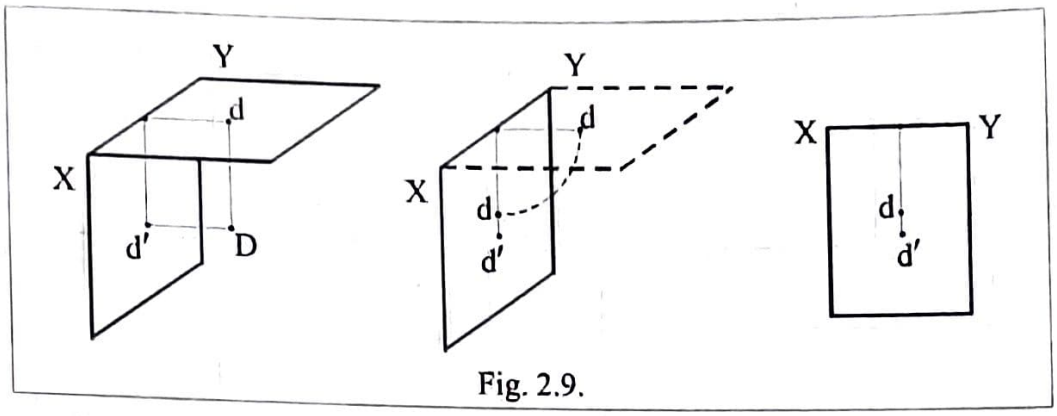


Fig. 2.9.

Case (v) When a point E is on HP and in front of VP.

When a point E is on HP and in front of VP, its elevation e' will be on XY line and its plan will be below XY line. Refer Fig. 2.10.

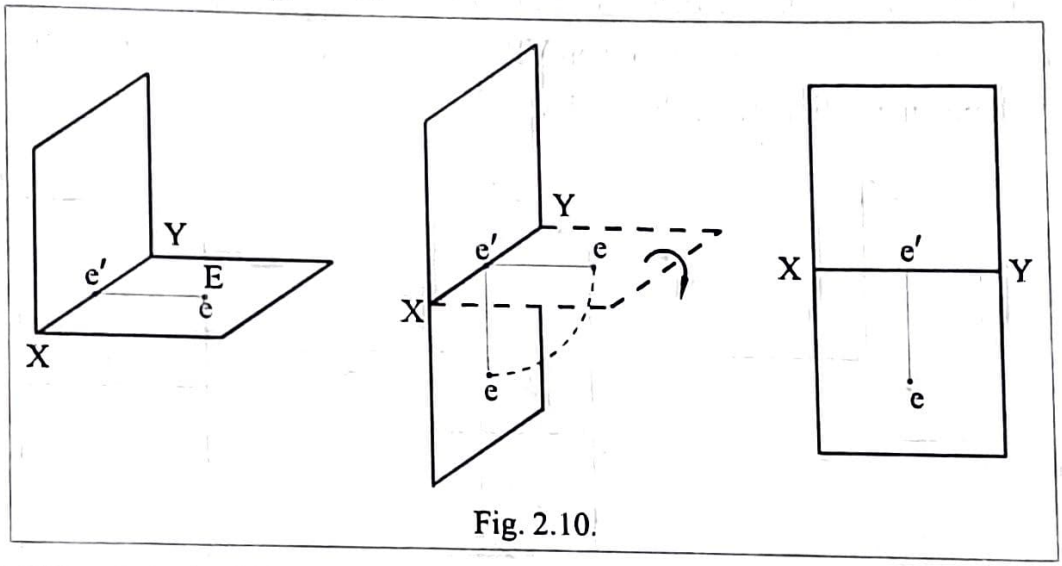


Fig. 2.10.

Case (vi) When a point F is on HP and behind VP.

When the point F is on HP and behind VP, its elevation f' will be on XY line and its plan will be above XY line. Refer Fig.2.11.

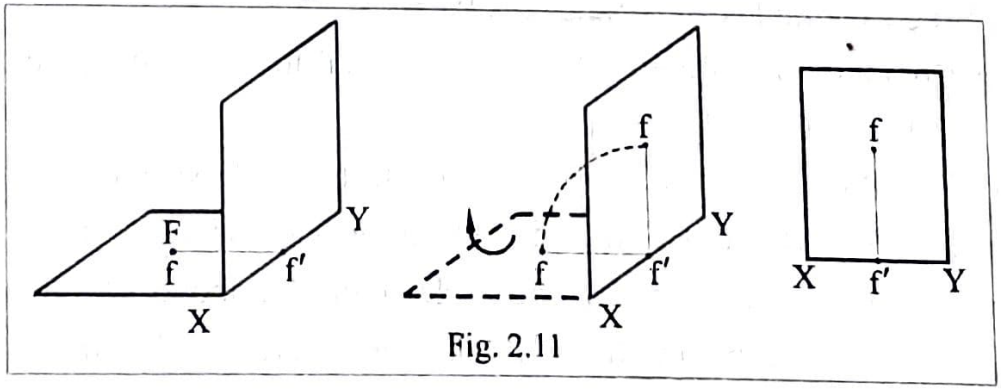


Fig. 2.11

Case (vii) When a point G is above HP and on VP.

When a point G is above HP and on VP its elevation g′ will be above XY line and its plan g will be on XY line. Refer Fig.2.12.

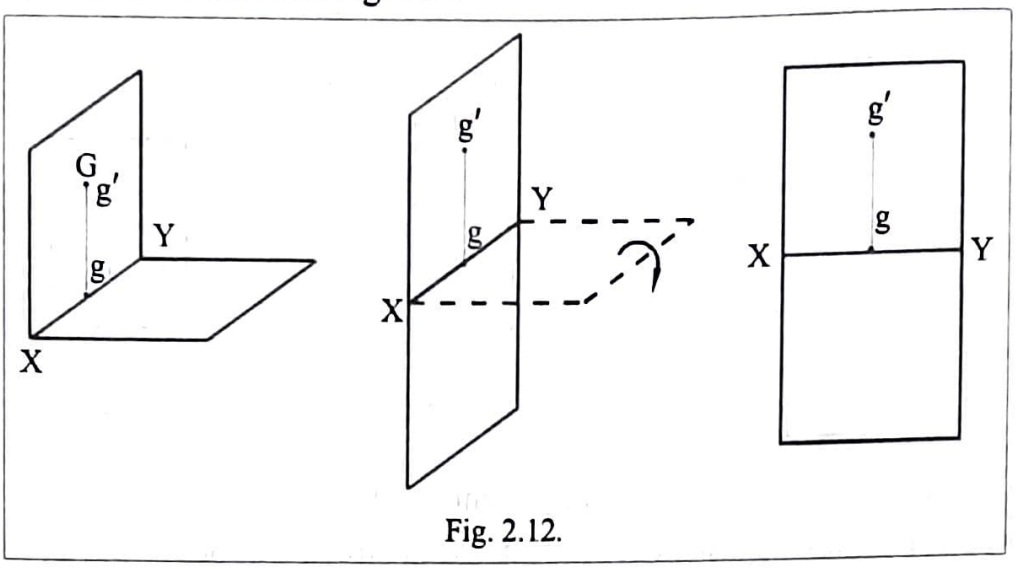


Fig. 2.12.

Case (viii) When a point H is below HP and on VP.

When a point H is below HP and on VP, its elevation h′ will be below XY line and its plan h will be on XY line. Refer Fig. 2.13.

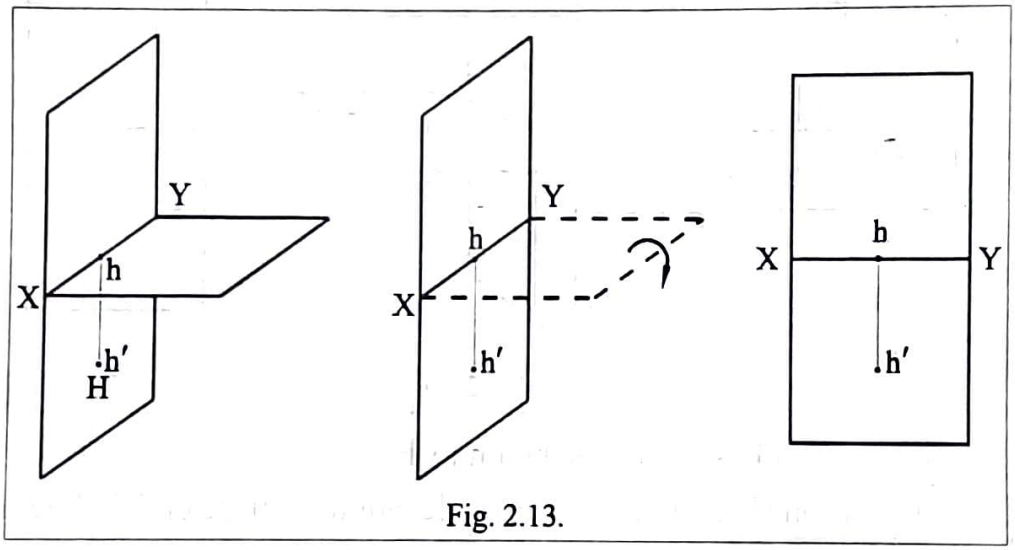


Fig. 2.13.

Case (ix) When a point I is on HP and on VP.

When a point I is on HP and on VP, its elevation i′ and plan i both are on XY line. Refer Fig. 2.14.

Refer Fig. 2.6. Point A is above HP and its elevation a′ is above XY line.

Refer Fig. 2.7. Point B is above HP and its elevation b′ is above XY line.

Refer Fig. 2.12. Point G is above HP and its elevation g′ is above XY line.

Refer Fig. 2.8. Point C is below HP and its elevation c′ is below XY line.

Refer Fig. 2.9. Point D is below HP and its elevation d′ is below XY line.

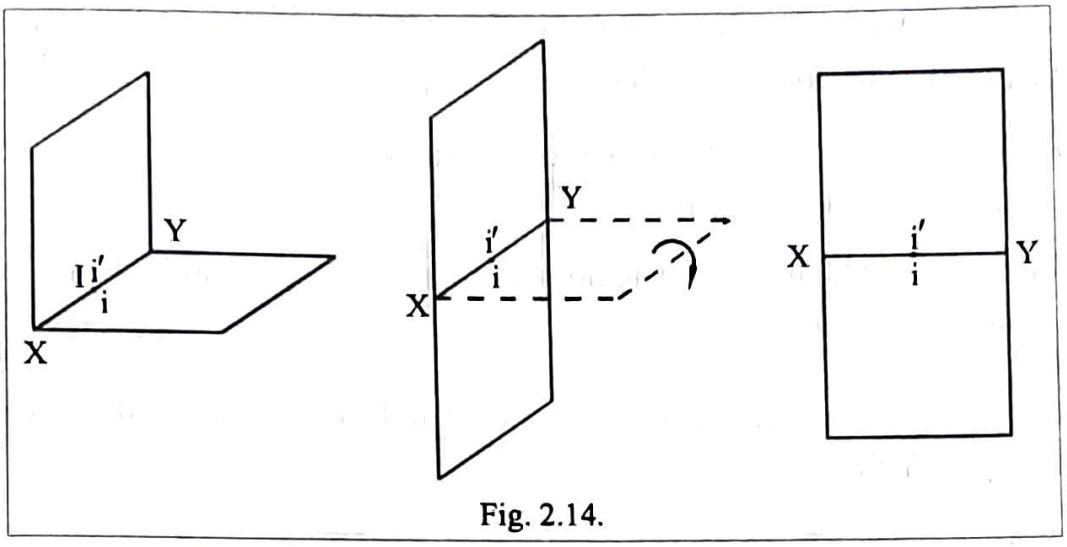


Fig. 2.14.

Refer Fig. 2.13. Point H is below HP and its elevation h′ is below XY line.

Refer Fig. 2.14. Point I is on HP and its elevation i′ is on XY line.

Refer Fig. 2.10. Point E is on HP and its elevation e′ is on XY line.

Refer Fig. 2.11. Point F is on HP and its elevation f′ is on XY line.

Points A, B and G are above HP, the elevations a′,b′ and g′ are above XY line .

Points C, D and H are below HP, the elevations c′,d′ and h′ are below XY line.

Points E , F and I are on HP, the elevations e′, f′and i′ are on XY line.

Conclusions.

1. When a point is above HP, its elevation will be above XY line.
2. When a point is below HP, its elevation will be below XY line.
3. When a point is on HP its elevation will be on XY line.

Example 2.1.

Specify the position of points A, B and C, with respect to HP, whose elevations are shown in Fig. 2.15.

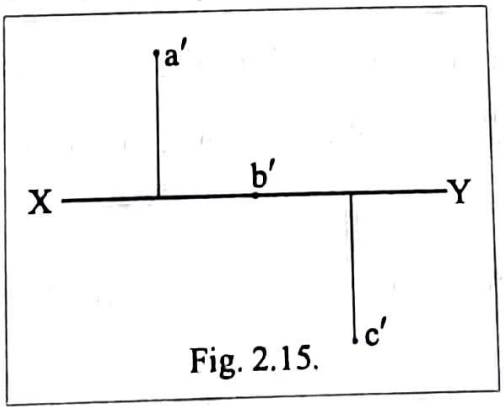


Fig. 2.15.

Solution.

Since a′ is above XY line, the point A is above HP. Since b′ is on XY line, the point B is on HP. Since the elevation c′ is below XY line, the point C is below HP.

Refer Fig. 2.6, 2.9 and 2.10. The points A , D and E are in front of VP and their plan points a , d and e are below XY line.

Refer Fig. 2.7, 2.8 and 2.11. The points B, C and F are behind VP and their plan points b, c and f are above XY line.

Refer Fig. 2.12, 2.13 and 2.14. The points G, H and I are on VP and thier plan points g, h and i are on XY line.

Conclusions.

1. When a point is in front of VP its plan will be below XY line.
2. When a point is behind VP, its plan will be above XY line.
3. When a point is on VP, its plan will be on XY line.

Example 2.2.

Specify the position of points A, B and C, with respect to VP, whose plan are shown in Fig. 2.16.

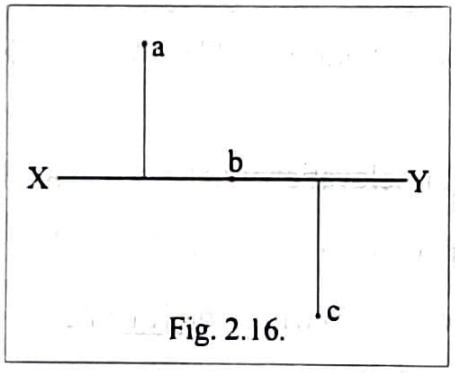


Fig. 2.16.

Solution.

Since the plan of point A, a, is above XY line, the point A is behind VP.

Since the plan of point B, b, is on XY line, the point B is on VP.

Since the plan of point C, c, is below XY line, the point C is in front of VP.

Example 2.3.

Specify the position of the points with respect to both HP and VP, whose projections are shown in Fig. 2.17.

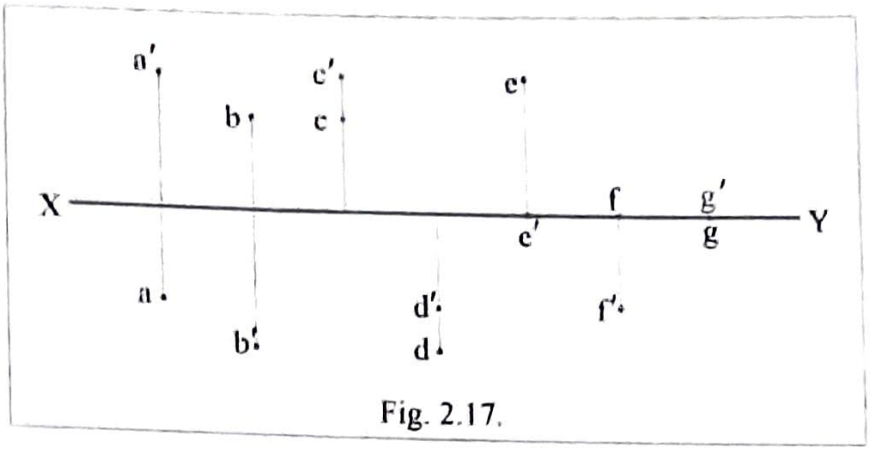


Fig. 2.17.

Solution.

Since the elevation a′ is above XY line, the point A is above HP. Since the plan a is below XY line, the point A is in front of VP.

The point A is above HP and in front of VP.

The point B is below HP and behind VP.

The point C is above HP and behind VP.

The point D is below HP and in front of VP.

The point E is on HP and behind VP.

The point F is below HP and on VP.

The point G is on HP and on VP.

2.3. To locate the plan and elevation of a point when the distance of the point from HP and VP are given.

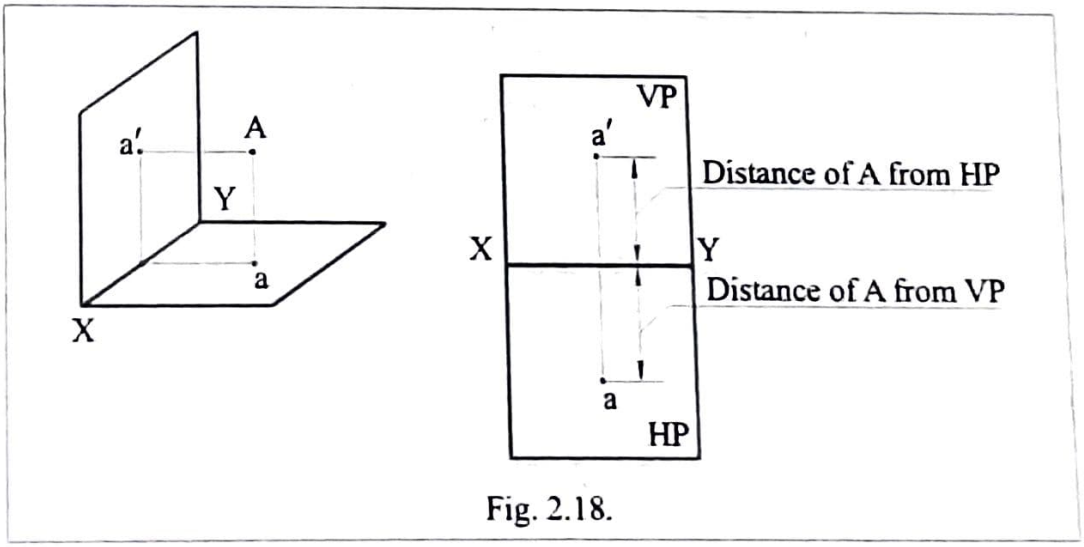


Fig. 2.18.

Refer Fig. 2.18. The distance of a′ from XY line is equal to a A, the distance of A from HP. The distance of elevation of a point from XY line is the distance of the point from HP. The distance of a point from HP can be seen in its elevation.

The distance of a from XY line is equal to a′ A, the distance of A from VP. The distance of plan of a point from XY line is the distance of the point from VP. The distance of a point from VP can be seen in its plan.

Example 2.4.

Specify the position of the points whose projections are shown in Fig.2.19.

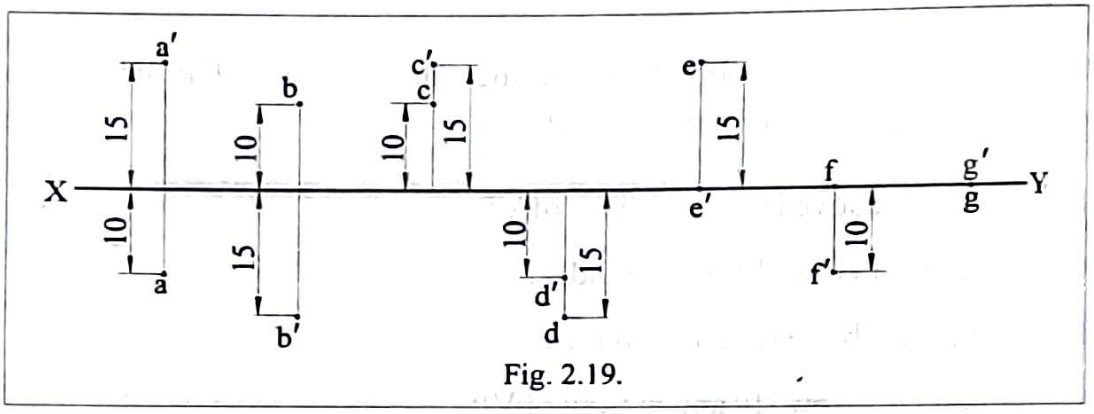


Fig. 2.19.

Solution.

Since the elevation of points A is 15mm above XY line, the point A is 15mm above HP.

Since the plan of point A is 10mm below XY line, the point A is 10mm in front of VP.

A is 15mm above HP and 10mm in front of VP.

B is 15mm below HP and 10mm behind VP.

C is 15mm above HP and 10mm behind VP.

D is 10mm below HP and 15mm in front of VP.

E is on HP and 15mm behind VP.

F is 10mm below HP and on VP.

G is on HP and on VP.

Problem for practice.

Specify the position of the points whose projections are shown in Fig. 2.20.

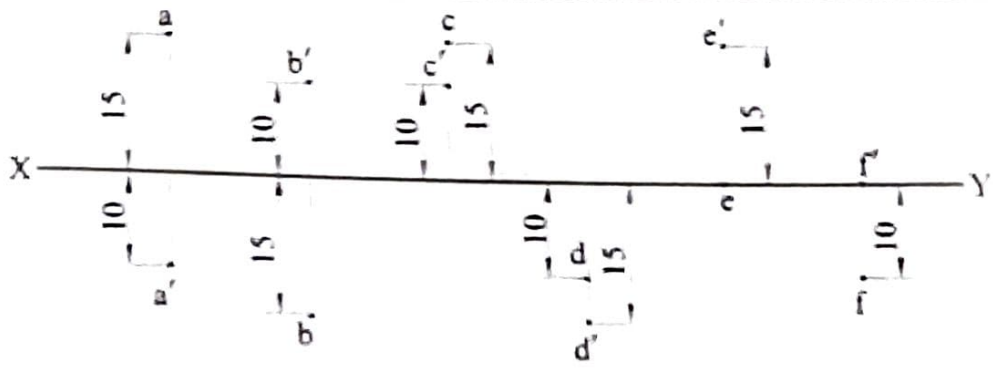


Fig. 2.20.

Example 2.5.

Draw the projections of the following points.

1. Point A which is in the first quadrant, 20mm from HP and 15mm from VP.
2. Point B which is in the second quadrant 15mm from either planes.
3. Point C which is in the third quadrant 20mm from HP and 15mm from VP.
4. Point D which is in the fourth quadrant 20mm from either planes.
5. Point E which is on HP and 20mm behind VP.
6. Point F which is 20mm below HP and on VP.

Solution.

Since A is in the first quadrant, it is above HP and in front of VP. A is 20mm above HP and 15mm in front of VP. a' is 20mm above XY line and a is 15mm below XY line.

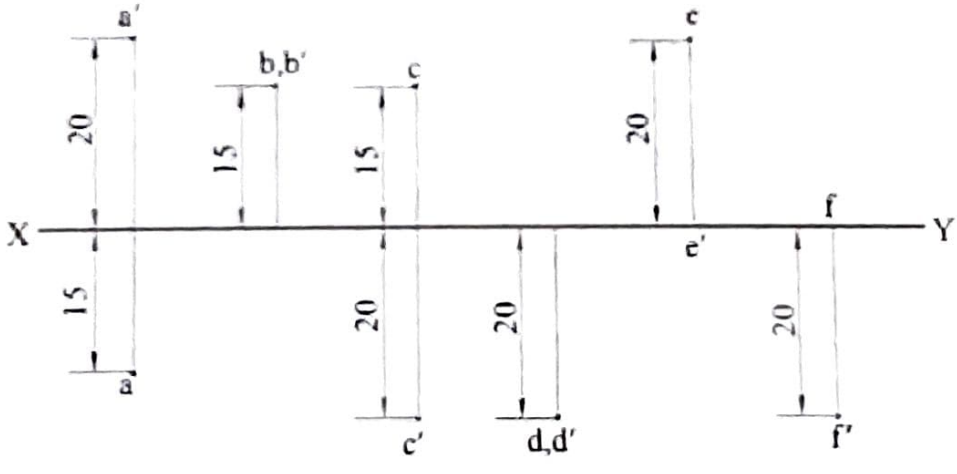


Fig. 2.21.

Since B is in the second quadrant , it is above HP and behind VP. B is 15mm above HP and 15mm behind VP. The points b' and b both are 15mm above XY line.

Since C is in the third quadrant, it is below HP and behind VP. C is 20mm below HP and 15mm behind VP. c' is 20mm below XY line and c is 15mm above XY line.

Since D is in the fourth quadrant it is below HP and in front of VP. D is 20mm below HP and 20mm in front of VP. d' and d both are 20mm below XY line.

Since E is on HP, e' is on XY line. Since E is 20mm behind VP, e is 20mm above XY line.

Since F is 20mm below HP, f' is 20mm below XY line. Since F is on VP, its plan f is on XY line.

Problem for practice.

Draw the projections of the following points.

1. Point A. It is on HP and 20mm in front of VP.
2. Point B. It is on HP and 20mm in behind VP.
3. Point C. It is 20mm below HP and on VP.
4. Point D. It is 20mm above HP and on VP.
5. Point E. It is 10mm below HP and 20mm in front of VP.
6. Point F. It is 20mm above HP and 10mm behind VP.
7. Point G. It is 15mm above HP and 15mm in front of VP.
8. Point H. It is 20mm below HP and 20 mm behind VP.

2.4. Side view or profile view of a point.

Profile plane or side plane is a plane perpendicular to both HP and VP. The line of intersection of vertical plane and profile plane is denoted by X_1Y_1. Projection of a point A on profile plane is called profile view or side view of point A and is denoted by a". Similarly profile view of points B, C etc are denoted by b", c" etc.

The distance of A from HP = aA = Ra' (Fig. 2.22) = Distance of a' from XY line. (Fig. 2.23).

The distance of elevation of a point from XY line is the distance of the point from HP.

The distance of A from VP = a'A = Ra (Fig. 2.22) = Distance of a from XY line. Fig.2.23

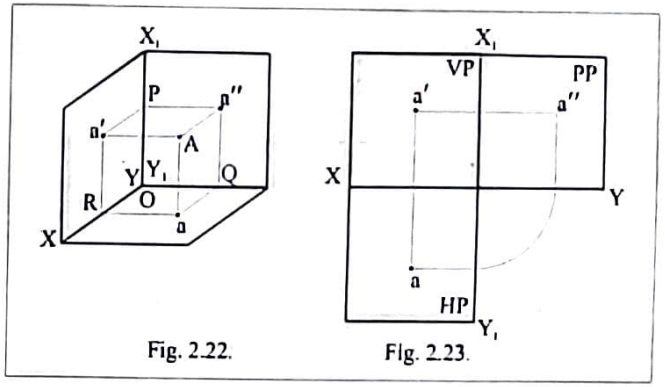


Fig. 2.22. Fig. 2.23.

The distance of plan of a point from XY line is the distance of the point from VP.

The distance of A from the profile plane = a" A = Qa = OR = Pa' (Fig.2.22) = Distance of a' as well as distance of a from X_1Y_1 line (Fig.2.23)

The distance of plan as well as elevation of a point from X_1Y_1 line is the distance of the point from the profile plane.

Distance of A from HP = aA = Qa" (Fig. 2.22) = Distance of a" from XY line (Fig. 2.23).

Distance of side view of a point from XY line is the distance of the point from HP.

Distance of A from VP = a'A = Pa" (Fig.2.22) = Distance of a" from X_1Y_1 line. (Fig.2.23).

Distance of side view of a point from X_1Y_1 line is the distance of the point from VP.

Distance of a' from XY line is the distance of A from HP..

Distance of a" from XY line is the distance of A from HP.

Distance of a from XY line is the distance of A from VP.

Distance of a" from X_1Y_1 line is the distance of A from VP.

Distance of a' from X_1Y_1 line is the distance of A from profile plane.

Distance of a from X_1Y_1 line is the distance of A from profile plane.

Example 2.6.

Specify the position of point A whose plan, elevation and side view are as shown in Fig. 2.24.

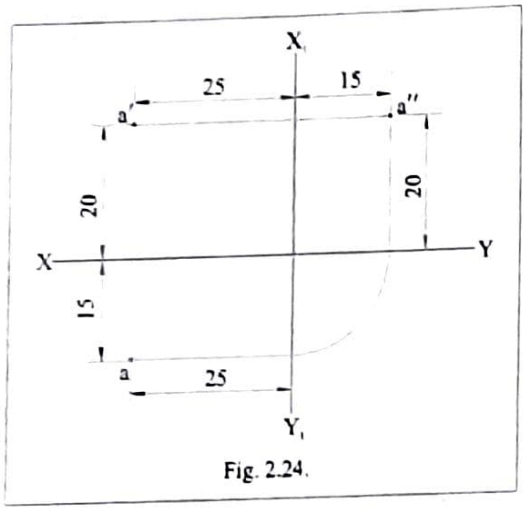


Fig. 2.24.

Solution.

Since a' is 20mm above XY line, the point A is 20mm above HP.

Since a is 15mm below XY line, the point A is 15mm in front of VP.

Since a' and a are 25mm from X_1Y_1 line, the point A is 25mm from the profile plane. The point A is 20mm above HP, 15mm in front of VP and 25mm from the profile plane.

Example 2.7.

Draw the plan, elevation and side view of a point A which is 25mm above HP, 20mm in front of VP and 15mm from the profile plane.

Solution.

Draw the XY line and locate a' and a, a' 25mm above XY line and a 20mm below XY line. Draw X_1Y_1 line, 15mm away from the line joining a' and a. From a' draw a horizontal line. a'' will be in this line. From a draw a horizontal line to intersect the X_1Y_1 line. With the point of intersection of XY and X_1Y_1 lines as center, draw an arc with 20mm radius to intersect the XY line. From this point draw a vertical line to intersect the horizontal line from a' at a''.

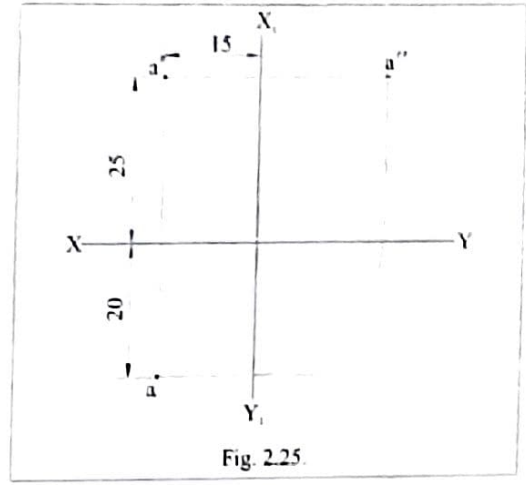


Fig. 2.25.

Example 2.8.

Draw the plan, elevation and side view of a point A which is 25mm above HP, and 15mm in front of VP.

Solution.

Draw the XY line and a projector which is perpendicular to XY line. Locate a' and a, a' 25mm above XY line and a 15mm below XY line. Since the distance of point A from the profile plane is not given, the X_1Y_1 line can be drawn at any convenient distance from the projector. Locate a'' are explained in the previous problem.

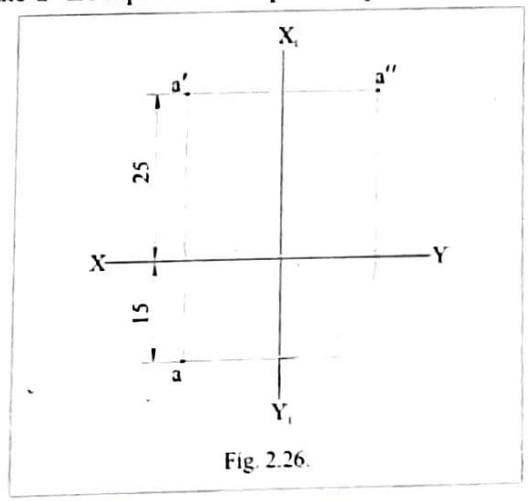


Fig. 2.26.

Problem for practice.

Draw the plan, elevation and side view of a point A which is 30mm below HP 25mm behind VP and 15 mm from the profile plane.

2.5. Projections of lines.

Projections of a line, that is, the plan, elevation and side view of a line can be drawn by joining the respective projections of its end points. After locating a, b, a', b', a'' and b'', by joining a and b we will get the plan of line AB. Elevation of the line is obtained by joining a' and b', side view of the line is obtained by joining a'' and b''.

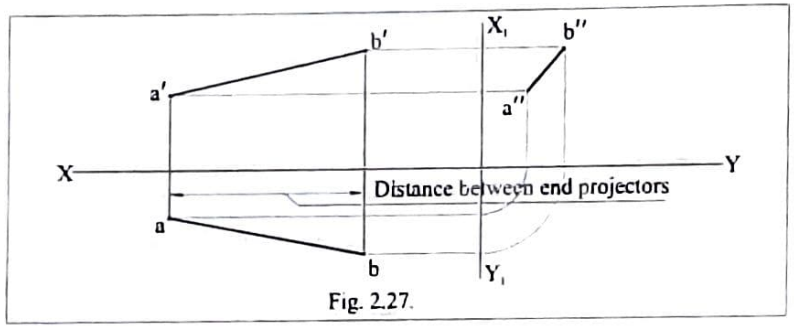


Fig. 2.27.

a' b' is the elevation of line AB.

ab is the plan of line AB.

a'' b'' is the profile view of line AB.

Example 2.9.

The distance between the end projectors of a line AB is 40mm. The end A is 10mm above HP and 30mm in front of VP. The end B is 25mm above HP and 15mm in front of VP. Draw the plan and elevation of the line AB.

Solution.

Draw the XY line and draw two lines perpendicular to XY line at the given distance of 40mm apart. In the first line, locate a' and a , a' 10mm above XY line and a 30mm below XY line. In the second line locate b' and b , b' 25mm above XY line and b 15mm below XY line. Join a and b to get the plan of the line AB. Join a' and b' to get the elevation of the line AB..

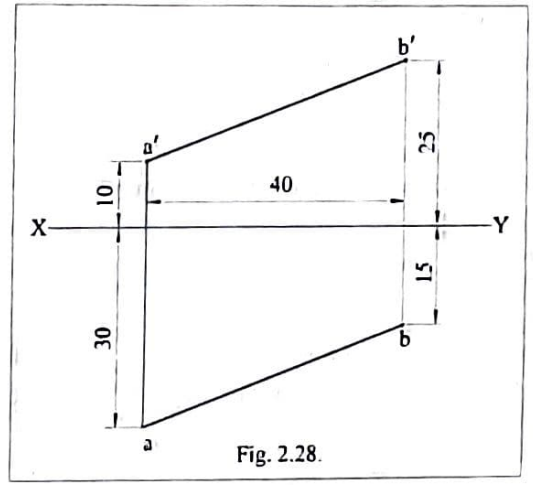


Fig. 2.28.

Example 2.10.

The end A of a line AB is 10mm above HP and 15mm in front of VP. The end B is also above HP and in front of VP. The length of elevation is 50mm and it is inclined at 25° with XY line. Draw the plan and elevation of the line AB when the plan of the line is inclined at 20° with XY line.

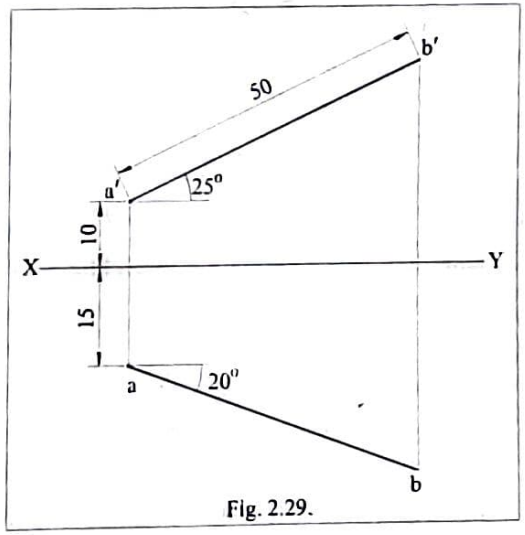


Fig. 2.29.

Solution.

Draw the XY line and draw a projector. Locate a' and a in this projector, a' 10mm above XY line and a 15mm below XY line. From a' draw a line of length 50mm, inclined

at 25° with horizontal. Mark the end point of this line as b'. From b' draw a line perpendicular to XY line. From a draw a line inclined at 20° with horizontal to intersect the vertical line from b' at b.

Example 2.11.

The end A of a line AB is 10mm above HP and 15mm in front of VP. The end B is in the second quadrant. The length of elevation is 50mm and it is inclined at 25° with horizontal. Draw its projections when the length of plan is 55mm.

Solution.

Draw the XY line and draw a projector. Locate a' and a, a' 10mm above XY line and a 15mm below XY line. From a' draw a line of lengh 50mm and inclined at 25° with

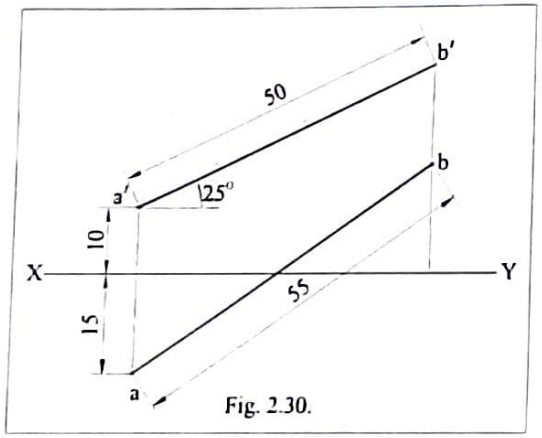


Fig. 2.30.

horizontal. Mark the end point of this line as b'. From b' draw a vertical line. With a as center and 55mm radius draw an arc to cut the vertical line from b'at b. Join a and b. Since B is in the second quadrant, both b' and b are above XY line.

Problem for practice.

1. The end A of a line AB is 15mm above HP and 10mm in front of VP. The end B is in the third quadrant. Length of plan is 50mm and it is inclined at 25° with horizontal. Draw its projections when the elevation is inclined at 30° with XY line.
2. The end A of a line AB is 10mm above HP and 15mm in front of VP. The end B is in the second quadrant. The length of plan is 50mm and it is inclined at 25° with horizontal. Draw its projections when the elevation is inclined at 30° with XY line.

Example 2.12.

The distance between the end projectors of a line AB is 40mm. The end A is 15mm above HP and 10mm in front of VP. The end B is 30mm above HP and 20mm in front of VP. Draw the plan, elevation and side view of the line AB.

Solution.

Draw the XY line and draw two lines perpendicular to XY line at the given distance of 40mm apart. In the first line, locate a' and a , a' 15mm above XY line and a 10mm below

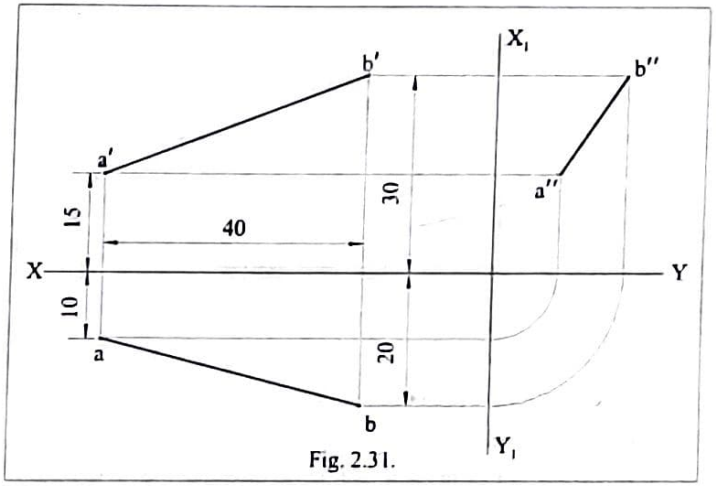


Fig. 2.31.

XY line. In the second line locate b' and b, b' 30mm above XY line and b 20mm below XY line. Join a and b to get the plan of the line AB. Join a' and b' to get the elevation of the line AB. From a' and b' draw lines parallel to XY line. a'' and b'' are on these lines respectively. From a and b draw horizontal lines to intersect the X_1Y_1 line. With the point of intersection of the lines XY and X_1Y_1 as center and the distance of a from XY line as radius draw arc to intersect the XY line. From this point draw a vertical line to intersect the line from a' at a''. Similarly locate b''. Join a'' and b''. This line a'' b'' is the side view of the line AB.

Example 2.13.

The distance between the end projectors of a line AB is 40mm. The end A is 15mm above HP and 20mm in front of VP. The end B is 15mm below HP and 30mm in front of VP. Draw the plan, elevation and side view of the line AB.

Solution.

Draw the XY line and draw two lines perpendicular to XY line at the given distance of 40mm apart. In the first line, locate a' and a , a' 15mm above XY line and a 20mm below XY line. In the second line locate b' and b, b' 15mm below XY line and b 30mm below

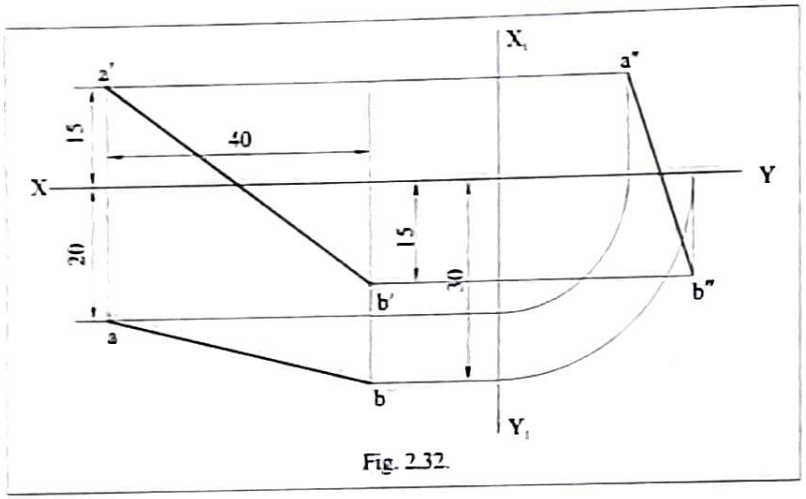


Fig. 2.32.

XY line. Join a and b to get the plan of the line AB. Join a' and b' to get the elevation of the line AB. From a' and b' draw lines parallel to XY line. a'' and b'' are on these lines respectively. From a and b draw horizontal lines to intersect the X_1Y_1 line. With the point of intersection of the lines XY and X_1Y_1 as center and the distance of a from XY line as radius draw arc to intersect the XY line. From this point draw a vertical line to intersect the line from a' at a''. Similarly locate b''. Join a'' and b''. This line a'' b'' is the side view of the line AB.

Example 2.14.

The distance between the end projectors of a line AB is 30mm. The end A is 15mm above HP and 20mm in front of VP. The end B is 30mm above HP and 10mm behind VP. Draw the plan, elevation and side view of the line AB.

Draw the XY line and draw two lines perpendicular to XY line at the given distance of 30mm apart. In the first line, locate a' and a , a' 15mm above XY line and a 20mm below XY line. In the second line locate b' and b, b' 30mm above XY line and b 10mm above XY line. Join a and b to get the plan of the line AB. Join a' and b' to get the elevation of the line AB. From a' and b' draw lines parallel to XY line. a'' and b'' are on these lines

respectively. From a and b draw horizontal lines to intersect the X_1Y_1 line. With the point of intersection of the lines XY and X_1Y_1 as center and the distance of a from XY line as radius draw an arc to intersect the XY line. From this point draw a vertical line to intersect

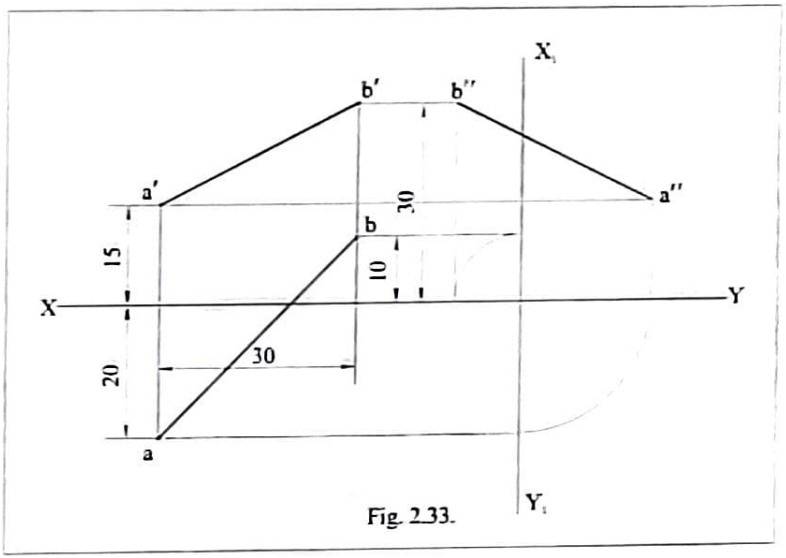


Fig. 2.33.

the line from a' at a''. Similarly locate b''. Join a'' and b''. This line a'' b'' is the side view of the line AB. It should be noted that since B is in the second quadrant, the position of b'' is left of X_1Y_1 line.

Problem for practice.

The distance between the end projectors of a line AB is 40mm. The end A is 10mm above HP and 20mm in front of VP. The end B is 15mm below HP and 25mm behind VP. Draw the plan, elevation and side view of the line AB.

Example 2.15.

Draw the projections of the following lines, keeping the distance between end projectors, 30mm.

Line AB. The end A is 20 mm above HP and 15 mm in front of VP. The end B is also 20 mm above and HP and 15 mm in front of VP.

Line CD. The end C is 10 mm above HP and 15 mm in front of VP. The end D is 25 mm above HP and 15 mm in front of VP.

Line EF. The end E is 15 mm above HP and 10mm in front of VP. The end F is 15 mm above HP and 25 mm in front of VP.

Line GH . The end G is 10 mm above HP and 15 mm in front of VP. The end H is 20mm above HP and 25 mm in front of VP.

Solution.

Draw an XY line and draw two lines perpendicular to XY line at 30mm apart. In the first line locate a′ and a , a′ 20mm above XY line and a 15mm below XY line. In the second line locate b′ and b , b′ 20mm above XY line and b 15mm below XY line. Join a′ and b′ to get the elevation and a and b to get the plan of the line AB. Like this draw the projections of the other lines.

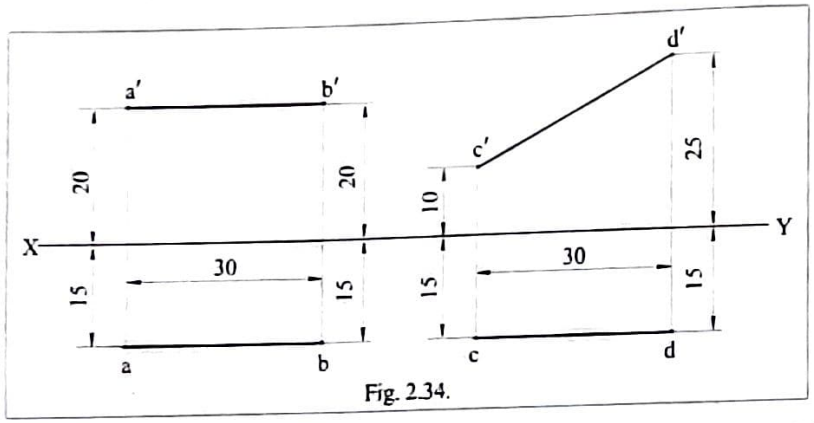


Fig. 2.34.

Refer Fig. 2.34. The ends A and B of the line AB are at the same distance (20 mm) from HP. Therefore the line AB is parallel to HP. Similarly the ends A and B of the line AB are at the same distance (15 mm) from VP. Therefore the line AB is parallel to VP. The line AB is parallel to both HP and VP.

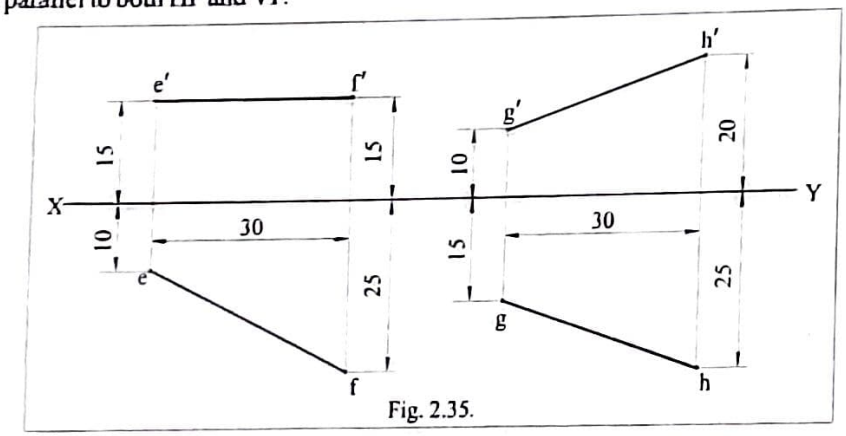


Fig. 2.35.

A line is said to be parallel to a reference plane when its end points are at the same distance from the reference plane. A line is said to be inclined to a reference plane when its end points are at different distances from the reference plane.

The end C of the line CD is nearer to HP compared to the other end D. Hence the line CD is inclined to HP. The end C and D are at the same distance from VP and hence the line CD is parallel to VP. The line CD is inclined to HP and parallel to VP. Refer Fig. 2.35. The line EF is parallel to HP and inclined to VP. The line GH is inclined to both HP and VP.

When a line is on a reference plane or parallel to a reference plane, the length of projection on that referance plane will be the true length of the line. That is when a line is on HP or parallel to HP, the length of projection on HP (length of plan) will be the true length (TL) of the line. Similarly when a line is on VP or parallel to VP, the length of projection on VP (length of elevation) will be the true length of the line. Refer Fig. 2.36. a′ b′ and ab are

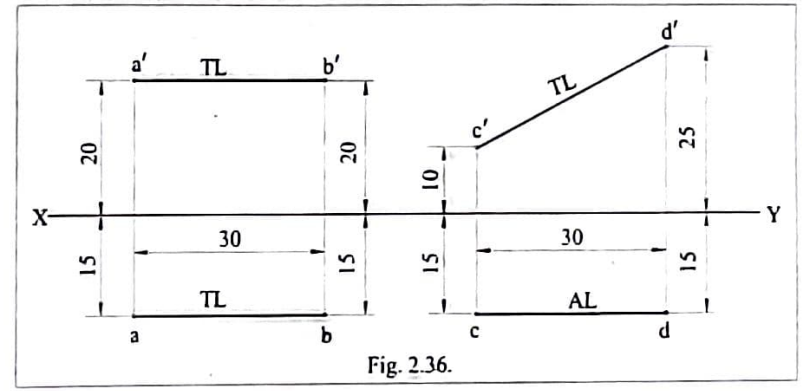


Fig. 2.36.

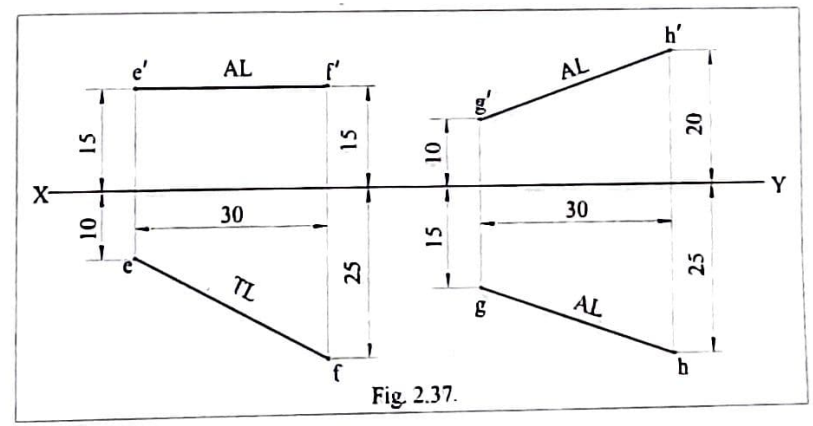


Fig. 2.37.

the true length of line AB. Since the line CD is parallel to VP, the length of projection on VP, the elevation c'd' is the true length of line CD. Since the line CD is inclined to HP, the length of projection on HP, the plan, cd is smaller than the true length of the line. This length of projection is called apparent length (AL) of the line. Refer Fig. 2.37. e' f' is the apparent length of line EF and ef is the true length of line EF. Since the line GH is inclined to both HP and VP, both g' h' and g h are apparent length of the line.

True inclination of a line with HP and VP are denoted by θ and ϕ respectively. Only true length shows true inclination and apparent length shows apparent inclination of the line. Apparent inclination of a line with HP and VP are denoted by α and β respectively.

It should be noted that inclination of a line with HP can be seen in its elevation and inclination of a line with VP can be seen in its plan. Inclination of elevation will be either θ or α. Inclination of plan will be either ϕ or β.

Inclination of elevation of a line will be θ when the length of elevation is true length of the line. Inclination of elevation will be α when length of elevation is apparent length of the line. Inclination of plan will be ϕ when length of plan is the true length of the line and the inclination of the plan will be β when length of the plan is apparent length of the line.

Refer Fig. 2.38. The inclination of c' d' is θ and that of g' h' is α. Similarly the inclination of ef is ϕ and the inclination of gh is β.

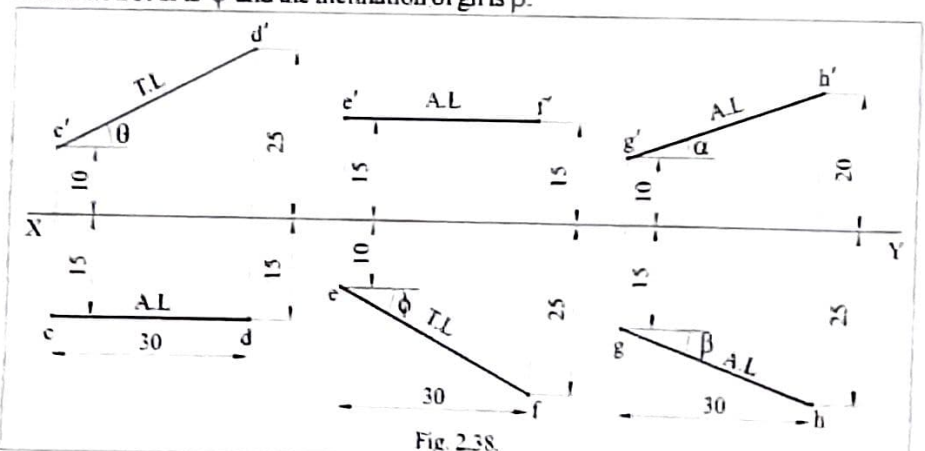


Fig. 2.38.

Example.2.16.

The length of elevation of a line parallel to HP an inclined at 30° to VP is 40mm. One end of the line is 15mm above HP and 10mm in front of VP. Draw the projections of the line and determine its true length.

Solution.

Draw the XY line and draw a projector perpendicular to XY line. Locate a' and a, a' 15mm above XY line and a 10mm below XY line. From a' draw a horizontal line of length

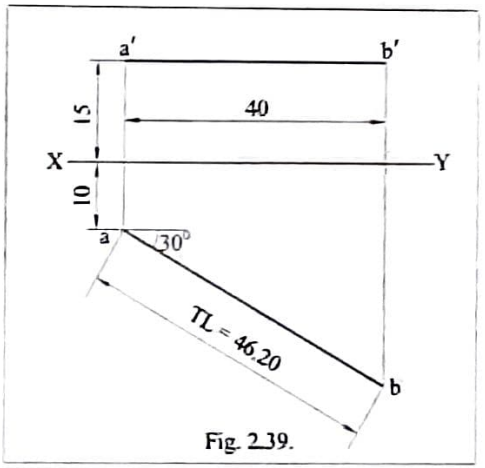


Fig. 2.39.

40mm. Mark the end point of this line as b'. From b' draw a vertical line. From the point a draw a line inclined at 30° with XY line to intersect the vertical line from b' at b. Joint a and b. This line is the plan of the line which itself is the true length of the line.

University questions.

1. The length of the top view of a line parallel to VP and inclined at 45° to HP is 50mm. One end of the line is 12mm above HP and 25 mm in front of VP. Draw the projections of the line and determine its true length. [CUSAT June 2013].

2. A pipe is to be fixed on a vertical wall. One end of the pipe is touching on the floor and the other end is at a height of 3 m. If the distance between the ends of the pipe measured along the floor is 6 m, find graphically the length of the pipe and its inclination to the floor. [MGU May 2012].

When a line is perpendicular to a reference plane, the length of projection on that reference plane will be zero. That is a point. When a line is perpendicular to HP, its plan will be a point . When a line is perpendicular to VP, its elevation will be a point. When a line is perpendicular to the profile plane, its profile view will be a point.

Refer Fig. 2.40. Line AB is perpendicular to VP and hence its elevation a' b' is a point.

The line CD is perpendicular to HP and hence its plan cd is a point. Line EF is perpendicular to the profile plane and hence its profile view e'' f'' is a point.

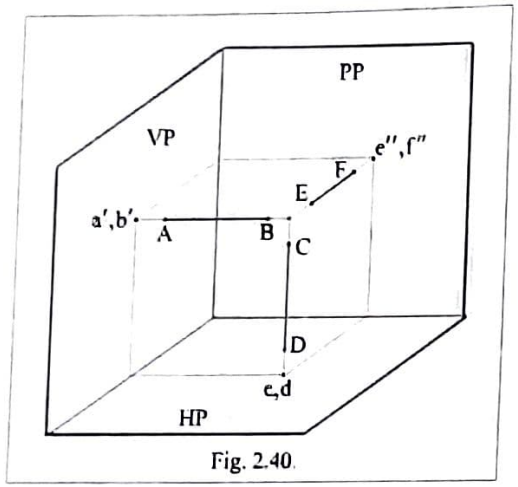


Fig. 2.40

Refer Fig. 2.41. Since the line AB is perpendicular to VP, it is parallel to HP and hence its plan ab is the true length of the line AB. Since the line CD is perpendicular to HP, it is parallel to VP and hence its elevation c' d' is the true length of the line CD. Since the line EF is perpendicular to the profile plane, it is parallel to both HP and VP and hence its plan and elevation, ef and e' f', are the true length of the line EF.

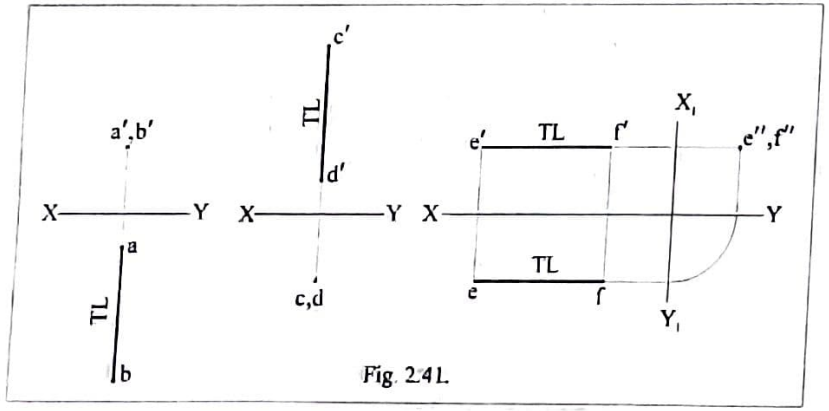


Fig. 2.41.

Example 2.17.

Draw the projections of the following lines.

1) Line IJ. It is perpendicular to VP and 15mm above HP. The end I is 10mm in front of VP and the end J is 40 mm in front of VP.

2) Line KL. It is perpendicular to HP and 20mm in front of VP. The end K is 30mm above HP and L is 5mm above HP.

Solution.

Since the line IJ is perpendicular to VP, its projection on VP ie, the elevation i' j' is a point, 15mm above XY line. Draw the XY line and draw a projector. Mark i' and j' both 15mm above XY line. This point i' j' is the elevation of the line IJ. Locate i and j on the same projector 10mm and 40mm below XY line respectively. Join the points i and j. This line is the plan of the line IJ. Refer Fig. 2.42.

Since the line IJ is perpendicular to VP, it is parallel to HP. Therefore the length of projection on HP, the plan i j will be the true length of the line IJ. Since the length of ij is the true length of the line IJ, its inclination is the true inclination of the line IJ with VP. Refer Fig. 2.43.

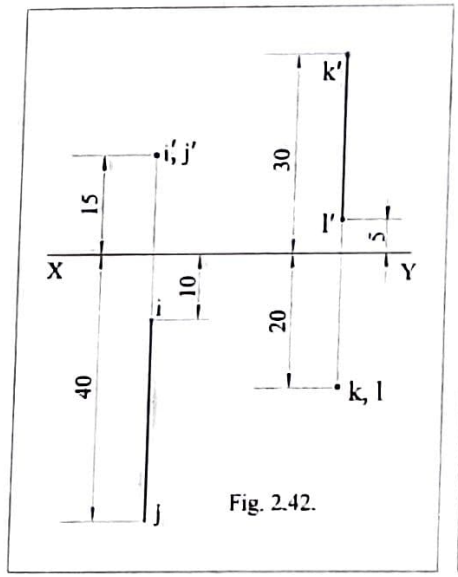


Fig. 2.42.

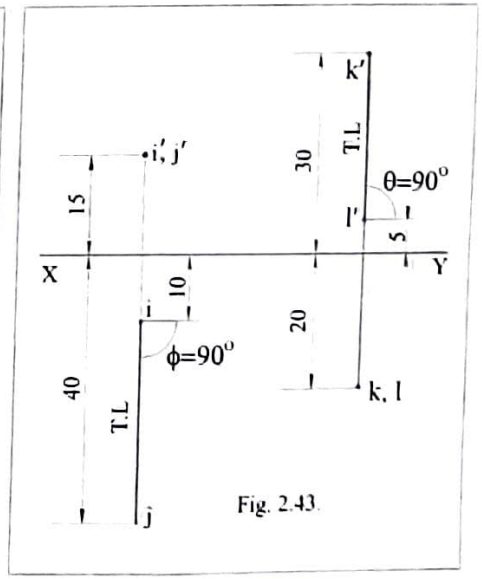


Fig. 2.43.

Since the line KL is perpendicular to HP, its projection on HP ie, the plan kl is a point, 20mm below XY line. Draw the XY line and draw a projector. Mark i and j both 20mm. below XY line. This point kl is the plan of line KL. Locate k' and l' on the same projector 30mm and 5mm above XY line respectively. Join the points k' and l'. This line is the elevation of the line KL. Refer Fig. 2.42.

Since the line KL is perpendicular to HP, it is parallel to VP. Therefore the length of projection on VP, the elevation k' l' will be the true length of the line KL. Since k' l' is the true length of the line KL its inclination is the true inclination of line KL with HP. Refer Fig. 2.43.

Example 2.18.

Draw the plan, elevation and side view of a line AB which is parallel to the profile plane. The end A is 40mm above HP and 10mm in front of VP. The end B is 10mm above HP and 35mm in front of VP.

Solution.

Draw XY and X_1Y_1 lines. Draw a projector perpendicular to XY line. Locate a', a, b' and b on this projector, a' 40mm above XY line, a 10mm below XY line, b' 10mm

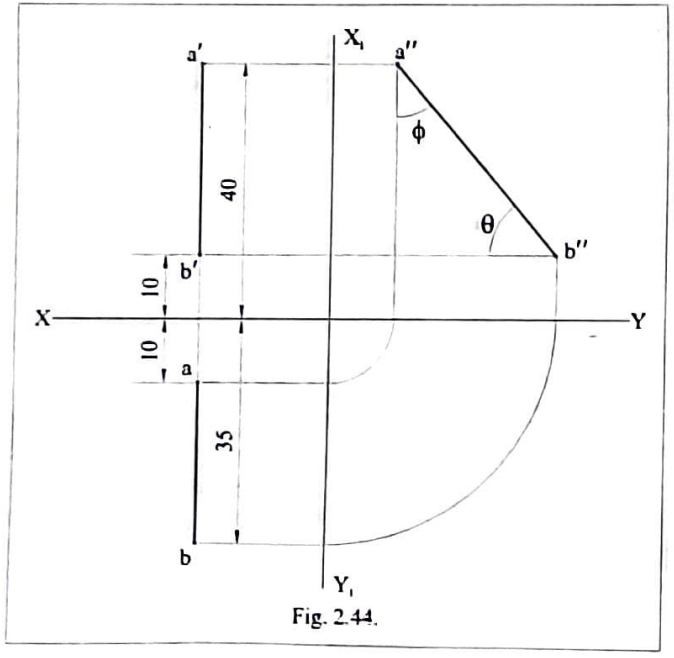


Fig. 2.44.

above XY line and b 35mm below XY line. Join a' and b'. Join a and b. Draw the side view a'' b'' as shown in Fig. 2.44. Since the line AB is parallel to the profile plane, the profile view a'' b'' will be the true length of the line. Since a'' b'' is the true length of the line AB, the inclination of the line a'' b'' will be the true inclination of line AB with HP and VP. Inclination of the line a'' b'' with horizontal is the true inclination of line AB with HP, θ and the inclination of the line a'' b'' with vertical is the true inclination of the line AB with VP, ϕ. Here $\theta + \phi = 90^\circ$. When $\theta + \phi = 90^\circ$, the plan and elevation are perpendicular to XY line and are on the same projector.

University question.

The end projectors of a line MN coincide. The end M is 15mm below HP and 25mm behind VP. The end N is 50mm above the HP and 40mm infront of the VP. Draw the projections, determine the true length and true inclinations with HP and VP. [CUSAT May 2007].

2.6. Trace of a line.

Consider a line which is inclined to a reference plane. When this line is extended it will meet that reference plane at a point. This point at which a line or extension of a line intersects a reference plane is called trace of the line. The point of intersection of a line or extension of a line with horizontal plane is called horizontal trace (HT) of the line. Similarly the point of intersection of a line or extension of a line with vertical plane is called vertical trace (VT) of the line.

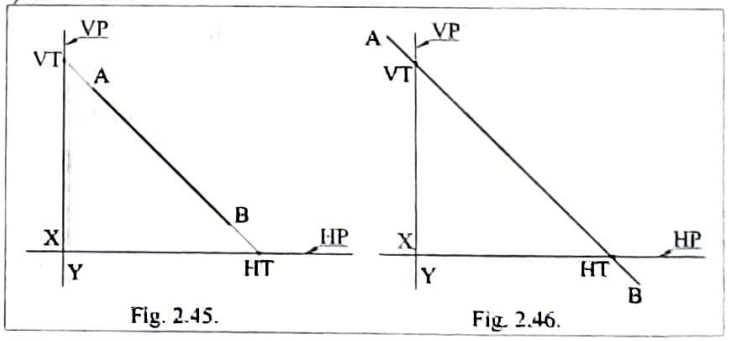


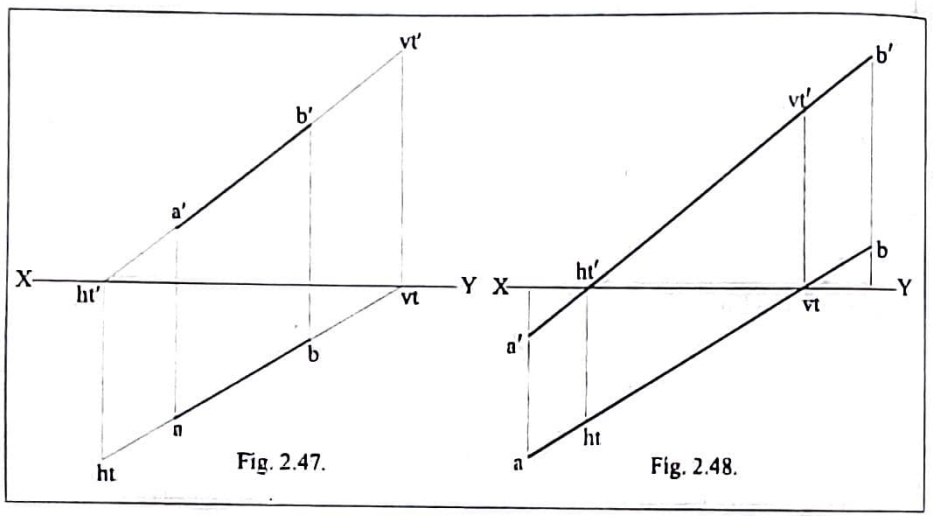
Fig. 2.45. Fig. 2.46.

The plan and elevation of HT are denoted by ht and ht'. The plan and elevation of VT are denoted by vt and vt'. Horizontal trace being a point on HP, its elevation, ht,' will be on XY line. Similarly since vertical trace is a point on VP, its plan, vt, will be on XY line. The position of ht and vt' may be either on XY line, above XY line or below XY line. Fig.2.45.

shows the position of HT and VT when the line is in the first quadrant. Fig.2.46 shows the position of HT and VT when one end of the line is in the second quadrant and the other end is in the fourth quadrant.

To locate ht, ht', vt and vt' when the projections of a line are given.

The elevation of horizontal trace, ht' and plan of vertical trace, vt are always on XY line. It is because HT is a point on HP and VT is a point on VP.



Procedure to locate the plan of horizontal trace of a line.

Extend the elevation, if necessary, to intersect the XY line. From this point draw a line perpendicular to XY line. Extend the plan, if necessary, to intersect the line drawn perpendicular to XY line. This point is the plan of horizontal trace, ht. Refer Fig. 2.47.

Procedure to locate the elevation of vertical trace of a line.

Extend the plan, if necessary, to intersect the XY line. From this point draw a line perpendicular to XY line. Extend the elevation, if necessary, to intersect the line drawn perpendicular to XY line. This intersecting point is the elevation of vertical trace, vt'. Refer Fig. 2.48.

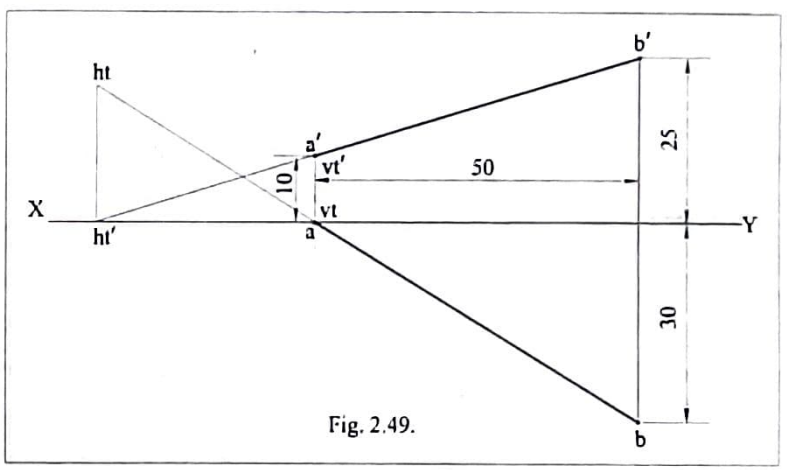
It should be noted that the position of vt' will be either in the elevation or in the extension of elevation of a line. Similarly the position of ht will be either in the plan or in the extension of plan of a line. After locating ht and vt', ht' and vt can be located on XY line. ht', vt', a' and b' are collinear. Similarly ht, vt, a and b are collinear.

Example 2.19.

The distance between the end projectors of a line AB is 50mm. The end A is 10mm above HP and on VP. The end B is 25 mm above HP and 30mm in front of VP. Draw the projections of the line and locate its traces.

Solution.

Draw the XY line and draw two projectors, perpendicular to XY line, at the given distance of 50 mm apart. Locate a, a', b and b'. Join a and b. This is the plan of line AB. Joint a' and b'. This is the elevation of line AB. Locate the traces as shown in Fig. 2.49.



Example 2.20.

The distance between the end projectors of a line AB is 50mm. The end A is on HP and 10mm in front of VP. The end B is 30mm above HP and 25mm in front of VP. Draw the projections of the line and locate its traces.

Solution.

Draw the XY line and draw two projectors, perpendicular to XY line, at the given distance of 50mm apart. Locate a', a, b' and b. Join a and b. This is the plan of line AB. Joint a' and b'. This is the elevation of line AB. Locate the traces as shown in Fig.2.50.

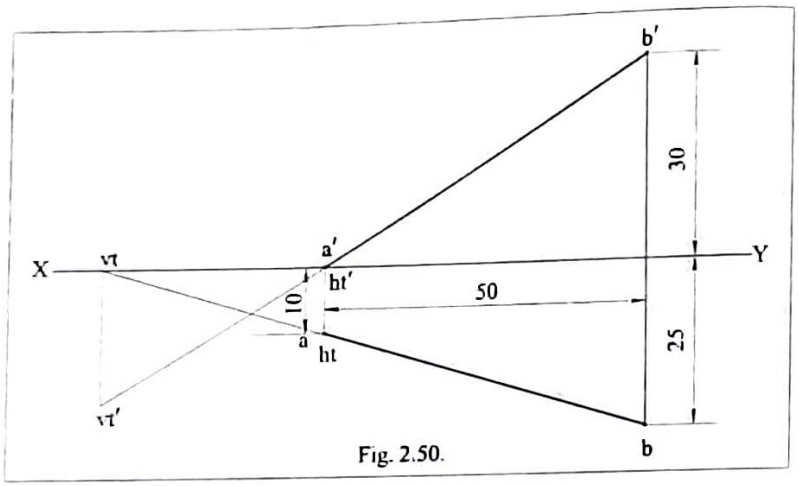


Fig. 2.50.

Problem for practice.

1. The distance between the end projectors of a line AB is 50mm. The end A is 20mm above HP and 10mm in front of VP. The end of B is 40mm above HP and 30mm in front of VP. Draw the projections of the line and locate its traces.
2. The distance between the end projectors of a line AB is 50mm. The end of A is 10mm above HP and 20mm in front of VP. The end B is 30mm above HP and 40mm in front of VP. Draw the projections of the line and locate its traces.
3. The distance between the end projectors of a line AB is 50mm. The end A is on HP and on VP. The end B is 30mm above HP and 40mm in front of VP. Draw the projections of the line and locate its traces.

University question.

A line AB of length 70mm is parallel to VP and 30mm in front of it. If the point A is 15 mm and the point B is 45mm above HP, draw its projections and find the horizontal trace of the line. [MGU May 2012].

2.7. True length and true inclination of a line which is inclined to both HP and VP.

When a line is on a reference plane or parallel to a reference plane, the length of projection on that reference plane will be the true length of the line. When the line is on HP or parallel to HP, the length of plan will be the true length of the line and inclination of this plan with XY line will be the true inclination of the line with VP, ϕ. When a line is on VP or parallel to VP the length of elevation will be the true length of the line and the inclination of this elevation with XY line will be the true inclination of the line with HP, θ. It should be

noted that the inclination of a line with HP can be seen in the elevation and inclination with VP can be seen in the plan.

When a line is on or parallel to the profile plane, the length of profile view will be the true length of the line and its inclination with horizontal will be the true inclination of the line with HP, θ. and the inclination of this profile view with vertical will be the true inclination of the line with VP, ϕ.

When the projections of a line which is inclined to both HP and VP are given, there are different methods to find the true length of the line and the true inclination of the line with HP and VP. These methods include i) Trapezoidal method and ii) Line rotation method.

I.) Trapezoidal method.

After drawing the plan and elevation of the line AB, from the end points of the elevation ie, form a' and b' draw lines perpendicular to the elevation a' b'. Then locate A and B on these lines such that a'A is the distance of a from XY line and b' B is the distance of b from XY line. Join A and B. AB is the true length of the line. Extend A B and a'b', if necessary, to intersect at a point. This intersecting point is the elevation of vertical trace, vt'. From vt' draw a vertical line to intersect the XY line. This point in the XY line is the plan

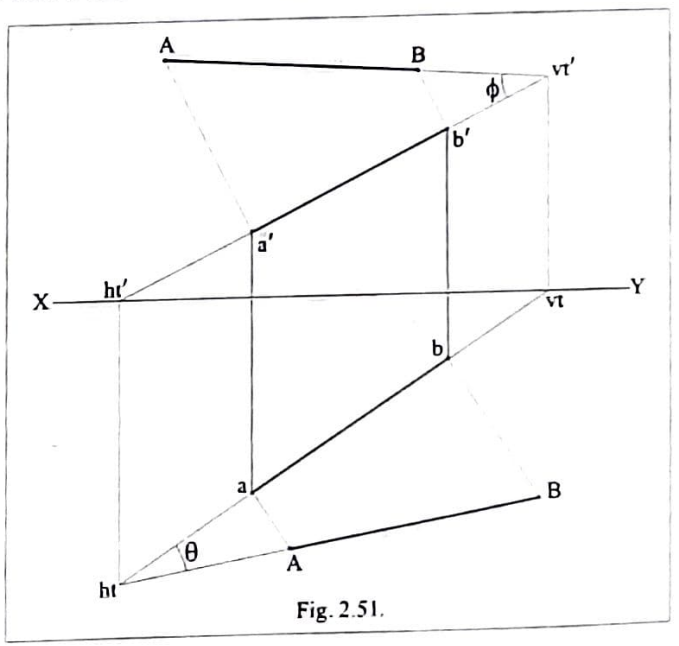


Fig. 2.51.

of vertical trace, vt. The angle between a′ b′ and AB is the true inclination of the line with VP, ϕ.

From the end points of the plan, ie from a and b draw lines perpendicular to the plan ab. Locate A and B such that aA is the distance of a′ from XY line and bB is the distance

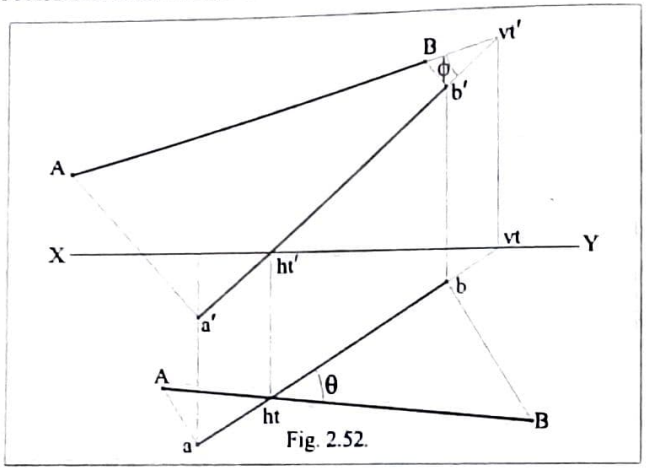


Fig. 2.52.

of b′ from XY line. Join A and B. AB is the true length of the line. Extend ab and AB, if necessary, to intersect at a point. This point is the plan of horizontal trace, ht. From ht, draw a vertical line to intersect the XY line. This point is the elevation of horizontal trace, ht′. The angle between ab and AB is the true inclination of the line with HP, θ.

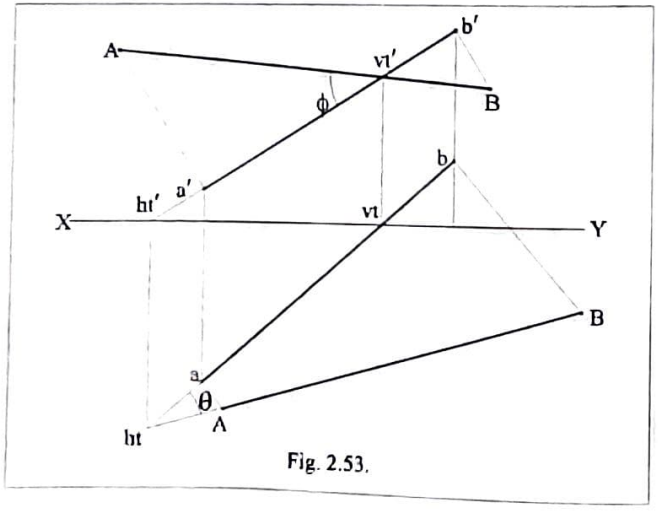


Fig. 2.53.

It should be noted that the lines perpendicular to the line a′b′ from a′ and b′ are drawn in the same direction because a and b are on the same side of XY line. Similarly the lines perpendicular to the plan ab, from a and b are drawn in the same direction because a′ and b′ are on the same side of XY line. Refer Fig. 2.51 and 2.53.

The lines perpendicular to the line a′b′, from a′ and b′ are drawn in opposite directions because a and b are on either sides of XY line. Refer Fig. 2.53. The lines perpendicular to the line ab, from a and b are drawn in opposite directions because a′ and b′ are on either sides of XY line. Refer Fig. 2.52.

a′A is the distance of a from XY line.

b′ B is the distance of b from XY line.

a A is the distance of a′ from XY line.

b B is the distance of b′ from XY line.

The point of intersection of lines ab and AB or the point of intersection of extension of lines ab and AB is the plan of horizontal trace of the line, ht. Similarly the point of intersection of the lines a′b′ and AB or the point of intersection of extension of the lines a′b′ and AB is the elevation of vertical trace of the line, vt′.

The angle between the lines ab and AB is the true inclination of the line with HP, θ.

The angle between the lines a′b′ and AB is the true inclination of the line with VP, ϕ.

Example 2.21.

The distance between end projectors of a line AB is 30mm. The end A is 10mm above HP and 30mm in front of VP. The end B is 25 mm above HP and 10mm in front of VP. Draw the projections of the line and find its true length and true inclination with the reference planes.

Solution.

Draw the XY line and draw two projectors perpendicular to the XY line at the given distance of 30mm apart. Locate a′, a, b′ and b. Join a′ and b′ to get the elevation of the line. Join a and b to get the plan of the line AB. From a′ draw a line perpendicular to a′ b′ line and mark A on it such that a′A=30mm. From b′ draw a line perpendicular to a′b′line and mark B on it such that b′ B = 10mm. Join A and B. AB is the true length of the line. It should be noted that the perpendiculars from a′ and b′ are drawn in the same direction, because a and b are on the same side of XY line. Extend the lines a′b′ and AB to intersect at vt′. Measure the angle between the lines a′b′ and AB. It is the true inclination of the line with VP, ϕ.

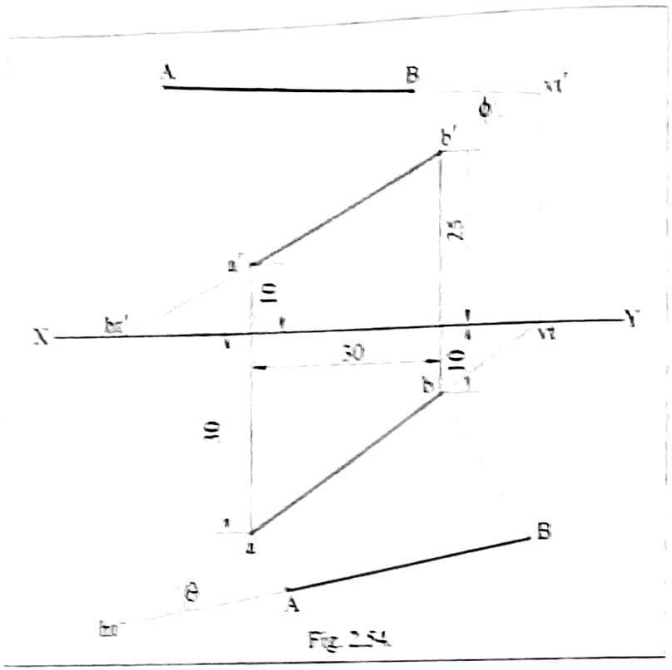


Fig. 2.54.

From a and b draw lines perpendicular to the plan ab. Mark A and B such that aA=10mm and bB =25mm. Join A and B. Extend the lines ab and AB to intersect at ht. The angle between ab and AB is the true inclination of the line with horizontal plane, θ. The perpendiculars from a and b should be drawn in the same direction because a' and b' are on the same side of XY line.

University question.

The top view of a line is 65mm long and inclined to XY at 30°. One end is 20mm above the HP and 10mm in front of VP. The other end is 60mm above HP and is in front of VP. What is the true length of the line and its inclination with HP and VP? Also show its traces. [CUSAT June 2012].

Example 2.22.

The distance between end projectors of a line AB is 30mm. The end A is 10mm below HP and 30mm in front of VP. The end B is 25 mm above HP and 10 mm in front of VP. Draw the projections of the line and find its true length and true inclination with the reference planes.

Solution.

Draw the projections of the line as shown in Fig. 2.55. Even though a and b are on the same side of XY line, the perpendiculars from a and b should be drawn in opposite

directions because a' and b' are on opposite sides of XY line. Even though a' and b' are on the same side of XY line, the perpendiculars from a' and b' should be drawn in the

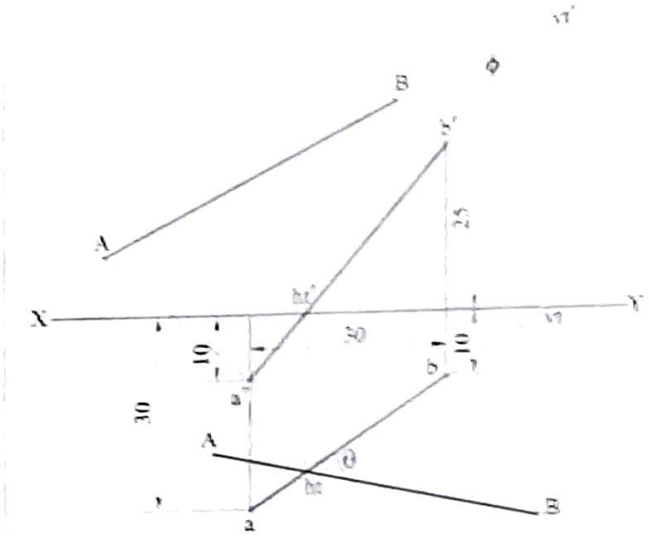


Fig. 2.55.

same directions because a and b are on same side of XY line. vt' is in the extension of elevation and ht is in the plan of the line itself.

University questions.

1. The projectors of the ends of a line AB are 50mm apart. The end A is 20mm above HP and 30mm in front of VP. The end B is 10mm below HP and 40mm behind VP. Determine the true length and traces of AB and its inclinations. [KU May 2009].
2. The projectors of point P and Q are 80mm apart. P is 60mm below the HP and 40mm infront of VP. Q is 75mm above HP and 30mm behind VP. Draw the projections of the line joining P and Q. Determine the true length and inclination of the line to the HP and VP. [KU May 2005].
3. The end A of a line AB is in the HP and 25mm in front of VP. The end B is in the VP and 50mm below HP. The distance between the end projectors is 75mm. Draw the projections of AB and determine its true length and inclinations with HP and VP. Also locate its traces. [CUSAT June 2008].
4. The front view of a line AB is 50mm long and it makes an angle of 35° with XY line. The point A lies 10mm above HP and 25mm behind VP. The difference between the

distances of A and B from VP is 25mm. The line AB is in the second quadrant. Draw the projections of the line, determine its true length and inclinations with HP and VP. [CUSAT June 2010].

5. The end projectors of line AB is 60mm apart. A is 20mm above HP and 30mm in front of VP. The end B is 70mm above HP and 45mm behind VP. Find the true length and true inclinations of the line. [CUSAT June 2010].
6. The projectors of the points P and Q are 100mm apart. P is 55mm below HP and 40mm in front of VP. Q is 100mm above HP and 35mm behind VP. Draw the projections of the line joining P and Q. Determine the true length of line PQ. [CUSAT June 2012].
7. The projectors of the ends of a line AB are 5cm apart. The end A is 2cm above HP and 3cm in front of the VP. The end B is 1cm below the HP and 4cm behind the VP. Determine the true length and traces of AB, and it's inclinations with the two planes. [CUSAT June 2009].
8. Point P is 25mm above HP and 35mm behind VP and point Q is 25mm above HP and 30mm in front of VP. If the distance between the projectors is 65mm draw its projections. What is the true length of the line PQ?. What is its true inclination with VP? [CUSAT June 2013].
9. A point C is 50mm above HP and 15mm behind VP. Point D is 10mm above HP and 25mm in front of VP. The distance between end projectors is 40mm. Draw the projections and determine the true length between C and D, true inclination of CD with HP and VP. [CUSAT June 2013].
10. The top view of a line PQ is 60mm long and its front view is 70mm. End Q is nearer to HP than P. Q is also nearer to VP than P. The distance between the end projectors of the line when measured parallel to the line of intersection of HP and VP is 50mm. Determine the true length and true inclinations. Draw its projections and locate its traces, if the end Q is 20mm away from both the planes. [CUSAT June 2013].
11. A line AB measuring 70mm has its VT 10mm above HP. The end A is 40mm above HP and 50mm in front of VP. The projectors through its VT and end A are 60mm apart. Draw the projection and HT of the line. Also find the inclinations to the reference planes. [MGU May 2013].
12. The top view of a line PQ makes an angle of 30 degree with the horizontal and has a length of 100mm. The end Q is in HP and P is in VP and 65mm above HP. Draw the projections of the line and find the true length and true inclinations with the reference planes. Also show its traces. [MGU May 2013].

Example 2.23.

A line AB inclined at 45° to VP has its ends 20mm and 50mm above HP. The length of its front view is 70mm and its VT is 10mm above HP. Find its true length, true inclination with HP and locate its traces.

Solution.

Draw the XY line and locate point a' 20mm above XY line. Draw a horizontal line 50mm above XY line. The point b' will be on this line. With a' as center and radius 70mm, draw an arc to locate b'. Join the points a' and b'. Extend the line b'a' to locate vt' 10mm above XY line. From vt' draw a line inclined at 45° with a' b' line. The points A and B

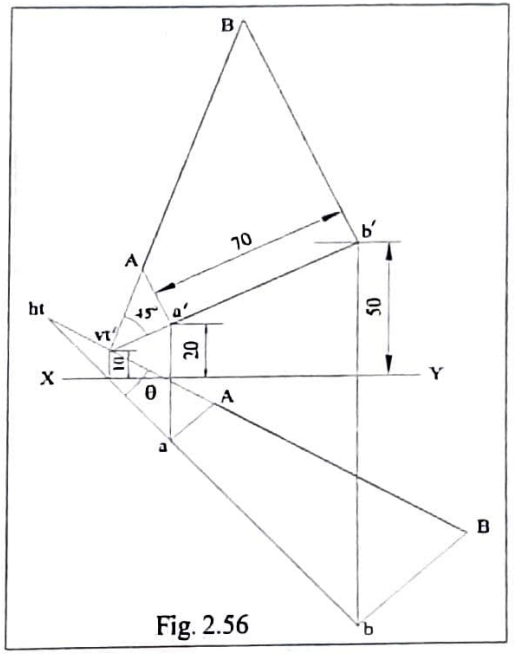


Fig. 2.56

are on this line. To locate A and B, draw lines perpendicular to the line a' b', from the points a' and b' as shown in Fig.2.56. AB is the true length of the line. Since a' A is the distance of a from XY line, locate point a at a distance a' A below XY line. Similarly locate point b at a distance b'B below XY line. Join a and b which is the plan of the line AB. From a and b draw lines perpendicular to line ab and mark points A and B such that aA is the distance of a' from XY line (20mm) and bB is the distance of b' from XY line (50 mm). Join A and B. AB is the true length of the line. Extend the lines ab and AB to intersect at ht. Measure the angle between ab and AB. This angle is the true inclination of the line with HP, θ.

Example 2.24.

The distance between end projections of a line AB is 30mm. The end A is 10mm above HP and is in front of VP. The end B is 30mm above HP. The vertical trace of the line is 15mm above HP and the line AB is inclined 40° with VP. Draw the projections of the line and obtain its true length and true inclination with HP.

Solution.

Draw the elevation a'b'. Locate vt' which is in the elevation, 15mm above XY line. Through this point vt' draw a line inclined at 40° with a'b' line. A and B are on this line.

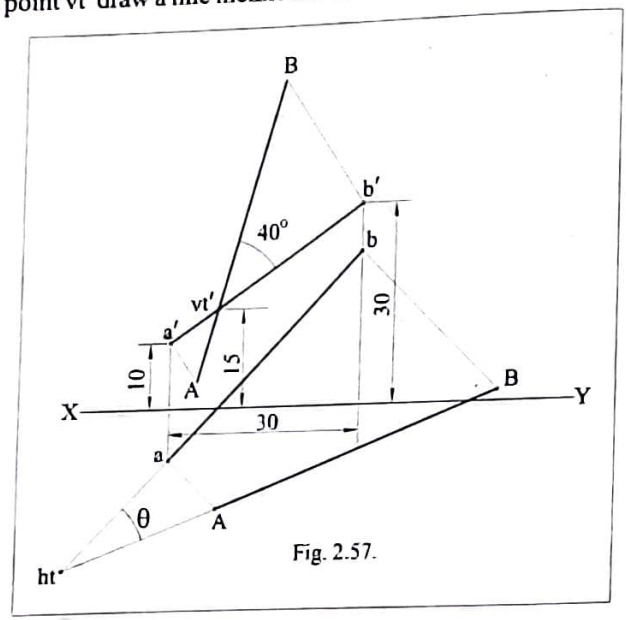


Fig. 2.57.

From a' and b', draw lines perpendicular to the line a'b', to intersect the line through vt' at A and B. Join A and B which is the true length of the line AB. Mark point a at a distance a'A below XY line. Since the perpendiculars from a' and b' are in opposite directions, a and b are on either sides of XY line. It is given that a is below XY line. Hence locate b at a distance b' B above XY line. Join a and b. From a and b draw lines perpendicular to the line ab in the same direction because a' and b' are on the same side of XY line. Mark A and B such that aA= 10 mm and bB= 30mm. Join A and B. The point of intersection of ab and AB is the plan of horizontal trace, ht and the angle between ab and AB is the true inclination of the line AB with horizontal plane, θ.

University questions.

1. A line AB inclined at 30° to VP has its end A 15mm and end B 50mm below HP. The length of its elevation is 60mm and its vertical trace is 7mm below HP. Draw the projections and determine the true length and inclination with HP. Also locate its horizontal trace. [CUSAT May 2007 and KU June 2009].
2. The front view of a line AB measures 75mm and makes an angle of 50° with XY. The end A is in the horizontal plane and the vertical trace of the line is 25mm above the horizontal plane. The line is inclined at 35° to the vertical plane. Draw the projections of the line and find its true length and inclination to the horizontal plane. Locate its horizontal trace. [KU Dec. 2004].
3. AB is a straight line whose front view measures 70mm and makes an angle of 30° with the XY line. The end A is in the HP and the vertical trace of the line is 10mm below the HP. The straight line is inclined at 45° to the VP. Draw the projections of the line, its true length, true inclination with HP. Also locate the horizontal trace. [KU Dec. 2006].
4. A straight line AB is inclined at 30° to H.P. while its top view at 45° to the XY line. The end A is 20mm in front of V.P. and is below H.P. The end B is 75 mm behind V.P. and it is above H.P. Draw the projections of the line when its V.T. is 40mm below H.P. Find the true length of the line and locate its horizontal trace. [CUSAT June 2009].

Example 2.25.

The distance between end projectors of a line AB is 30mm. The end A is above HP and 10mm in front of VP. The end B is 30mm in front of VP. The horizontal trace of the line is 20mm in front of VP and the line AB is inclined at 40° with HP. Draw the projections of the line and obtain its true length and true inclination with VP.

Solution.

Draw the plan of the line ab as shown in Fig. 2.58. Locate ht in between a and b, 20mm below XY line. Draw a line through ht, inclined at 40° with the line ab. Draw lines perpendicular to the line ab from its end points a and b to meet the line through ht at A and B. AB is the true length of the line. The distance aA is the distance of a' from XY line.

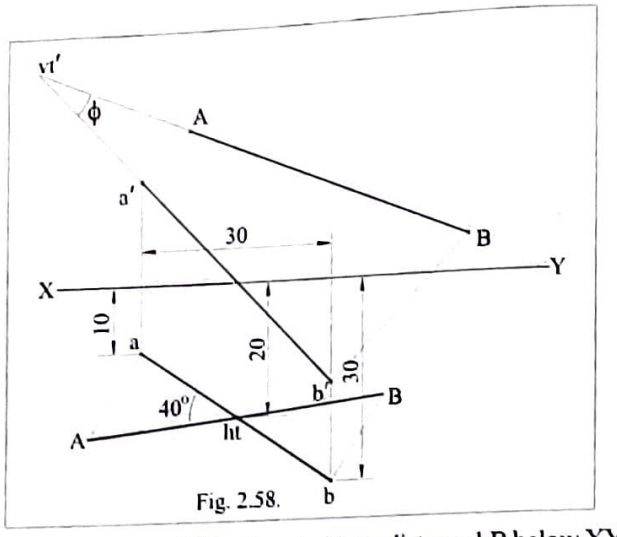


Fig. 2.58.

Locate a′ at a distance aA, above XY line. Locate b′ at a distance bB below XY line. The perpendicular from a and b are in opposite directions showing that a′ and b′ are on either sides of XY line. From a′ and b′ draw lines perpendicular to the line a′ b′ in the same direction and mark A and B on it such that a′ A = 10mm and b′ B = 30mm. Join the points A and B. Extend the lines a′ b′ and AB to intersect at vt′. The angle between a′ b′ and AB is the true inclination of the line with VP, ϕ.

University questions.

1. A line AB is in the third quadrant. The ends A and B are 20mm and 60mm behind the VP. The distance between the end projectors is 75mm the line is inclined at 30° to the HP and its horizontal trace is 10mm above the xy-line. Draw the projections of the line AB, determine its true length and vertical trace. [CUSAT June 2009].
2. A line AB has its ends A and B, 20mm and 45mm in front of VP respectively. The projectors of the line are 50mm apart. The HT of the line is 10mm in front of VP. The line AB is inclined at 35° to HP. Draw the projections of the line and determine the true length of the line and locate its VT. Find inclination of the line with HP. [CUSAT June 2011].

Example 2.26.

The distance between the traces of a line AB , measured parallel to XY line is 50mm. The horizontal trace is 25mm in front of VP and the vertical trace is 30mm above HP. The distance between end projectors of the line is 30 mm and the end A is 10 mm above HP. Obtain the true length of the line AB and its true inclination with the reference planes.

Solution.

Generally when the distance between the end projectors are given, two lines perpendicular to XY line should be drawn at the given distance apart. But when the distance between the end projectors as well as the distance between the traces are given, after

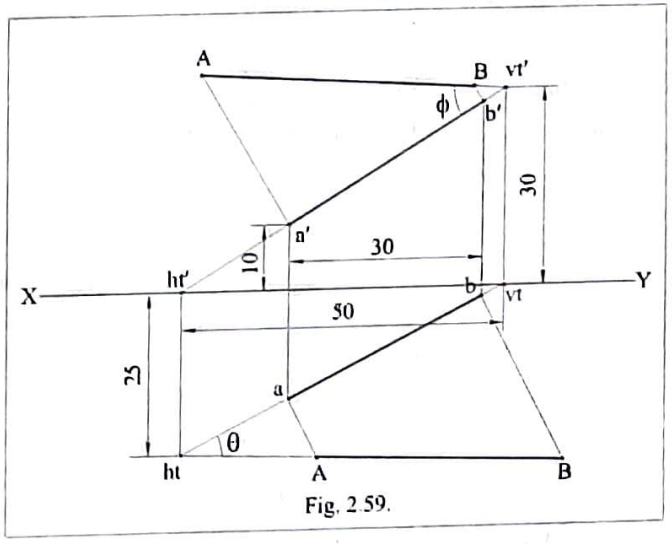


Fig. 2.59.

drawing the XY line draw two lines perpendicular to XY line at the given distance between the traces and locate ht′ and vt in the XY line as shown in Fig. 2. 59. Locate ht 25 mm below ht′ and vt′ 30 mm above vt. Join ht′ and vt′. The elevation of line, a′b′, is on this line. Join ht and vt. The plan of the line, ab, is on this line. Locate a′ which is in the line joining ht′ and vt′, 10mm above XY line. Draw the projector from a′ to locate a in the line joining ht and vt. Draw the second projector at a distance 30mm away from the line joining a′ and a, to intersect the line joining ht′ and vt′ at b′and line joining ht and vt at b. Join a and b which is the plan of the line AB. Join a′ and b′ which is the elevation of the line AB. From a′and b′ draw lines perpendicular to the line a′b′ and locate A and B such that a′A is the distance of a from XY line and b′ B is the distance of b from XY line. Join A and B. Extend the lines AB and a′b′ to intersect at vt′. The angle between a′b′ and AB is the true inclination of the line with VP, ϕ. From a and b draw lines perpendicular to the line ab and locate A and B such that aA is the distance of a′ from XY line (10mm) and bB is the distance of b′ from XY line (30mm). Join A and B. Extend the lines ab and AB to meet at ht. The angle between ab and AB is the true inclination of the line with HP,

Example 2.27.

The distance between the traces of a line measured parallel to XY line is 50 mm. The ht is 20mm in front of VP and the vertical trace is 30mm above HP. The end A is 10mm below HP and the end B is 10 mm in front of VP. Draw the projections of the line and obtain its true length and true inclination with HP and VP.

Solution.

Draw the XY line and draw two lines perpendicular to XY line at 50mm apart. Locate ht′ and vt on XY line. Locate ht 20mm below XY line and vt′ 30mm above XY line

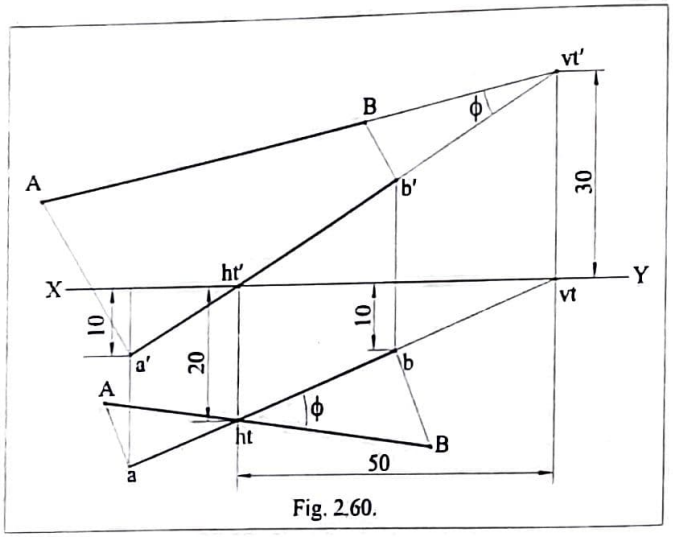


Fig. 2.60.

as shown in Fig. 2.60. Join ht′ and vt′. The elevation of the line, a′b′, will be either in this line or in the extension of this line. Join ht and vt. The plan of the line , ab, will be either in this line or in the extension of this line. Extend the line vt′ht′ and locate a′ on this line, 10 mm below XY line. Extend the line vt ht and locate point a on these line just below a′. Locate b on the line joining ht vt, 10mm below XY line. b′ is just above b, on the line joining ht′and vt′. a′b′ is the elevation of the line AB and ab is the plan of the line AB. From a′and b′ draw lines perpendicular to the line a′b′, in the same direction. The lines are to be drawn in the same direction because a and b are on the same side of XY line. Mark A and B such

that a′A is the distance of a from XY line and b′B is the distance of b from XY line. From a and b draw lines perpendicular to the line ab in opposite directions and mark A and B such that aA is the distance of a′ from XY line and bB is the distance of b′ from XY line. The angle between a′b′ and AB is the true inclination of the line with VP, ϕ and the angle between ab and AB is the true inclination of the line with HP, θ.

University questions.

1. The projectors on the XY line of the horizontal and vertical traces of a line AB in the first quadrant are 120 mm apart. The VT is 100mm above XY and HT is 50mm infront of XY. The point A and B are 30mm and 70mm above the HP. Draw the projections and obtain true length and true inclination. [KU June 2011].
2. The projectors drawn through the HT and the VT of a straight line AB are 80 mm. apart and those drawn through its end points are 50 mm. apart. The HT is 30 mm behind VP and VT is 40 mm below HP. The end A of the line is in HP. Draw the projections and determine its true length and its inclination with reference planes. [KU June 2004].
3. The projectors through the traces of a line are 110 mm apart and those through the ends of line AB are 50 mm apart. The end A of the line is 20mm below H.P. and in front of VP. The top and the front views of the line make 30^{o} and 45^{o} respectively with XY line. Draw the projections of the line. Also find the true inclinations of the line. [KU June 2004].
4. An end point A of a straight line is on the HP and 40 mm behind the VP. The distance between the end projectors as measured parallel to the line of intersection of the HP and the VP is 40 mm and the distance between the HT and VT is 100mm as mea sured parallel to the ground line. The vertical trace is 30mm above the HP. Draw the projections of the line and find its true length. [KU June 2011].

Example 2.28.

The projections of a line AB are on the same projector. A is 15mm below HP and 20mm in front of VP. B is 40mm above HP and 10mm behind VP. Draw the projections of the line AB and determine its true length, inclination with HP and VP and also locate its traces.

Solution.

Draw the XY line and draw a projector perpendicular to XY line. Locate a' 15mm below XY line and a 20mm below XY line. Locate b' 40mm above XY line and b 10mm above XY line. From a' and b', draw lines perpendicular to a' b' line in opposite directions and mark A and B such that a'A is the distance of a from XY line (20mm), b' B is the

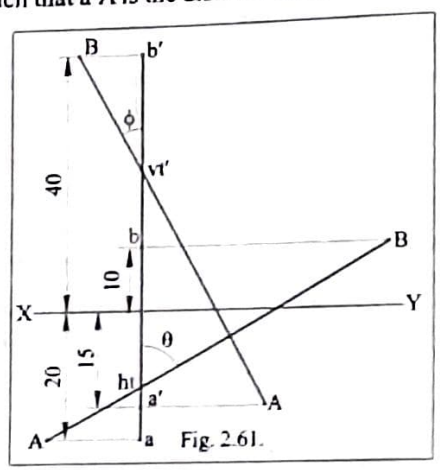


Fig. 2.61.

distance of b from XY line (10mm). Join A and B. The point of intersection of this line and a' b' line is the elevation of vertical trace, vt'. The angle between AB and a'b' is the true inclination of the line with VP, ϕ.

From a and b draw lines perpendicular to ab line in opposite directions and mark A and B such that aA is the distance of a' from XY line (15 mm) and bB is the distance of b' from XY line (40 mm). Join A and B. The length of AB is the true length of the line. The point of intersection of AB and ab is the plan of the horizontal trace, ht and the angle between AB and ab is the true inclination of the line AB with HP. The lines perpendicular to a'b' from a'and b' are drawn in opposite directions because a and b are on either sides of XY line. Similarly the lines from a and b, perpendicular to ab, are drawn in opposite directions because a'and b' are on either sides of XY line.

Alternate solution.

Since the plan and elevation of the line are perpendicular to XY line, the line AB is parallel to the profile plane and hence the profile view will be the true length of the line AB and the inclination of profile view with horizontal will be the true inclination of the line with

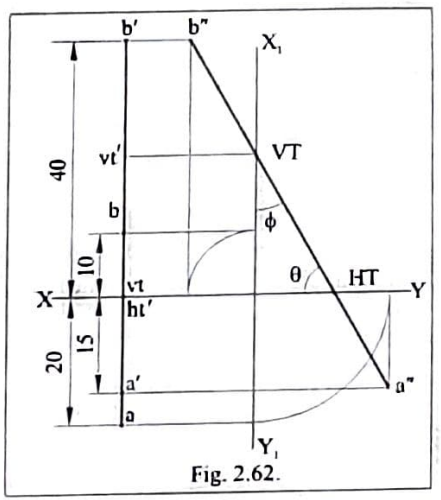


Fig. 2.62.

HP and the inclination of the profile view with vertical will be the true inclination of the line with VP. Draw the plan and elevation of the line as shown in Fig 4.62. Draw X_1Y_1 line perpendicular to XY line. Locate a'' and b'' as shown in Fig 4.62. Join a'' and b''. The length of a'' b'' is the true length of line AB. Its inclination with horizontal and vertical are the true inclination of the line with HP and VP respectively.

Problem for practice.

A line AB is parallel to the profile plane. The end A is 15mm above HP and 15mm in front of VP. The end B is 45mm above HP and 35mm in front of VP. Draw the projections of the line and locate its traces. Also obtain the true length and true inclination of the line with HP and VP.

University question.

The projections of a line AB are on the same projector. A is 10mm above HP and 20mm in front of VP. B is 35mm below HP and 25mm behind VP. Draw the projections of the line AB and determine its true length , inclination with HP and VP and also locate its traces. [CUSAT June 2011].

(ii) Line rotation method.

When a line is on a reference plane or parallel to a reference plane, the length of projection on that reference plane will be the true length of the line and the inclination of true length line is the true inclination of the line with the other reference plane. The projec-

tion on the other reference plane will be either on XY line or parallel to XY line. In plane rotation method this basic principle is used to draw the projections of a line which is inclined to both HP and VP.

When a line is parallel to VP, the length of elevation will be the true length of the line and the inclination of this elevation will be the true inclination of the line with HP. The plan will be parallel to XY line. Refer Fig. 2.63.

When a line is inclined to VP, the length of elevation will be smaller than the true length of the line. Its inclination is the apparent inclination of the line with HP. The plan will be inclined to XY line. Refer Fig 2.64.

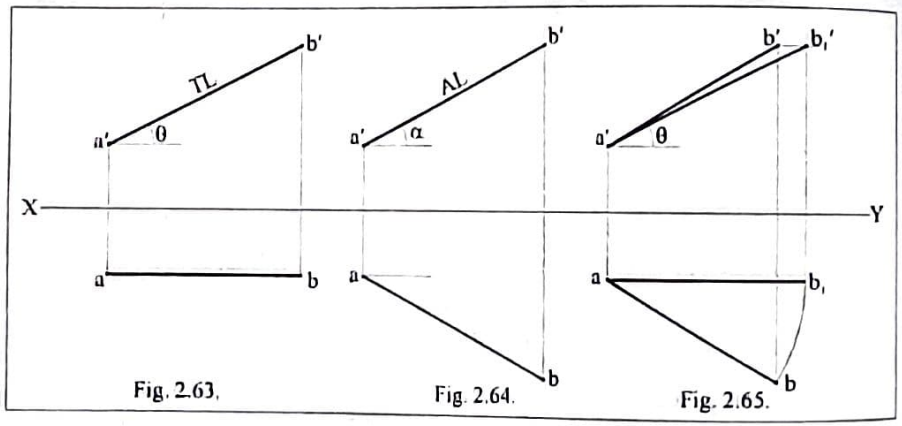


Fig. 2.63. Fig. 2.64. Fig. 2.65.

In order to get the true length in elevation, rotate the plan about any point, say, about the point a and make the plan parallel to XY line. Refer Fig. 2.65. The corresponding elevation will be the true length of the line and its inclination will be the true inclination of the line with HP. ab is the length of plan when the line is inclined to VPand ab_1 is the length of plan when the line is parallel to VP. The length of plan when the line is inclined to VP and parallel to VP remains the same because the line inclined to VP is rotated to make it parallel to VP, without changing the inclination of the line with HP. As long as the inclination of a line with HP is not changed, its length of plan will not change.

Refer Fig. 2.65. If the inclination of a line with HP is not changed, the height of B from HP will be the same when the line is parallel to VP as well as inclined to VP. Therefore b' and b_1 in Fig 2.65 are at the same level. The line joining b' and b_1' will be parallel to XY line. Since $ab = ab_1$, the locus of b is an arc with a as centre and ab radius.

In plane rotation method, when the locus of projection of a point in one of the reference planes is an arc, then the locus of projection of the same point in the other reference plane will be a line parallel to XY line. ie.,when the locus of b is an arc, the locus of b' will be a line parallel to XY line.

Refer Fig 2.66. The line AB is parallel to HP and hence its plan ab is the true length of the line and its inclination is the true inclination of the line with VP. Refer Fig.2.67 The elevation is inclined to XY line and hence the plan is the apparent length of the line and its inclination is the apparent inclination of the line with VP . Refer Fig. 2.68. The elevation is rotated about a' to make it parallel to XY line. $a'b_1' = a'b'$. The locus of b' is an arc and the locus of b is a line parallel to XY line. ab_1 is the true length of the line and its inclination is the true inclination of the line with VP.

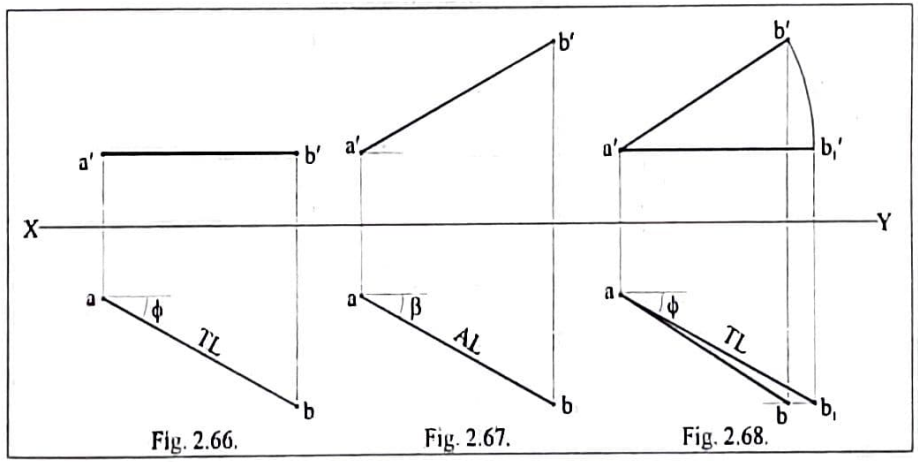


Fig. 2.66. Fig. 2.67. Fig. 2.68.

To get the true length and true inclination of a line with HP, rotate the plan and make it parallel to XY line. The corresponding length of elevation will be the true length of the line and its inclination will be the true inclination of the line with HP.

To get the true length and true inclination of a line with VP, rotate the elevation and make it parallel to XY line. The corresponding length of plan will be the true length of the line and its inclination will be the true inclination of the line with VP.

It should be noted that the locus which is parallel to XY line always passes through the end point of the true length line.

Example 2.29.

The distance between the end projectors of a line AB is 30mm. The end A is 10mm above HP and 10mm in front of VP. The end B is 30 mm above HP and 40mm in front of VP. Draw the projections of the line and find its true length and true inclination with HP and VP, using line rotation method.

Solution.

Draw the plan and elevation of the line as shown in Fig 2.69. Draw a horizontal line from a'. With a' as center, a'b' radius, draw an arc to intersect the line from a' at b_1'. Point b_1 is the point of intersection of vertical line from b_1' and horizontal line from b. Join a and b_1 which is the true length of the line AB and its inclination with horizontal is the true inclination of the line AB with VP, ϕ.

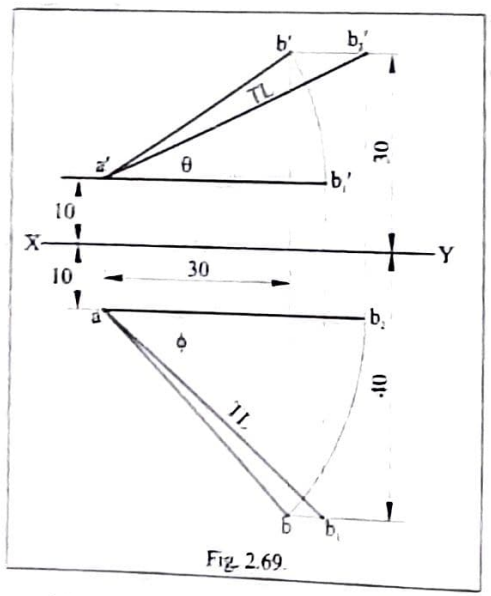


Fig. 2.69.

Draw a horizontal line from a. With a as center, ab radius, draw an arc to get b_2 on the horizontal line from a. Point b_2' is the point of intersection of vertical line from b_2 and horizontal line from b'. Join a' and b_2' which is the true length of line AB and its inclination with horizontal is the true inclination of the line with HP.

Problem for practice.

The end A of a line AB is 30 mm above HP and 25mm infront of VP. The end B is 50 mm above HP and 15 mm behind VP. The distance between the end projectors is 60mm.

Draw the projections of the line and determine its true length and true inclination with HP and VP, using line rotation method.

University question.

A line AB measuring 70 mm has its VT 10mm above HP. The end A is 40mm above HP and 50mm in front of VP. The projectors through its VT and A are 60mm apart. Draw the projection and HT of the line. Also find the inclinations to the reference planes. [MGU May 2013].

Example 2.30.

An 80mm long line PQ has its end P on the HP and 15mm in front of the VP. The line is inclined at 30° to the HP and its top view is inclined at 60° to the reference line. Draw the projections of the line PQ and determine true angle of inclination with the VP.

Solution.

Draw the XY line and locate p' and p, p' on XY line and p 15mm below XY line. From p', draw a line inclined at 30° with horizontal and mark q_1' on this line such that $p'q_1' = 80$mm. From q_1' draw a line parallel to XY line. q' is on this line. From p draw

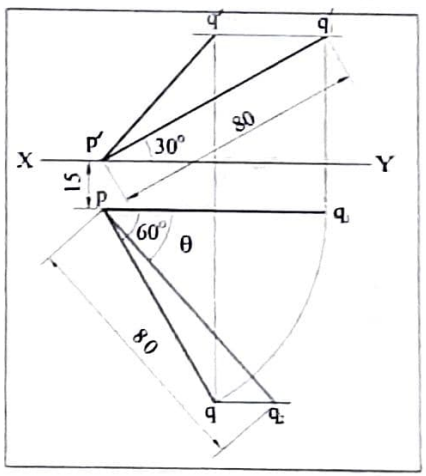


Fig. 2.70

a horizontal line and mark q_1 on this line, just below q_1'. From p, draw a line inclined at 60° with horizontal. With p as center, pq_1 radius, draw an arc to cut the inclined line from p at q. Join p and q. pq is the plan of line PQ. From q draw a vertical line to intersect the horizontal line from q_1' at q'. Join p' and q' which is the elevation of the line PQ. Draw a

horizontal line from q. Locate point q_2 by drawing an arc with p as center and radius 80mm. Join p and q_2. The line pq_2 is the true length of the line PQ and the inclination of the line pq_2 is the true inclination of the line with VP, ϕ

University questions.

1. A line PQ 75mm long, is inclined at 45° to the HP and its top view makes an angle of 60° with VP. The end P is in the HP and 10mm in front of VP. Draw its front view and find its true inclination with the VP. Also locate its traces. [KU May 2007].
2. A line AB, 60mm long is inclined to the HP at 40°. Its plan makes an angle of 30° with the XY line. Draw its projections and determine the inclination with VP. [CUSAT June 2009].

Example 2.31.

A line AB 40mm long has its end A 10mm above HP and 10mm in front of VP. The end B is 25mm above HP and 40mm in front of VP. Draw the projections of AB and show its inclinations with HP and VP.

Solution.

Draw the XY line. Draw a projector and locate point a' and a on it, a' 10mm above XY line and a 10mm below XY line. Draw two horizontal lines, one 25mm above XY line

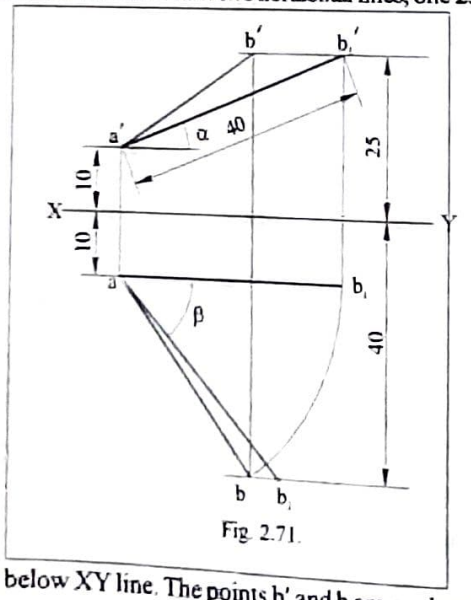


Fig. 2.71

and the other 40mm below XY line. The points b' and b are on these lines respectively. With a' as centre, 40mm radius (TL of the line AB), draw an arc to cut the horizontal line

above XY at b_1'. From this point draw a vertical line. From the point a draw a horizontal line to intersect the verticle line at b_1. Join a and b_1. Length of this line is the final length of plan ab. With a as centre, ab_1 radius, draw an arc to cut the horizontal line which is drawn 40mm below XY line at b. Join a and b. This line ab is the plan of line AB. From b, draw a verticle line to meet the horizontal line through b_1, at b'. Join a' and b'. This line a' b' is the elevation of the line AB. With a as centre, 40mm radius, draw an arc to cut the horizontal line through b at b_2. Join a and b_2. This line a b_2 is the true length of the line AB. Inclination of line a' b_1' is the true inclination of the line AB with HP, θ. Inclination of the line ab_2 is the true inclination of the line AB with VP, ϕ.

University questions.

1. A line PQ 50mm long has its end P 15mm below HP and 10mm behind VP. The end Q is 40mm below HP and 45mm behind VP. Draw the projections of the line and determine the inclinations with the reference planes. Also locate its traces. [KU June 2010].
2. A line AB, 45mm long has its end A 15mm below HP and 10mm behind VP. End B is 40mm below the HP and 45mm behind the VP. Draw its projections and determine its inclinations with HP and VP. [CUSAT June 2013].
3. A line AB 70mm long has its end A 20mm above HP and 25mm in front of VP. The end B is 40mm above HP and 60mm in front of VP. Draw the projections of AB and show its inclinations with HP and VP. [KU June 2005 and CUSAT June 2013].
4. A line has one end 30mm in front of VP and 15mm above HP and the other end is 15mm in front of VP. The line is 60mm in length and top view measures 40mm. Draw the projections and find the inclination of the line with HP and VP. [MGU May 2013]

Example 2.32.

A line AB 50mm long is inclined at 30° to HP. The end A is 10mm above HP and the end B is 35 mm infront of VP. Draw the projections of the line if its front view measures 40mm. Also find the inclination of the line with VP.

Solution.

Draw the XY line and a projector. Locate point a' 10mm above XY line. From a' draw the line a'b_1' of length 50mm and inclined at 30° with XY line. From b_1' draw a horizontal line. With a' as centre, 40mm radius draw an arc to cut the horizontal line from b_1' at b'. Join a' and b'. From b' draw a vertical line and locate point b on it, 35 mm below the XY line. With b as centre draw an arc with radius equal to the distance between the

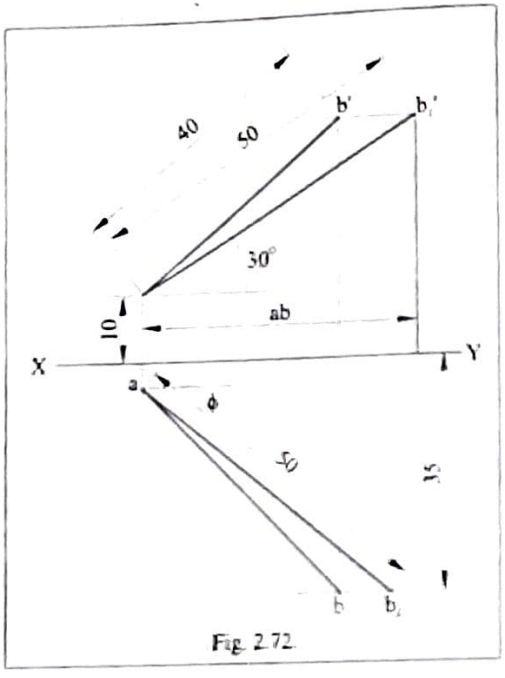


Fig. 2.72.

projectors from a' and b_1', to cut the projector from a' at a. Join the points a and b. From b draw a horizontal line. With the point a as center, radius 50mm (TL of line AB) draw an arc to cut the horizontal line from b at b_2. Join the points a and b_2. Inclination of this true length line is the true inclination of the line AB with VP, ϕ

University questions.

1. A line AB, 100mm long, is inclined at 50° to HP. The end A is 10mm above the HP and end B is 65 mm in front of the VP. Draw projections of the line if its front view measures 90mm. Locate traces and find the inclination of the line with the VP. [KU June 2010].
2. Length of the line AB in front view measures 30mm. A is 15mm above HP and 25mm in front of VP. B is 40mm above HP and the angle of the line with VP is 30°. Draw the projections and find the true inclination with HP. [CUSAT May 2007].
3. A line PQ 100mm long has its end P in the first quadrant, 25mm from both HP and VP and the other end Q in the second quadrant 50mm from both HP and VP. Draw its projections and determine its traces and inclinations to the HP and VP. [KU June 2012].

4. Draw the projection of the AB 80mm long. The end A of the line touches HP and 40mm in front of VP. The other end B touches VP and 50mm above HP. Find the inclinations of the line with HP and VP and also mark the traces. [CUSAT June 2012].

Example 2.33.

The end A of a line AB, 45 mm long and inclined at 40° with HP and 30° with VP is 10mm above HP and 15mm in front of VP. Draw its projections.

Solution.

Draw the XY line and locate a' and a , a' 10mm above XY line and a 15mm below XY line. From a', draw the true length line at true inclination of 40° with horizontal. Mark

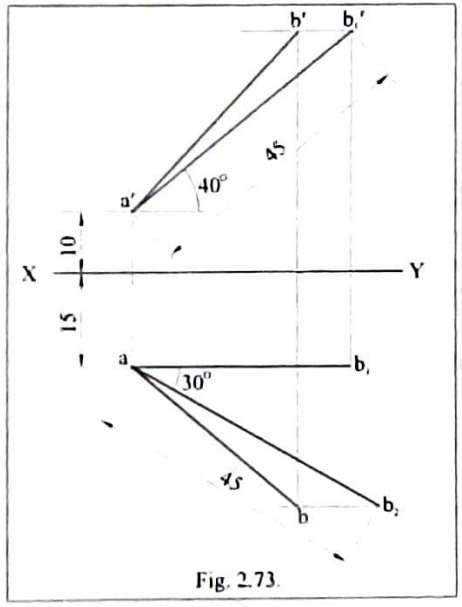


Fig. 2.73.

b_1' on it such that $a'b_1' = 45$mm. From b_1', draw a line parallel to XY line. b' is on this line. The corresponding plan is horizontal. Draw ab_1, parallel to XY line. From a, draw a line inclined at 30° with horizontal and mark b_2 on it such that $ab_2 = 45$mm. From b_2 draw a horizontal line. b will be on this line. With a as center, ab_1 radius, draw an arc to cut the horizontal line from b_2 at b. Join a and b. ab is the plan of the line AB. From b, draw a vertical line to intersect the horizontal line from b_1' at b'. Joint a' and b'. a'b' is the elevation of the line AB.

Example 2.34.

The end A of a line AB, 45mm long and inclined at 40° with HP and 30° with VP is on HP and the other end B is on VP. Draw its projections.

Solution.

When the elevation is drawn at true inclination with HP, the plan will be parallel to XY line. The length of plan is the horizontal distance between the end projectors. Similarly when the plan is drawn at true length at true inclination with VP, the elevation will be

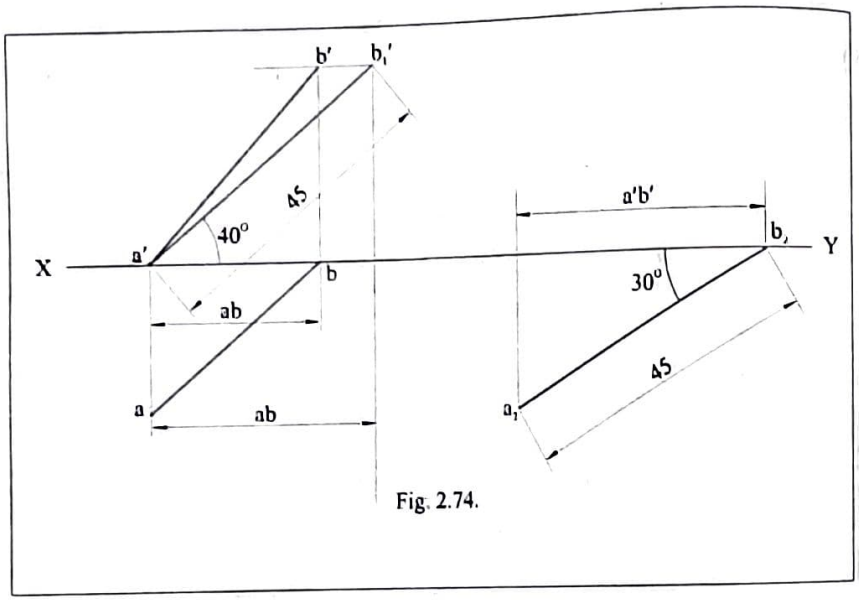


Fig. 2.74.

parallel to XY line. The length of elevation will be the distance between the end projectors. Draw XY line and locate a′ on XY line. From a′, draw a line inclined at 40° with XY line and mark b_1' on it such that $a'b_1' = 45$mm. From b_1', draw a line parallel to XY line. b′ is on this line. From b_1' draw a vertical line. The distance between the vertical lines from a′ and b_1' is the length of plan of the line ab. Mark a point b_2 on XY line. From b_2 draw a line inclined at 30° with XY line. Mark a_2 on this line such that $b_2a_2 = 45$mm. Draw vertical lines from a_2 and b_2. The distance between these lines is the length of the elevation of the line, a′b′. With a′ as centre, a′b′ as radius, draw an arc to cut the horizontal line from b_1' at b′. Join a′ and b′. Mark b on XY line, just below b′. With b as centre, length of plan, ab as radius, draw an arc to cut the vertical line from a′ at a. Join a and b. ab is the plan of the line AB.

Example 2.35.

The end A of a line AB, 45mm long and inclined at 50° with HP and 40° with VP is on HP and the other end B is on VP. Draw its projections.

Solution.

Since $\theta+\phi = 90°$, the line is parallel to the profile plane and hence the profile view a″ b″will be the true length of the line. a″ is on XY line and b″ is on X_1Y_1 line. Draw the XY

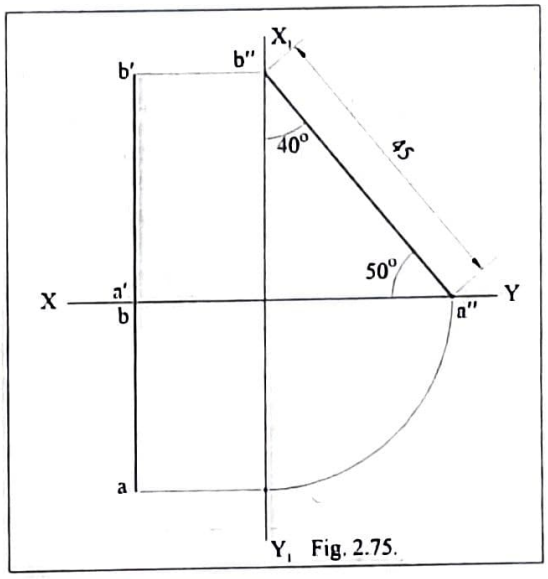


Fig. 2.75.

line and locate a″ on XY line. From a″ draw a line inclined at 50° with XY line and mark b″ such that a″b″ = 45mm. Draw the X_1Y_1 line passing through b″. Since the line is parallel to the profile plane, the plan and elevation are perpendicular to XY line and are on the same projector. Draw a projector at any distance from X_1Y_1 line. From a″ and b″ draw horizontal lines to locate a′ and b′ on the projector. Locate a and b as shown in Fig. 2.75. Join a′ and b′ which is the elevation of the line AB. Join a and b which is the plan of the line AB.

University questions.

1. A line AB of length 50mm has its end A 15mm above HP and 30mm in front of VP. At A, the line is inclined at 30° to HP and is also inclined at 45° to VP. Draw the plan and elevation of the line AB. [CUSAT June 2013].
2. Draw the projections of a line AB 100mm long inclined at 30° to HP and 45° to VP.

The end A of the line is 50mm below the HP and 25mm behind VP. [CUSAT June 2013].

Example 2.36.

The end A of a line AB, 45mm long is 10mm above HP and 15mm in front of VP. Draw its projections when the length of plan is 40mm and length of elevation is 35mm. Obtain the inclinations of the line with HP and VP.

Solution.

Draw the XY line and locate a' and a, a' 10mm above XY line and a 15mm below XY line. Draw $ab_1 = ab = 40$mm parallel to XY line. From b_1, draw a vertical line. b_1' is on this line. With a' as center, 45mm radius, draw an arc to cut the vertical line from b_1 at b_1'.

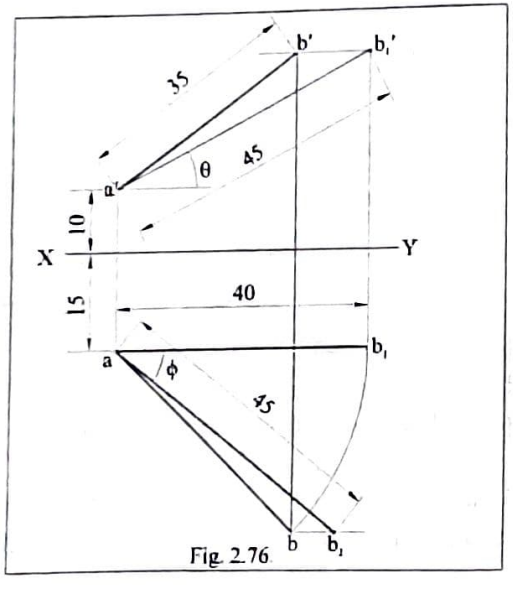


Fig. 2.76

Join a' and b_1'. The inclination of $a'b_1'$ is the true inclination of the line with HP. From b_1', draw a horizontal line, b' is on this line. With a' as center, 35mm radius, draw an arc to cut the horizontal line from b_1' at b'. Join a' and b' which is the elevation of the line. From b' draw a vertical line. b is on this line. With a as center, 40mm radius draw an arc to cut the vertical line from b' at b. Join a and b which is the plan of the line AB. From b, draw a horizontal line. With a as center, 45mm radius, draw an arc to cut the horizontal line from b at b_2. Since ab_2 is the true length of the line, its inclination is the true inclination of the line with VP.

University questions.

1. A line AB 100mm long has a length of 70mm in top view and 85mm in front view. If one end A is 30mm above HP and 40mm in front of VP, determine the inclination of the line with HP and VP. [CUSAT June 2012].
2. A line AB, 90mm long has a length of 70mm in the top view and 80mm in the front view. If one end is 20mm above HP and 12mm in front of VP, determine the inclinations of the line with HP and VP. Also locate the traces of the line AB. [MGU April 2011].

Example 2.37.

The end A of a line AB is 15mm below HP and the other end B is 25mm above HP. The horizontal trace of the line is 25mm in front of VP and the plan is 40mm long and it is inclined at 40° with XY line. Draw its projections and find the true length and true inclinations of the line with HP and VP.

Solution.

Draw the XY line and draw two lines parallel to XY line, one 15mm below XY line and the other 25mm above XY line. Draw a horizontal line a_1b_1 of length 40mm, 25mm below

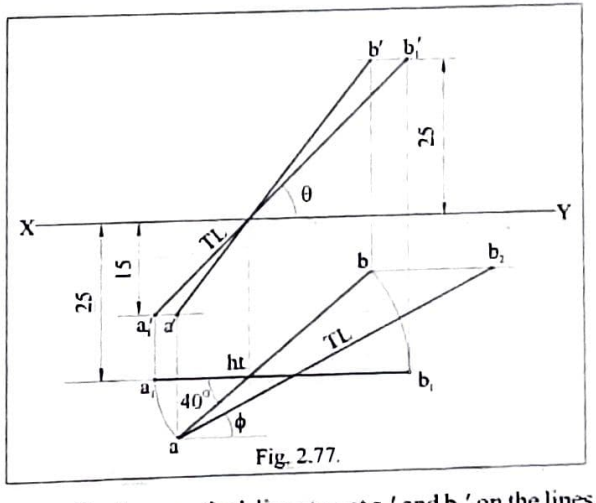


Fig. 2.77.

XY line. From a_1 and b_1 draw vertical lines to get a_1' and b_1' on the lines drawn parallel to XY line, as shown in Fig. 2.77. Join a_1' and b_1'. Length of $a_1'b_1'$ is the true length of the line and its inclination is the true inclination of the line with HP. From a_1' and b_1', draw horizontal lines. a' and b' are on these lines. From the point of intersection of the lines

$a_1'b_1'$ and XY line, draw a vertical line to get ht on a_1b_1 line. Draw a line inclined at 40° with a_1b_1 and passing through ht. With ht as center draw arcs with ht a_1 and ht b_1 as radius to get a and b in the inclined line drawn through ht. From a and b, draw vertical lines to get a' and b' on the horizontal lines from a_1' and b_1' respectively. Join a' and b'. From the point b, draw a horizontal line. With a as center, TL of the line $a_1'b_1'$ as radius draw an arc to cut the horizontal line from b at b_2. ab_2 is the true length of the line and hence its inclination is the true inclination of the line with VP.

Alternate solution.

Draw a line ab of length 40 mm, inclined at 40° with horizontal. From a and b draw lines perpendicular to the line ab, in opposite directions. Mark points A and B

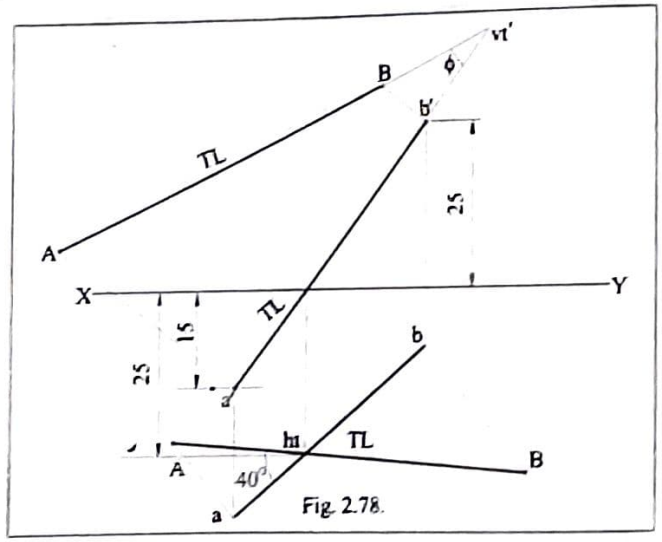


Fig. 2.78.

such that aA = 15 mm and bB = 25mm. Join points A and B. AB is the true length of the line. The point of intersection of lines ab and AB is the plan of horizontal trace, ht. The angle between the lines ab and AB is the true inclination of the line with HP, θ.

Draw the XY line, 25mm above the horizontal trace, ht. Draw projectors from a and b. Mark point a' 15mm below XY line and b' 25mm above XY line. Join a' and b'. From points a' and b' draw lines perpendicular to the line a'b', in the same direction. Locate points A and B such that a' A is the distance of a from XY line and b'B is the distance of b from XY line. Join the points A and B. Extend the lines AB and a' b' to meet at vt'. The angle between the lines AB and a'b' is the true inclination of the line with VP, ϕ.

Example 2.38.

The mid point M of a line AB measuring 80mm is50mm above HP and 30mm in front of VP. The line is inclined at 45° to HP and 30° to VP. Draw the projections and find the length of plan and elevation.

Solution.

Draw the XY line and locate m' and m, point m' 50mm above XY line and point m 30mm below XY line. Through m', draw a line inclined at 45° with horizontal and mark a_1' and b_1' such that $m'a_1' = m'b_1' = 80/2 = 40$mm. From a_1' and b_1' draw lines parallel to XY line.

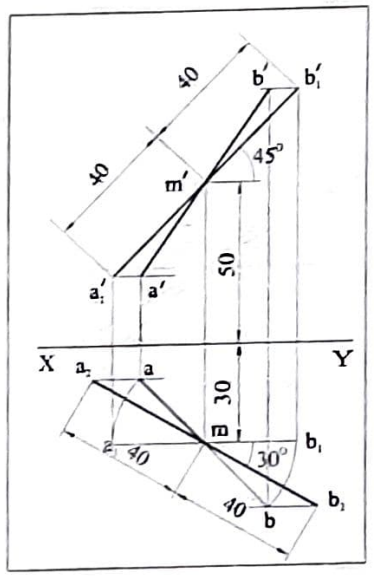


Fig. 2.79

a'and b' are on these lines respectively. Draw a horizontal line through m and locate a_1 and b_1 on this line, just below a_1' and b_1'. The length of a_1b_1 is the final length of plan, ab. Through the point m, draw a line inclined at 30° with horizontal and mark points a_2 and b_2 on it such that $ma_2 = mb_2 = 40$mm. From a_2 and b_2, draw lines parallel to XY line. Rotate the line a_1b_1, about point m to get points a and b on the lines from a_2 and b_2. Join points a and b. This line passing through point m is the plan of the line AB. From points a and b, draw vertical lines to get points a' and b' on the lines from points a_1' and b_1'. Join points a' and b'. This line passing through point m' is elevation of the line AB.

Example 2.39.

The midpoint M of a line AB, 50mm long and inclined at 40° with HP and 30° with VP is 10mm above HP and on VP. The end A is in the third quadrant and the end B is in the first quadrant. Draw its projections.

Solution.

Draw the XY line and locate m' and m, m'10 mm above XY line and m on XY line. Through m', draw a line inclined at 40° with horizontal and mark a_1' and b_1' such that $m'a_1' = m'b_1' = 50/2 = 25$mm. From a_1' and b_1' draw lines parallel to XY line.

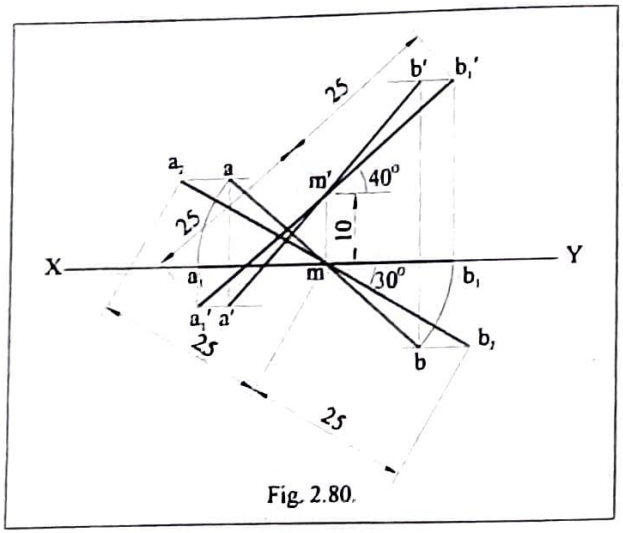


Fig. 2.80.

a' and b' are on these lines respectively. Mark a_1 and b_1 on the XY line just above a_1' and just below b_1'. The length of a_1b_1 is the final length of plan ab. Through the point m, draw a line inclined at 30° with horizontal and mark a_2 and b_2 on it such that $ma_2 = mb_2 = 25$mm. From a_2 and b_2, draw lines parallel to XY line. Rotate the line a_1b_1 about m to get a and b as shown in Fig. 2.80. Join a and b. This line passing through m is the plan of the line AB. From a and b draw vertical lines to get a' and b' on the horizontal lines through a_1' and b_1'. Join a' and b'. a'b' is the elevation of the line AB.

University questions.

1. Draw the projections of the line AB of length 80mm, inclined at 30° with HP and 45° with VP. A point M on AB, 30mm from A is at a distance of 35mm above HP and 40mm in front of VP. [CUSAT June 2007].

2. A line AB 120mm long is inclined at 45° to the HP and 30° to the VP. Its midpoint is in VP and 20mm above HP. The end A is in the third quadrant and B is in the first quadrant. Draw the projections of the line. Mark the traces of the line. [KU June 2007].
3. Draw the projections of the line AB of length 90mm, inclined at 30° with HP and 45° with VP. A point M on AB, 30mm from A is at a distance of 35mm above HP and 40mm in front of VP. Also find the position of A if the portion containing A is rotated towards the reference planes. [MG May 2012].

Example 2.40.

A point P is 25mm above HP and 40mm in front of VP. Another point Q is 50mm above HP and 30mm in front of VP. The distance between their end projectors is 60mm. A third point R is 50mm from P and 65mm from Q and lies in the HP. Draw the projections of the triangle thus formed. [MGU April 2011].

Solution.

Draw the XY line and two projectors at the given distance of 60mm apart. Locate p and p', p 40mm below XY line and p' 25mm above XY line. Locate q and q', q 30mm below XY line and q' 50mm above XY line. Join points p' and q' to get the elevation of line PQ. Join points p and q to get the plan of line PQ. With p' as centre draw an arc with radius 50mm to cut the XY line at r_1'. With q' as centre draw an arc of radius 65mm to cut the XY line at r_2'. $p'r_1'$ and $q'r_2'$ are the true length of lines PR and QR and hence the top views pr_1 and qr_2 are parallel to XY line. Point r_1 is just below point r_1' and point r_2 is just below point r_2'. Rotate the lines pr_1 and qr_2 about p and q respectively to meet at point r. From this point r, draw a vertical line to meet the XY line at r'. Since the point R is on HP, its elevation r' is on XY line. Join the points p' and q' with r'. p'q'r' is the elevation of the triangle and pqr is the plan of the triangle.

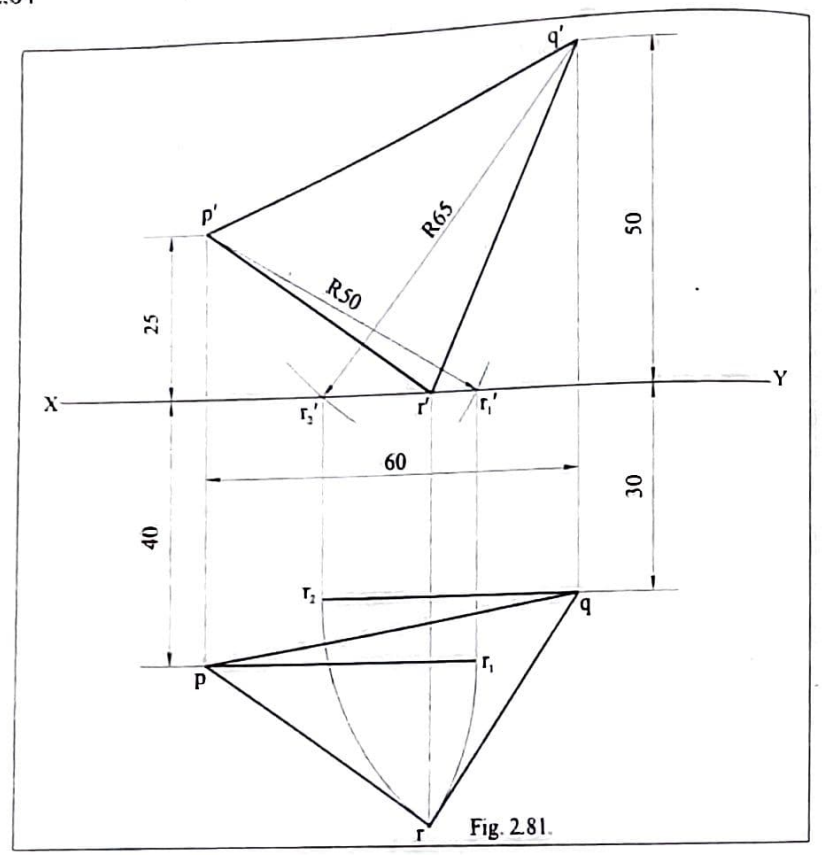


Fig. 2.81.

Example 2.41.

The projectors of two points A and B in space are 55mm apart. a is 32mm in front of VP and 18mm above HP and B is 25mm in front of the VP and 45mm above the HP. A third point C is 35mm from A and 60mm from B and is in the VP. Draw the projections of the point C and measure its distance from the HP. [KU June 2013].

Solution.

Draw the plan and elevation of the line AB. With the point a as centre, 35mm radius, draw an arc to cut the XY line at c_1. With the point b as centre, 60mm radius, draw an arc to cut the XY line at c_2. From c_1 and c_2 draw vertical lines. From a′ and b′ draw horizontal lines to get c_1' and c_2' on the lines from c_1 and c_2 respectively. Rotate the lines $a'c_1'$ and $b'c_2'$ about a′ and b′ respectively to meet at point c′. From c′ draw a vertical line to get point c on XY line. Join the points a and b with c. The length of line cc′ is the distance of point C from HP.

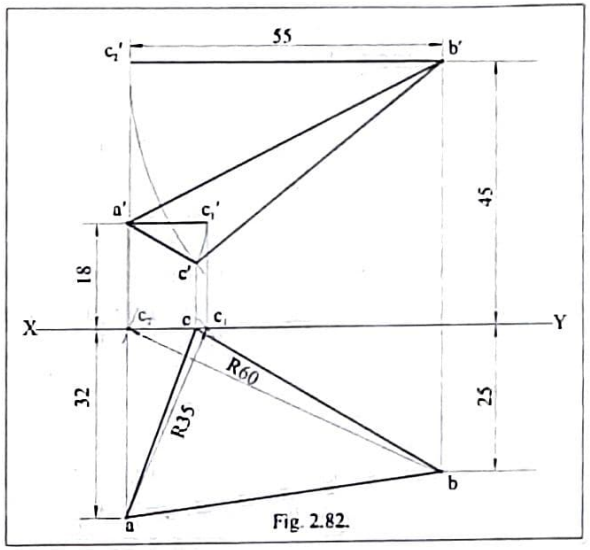


Fig. 2.82.

Example 2.42.

A room is 4.8m x 4.2m x 3.6m high. Determine graphically the distance between a top corner and the bottom corner diagonally opposite to it.

Solution.

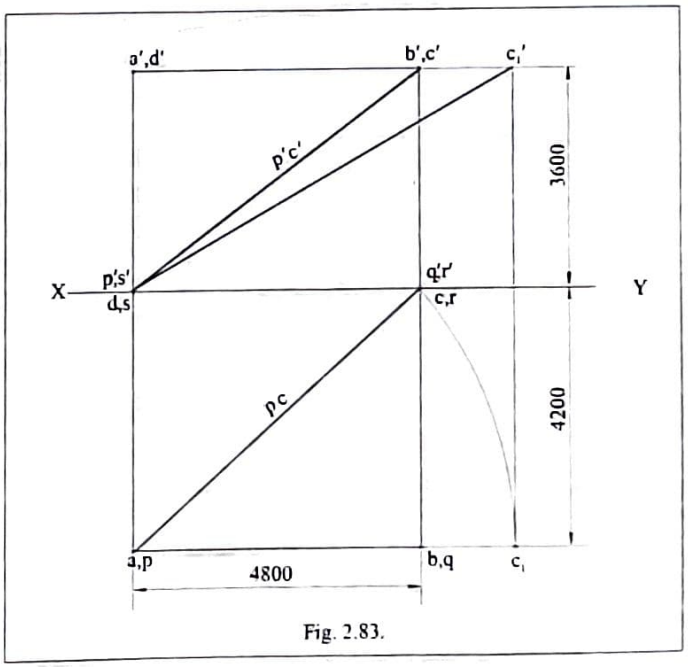


Fig. 2.83.

Draw the plan of the floor of the room which is a rectangle of 4.8m x 4.2m. The elevation of the wall is a rectangle 4.8m x 3.6m. Line p'c' in Fig. 2.83 is the elevation of the line joining a point at the bottom corner (P) and a point at the top corner (C). pc is the plan of this line. Rotate the line pc about p to make it horizontal. pc_1 is horizontal and hence $p'c_1'$ is the true distance between P and C.

Example 2.43.

A room 6m x 4m x 3m is fitted with an electric light at the centre of the room 1m below the ceiling. The switch is at one of the corners, 1.5m above the floor. Draw the plan and elevation of the room showing the fittings and find the shortest distance of the light from the switch. [KU May 2008]

Solution.

Draw the plan of the room which is a rectangle of sides 6m and 4m. The elevation of the wall is a rectangle of sides 6m and 3m as shown in Fig. 2.84. Since the light is

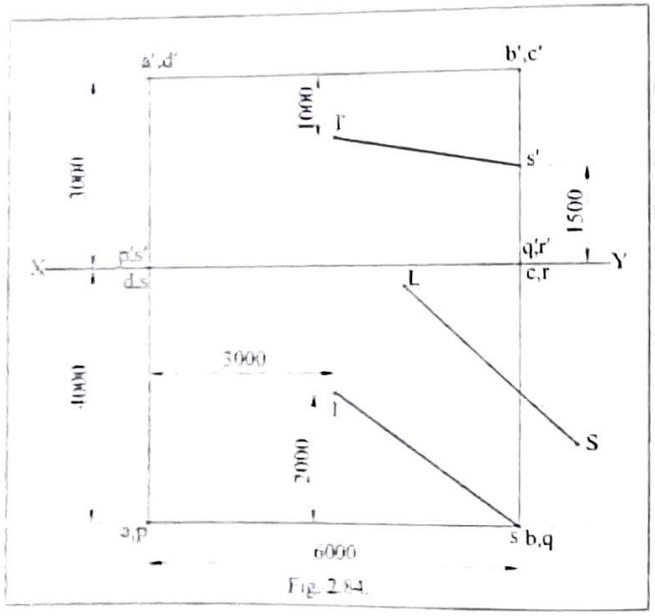


Fig. 2.84.

at the center, mark the top view of the light I at the center of the bottom rectangle and the elevation of the light, I' at a distance of one metre below the line representing the ceiling. Mark the plan of the switch, s, at any one of the corners of the bottom rectangle. Mark the

elevation of the switch, s', 1.5m above as shown in Fig. 2.84. Join the points I' and s'. Join the points I and s. From I and s draw lines perpendicular to the line I s and mark L and S such that I L is 2m and s S is 1.5m. Join L and S. The length of L S is the distance of light from the switch.

Example 2.44.

Two oranges on a tree are respectively 1.8m and 3m above the ground and 1.3m and 2.1m from a 0.3m thick wall, but on the opposite sides of it. The distance between the oranges measured along the ground and parallel to the wall is 2.7m. Determine the real distance between the oranges. [CUSAT June 2010]

Solution.

The distance of oranges from the wall are 1.3m and 2.1m. The distance of these oranges from the centre line of the wall are 1.3 + 0.15 = 1.45m and 2.1 + 0.15 = 2.25m. Draw a horizontal line representing the centre line of the wall. Draw two vertical lines 2.7m

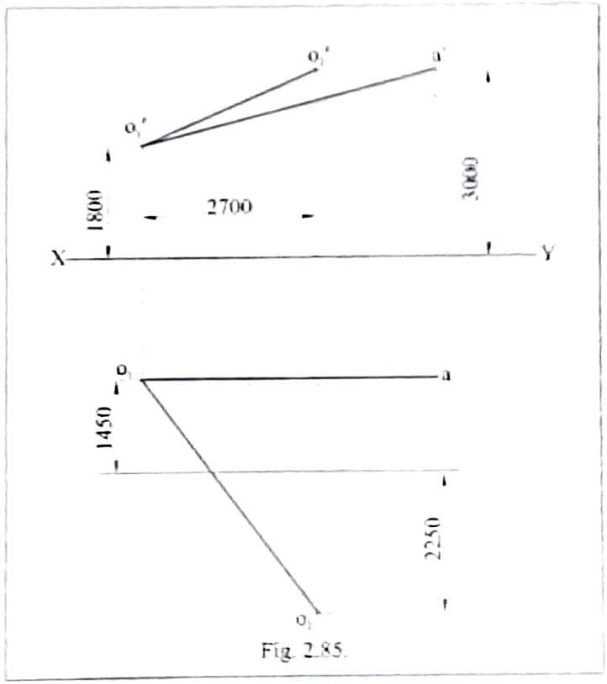


Fig. 2.85.

apart and locate points o_1 and o_2', o_1 at 1.45m above the centre line of wall and o_2 at 2.25m below the centre line. Join the points o_1 and o_2. This line is the plan of the line joining

the oranges. Draw the XY line, just above the point o_1 and locate the points o_1' and o_2', o_1' 1.8m and o_2' 3m above the XY line. Join the points o_1' and o_2'. This line is the elevation of the line joining the oranges. Rotate the plan o_1o_2 about o_1 to make it parallel to XY line, $o_1a = o_1o_2$, is parallel to XY line and hence $o_1'a'$ will be the real distance between the oranges. To locate the point a', draw a vertical line from the point a, and a horizontal line from o_2'. Join the points o_1' and a'.

Example 2.45.

The ends of three guy ropes are tied to a vertical post at a height of 20m above the ground. The other ends of the ropes are pegged to the ground. In the front view the distance between the first peg and the pole is 10m and is on the left side of the pole while the other two pegs are on the right side of the pole and are 15m and 20m from the pole respectively. In the top view the bearings of the ropes appear as S 45° W, N 30° E, and S 40° E, for the first, second, and third ropes respectively. Find the true lengths and inclinations of the ropes with the ground. [KU Dec. 2005].

Solution.

Draw the XY line and draw a vertical line $o_1'o'$ of length 20m, representing the elevation of the post. Locate the points a', b' and c' on XY line, a' at 10m towards left of o_1', b' and c', 15m and 20m towards right of o_1' respectively.

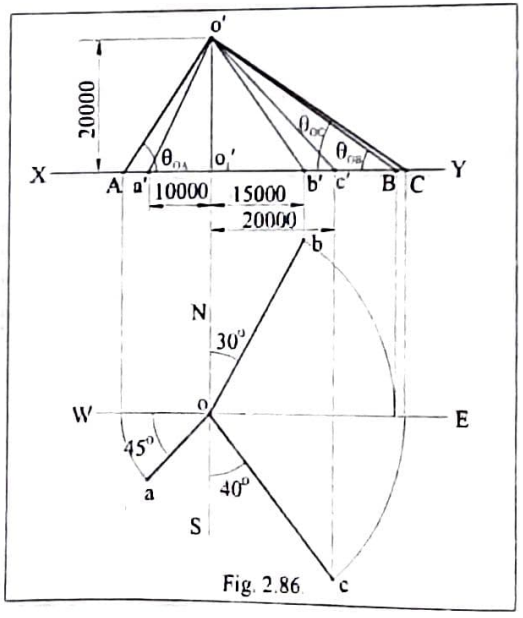


Fig. 2.86

Join the points a', b' and c' with o'. These lines are the elevation of the guy ropes. Locate the point o at a convenient distance below the XY line. Draw the lines oa, ob and oc as shown in Fig. 2.86. Rotate the lines oa, ob and oc about o, to make these lines parallel to XY line. The lengths of the corresponding elevation lines, shown in Fig. 2.86, are the true length of the ropes and the inclination of these lines with horizontal are the true inclination of the ropes with the ground.

Example 2.46

An electric lamp is hung vertically from the center of the flat roof of a room (5m x 5m and height 6m) at a height of 4m above the floor. Find graphically the distance between the lamp and any one of the floor corners.

Solution

Draw the plan of the room at a convinient distance below XY line. It is a square of side 5m. The elevation of the room is a rectangle of width 5m and height 6m. Since the light is at the center of the roof, mark the plan of light *l* at the center of the plan. Mark the elevation of the light *l'*, 4m above XY line. Mark the plan of corner c at one of the corners in the plan and elevation of corner C, c' in one of the bottom corners in the elevation. Join *l'* and c' to get the elevation and join *l* and c to get the plan of the distance between the light and a corner at the floor. Obtain the true distance LC as shown in Fig. 2.87

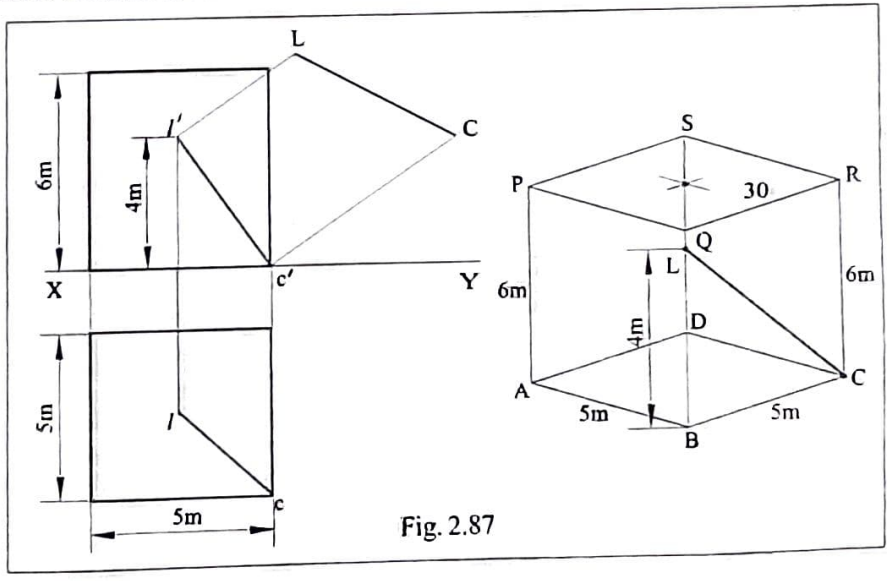


Fig. 2.87

2.8 Additional problems with solutions.

Problems of type 1.

To draw the plan and elevation of a line when different datas are given.

To draw the plan and elevation of a line, minimum five data are required. These data may be distances of some points in the line from HP and VP, distance between end projectors, length of plan of the line, length of elevation of the line, inclination of plan of the line, inclination of elevation of the line, distance of HT from VP, distance of VT from HP, distance between the traces etc.

Points to be remembered

* Plan and elevation of a point are on the same line drawn perpendicular to XY line.
* When a point is above HP, its elevation will be above XY line.
* When a point is below HP its elevation will be below XY line.
* When a point is on HP, its elevation will be on XY line.
* When a point is behind VP, its plan will be above XY line.
* When a point is in front of VP, its plan will be below XY line.
* When a point is on VP, its plan will be on XY line.
* Since horizontal trace is a point on HP, its elevation ht′ will be on XY line.
* Since vertical trace is a point on VP, its plan vt will be on XY line.
* ht′ and vt are always on XY line.
* Position of vt′ will be either in the elevation of a line or in the extension of elevation of a line.
* Position of ht will be either in the plan of a line or in the extension of plan of a line.
* When a line AB is inclined to both HP and VP, its plan points, a,b,ht and vt are collinear.
* Similarly its elevation points a′ , b′ , ht′ and vt′ are collinear.
* When the distance between the end projectors are given, then draw these projectors at the given distance apart and then proceed.
* When the distance between the end projectors and the distance between the traces are given, then draw two lines perpendicular to XY line at the given distance between the traces and then proceed.

Probelm 2.1.

The distance between the end projectors of a line AB is 40mm. The end A is 10mm above HP and 20mm infront of VP. The end B is 15mm below HP and 25mm behind VP. Draw the plan and elevation of the line.

Given datas.

1.Distance between end projectors.

2.Position of a′ 3.Position of a 4.Position of b′ 5.Position of b

Solution

1. Draw the XY line
2. Draw two lines perpendicular to XY line at the given distance of 40mm apart.
3. Locate a′ 10mm above XY line and a 20mm below XY line.
4. Locate b′ 15mm below XY line and b 25mm above XY line.
5. Joint a′ and b′ get the elevation of line AB
6. Join a and b to get the plan of line AB.

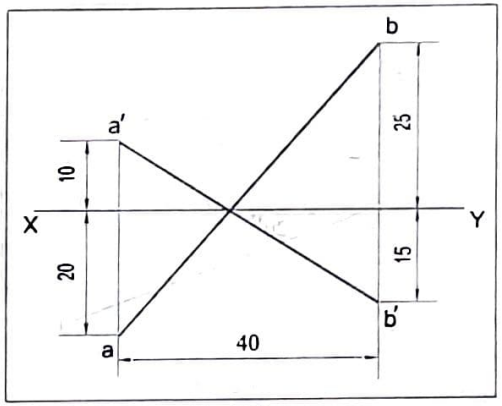


Fig. 2.88

Problem 2.2.

The distance between end projectors of a line AB is 45mm. The end A is 10mm above HP and 15mm in front of VP. The length of elevation is 50mm and the plan is inclined at 20^0 with horizontal. Draw the projections of the line when the line AB is in the first quadrant.

Given datas

1.Distance between end projectors.

2.Position of a′

3.Position of a

4.Length of elevaton a′b′

5.Inclination of plan ab

Solution

1. Draw the XY line.
2. Draw two lines perpendicular to XY line at the given distance of 45mm apart.
3. Locate a′ 10mm above XY line and a 15mm below XY line.
4. With a′ as centre, radius 50mm, draw an arc to cut the other projctor at b′

5. Join a' and b'
6. From the point a draw a line inclined at 20° with horizontal to get point b, below XY line.
7. Join points a and b.

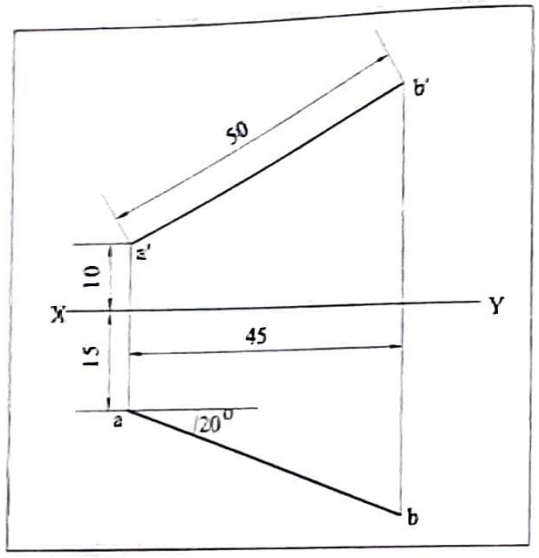


Fig. 2.89

Problem 2.3.

The distance between end projectors of a line AB is 45mm. The end A is 10mm above HP and 15mm infront of VP. The length of elevation is 50mm and the plan is inclined at 30° with horizontal. Draw the projections of the line when the end B is in the second quadrant.

Given datas

1. Distance between end projectors.
2. Position of a'
3. Position of a
4. Length of elevaton a'b'
5. Inclination of plan ab

Solution

1. Draw the XY line.
2. Draw two lines perpendicular to XY line at the given distance of 45mm apart.
3. Locate a' 10mm above XY line and a 15mm below XY line.
4. With a' as centre, radius 50mm, draw an arc to cut the other projctor at b'
5. Join a' and b'

6. From a draw a line inclined at 30° with horizontal to get point b, above XY line.
7. Join points a and b.

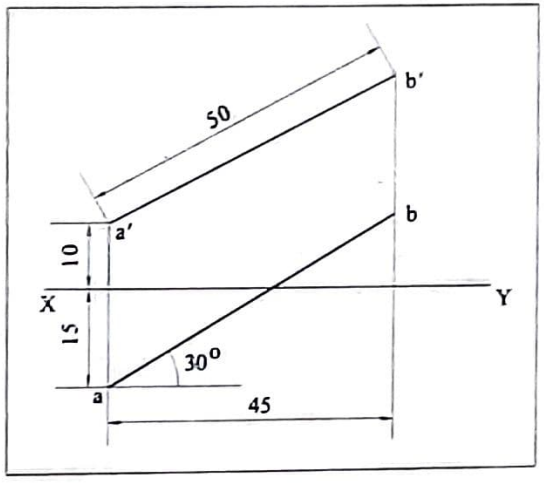


Fig. 2.90

Problem 2.4.

The end A of a line AB is in the first quadrant and the other end B is in the second quadrant. The end A is 10mm from HP and 15mm from VP. The length of elevation is 50mm and it is inclined at 30° with horizontal. Draw the projections of line AB when the plan is inclined at 35° with horizontal.

Given datas

1. Position of a'
2. Position of a
3. Length of elevation a'b'
4. Inclination of elevation a'b'
5. Inclination of plan ab

Solution

1. Draw the XY line.
2. Draw a projector and locate a' 10mm above XY line and a 15mm below XY line.
3. From a' draw the line a'b' of length 50mm and inclined at 30° with horizontal.
4. From b' draw a line perpendicular to XY line.
5. From the point a draw a line inclined at 35° with horizontal to get point b above XY line and below b'.

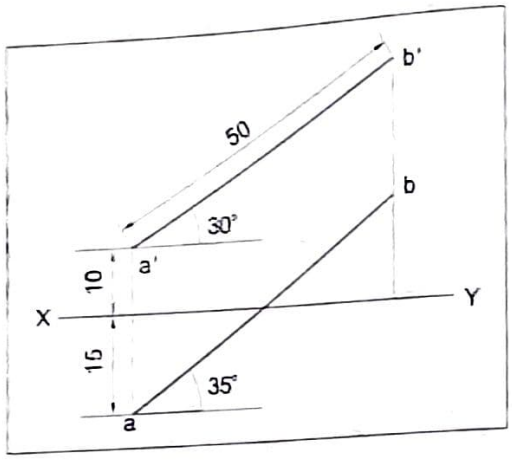


Fig. 2.91

Problem 2.5.

The end A of a line AB is 10mm below HP and 15mm in front of VP. The other end B is 25mm above HP and 10mm behind VP. Draw the projections of the line when the length of elevation is 60mm.

Given datas

1. Position of a' 2. Position of a
3. Distance of b' from XY line 4. Distance of b from XY line
5. Length of elevation a'b'

Solution

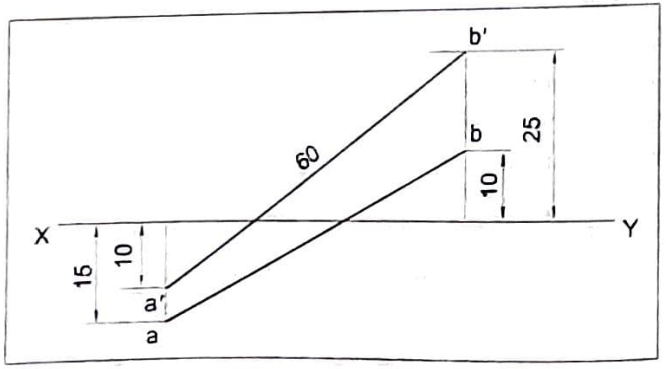


Fig. 2.92

1. Draw the XY line.
2. Draw a projector and locate a' 10mm below XY line and a 15mm below XY line.
3. Draw a horizontal line 25mm above XY line. The point b' is on this line.
4. With a' as centre, radius 60mm draw an arc to locate the point b'
5. From b' draw a line perpendicular to XY line.
6. Locate point b on this line, 10mm above XY line.
7. Join the points a' and b' to get the elevation of the line and join a and b to get the plan of the line.

Problem 2.6.

The mid point M of a line AB which is in the first quadrant is 20mm above HP and 25mm in front of VP. The length of elevation is 50mm which is inclined at 30° with horizontal. The plan is inclined at 40° with horizontal. Draw the plan and elevation of the line when the end A is nearer to HP and the end B is nearer to VP.

Given datas

1. Position of m'
2. Position of m
3. Inclin ation of elevation a'b'
4. Length of elevation a'b'
5. Inclination of plan ab

Solution

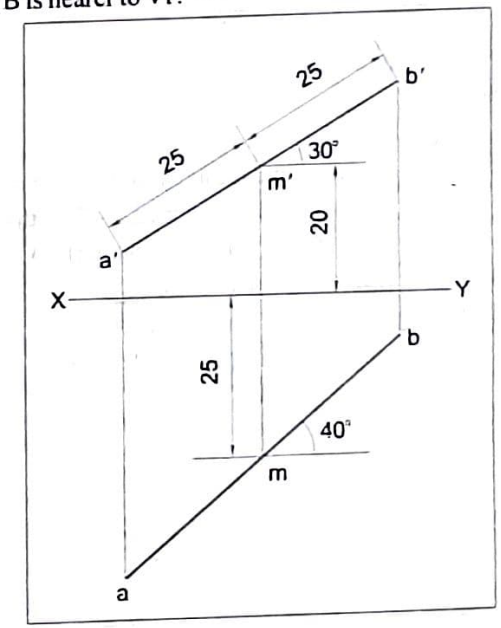


Fig. 2.93

1. Draw the XY line.
2. Draw a projector and locate m' 20mm above XY and m 25mm below XY line.
3. Through m' draw a line inclined at 30° with horizontal and locate $a_1'b_1'$ such that m'a'= m'b'= 25mm. Since A is nearer to HP, the line a'b' should be drawn such that a' is nearer to XY line.

4. Draw projectors from a′ and b′
5. Through m draw a line inclined at 40° with horizontal to intersect the projectors at a and b. Since B is nearer to VP, the line ab should be drawn such that the end b is nearer to XY line.

Problem 2.7.

The end P of a line PQ is in the third quadrant and Q is in the first quardrant. The mid point M of PQ is 10mm above HP and is on VP. The length of elevation is 50mm and it is inclined at 45° with horizontal. The plan of the line PQ is inclined at 30° with horizontal. Draw the projections of the line PQ.

Given datas

1. Position of m′
2. Position of m
3. Inclination of elevation p′q′
4. Length of elevation p′q′
5. Inclination of plan pq.

Soluton

1. Draw the XY line.
2. Draw a projector and locate m′ 10mm above XY line and m on XY line.
3. Through m′ draw a line inclined at 45° with horizontal and mark p′ and q′ such that m′p′= m′q′ = 25mm. This line should be drawn such that the end p′ is below XY line.
4. Draw projectors from p′ and q′
5. Through m draw a line inclined at 30° with horizontal to intersect the projectors at p and q. Since the point P is in the third quadrant, the line pq should be drawn such that the end p is above XY line.

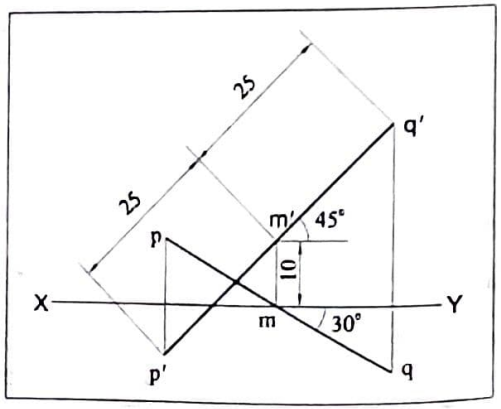


Fig. 2.94

Problem 2.8.

The length of elevation of a line AB is 50mm and it is inclined at 30° with horizontal. The plan is inclined at 20° with horizontal and the horizontal trace of the line is 10mm in front of VP. Draw the projections when the end A is 10mm above HP.

Given datas

1. Position of a′
2. Inclination of elevation a′b′
3. Length of elevation a′b′
4. Inclination of plan ab.
5. Position of horizontal trace ht.

Solution

1. Draw the XY line.
2. Draw a projector and locate a′ 10mm above XY line.
3. Draw the line a′b′of length 50mm, inclined at 30° with horizontal.
4. From b_1 draw the projector.
5. Extend the elevation a′b′ to get ht′on XY line
6. Locate ht 10mm below ht`
7. From ht draw a line inclined at 20° with horizontal to intersect the projectors from a′ and b′ at a and b.

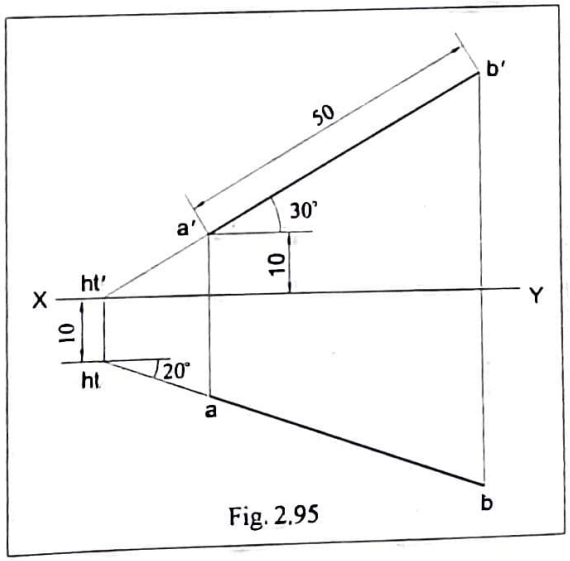


Fig. 2.95

Problem 2.9.

The end A of a line AB is 15mm above HP and 10mm in front of VP. The length of plan is 40mm and it is inclined at 30° with horizontal. The vertical trace of the line is 10mm above HP. Draw the projections of the line AB.

Given datas

1. Position of a'
2. Position of a
3. Inclination of plan ab, β
4. Length of plan, ab
5. Position of vt'

Solution

1. Draw the XY line
2. Draw a projector and locate a' 15mm above XY line and a 10mm below XY line
3. Draw line ab of length 40mm inclined at 30° with horizontal.
4. Extend the line ab to get vt on XY line, and locate vt' 10mm above vt
5. Join vt' and a' and extend it to intersect the projector from b at b'.

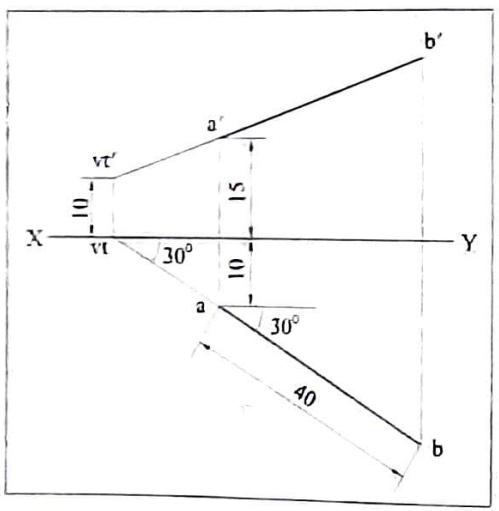


Fig. 2.96

Problem 2.10.

The distance between the traces of a line AB measured parallel to XY line is 55mm. The horizontal trace is 20mm in front of VP and the vertical trace is 25mm above HP. The distance between the end projectors is 35mm. Draw the projections when the end A is 5mm above HP.

Given datas

1. Distance between the traces
2. Position of horizontal trace ht
3. Position of vertical trace vt'
4. Distance of a' from XY line
5. Distance between end projectors

Solution

1. Draw the XY line.
2. Draw two projectors at the given distance of 55mm apart.
3. Locate ht, 20mm below XY line and ht' on XY line.
4. Locate vt', 25mm above XY line vt on XY line.
5. Join ht' and vt'
6. Join ht and vt
7. Locate a' on the line joining ht' and vt', 5mm above XY line.
8. Locate a on the line joining ht and vt, just below a'
9. Draw the projector containing b' and b at a distance 35mm from the projector containing a' and a.

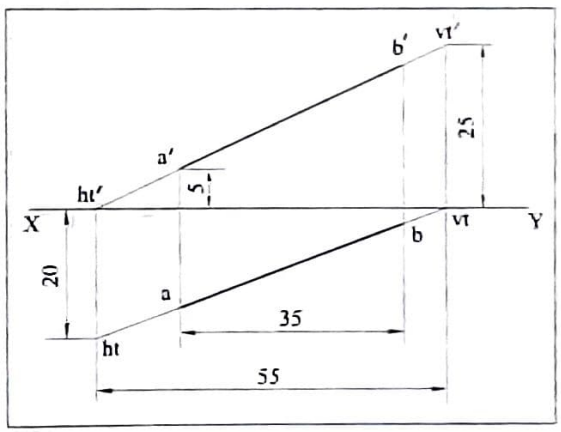


Fig. 2.97

Problem 2.11.

The distance between end projectors of a line AB is 55mm and that between the traces measured parallel to XY line is 35mm. The horizontal trace of the line is 15mm in front of VP and the vertical trace is 20mm above HP. Draw the projections of the line when the end A is 5mm below HP.

Given datas

1. Distance between the traces
2. Position of horizontal trace ht
3. Position of vertical trace vt'
4. Distance of a' from XY line
5. Distance between end projectors.

Solution

1. Draw the XY line
2. Draw two projectors, 35mm apart
3. Locate ht 15mm below XY line and ht' on XY line.
4. Locate vt' 20mm above XY line and vt on XY line
5. Join ht' and vt'
6. Join ht and vt
7. Extend the line joining ht' and vt' and locate a' on this line, 5mm below XY line.
8. Through a' draw a vertical line and locate a on the line of extension of line joining ht and vt
9. Draw a projector 55mm away from the line joining a' and a.
10. Extend the line joining ht and vt to locate b'.
11. Extend the line joining ht and vt to locate b.

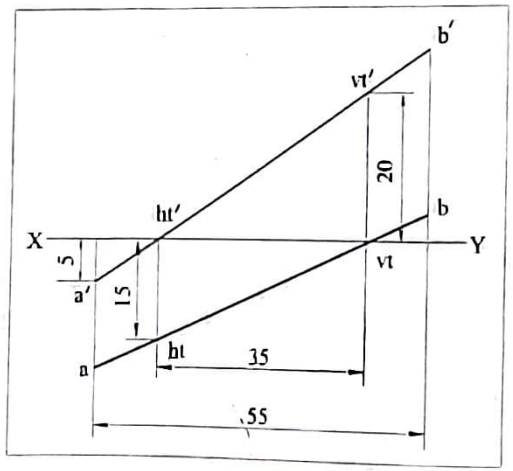


Fig. 2.98

Problem 2.12.

The distance between the traces of a line is 20mm. The horizontal trace is 10mm behind VP and the vertical trace is 5mm above HP. The ends A and B are 10mm and 20mm above HP. Draw the projections of the line.

Given datas

1. Distance between the traces
2. Position of horizontal trace ht
3. Position of vertical trace vt'
4. Distance of a' from XY line
5. Distance of b' from XY line

Solution

1. Draw the XY line.
2. Draw two projectors 20mm apart
3. Locate ht, 10mm above XY line and ht' on XY line
4. Locate vt' 5mm above XY line and vt on XY line
5. Join ht' and vt' and extend it
6. Join ht and vt and extend it
7. Locate a' 10mm above XY line and b' 20mm above XY line on the line of extension of ht' and vt'
8. Locate a and b on the line of extension of ht and vt.

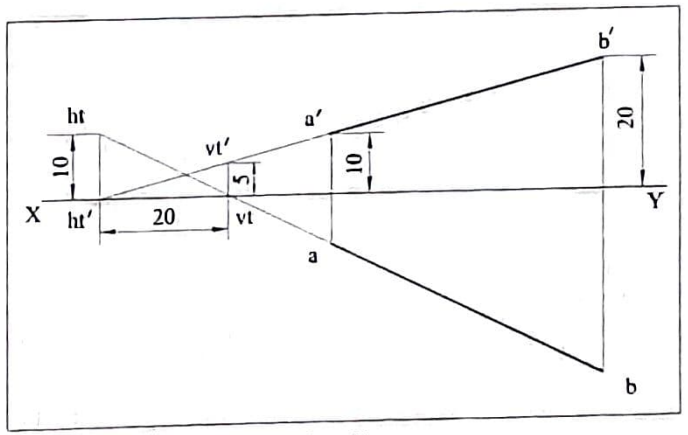


Fig. 2.99

Problem 2.13.

The end A of a line AB is 10mm below HP and the other end B is 15mm above HP and is on VP. The length of elevation is 50mm. Draw the projections of the line when the horizontal trace of the line is 15mm behind VP.

Given datas

1. Position of a'

2. Position of horizontal trace ht
3. Position of b`
4. Length of elevation a'b'
5. Position of b

Solution

1. Draw the XY line.
2. Draw a projector and locate a' 10mm below XY line.
3. Draw a horizontal line 15mm above XY line, b' will be on this line.
4. With a' as centre, 50mm radius draw an arc to locate point b'
5. Locate b on XY line, below b`
6. Join a' and b' to intersect the XY line and ht'
7. Locate ht, 15mm above ht'
8. Join b and ht and extend it.
9. From a' draw a vertical line to locate a on the line of extension of points b and ht.

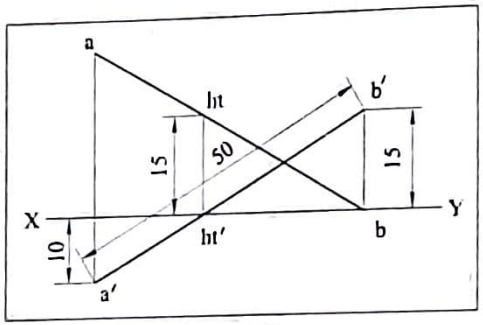


Fig. 2.100

Problems of type 2

To find the true length and true inclination of a line, using trapezium method.

Points to be remembered

* After drawing the plan and elevation of a line, the lines perpendicular to the elevation, from its end points, are to be drawn in the same direction when the end points of the plan are on the same side of XY line. If the end points of plan are on opposite sides of XY line, the perpendicular from the end points of elevation should be drawn in opposite directions.
* The lines perpendicular to the plan, from its end points are to be drawn in the same direction when the end points of elevation of the line are in the same side of XY line and the perpendiculars from the end points of plan are to be drawn in opposite directions when the end points of elevation of the line are in the opposite sides of XY line.

* When the lines a'b' and ab are the elevation and plan of a line AB then,
  a'A is the distance of a from XY line.
  b'B is the distance of b from XY line.
  aA is the distance of a' from XY line.
  bB is the distance of b' from XY line.
* Point of intersection of extension of lines a'b' and AB is the elevation vt ' of the VT of the line. (vt is on XY line)
* The angle between the lines a'b' and AB is the true inclination of the line with VP,
* Point of intersection of lines ab and AB or point of intersection of extension of the lines ab and AB is the plan ht of the horinzontal trace of the line.(ht' is on XY line)
* The angle between the lines ab and AB is the true inclination of the line with HP,

Problem 2.14

The distance between end projectors of a line AB is 45mm. The end A is 10mm above HP and 15mm in front of VP. The length of elevation is 50mm and the plan is inclined at 20^0 with horizontal. The line AB is in the first quadrant. Draw the projections of the line and obtain its true length and true inclination with HP and VP.

Solution.

1. Draw the projections of the line AB. [Refer problem 2.2]
2. From a' and b', draw lines perpendicular to the line a'b' in the same direction.

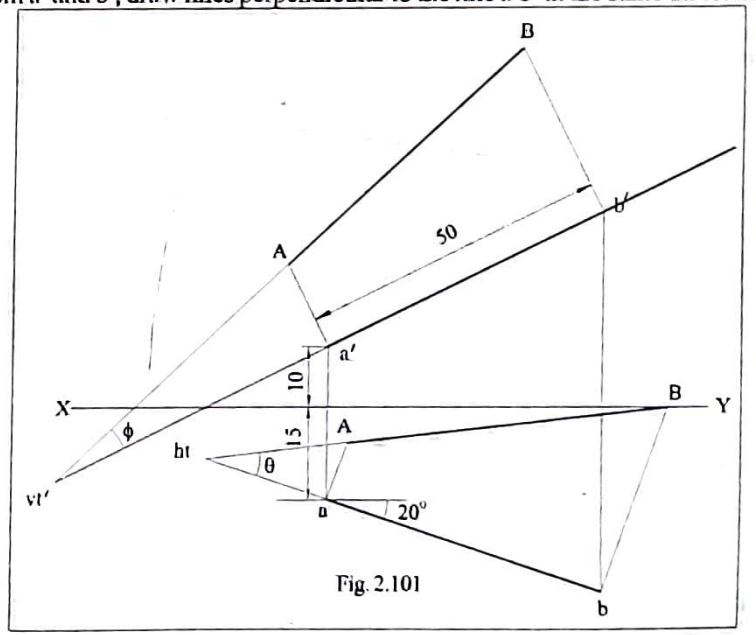


Fig. 2.101

3. Locate points A and B such that a' A is the distance of a from XY line and b' B is the distance of b from XY line. Join A and B. AB is the true length of the line.
4. Extend AB and a'b' to intersect at vt'
5. The angle between AB and a'b' is the true inclination of the line with VP,
6. From the points a and b draw lines perpendicular to the line ab. Locate points A and B such that aA is the distance of a' from XY line and bB is the distance of b' from XY line. Join the points A and B.
7. Extend the lines AB and ab to intersect at ht.
8. The angle between AB and ab is the true inclination of the line with HP,

Problem 2.15

The distance between end projectors of a line AB is 45mm. The end A is 10mm above HP and 15mm in front of VP. The length of elevation is 50mm and the plan is inclined at 30° with horizontal. Draw the projections of the line and find its true length and true inclination with HP and VP.

Solution.

1. Draw the projections of the line [Refer problem 2.3]
2. From a' and b' draw lines perpendicular to the elevation a'b' in opposite directions (a and b are on opposite sides of XY line)

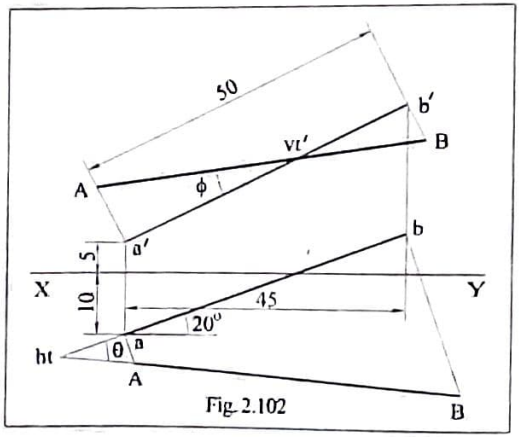


Fig. 2.102

3. Mark points A and B such that a' A is the distance of a from XY line and b'B is the distance of b from XY line.
4. Join the points A and B
5. From points a and b draw lines perpendicular to the plan ab in the same direction (a' and b' are on the same side of XY line)

6. Mark points A and B such that aA is the distance of a' from XY line and bB is the distance of b' from XY line.
7. Join the points A and B

AB is the true length of the line. Angle between the lines a'b' and AB is the true inclination of the line with VP and angle between ab and AB is the true inclination of the line with HP.

Problem 2.16

The ends of a line AB are 50mm and 20mm above HP. The length of elevation is 70mm and its VT is 10mm above HP. The line is inclined at 40° to VP. Find its true length and true inclination with HP. Also locate its traces.

Given datas

1. Distance from a' from XY line, 2. Distance from b'1 from XY line
3. Length of elevation a'b', 4. Position of vt'
5. Inclination of line with VP,

Solution.

1. Draw the XY line.
2. Draw a projector and locate a' 50mm above XY line.
3. Draw a horizontal line 20mm above XY line. The point b' is on this line.

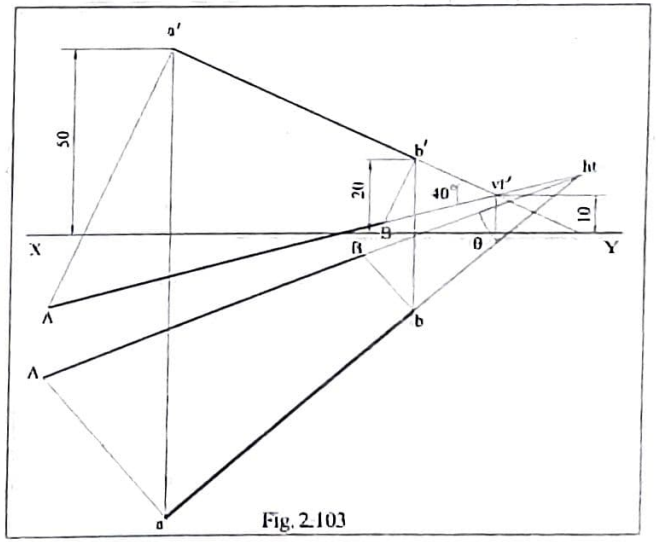


Fig. 2.103

4. Locate the point b' by drawing an arc with a' as center and radius 70mm.
5. Extend the line a'b' and mark vt' on it, 10mm above XY line.

6. From vt' draw a line inclined at 40^0 with the a'b' line.
7. From a' and b' draw lines perpendicular to the line a'b' and locate A and B.
8. Join the points A and B
9. Locate point a such that the distance of a from XY line is the distance a'A.
10. Locate point b such that the distance of b from xy line is the distance b'B.
11. Join the points a and b
12. From a and b, draw lines perpendicular to the line ab.
13. Mark points A and B such that aA is the distance of a' from XY line (50mm) and bB is the distance of b' from XY line (20mm)
14. Join the points A and B
15. Extend the lines AB and ab to intersect at ht. The angle between AB and ab is the true inclination of the line with HP

Problem 2.17

The distance between end projectors of a line AB is 40mm. The end A is 10mm above HP and is in front of VP. The end B is 25mm above HP. The vertical trace of the line is 20mm above HP and the line AB is inclined at 30^0 with VP. Draw the projections of the line and find its true length and true inclination with HP.

Given datas

1. Distance between end projectors
2. Position of a`
3. Position of b`
4. Position of vt`
5. Inclination of line with VP

Solution

1. Draw the XY line
2. Draw two projectors at 40mm apart
3. Locate a' 10mm above XY line and b' 25mm above XY line.
4. Join the points a' and b'
5. Locate the vt' on a'b' line, 20mm above XY line
6. Through vt' draw a line inclined at 30^0 with a'b' line.
7. Locate the points A and B by drawing lines perpendicular to the line a'b' from a' and b'.
8. Locate point a below XY line such that its distance from XY line is a'A
9. Locate point b above XY line (perpendiculars from a' and b' are in opposite directions) such that its distance from XY line is b'B
10. Join the points a and b

11. From a and b, draw lines perpendicular to the line a and b and locate points A and B such that aA is the distance of a' from XY line (10mm) and bB is the distance of b' from XY line (25mm).
12. Join the points A and B
13. Extend the lines AB and ab to intersect at ht.
14. Measure the angle between AB and ab which is the true inclination of the line with HP,

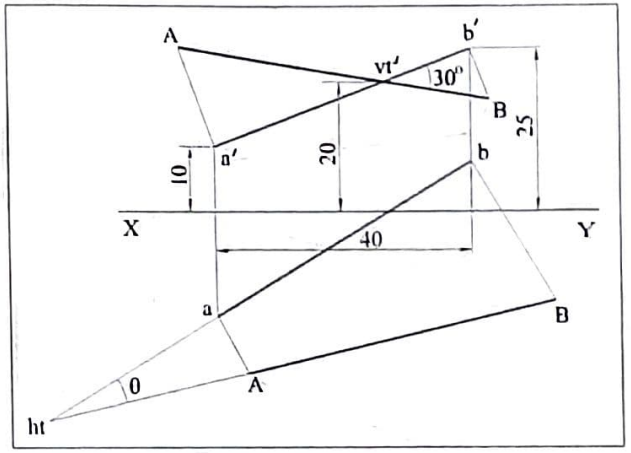


Fig. 2.104

Problem 2.18

The distance between end projectors of a line AB is 40mm. The end A is 5mm above HP and the end B is 15mm above HP. The vertical trace of the line is 20mm above HP and the line AB is inclined at 20^0 with VP. Draw the projections of the line and find its true length and true inclination with HP.

Given datas

1. Distance between end projectors
2. Position of a`
3. Position of b`
4. Position of vt`
5. Inclination of line with VP

Solution

1. Draw the XY line
2. Draw two projectors, 40mm apart.
3. Locate a' 5mm above XY line and b' 15mm above XY line.
4. Join the points a' and b'

5. Extend the line a'b' and locate vt' on it, 20mm above XY line
6. From vt', draw a line inclined at 20° with a'b' line.
7. Locate points A and B by drawing perpendiculars to the line a'b' from a' and b'
8. Join the points A and B
9. Locate points a and b such that the distance of a from XY line is the distance a'A and distance of b from XY line is the distance b'B

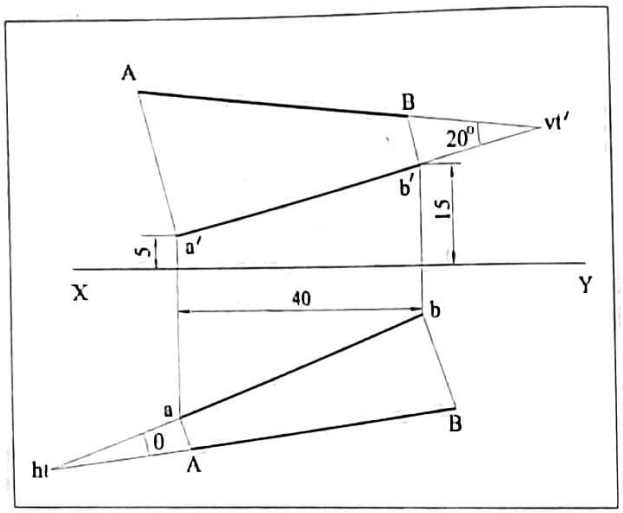


Fig. 2.105

10. Join the points a and b
11. From a and b, draw lines perpendicular to the line ab.
12. Locate points A and B such that aA is the distance of a' from XY line (5mm) and bB is the distance of b' from XY line (15mm)
13. Join the points A and B
14. Extend the lines ab and AB to intersect at ht
15. Measure the angle between the lines AB and ab, which is the true inclination of the line with HP,

Problem 2.19

The distance between end projectors of a line AB is 45mm. The end A is 10mm in front of VP and is above HP. The end B is 25 mm in front of VP. The AB is inclined at 25° with HP. Draw the projections of the line and find its true length and true inclination with VP when the horizontal trace of the line is 5mm in front of VP.

Given datas

1. Distance between end projectors
2. Position of a
3. Position of b
4. Distance of ht from XY line
5. Inclination of line with HP,

Solution

1. Draw the XY line.
2. Draw two projectors at 45mm apart.
3. Locate a 10mm below XY line and b 25mm below XY line.
4. Join the points a and b
5. Extend the line ba and mark ht 5mm below XY line.
6. From ht, draw a line inclined at 20° with plan ab
7. Locate A and B on this line by drawing perpendicular to line ab from its end points a and b
8. Locate a' and b' such that the distance of a' from XY line the distance aA and the distance of b' from XY line is the distance bB.
9. Join the points A and B
10. Extend the lines a'b' and AB to intersect at vt'
11. Measure the angle between the lines AB and a'b' which is the true inclination of the line AB with VP,

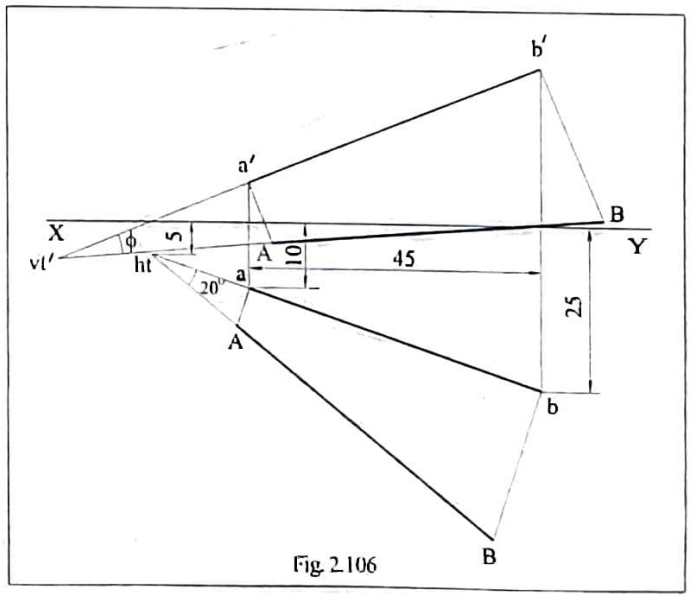


Fig. 2.106

Problem 2.20

The end A of a line AB is 10mm in front of VP and is above HP. The other end B is 25mm in front of VP. The length of plan is 50mm. The horizontal trace of the line is 20mm in front of VP and the line AB is inclined at 30° with HP. Draw the projections of the line and find its true length and true inclination with VP.

Given datas

1. Position of a
2. Distance of b from XY line
3. Length of plan, ab
4. Distance of ht from XY line
5. Inclination of line with HP,

Solution

1. Draw the XY line
2. Draw a projector and locate point a 10mm below XY line.
3. Draw a horizontal line 25mm below XY line. Point b is on this line.
4. With a as center, radius 50mm draw an arc to locate point b
5. Join the points a and b

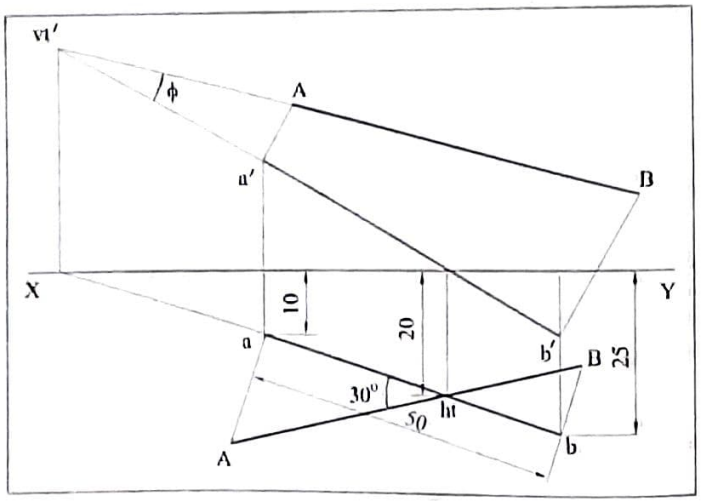


Fig. 2.107

6. Locate ht on ab, 20mm below XY line.
7. Through ht, draw a line inclined at 30° with ab line. The points A and B are on this line.

8. From points a and b, draw lines perpendicular to the line ab to get points A and B
9. Join the points A and B
10. Locate a' above XY line such that its distance from XY line is aA.
11. Locate b' below XY line (perpendicular lines from a and b are in opposite direction) such that its distance from XY line is bB.
12. Join the points a' and b'
13. From a' and b' draw lines perpendicular to the line a'b'
14. Locate points A and B such that a'A is the distance of a from XY line (10mm) and b'B is the distance of b from XY line (25mm)
15. Join the points A and B
16. Extend the lines AB and a'b' to meet at vt'
17. Measure the angle between AB and a'b', which is the true inclination of the line AB with VP,

Problem 2.21

The distance between end projectors of a line AB is 40mm. The end A is below HP and 10mm in front of VP. The end B is 20mm behind VP. The vertical trace of the line is 15mm below HP and the line is inclined at 25° with HP. The end B is nearer to HP. Draw the projections of the line and find its true length and true inclination with VP.

Given datas

1. Distance between end projectors
2. Position of a
3. Position of b
4. Distance of vt' from XY line
5. Inclination of line with HP,

Solution

1. Draw the XY line.
2. Draw projectors at 40mm apart
3. Locate a 10mm below XY line and b 20mm above XY line.
4. Join the points a and b to interseot the XY line at vt.
5. Locate vt' 20mm below vt
6. From vt, draw a line perpendicular to the line ab and locate a point on this line, 25mm from vt and through this point draw a line inclined at 25° with ab line. Points A and B are on this line.
7. From points a and b draw lines perpendicular to the line ab to get points A and B
8. Locate point a' below XY line and b' above XY line such that the distance of a' from

XY line is aA and the distance of b′ from XY line is bB.

9. Join the points A and B
10. Measure the angle between a′b′ and AB which is the true inclination of the line with VP.

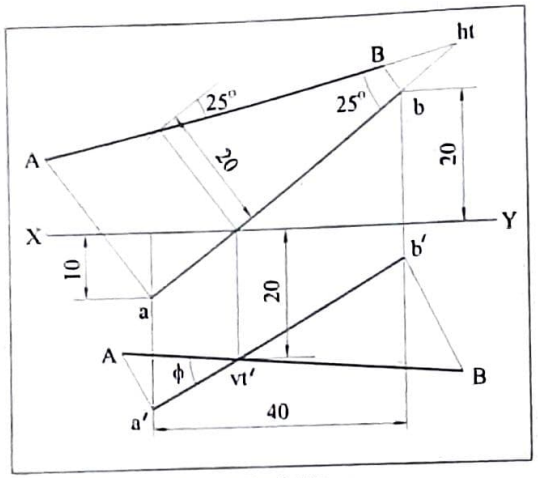


Fig. 2.108

Problem 2.22

The end P of a line PQ is 10mm above HP and is in front of VP. The length of elevation is 50mm and it is inclined 20° with horizontal. The horizontal trace of the line is 30mm in front of VP and the line PQ is inclined at 25° with VP. Draw the projections of the line and find its true length and true inclination with HP when the end Q is in the second quadrant.

Given datas

1. Position of p′
2. Inclination of p′q′
3. Length of p′q′
4. Distance of ht from XY line
5. Inclination of line with VP,

Solution

1. Draw the XY line
2. Draw a projector and locate p′ 10mm above XY line.
3. Draw the line p′q′ of length 50mm and inclined at 20° with horizontal.
4. Extend the line q′p′ to intersect the XY line at ht′
5. Locate ht 30mm below ht′

6. From ht′, draw a line perpendicular to p′q′ line and on it mark a point 30mm from ht′ and from this point draw a line inclined at 25° with the line p′q′. P and Q are on this line.

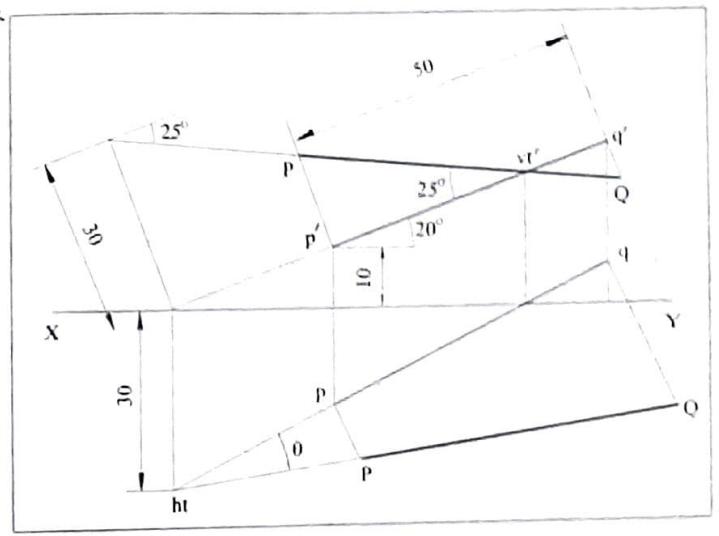


Fig. 2.109

7. From p′ and q′, draw lines perpendicular to p′q′ line to get the points P and Q
8. Join the points P and Q.
9. Locate point q above XY line (Q is in the second quadrant) such that its distance from XY line is q′Q
10. Locate p below XY line (perpendiculars from p′ and q′ are in opposite direction) such that the distance of p from XY line is p′P
11. Join the points p and q
12. From p and q draw lines perpendicular to the line pq. Points P and Q are on this line.
13. Locate P and Q such that pP is the distance of p′ from XY line and qQ is the distance of q′ from XY line.
14. Join the points P and Q
15. Extend the lines pq and PQ to meet at ht

Problem 2.23

The distance between end projectors of a line AB is 55mm and that between the traces measured parallel to XY line is 35mm. The horizontal trace is 15mm in front of VP and the vertical trace is 20mm above HP. Draw the projections of the line and find its true length and true inclination with HP and VP, when the end A is 5mm below HP.

Given datas

1. Distance between traces
2. Distance between end projectors
3. Distance of ht from XY line
4. Distance of vt` from XY line
5. Distance of a` from XY line

Solution

1. Draw the projections of the line a'b' and ab [Refer problem 2.11]
2. From a' and b', draw lines perpendicular to line a'b', in opposite directions.
3. Locate points A and B such that a' A is the distance of a from XY line and b'B is the distance of b from XY line.
4. Join the points A and B. The point of intersection of lines a'b' and AB is vt and the angle between a'b' and AB is the true inclination of the line with VP,
5. From a and b, draw lines perpendicular to line ab in opposite directions.
6. Locate A and B such that aA is the distance of a' from XY line and bB is the distance of b' from XY line.
7. Join the points A and B. The point of intersection of the lines ab and AB is ht and the angle between ab and AB is the true inclination with HP,

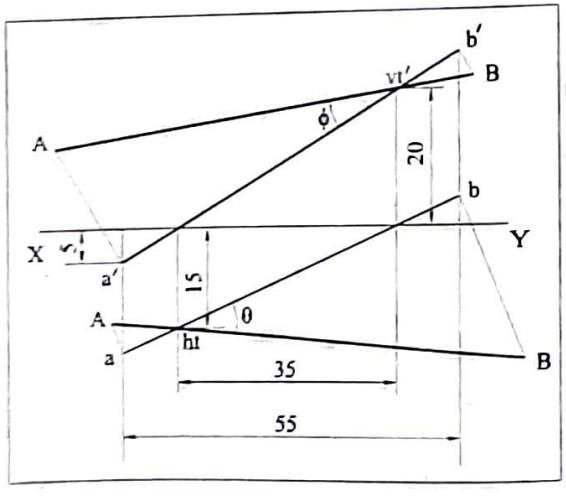


Fig. 2.110

Problem 2.24

The distance between end projectors of a line AB is 80mm. The end A is 20mm above HP and is in front of VP. The end B is 50mm above HP and is behind VP. The horizontal trace of the line is 40mm in front of VP. The line AB is inclined at 20° with VP. Draw its projections and find its true inclination with HP

Given datas

1. Distance between end projectors
2. Position of a'
3. Distance of b' from XY line
4. Position of ht
5. Inclination of line AB with VP,

Solution

1. Draw the XY line
2. Draw two projectors at 80mm apart
3. Locate a' 20mm above XY line and b' 50mm above XY line.
4. Join the points a' and b'
5. Extend the line b'a' to get ht' on XY line and locate ht 40mm below ht'
6. Draw a line perpendicular to ht'b' line, from ht'

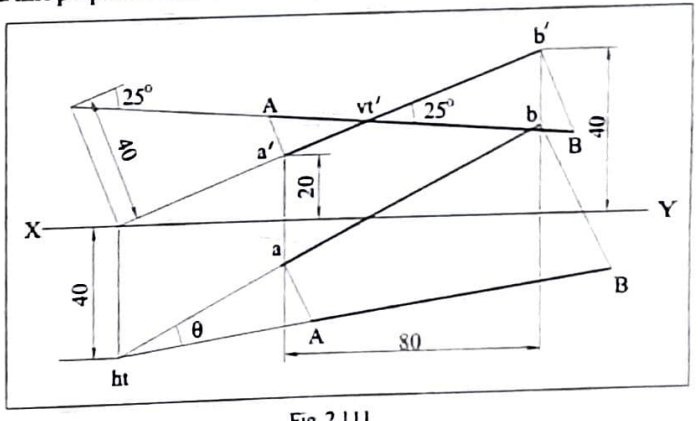


Fig. 2.111

7. Locate a point on this line, 40mm from ht' and through this point draw a line parallel to ht'b' line.
8. From the located point draw a line inclined at 25° with ht'b' line to intersect a'b' line at vt'. A and B are on this line
9. From a' and b', draw lines perpendicular to the line a'b' and locate points A and B

10. Locate points a and b such that the distance of a from XY line is the distance a'A and the distance of b from XY line is the distance b'B. The point a should be located below XY line and the point b should be located above XY line.
11. Join points a and b
12. Draw lines perpendicular to the line ab from the end points a and b and locate A and B such that aA = 20mm and bB = 50mm
13. Join points A and B
14. Extend the lines ab and AB to meet at ht
15. Measure the angle between AB and ab which is the true inclination of the line AB with HP.

Problem 2.25

The distance between the end projectors of a line AB is 80mm. The end A is above HP and 20mm behind VP. The end B is 40mm in front of VP. The vertical trace of the line is 40mm above HP and the line is inclined at 20° with HP. Draw the projections of the line AB.

Given datas

1. Distance between end projectors
2. Position of a
3. Position of b
4. Inclination of the line AB with HP.

Solution

1. Draw the XY line
2. Draw two projectors at a distance 80mm apart

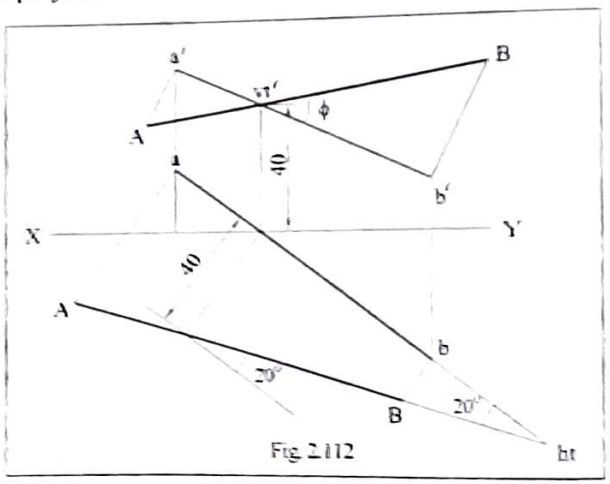


Fig. 2.112

3. Locate the points a and b and join them
4. Locate the point vt on XY line and vt' 40mm above XY line.
5. Draw a line perpendicular to the line ab from the point vt and locate a point c on it such that vt - c= 40mm
6. Through the point c, draw a line inclined at 20° with the line ab. A and B are on this line.
7. Draw lines perpendicular to the line ab from a and b to locate points A and B and join the points A and B
8. Extend the lines ab and AB to intersect at ht
9. Locate a' and b' both above XY line such that the distances of a' and b' from XY line are aA and bB respectively, and join a' and b'
10. Draw lines perpendicular to the line a'b' from a' and b' and locate A and B such that a'A is the distance of a from XY line and b'B is the distance of b from XY line.
11. Join the points A and B to intersect a'b' line at vt'
12. Measure the angle between a'b' and AB which is the true inclination of line AB with VP.

Problem 2.26

Find graphically the length of the largest rod that can be kept inside a hollow cuboid (rectangular prism) of 60mm x 40mm x 30mm

1. Draw the XY line
2. Draw the elevation of the room which is a rectangle of sides 60mm x 30mm
3. Join the points d' and q' which is the elevation of rod DQ

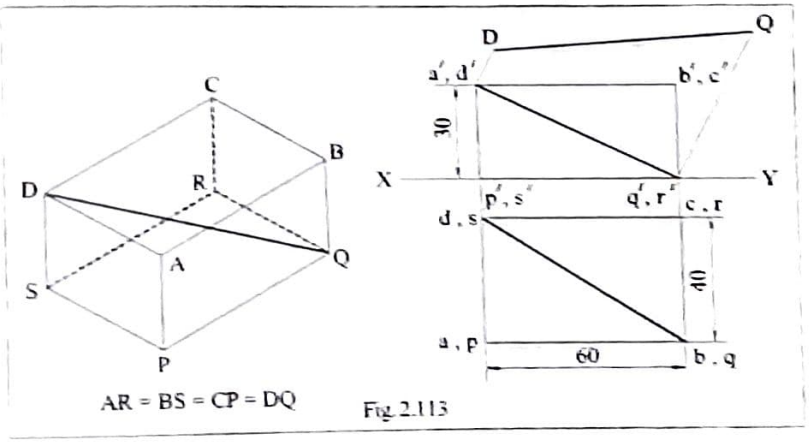


Fig. 2.113

4. Draw the plan which is a rectangle of sides 60mm x 40mm
5. Join the points d and q which is the plan of rod DQ
6. Draw lines perpendicular to the line d'q' from its end points d' and q'
7. Mark points D and Q such that d'D is the distance of d from XY line and q'Q is the distance of q from XY line.
8. Join the points D and Q. Length of DQ is the length of the largest rod which can be kept inside the hollow rectangular prism.

Problem 2.27

The end A of a line AB 100mm long is 20mm above HP and 30mm in front of VP. Draw its Projections when the inclination of elevation and plan are 45° and 30° respectively. Also find the true length and true inclinations of the line with HP and VP.

Solution

1. Draw the XY line
2. Draw a projector and locate a' 20mm above XY line and a 30mm below XY line.
3. Draw lines from a' and b' inclined at 45° and 30° with horizontal respectively.

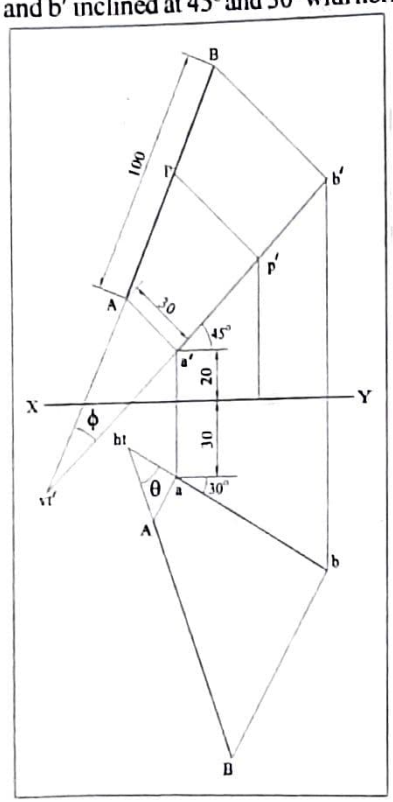


Fig. 2.114

4. Draw a projector at any position and locate p' and p. Lines a'p' and ap are the elevation and plan of a line AP, where P is a point on the line AB of length 100mm
5. From a' and p', draw lines perpendicular to the line a'p' and locate A and P such that a' A is the distance from a from XY line and p'P is the distance of p from XY line.
6. Join A and P and extend it and locate point B on it such that AB = 100mm. Extend the line a'p' and from B draw a line parallel to p'P to get b'. Draw a vertical line from b' to get point b on the extension of line ap.

Problems of type 3

To find the true length and true inclination of a line with HP and VP, using line rotation method.

Points to be remembered

* When the elevation of a line shows the true length of a line at true inclination with HP, the plan will be parallel to XY line.
* The final length of plan of a line will be the distance length line in elevation.
* When the plan of a line is parallel to XY line, the corresponding elevation will be the true length of the line and its inclination will be the true inclination of the line with HP,
* When the plan of a line shows the true length of a line at true inclination with VP, the elevation will be parallel to XY line.
* The final length of elevation of a line will be the distance between the end projectors of a true length line in plan.
* When the elevation of a line is parallel to XY line the corresponding plan will be the true length of the line and its ionclination will be the true inclination of the line with VP ( )
* When the locus of projection of a point in one of the reference plane is an arc, then the locus of projection of the same point in the other reference plane will be a line parallel to XY line. ie, when the locus of point a is an arc then the locus of a will be a line parallel to XY line and vice versa.
* The locus which is parallel to XY line always passes through the end point of true length line.

Problem 2.28

The end A of a line AB 40mm long and inclined at 35° with HP and 40° with VP is 10mm above HP and 15mm in front of VP, Draw its projections.

Given datas

1. Position of a'
2. Position of a
3. True length of line AB
4. True inclination with HP,
5. True inclination with VP

2.100

Solution

1. Draw the XY line
2. Draw a projector and locate a' 10mm above XY line and a 15mm below XY line.
3. Draw the line $a'b_1'$ of length 40mm, inclined at 35° with horizontal
4. From b_1' draw a horizontal line. The point b' will be on this line.

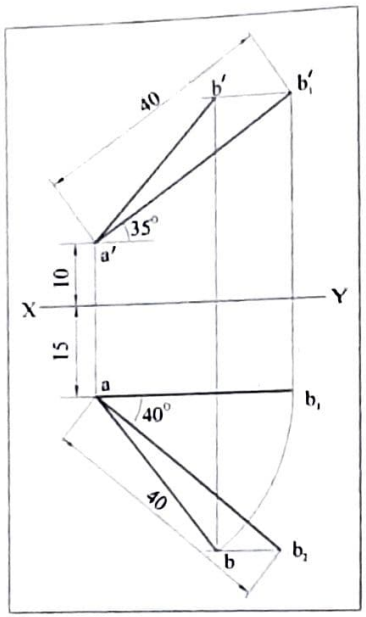


Fig. 2.115

5. Draw ab_1 line parallel to XY line (a'b' is the true length) ab_1 is the final length of plan ab
6. Draw the line ab_2 of length 40mm, inclined at 40° with horizontal.
7. From b_2 draw a horizontal line. The point b is on this line.
8. With point a as center, radius ab_1, draw an arc to locate the point b
9. Join points a and b
10. From b, draw a vertical line to locate b'
11. Join the points a' and b'

Problem 2.29

Draw the projections of the line AB of length 80mm inclined at 30° with HP and 45° with VP. A point C on AB is 30mm from A is at a distance of 35mm above HP and 40mm in front of VP. The end A is nearer to both HP and VP compared to end B.

Given datas

1. True length of AB
2. Inclination of the line with HP,
3. Inclination of line with VP,
4. Position of point C in the line AB
5. Position of c'
6. Position of c

Solution

1. Draw the XY line
2. Draw a projector and locate c' 35mm above XY line and c 40mm below XY line.
3. Through c', draw the line $a_1'b_1'$ of length 80mm and inclined at 30° with horizontal such that $c'a_1' = 30mm$ and $c'b_1' = 50mm$
4. From a_1' and b_1' draw horizontal lines. a' and b' are on these lines respectively
5. Through c, draw a horizontal line and locate a_1 and b_1, below a_1' and b_1'

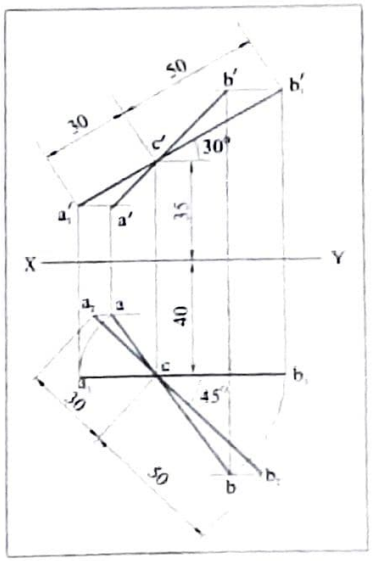


Fig. 2.116

6. Through point c, draw the line a_2b_2 of length 80mm and inclined at 45° such that a_2c= 30mm and cb_2 = 50mm
7. From a_2 and b_2 draw horizontal lines. The points a and b are on these lines.
8. Rotate the line a_1b_1 about c to locate a and b
9. Join the points a and b
10. From a and b draw vertical lines to locate a' and b'
11. Join the points a' and b'

Problem 2.30

The front and top views of an 80mm long line PQ measures 70mm and 60mm respectively. The end P is on the HP and the end Q is in the VP. Draw the projections of line PQ and determine its inclinations with HP and VP. Also locate the traces.

Given datas

1. True length of line PQ
2. Length of plan, pq
3. Length of elevation, p'q'
4. Position of p'
5. Position of q

Solution

1. Draw the XY line
2. Locate p' on XY line
3. Draw a projector 60mm away from p' (when the elevation shows the true length at true inclination with HP, the distance between the projectors is the length of plan)
4. With p' as center, 80mm radius, draw an arc to cut the projector at q_1'
5. Join p' and q_1'. Inclination of this true length line is the true inclination of the line with HP.

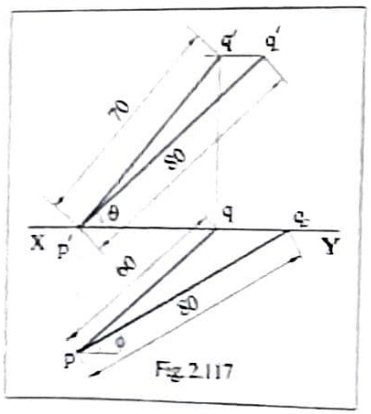


Fig. 2.117

6. From q_1', draw a horizontal line. The point q is on this line.
7. With p' as centre, radius 70mm draw an arc to locate q' on the horizontal line from q_1'
8. Join the points p' and q'
9. From q' draw a vertical line to get the point q on XY line.
10. With q as center, 60mm radius, draw an arc to locate p below p'
11. Join p and q
12. With p as center radius 80mm, draw an arc to locate q_2 on XY line.
13. Join the points p and q_2
14. Measure the inclination of the line pq_2 with horizontal which is the true inclination of the line PQ with VP,

Problem 2.31

The front and top views of a straight line PQ measures 50mm and 65mm respectively. the point P is on the HP and 20mm in front of the VP. The front view of the line is inclined at 45° to the reference line. Determine the true length of PQ and its true inclinations with the reference planes. Also locate the traces.

Given datas

1. Length of elevation, p'q'
2. Length of plan, pq
3. Position of p'
4. Position of p
5. Inclination of elevation, α

Solution

1. Draw the XY line.
2. Draw a projector and locate p' on XY line and p 20mm below XY line.
3. Draw the line p'q' of length 50mm and inclined at 45°
4. From q', draw a vertical line and locate q on it such that pq = 65mm. Join points p and q
5. Rotate the line pq to get pq_1 horizontal
6. From q_1, draw a vertical line and from q' draw a horizontal line to get q_1'
7. Join p'q_1' which is the true length of the line PQ and its inclination is the true inclination of the line with HP,
8. Rotate the line p'q' to get horizontal line pq_2'
9. From q_2', draw a vertical line and from q draw a horizontal line to get q_2
10. Join p and q_2 which is the true length of the line PQ and its inclination is the true inclination of the line with VP,

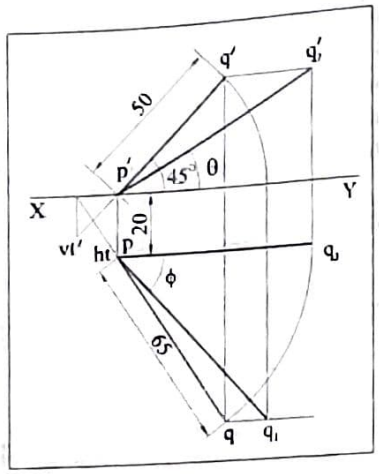


Fig. 2.118

Problem 2.32

The end A of a line AB 100mm long is 20mm above HP and 30mm in front of VP. Draw its Projections when the inclination of elevation and plan are 45° and 30° respectively. Also find the true length and true inclinations of the line with HP and VP.

Given datas

1. Draw the XY line
2. Draw a projector and locate a' 20mm above XY line and a 30mm below XY line.
3. Draw lines from a' and b' inclined at 45° and 30° with horizontal respectively.
4. Draw a projector at any position and locate p' and p. Lines a'p' and ap are the elevation and plan of a line AP, where P is a point on the line AB of length 100mm
5. Draw a horizontal line from a' and with a' as center and a'p', draw an arc to locate p_1' on the horizontal line from a'
6. Draw a vertical line from p_1' and horizontal line from p to get the point p_1
7. Join the points a and p_1. This ap_1 is the true length of line AP
8. Extend the line ap_1 and locate point b_1 such that ab_1=100mm
9. Measure the inclination of ab_1 which is the true inclination of line AB with VP,
10. Draw a horizontal line from b_1 to intersect the extension of the line ap at B.
11. Join the points a' and b_1'
12. Draw a vertical line from b to intersect the extension of line a'p' at b'

13. Join the points a' and b'
14. Draw a horizontal line from b' and locate b_1' on it such that $a'b_1' = 100mm$
15. Join the points a' and b_1'. The inclination of the line ab_1 is the inclination of the line with HP.

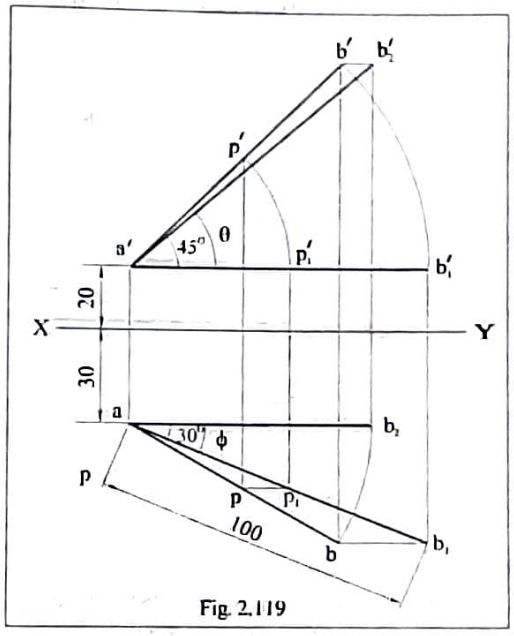


Fig. 2.119

Problem 2.33

The end A of a line AB is 15mm above HP and the other end is 40mm above HP. The length of plan is 80mm and is inclined at 25° with horizontal. Draw the projections of the line and find its true length and true inclinations with HP and VP when the horizontal trace of the line is 20mm in front of VP.

Given datas

1. Position of a'
2. Position of b'
3. Length of plan, ab.
4. Inclination of plan, β
5. Position of ht

Solution

1. Draw the XY line
2. Draw a projector and locate a_1' 15mm above XY line and a_1 20mm below XY line (ht is 20mm in front of VP)

3. Draw a_1b_1 line of length 80mm
4. Draw a vertical line b_1 and locate b_1' 40mm above XY line.
5. Join the points a_1' and b_1'. The length of this line $a_1'b_1'$ is the true length of line AB and its inclination is the true inclination of the line AB with HP.
6. Extend the line $b_1'a_1'$ to get ht' on XY line

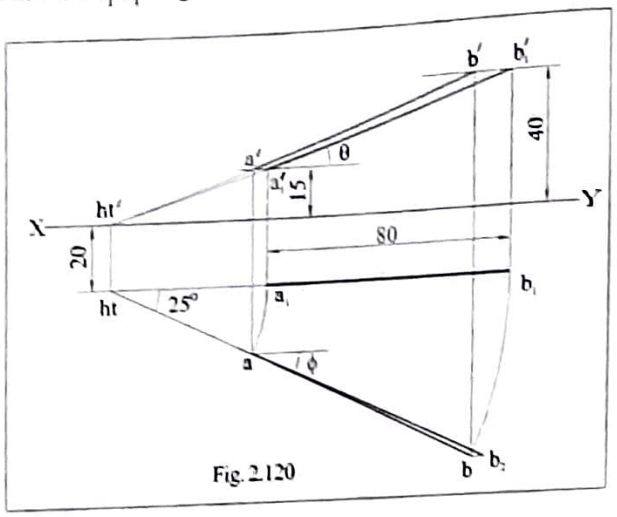


Fig. 2.120

7. Locate ht, 20mm below XY line
8. Rotate the line ht a_1b_1 about ht through angle 25° and locate a and b
9. Draw vertical lines from a and b and horizontal lines from a_1' and b_1' to get a' and b'
10. Join the points a' and b'
11. Draw a horizontal line from b and locate b_2 on it such that $ab_2 = a_1'b_1'$ = true length of line AB. The inclination of this line ab_2 is the true inclination of the line AB with VP,

Problem 2.34

Three wires AB, CD and EF are tied at points A, C and E on a 14m long vertical post at heights 12m, 10m, 8m respectively from the ground. The lower ends of the wires are tied to hooks at points B, D and F on the ground level, all of which lie at the corners of an equilateral triangle of 9m side. If the pole is situated at the center of the triangle, determine the length of each rope and its inclination with the ground.

Solution

1. Draw the XY line
2. Draw the equilateral triangle bdf, in any position and locate its center. This point is the plan of the vertical post as well as the plan of points A, C and E.

3. Join the points b,d and f with the center of the triangle. These lines are the plan of wires AB, CD and EF, ab,cd and ef
4. Draw a vertical line from the center of the triangle and mark points a', c' and e', 12m, 10m and 8m above XY line.

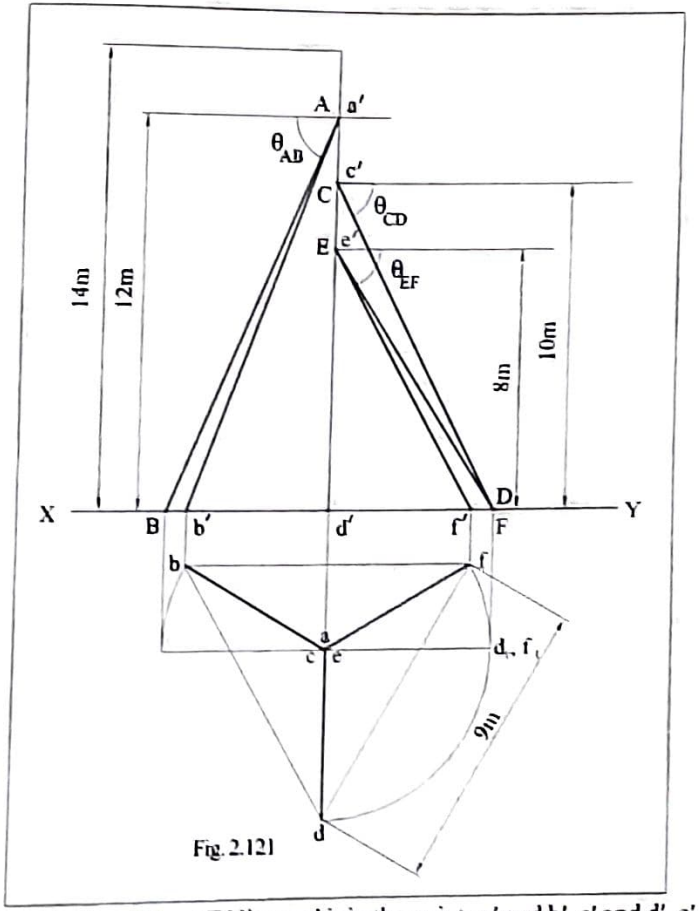


Fig. 2.121

5. Mark points b', d' and f' on XY line and join the points a' and b', c' and d', e' and f'
6. Rotate the lines ab, cd and ef to get the horizontal lines ab_1, cd_1 and ef_1
7. Locate the points b_1', d_1' and f_1' on XY line
8. Join the points a' and b_1', c' and d_1', e' and f_1'. These are the true length of wires AB, CD and EF respectively.
9. Measure the inclination of lines $a'b_1'$, $c'd_1'$ and $e'f_1'$ with horizontal. These angles are the inclination of wires AB, CD and EF with horizontal,

3

Projections of solids

3.1. Introduction.

A solid is a three dimensional object having length, breadth and thickness. It may be formed by plane surfaces, curved surfaces or a combination of both plane and curved surfaces.

Solids are divided into two main groups.

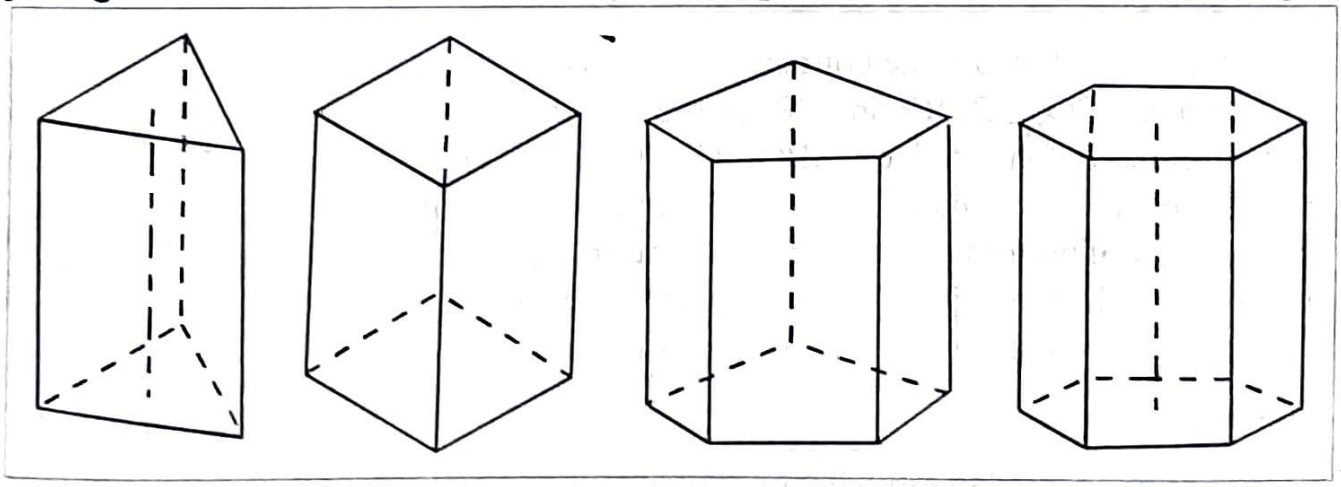
1. Polyhedra and
2. Solids of revolution.

1. Polyhedron.

A solid bounded by plane surfaces is called polyhedron. Polyhedra are further sub divided into, (i) Prism, (ii) Pyramid and (iii) Regular polyhedron.

(i) Prism.

A prism is a polyhedron having two equal and similar end faces called top face and bottom face (base). These faces are joined by rectangular faces. The imaginary line joining the centres of the end faces is called axis of prism. Prisms are named according to



1) Triangular prism. 2) Square prism. 3) Pentagonal prism 4) Hexagonal prism

Fig.3.1. Right prisms.

the shape of its base. For example, when the base of a prism is a rectangle the prism is called rectangular prism. When the axis of a prism is perpendicular to its base, the prism is called right prism. When the axis is inclined to the base, the prism is called oblique prism. Fig. 3.1 shows right prisms and Fig. 3.2 shows oblique prisms.

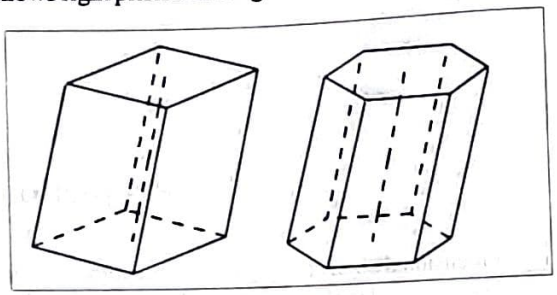


Fig. 3.2. Oblique prisms.

Fig. 3.3 shows a rectangular prism and its top view when the base is on HP. ABCD

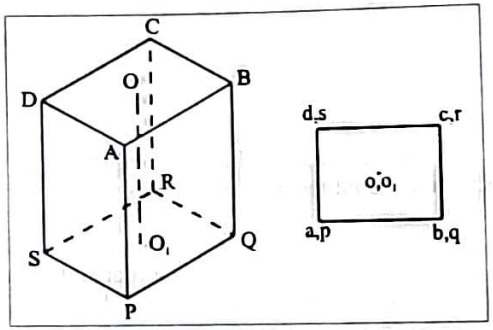


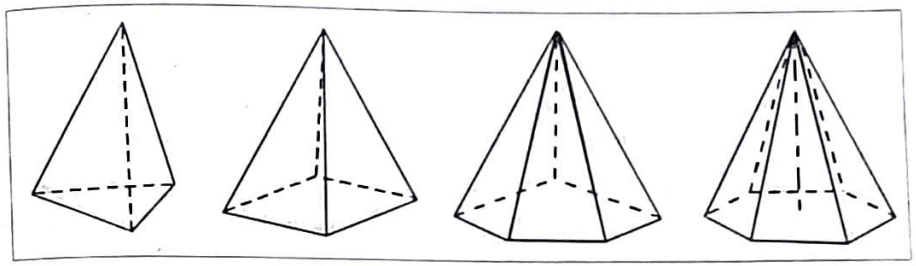
Fig.3.3.

is the top face. PQRS is the bottom face (base) OO_1 is the axis. P, Q, R and S are the base corners. PQ, QR, RS and SP are the base edges. AP, BQ, CR and DS are the vertical edges or longer edges. ABQP, CBRQ, DCRS and DAPS are the vertical faces. pqrs is the top view of base. a,b,c and d are the top view of top corners. p, q, r and s are the top view of bottom corners. pq, qr, rs and sp are the top view of base edges. ap, bq, cr and ds are the top view of vertical edges. abqp, bcrq, cdsr and daps are the top view of vertical faces (rectangular faces), oo_1, is the top view of the axis.

(ii) Pyramid.

A pyramid is a polyhedron having a plane surface as its base and inclined isosceles triangular faces meeting at a point above the base. This point is the vertex or apex of pyramid. The imaginary line joining the centre of base and vertex is the axis of pyramid.

Pyramids are named according to the shape of its base. For example, when the base of a pyramid is a rectangle the pyramid is called rectangular pyramid. When the axis of a pyramid is perpendicular to its base, the pyramid is called right pyramid. When the axis is inclined to the base, the pyramid is called oblique pyramid. Fig. 3.4. shows right pyramids and Fig. 3.5. shows oblique pyramids.



1) Triangular pyramid. 2) Square pyramid. 3) Pentagonal pyramid. 4) Hexagonal pyramid.

Fig. 3.4. Right pyramids.

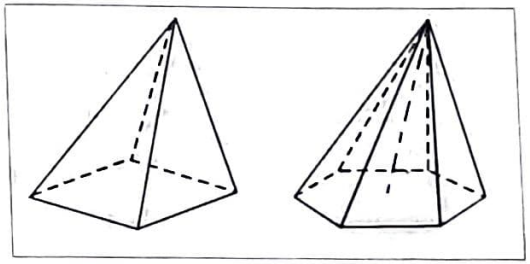


Fig. 3.5. Oblique pyramids.

Fig. 3.6 shows a rectangular pyramid and its top view when the base is on HP.

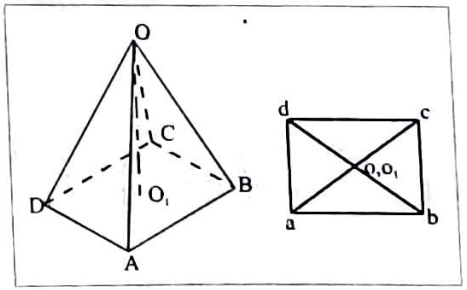


Fig. 3.6.

ABCD is the base of pyramid. OO_1 is the axis. A, B, C and D are the base corners. AB, BC, CD and DA are the base edges. OA, OB, OC and OD are the slant edges. OAB, OBC, OCD and ODA are the slant faces. (triangular faces). abcd is the top view of base. a, b, c and d are top view of base corners. ab, bc, cd and da are the top view of base edges. oa, ob, oc and od are the top view of slant edges. oab, obc, ocd and oda are the top view of slant faces. oo_1 is the top view of the axis.

(iii) Regular polyhedron.

A regular polyhedron is a solid bounded by plane surfaces which are of the same size and shape. Some of the important regular polyhedra are cube, tetrahedron and octahedron.

a) Cube (hexahedron).

It is a solid bounded by six equal square planes. All the twelve edges are of equal length.

b) Tetrahedron.

It is a triangular pyramid in which all the four faces are equilateral triangles and hence all the six edges are of equal length. AB = BC = CA = OA = OB = OC.

The triangles ABC,OAB, OBC and OCA are equilateral triangles.

c) Octahedron.

An octahedron has eight equilateral triangles of same size as its faces. All the twelve edges are of equal length. Consider a square pyramid in which the length of slant edges are equal to the four base edges. All the four slant faces are equilateral triangles. An octahedron is formed by keeping the base of two such square pyramids together. All the eight faces thus formed are equilateral triangles and all the twelve edges are of equal length.

$AB = BC = CD = DA = OA = OB = OC = OD = O_1A = O_1B = O_1C = O_1D$.

Length of axis $OO_1 = AC = BD$, the length of diagonal of the base of square pyramid.

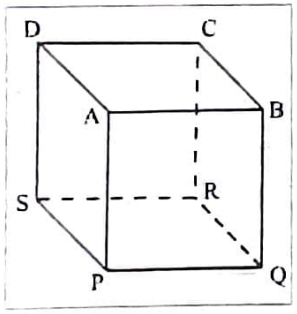


Fig. 3.7. Cube.

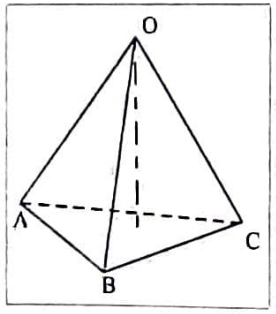


Fig. 3.8. Tetrahedron.

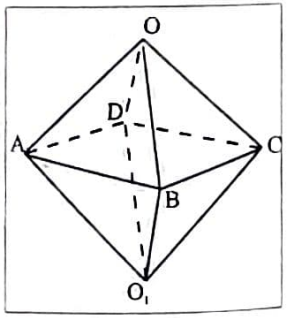


Fig. 3.9. Octahedron.

2. Solids of revolution

A solid generated when a plane surface is revolved about one of its edges is called solid of revolution. Cylinder, cone and sphere are examples of solids of revolution. When a rectangle of sides h and b is revolved about the edge h, a cylinder of height h and radius b is generated.

A line drawn on the surface of a cylinder and parallel to the axis is called generator of the cylinder. The surface of the cylinder is genrated when this line is revolved about a vertical axis.

When a right angled triangular surface is revolved about its vertical or horizontal edge, a cone is generated. When a right angled triangle of sides h and b is revolved about the edge h, a cone of height h and base radius b is generated.

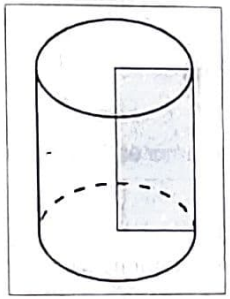


Fig. 3.10. Cylinder.

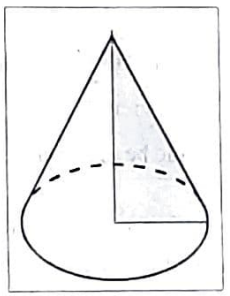


Fig. 3.11. Cone

A line drawn from the vertex to any point on the circumference of the base of cone is called generator of the cone. The surface of a cone is generated when this inclined line is revolved about a vertical axis.

3.2. Projections of a solid when the solid is in simple position.

A solid is said to be in simple position when its axis is perpendicular to one of the reference planes, perpendicular to HP, perpendicular to VP or perpendicular to the profile plane. When the axis is perpendicular to one of the reference planes, it will be parallel to the other two reference planes. When the axis is perpendicular to HP, it will be parallel to VP and PP. When the axis is perpendicular to VP, it will be parallel to HP and PP. When the axis is parallel to both HP and VP, it will be perpendicular to the PP. In the case of right prism, pyramid, cone and cylinder, when the base is on a reference plane or parallel to a reference plane, the axis will be perpendicular to that reference plane.

Rule for starting the drawing.

The drawing should be started with the view on that reference plane to which the axis is

perpendicular. This view will be the true shape of the base of the solid. When the axis is perpendicular to the HP, start with the plan. When the axis is perpendicular to the VP, start with the elevation and when the axis is perpendicular to the profile plane, start with the profile view.

When an object is in simple position, analyse the problem by asking the following three questions.

1. How the object is kept ?

The answer should be to which reference plane the axis is perpendicular. This position of the axis decides whether the drawing should be started with the top view, front view or side view. When the base is on a reference plane or paralel to a referance plane, The axis will be perpendicular to that referance plane.

2. How to keep the view ?

The answer should be the inclination of base edges of the object with XY line.

3. Where to keep the view ?

The answer should be the distance of an edge, a corner or the centre of the view from XY line.

After drawing the view on that reference plane to which the axis is perpendicular, the other views can be drawn by satisfying the given conditions with respect to the other reference planes.

Example 3.1.

A rectangular pyramid side of base 20mm x 25mm and axis height 35mm is kept with its base on HP with the 25mm edge inclined at 20° with VP and the nearest base corner 7.5mm in front of VP. Draw its plan, elevation and side view.

Solution.

Since the base is on HP, the axis is perpendicular to HP and hence start with the top view which is a rectangle of sides 20mm and 25mm. Draw the rectangle abcd with d 7.5mm below XY line and the 25mm edge dc inclined at 20° with XY line. Since the base ABCD is on HP, a', b', c' and d' are on XY line, o_1' is also on XY line. o_1' o' length is 35mm. Join o' with a', b', c' and d'. Draw the side view as shown in Fig. 3.12.

General rules for identifying visible and invisible points, lines and faces in the view of an object.

1. All the boundary lines in a view are visible lines.
2. Points, lines and faces which are far away from a reference line in one of the views are visible in the other view. Points and lines which are far away from XY line in the plan are visible in the elevation. Similarly, points and lines which are far away from XY line in the elevation are visible in the plan.
3. All the lines meeting at an invisible point are invisible lines.
4. Two visible lines never cross each other.
5. Whenever a visible line and an invisible line coincide, show the visible line. Whenever axis line and an invisible line coincide, show the invisible line.

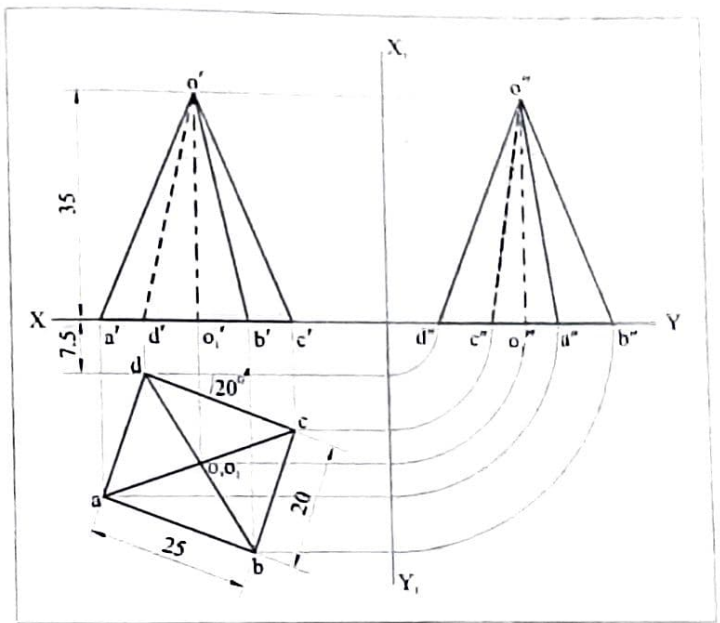


Fig. 3.12.

Refer Fig. 3.12. In the plan, the line ob is far away from XY line and hence o' b' in the elevation is visible. Line od is nearest to XY line and hence in the elevation o' d' is invisible line. In the elevation the line o' a' is far away from X_1Y_1 line compared to the line o' c'. Therefore o''a'' is visible line and o''c'' is invisible line.

Problem for practice.

An equilateral triangular pyramid of side of base 40mm and axis height 60mm is kept with its base on HP with one of the base edges inclined at 15° with VP and the nearest base corner 10mm in front of VP. Draw its plan, elevation and side view.

Example 3.2.

A rectangular prism side of base 20mm x 25mm and axis height 35mm is kept with its base on HP with the rectangular face containing the 25mm base edge inclined at 15° with VP and the nearest vertical edge 7.5mm in front of VP. Draw its plan, elevation and side view.

Solution.

Since the base is on HP, the axis is perpendicular to HP and hence start with the top view which is a rectangle of sides 25mm and 20mm. Since the rectangular face containing the 25mm base edge is inclined at 15° with VP, the line a b q p in the top view should be

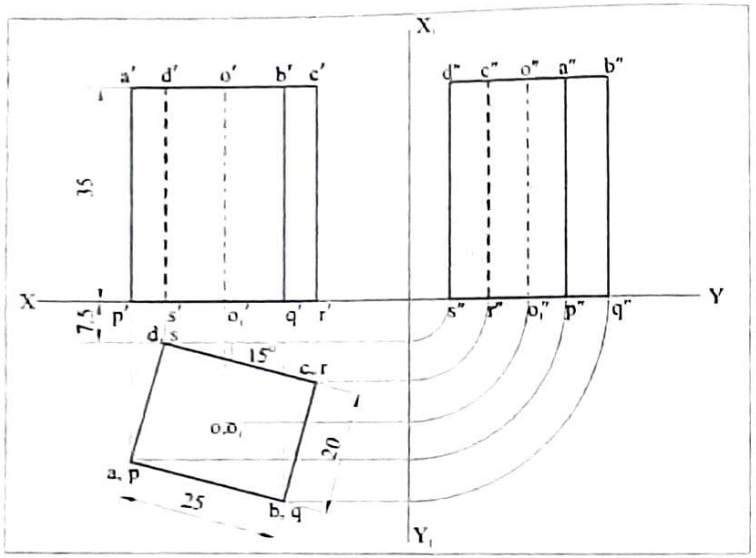


Fig. 3.13.

drawn inclined at 15° with XY line. Since the nearest vertical edge is 7.5mm in front of VP, the point d, s in the top view which is the plan of vertical edge DS should be kept 7.5mm below XY line as shown in Fig. 3.13. The base P Q R S is on HP. Therefore mark the points p', q', r' and s' on XY line. o_1' is also on XY line. o' is 35mm above o_1'. Complete the elevation and side view as shown in Fig. 3.13. The vertical edge DS is nearest to XY line in the top view and hence d' s' in the elevation is invisible line. Similarly the vertical edge BQ is far away from XY line in the top view and hence the line b' q' in the elevation is visible. ap in the top view and a' p' in the elevation are far away from X_1Y_1 line and hence a''p'' in the side view is visible line. cr in the top view and c' r' in the

elevation are nearer to X_1Y_1 line and hence c'' r'' is invisible line in the side view. b''q'' and d''s'' are part of boundary of the side view and hence these two lines are visible lines.

Problem for practice.

An equilateral triangular prism of side of base 30mm and axis height 60mm is kept with its base on HP with one of the rectangular faces inclined at 15° with VP. Draw its plan, elevation and side view when the centre of the prism is 25mm in front of VP. [Hint. Draw the top view with one side inclined at 15° with horizontal and then locate the centre of this equilateral triangle. Now draw the XY line 25mm above this centre of the triangle].

Example 3.3.

A cone of base diameter 30mm and axis height 35mm is kept with its base on HP, with the axis 25mm in front of VP. Draw its plan, elevation and side view.

Solution.

Since the base is on HP, the axis is perpendicular to HP and hence start with the top view which is a circle of diameter 30mm. The centre of this circle should be 25mm

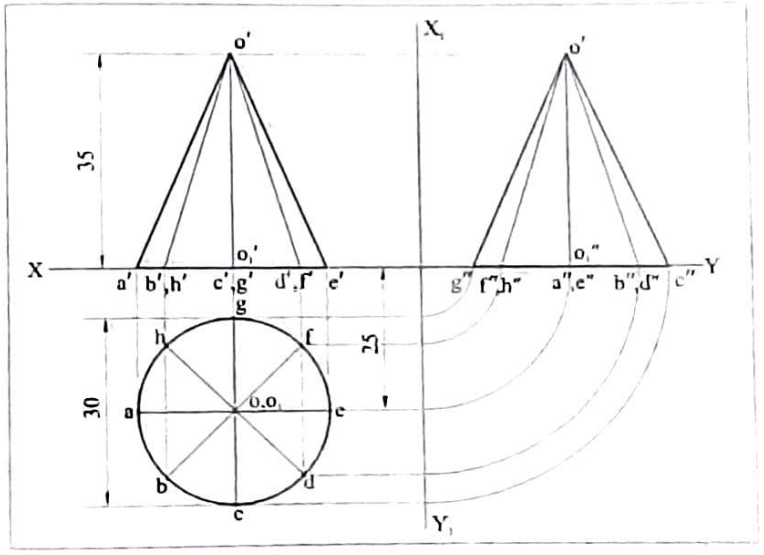


Fig. 3.14.

below XY line. Since the base is on HP, o_1' is on XY line. o' is 35mm above o_1'. Complete the projections as shown in Fig. 3.14.

Problem for practice.

A cone of base diameter 50mm and axis height 60mm is kept with its base parallel to HP and 10mm above it. Draw its plan, elevation and side view when the centre of the cone is 30mm in front of VP.

Example 3.4.

A cylinder of diameter 30mm and height 35mm is kept with its base on HP with the axis 25mm in front of VP. Draw its plan and elevation.

Solution.

Since the base is on HP, the axis is perpendicular to HP and hence start with the top view which is a circle of diameter 30mm. The centre of this circle should be 25mm below

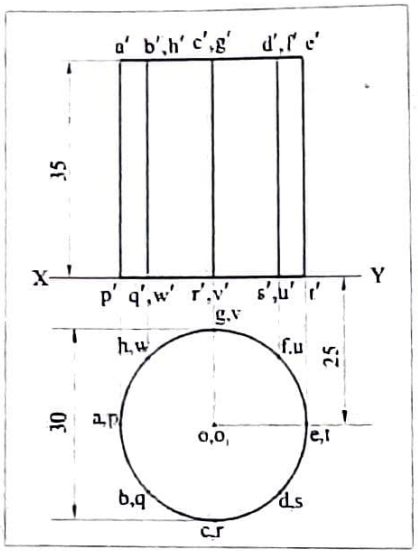


Fig. 3.15.

XY line. Since the base is on HP, mark o_1' on XY line. o' is 30mm above o_1'. Complete the drawing as shown in Fig. 3.15.

Problem for practice.

A cylinder of diameter 50mm and height 60mm is kept with its base parallel to HP and 10mm above it. Draw its plan, elevation and side view when the centre of the cylinder is 30mm in front of VP.

Example 3.5.

A pentagonal pyramid side of base 17.5mm and axis height 35mm is kept with its base on HP with one of the base edges parallel to VP and 10mm in front of it. Draw its plan, elevation and side view.

Solution.

Since the base is on HP, the axis is perpendicular to HP and hence start with the top view which is a pentagon of side 17.5mm. One of the sides of this pentagon should be kept parallel to XY line and 10mm below XY line. Locate the centre of this pentagon and

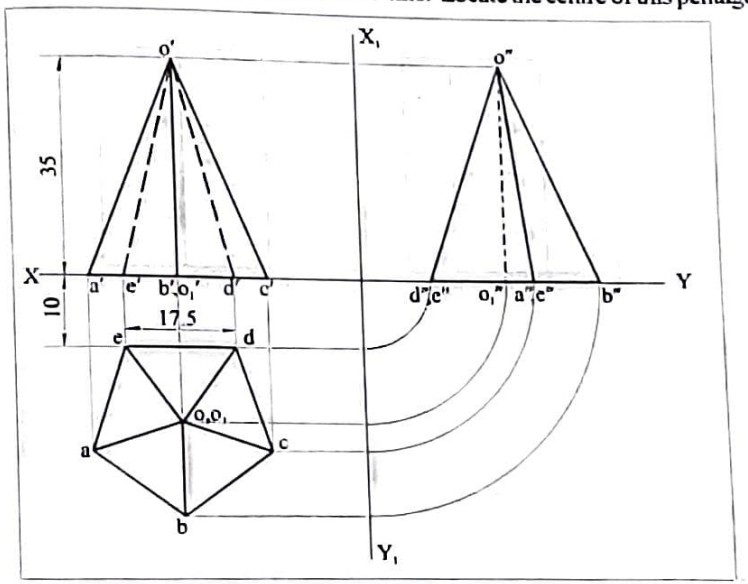


Fig. 3.16.

join this point o with all the five corners of the pentagon. In the top view ob is far away from XY line, od and oe are nearer to XY line. Hence in the elevation o' b' is visible line and o' d', o' e' are invisible lines. o'a' and o'c' are part of boundary of elevation and hence o' a' and o' c' are visible in the elevation. Since o' a' is far away from X_1Y_1 line in the elevation, o'' a'' is visible in the side view.

Problem for practice.

A pentagonal pyramid side of base 25mm and axis height 50mm is kept with its base on HP with one of the base edges inclined at 10° with VP. Draw its plan, elevation and side view, when the nearest base corner is 10mm in front of VP.

Example 3.6.

A hexagonal prism side of base 15mm and axis height 35mm is kept with its base on HP with one of its rectangular faces parallel to VP and 10mm in front of VP. Draw its projections.

Solution.

Since the base is on HP, the axis is perpendicular to HP and hence start with the top view which is a hexagon of side 15mm. One of the sides of this hexagon should be kept

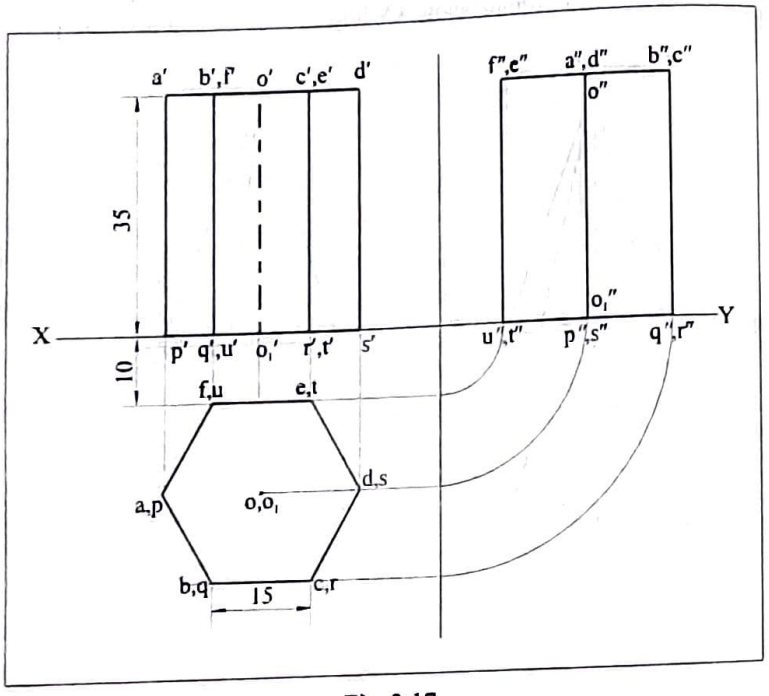


Fig. 3.17.

parallel to XY line and 10mm below XY line. Mark the centre of the hexagon as o, o_1. Complete the elevation as shown in Fig. 3.17.

Problem for practice.

A hexagonal prism side of base 25mm and axis height 50mm is kept with its base on HP with one of the rectangular faces inclined at 10° with VP and the nearest vertical edge 10mm in front of VP. Draw its plan, elevation and side view.

Example 3.7.

A pentagonal prism side of base 17.5mm and axis height 35mm is kept with one of its rectangular faces on HP with axis perpendicular to VP. The nearest pentagonal face is 10mm in front of VP. Draw its projections.

Solution.

When a rectangular face of a prism, longer edge of a prism, generator of a cylinder are on a reference plane or parallel to a reference plane, the axis will be parallel to that reference plane. Since the rectangular face of the pentagonal prism is on HP, the axis is parallel to

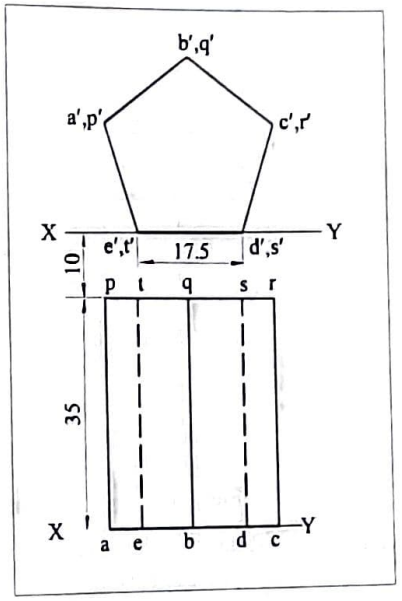


Fig. 3.18.

HP. It is given that the axis is perpendicular to VP. The axis is parallel to HP and perpendicular to VP. Hence start with the elevation which is a pentagon of side 17.5mm. Since a rectangular face is on HP, keep one of the sides of pentagon on XY line in the elevation. Draw the top view in which the line representing the pentagonal face should be 10mm below XY line. Since b' q' is far away from XY line in the elevation, bq in the plan is visible. Since e' t' and d' s' are on HP, et and ds in the top view are invisible lines. ap and cr being part of boundary, these lines are visible in the top view.

Problem for practice.

A hexagonal prism side of base 25mm and axis height 50mm is kept with one of its

longer edges on HP with axis perpendicular to VP. One of the rectangular faces containing the longer edge is inclined at 10° with HP. Draw its projections.

Example 3.8.

A cylinder of diameter 25mm and axis height 30mm is kept with its generator on HP with axis perpendicular to VP. Draw its projections when one of the end faces is 10mm in front of VP.

Solution.

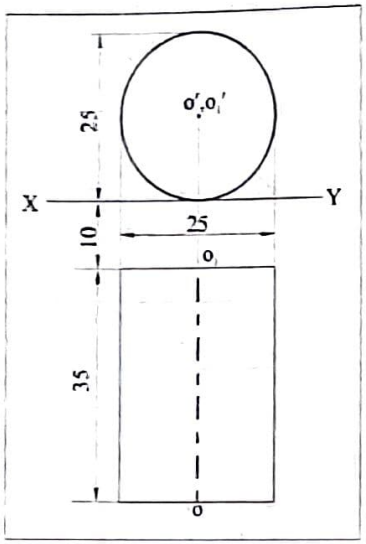


Fig. 3.19.

Since the axis is perpendicular to VP, start with the elevation which is a circle of diameter 25mm. Since the generator is on HP, draw the circle touching the XY line. The end of the axis nearer to VP should be kept 10mm below XY line as shown in Fig. 3.19.

Example 3.9.

An equilateral triangular prism of side of base 25mm and axis height 35mm is kept with one of its longer edges on HP with axis parallel to and 20 mm in front of VP. One of the rectangular faces containing the edge on HP is inclined at 15° with HP. Draw the projections of the prism.

Solution.

Since the longer edge of the prism is on HP, the axis is parallel to HP. It is given that the axis is parallel to VP. Therefore the axis is parallel to both HP and VP and hence it is perpendicular to profile plane. The drawing should be started with the view on the profile

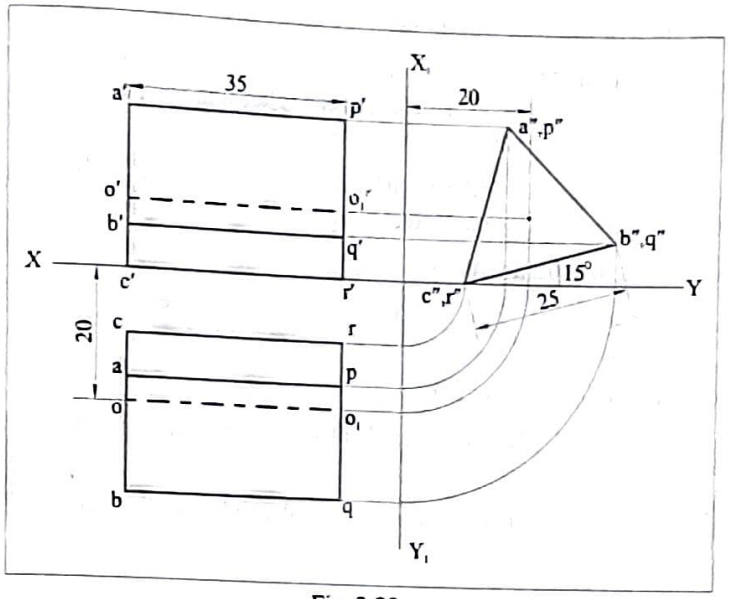


Fig. 3.20.

plane that is the profile view which is an equilateral triangle of side 25mm. Since the longer edge is on HP, keep one of the corners of this triangle, representing the longer edge, on XY line. One of the sides of the triangle representing the rectangular face should be kept inclined at 15° with XY line. Complete the profile view as shown in Fig. 3.20. Locate the centre of this equilateral triangle which is the axis of the prism. Draw the X_1Y_1 line 20mm towards left of this point. Complete the projections as shown in Fig. 3.20. Since b'' q'' in the side view is far away from X_1Y_1 line, b' q' in the elevation is a visible line. Similarly, since a'' p'' in the side view is far away from XY line, ap in the plan is a visible line. Other lines are boundary lines of the view and hence those lines are visible lines.

Problems for practice.

1. A hexagonal prism, side of base 20mm and axis height 50mm is kept with one of its longer edges on HP with the axis parallel to VP and 25mm in front of VP. Draw its projections.
2. A pentagonal prism, side of base 25mm and axis height 50mm is kept with one of its rectangular faces on HP with axis parallel to VP and 25mm in front of VP. Draw its projections.

3.3. Projection of solids on auxiliary planes.

Horizontal, vertical and profile planes are the three principal reference planes of projection. A plane which is inclined to one of these reference planes and perpendicular to the other reference plane is called auxiliary plane. The two important auxiliary planes are,

i) Auxiliary vertical plane (AVP) and (ii) Auxiliary inclined plane (AIP). Projections on auxiliary planes are called auxiliary projections.

i) Auxiliary vertical plane [AVP].

It is a plane perpendicular to HP and inclined to VP. The view on this plane is called auxiliary elevation.

ii) Auxiliary inclined plane [AIP].

It is a plane inclined to HP and perpendicular to VP. Projection on this plane is called auxiliary plan.

Fig. 3.21 shows the auxiliary elavation and auxiliary plan of a line AB.

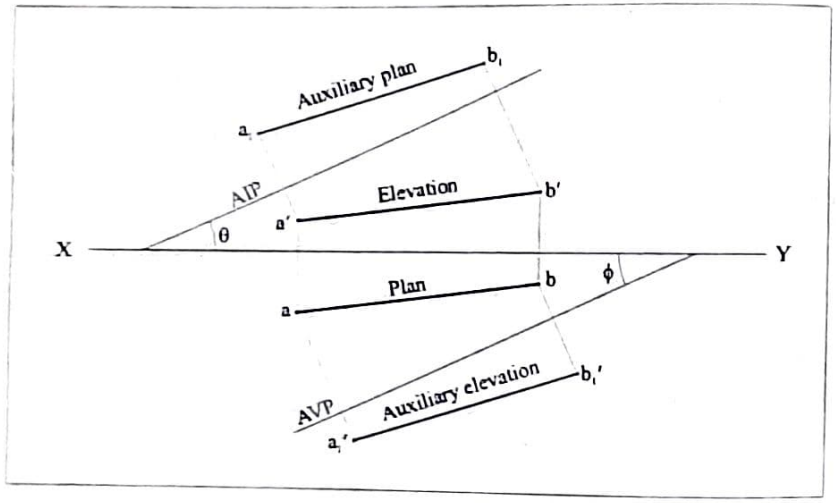


Fig. 3.21.

To draw the auxiliary elevation, projectors [lines perpendicular to the auxiliary plane] are to be drawn from the plan. The distances of points in the auxiliary elevation from AVP are the distances of corresponding points in the elevation from XY line.

Refer Fig. 3.21. The distance of auxiliary elevation, a_1', from AVP is the distance of a' from XY line.

To draw the auxiliary plan, projectors (lines perpendicular to the auxiliary plane) are to be drawn from the elevation. The distances of points in the auxiliary plan from AIP are the distances of corresponding points in the plan from XY line. Refer Fig. 3.21. The distance of auxiliary plan, a_1, from AIP is the distance of a from XY line.

Example 3.10.

A square prism of side of base 20mm and height 30mm is kept with its base on HP with one of its rectangular faces parallel to VP. Draw its auxiliary plan on a plane inclined at 40° with HP.

Solution.

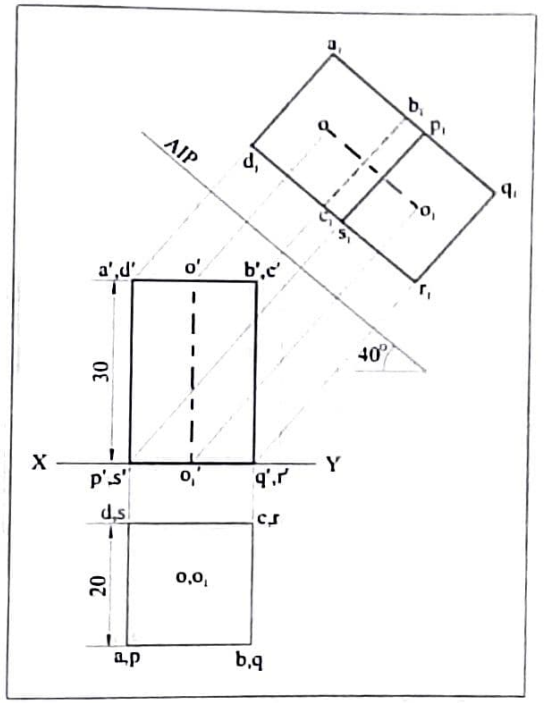


Fig. 3.22.

Draw the plan and elevation of the square prism as shown in Fig. 3.22. Draw the elevation of the auxiliary inclined plane (a line) inclined at 40° with XY line. Draw the projectors from the elevation points and mark the points a_1, b_1 etc. Distance of a_1 from

AIP is the distance of a in the plan, from XY line. Complete the auxiliary plan as shown in Fig. 3.22. p's' in the elevation is far away from AIP and hence the line p_1s_1 in the auxiliary plan is visible. b' c' is nearest to AIP and hence b_1c_1 in the auxiliary plan is invisible.

Example 3.11.

A square prism, side of base 20mm and height 30mm is kept with its base on VP with one of the rectangular faces parallel to HP and 10mm above HP. Draw its auxiliary elevation on a plane inclined at 40° with VP.

Solution.

Draw the elevation and plan of the square prism as shown in Fig. 3.23. Draw the plan of auxiliary vertical plane (a line) inclined at 40° with XY line. Draw the projectors from the plan points and mark the points a_1', b_1', etc. Distance of a_1' from AVP is the distance

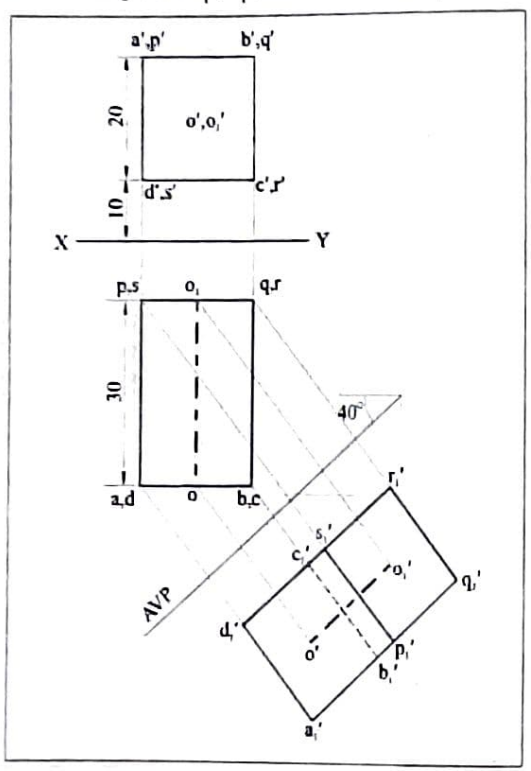


Fig. 3.23.

of a' in the elevation from XY line. In the plan p s is far away from AVP and hence in the auxiliary elevation $p_1's_1'$ is visible. Similarly, b c is nearest to AVP and hence $b_1'c_1'$ is

invisible in the auxiliary elevation.

Example 3.12.

A pentagonal prism of side of base 17.5mm and height 35mm is kept with one of its rectangular faces on HP with axis perpendicular to VP. Draw its auxiliary elevation on a plane inclined at 35° with VP.

Solution.

Draw the elevation and plan of the prism as shown in Fig. 3.24. Since the rectangular face is on HP, in the elevation one of the sides of the pentagon should be kept on XY line. Draw the plan

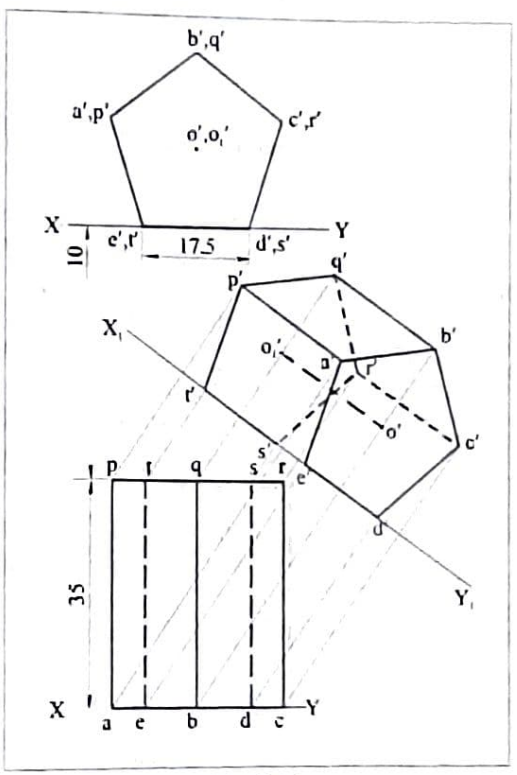


Fig. 3.24.

of AVP which is a line inclined at 35° with XY line. Complete the auxiliary elevation as shown in Fig. 3.24. In the plan, the abcde face of the pentagon is far away from AVP. Hence the face $a_1'b_1'c_1'd_1'e_1'$ in the auxiliary elevation is visible.

Problems for practice.

1. A cone of base diameter 50mm and axis height 60mm is kept with its base on HP. Draw its auxiliary plan on a plane inclined at 30° with HP.
2. A cylinder of diameter 50mm and height 60mm is kept on HP with its axis perpendicular to VP. Draw its view on a plane perpendicular to HP and inclined at 35° with VP.
3. A pentagonal pyramid side of base 25mm and axis height 60mm is kept with its base on HP with one of the base edges parallel to VP and nearer to it. Draw its auxiliary plan on a plane inclined at 30° with HP.
4. A hexagonal prism side of base 20mm and axis height 50mm is kept with one of its rectangular faces on HP with axis parallel to VP. Draw its view on a plane,

(i) perpendicular to HP and inclined at 35° with VP and
(ii) perpendicular to VP and inclined at 35° with HP.

3.4. Projection of solids with axis inclined to one of the reference planes and parallel to the other reference plane.

As a general rule, the drawing should be started with the view on that reference plane to which the axis is perpendicular. When the axis is inclined to one of the reference planes and parallel to the other reference plane, the axis is not perpendicular to any of the reference planes. Hence, to begin with an initial position should be assumed with axis perpendicular to that reference plane to which the axis is actually inclined. When the axis is inclined to HP and parallel to VP, in the initial position assume that the axis is perpendicular to HP and hence start with the top view. Similarly, when the axis is inclined to VP and parallel to HP, in the initial position assume that the axis is perpendicular to VP and hence start with the elevation.

After drawing the initial projections, the final projections can be drawn either by change of position method or by change of reference axis (auxiliary) method. In change of position method, the plan or elevation whichever is required should be redrawn satisfying the given conditions. In auxiliary method the required final projections can be drawn on an auxiliary plane as explained in the previous article.

Example 3.13.

A cone of base diameter 30mm and axis height 35mm is kept with its generator on HP with the axis parallel to VP. Draw its projection by,

(i) Change of position method and
(ii) Auxiliary method.

Solution.

Since the cone rests with its generator on HP, the axis is inclined to HP. It is given that the axis is parallel to VP. Therefore the axis is inclined to HP and parallel to VP. In the initial position assume that the axis is perpendicular to HP and hence start with the top view which is a circle of diameter 30mm. Divide the circumference of this circle into eight equal divisions and mark the division points as a, b, c etc. Draw the corresponding elevation which is a triangle of base 30mm and height 35mm. Mark the points a', b', c' etc. and join these points with o'.

(i) Change of position method.

Redraw the elevation with the generator o'e' on XY line. Draw the corresponding plan. In the second elevation the centre of the base o_1' is far away from reference line compared to the apex o'. Therefore the base in the second plan is completely visible.

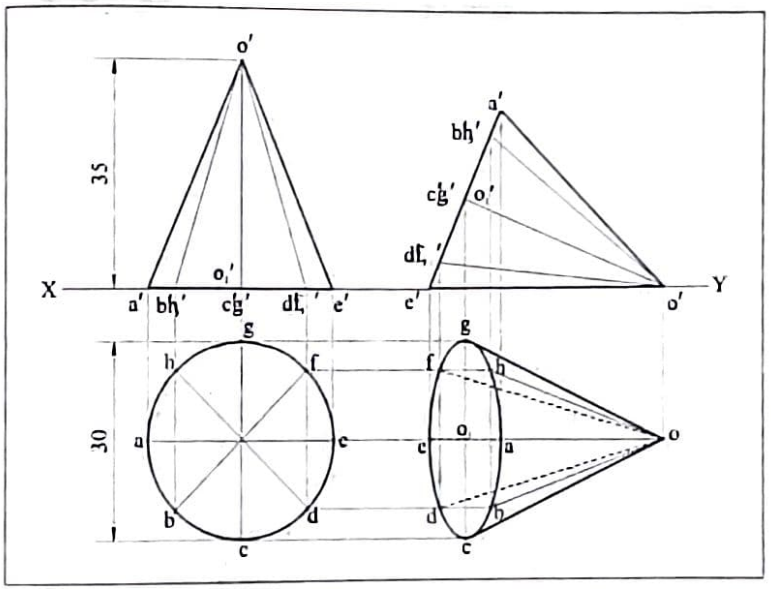


Fig. 3.25.

(ii) Auxiliary method.

Draw the new reference line X_1Y_1 through the generator o'e'. Draw the projectors from a', b', c' etc. and mark a, b, c etc on the respective projectors. The distance of the points a, b, c etc. in the second plan from X_1Y_1 line are the distance of plan points a,b,c etc. in the first plans from XY line.

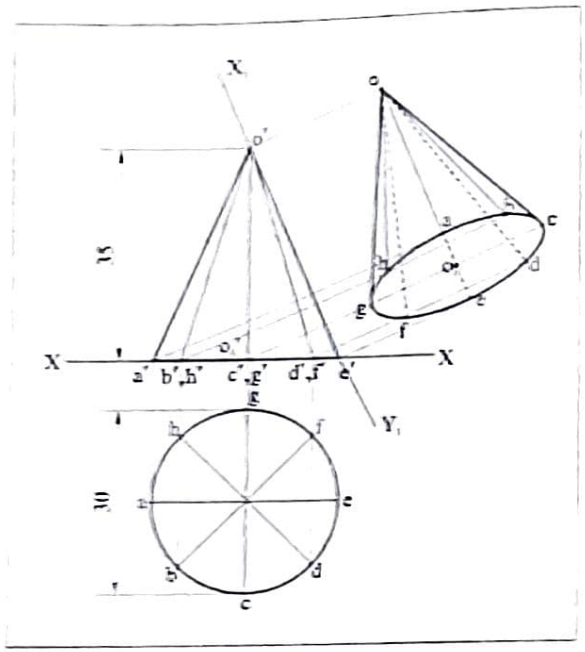


Fig. 3.26.

Problems for practice.

1. A cone of base diameter 50mm and axis height 60mm is kept with its generator on VP with axis parallel to HP. Draw its projections.
2. A cone of base diameter 50mm and axis height 60mm is kept with a point on the circumference on HP with the generator passing through this point vertical. Draw its projections when the axis is kept parallel to VP.
3. A cone of base diameter 50mm and axis height 60mm is kept with a point on the base on HP with axis inclined at 40° with HP and parallel to VP. Draw its projections.

Example 3.14.

A cylinder of diameter 30mm and height 35mm is kept with its generator on HP with axis inclined at 40° with VP. Draw its projections.

Solution.

Since the axis is inclined to VP, in the initial position assume that the axis is perpendicular to VP and hence start with the elevation which is a circle, touching the XY

line. Draw the plan which is a rectangle. Redraw this plan with axis inclined at 40° with XY line. Complete the final elevation as shown in Fig.3.27. In the top view, the end face

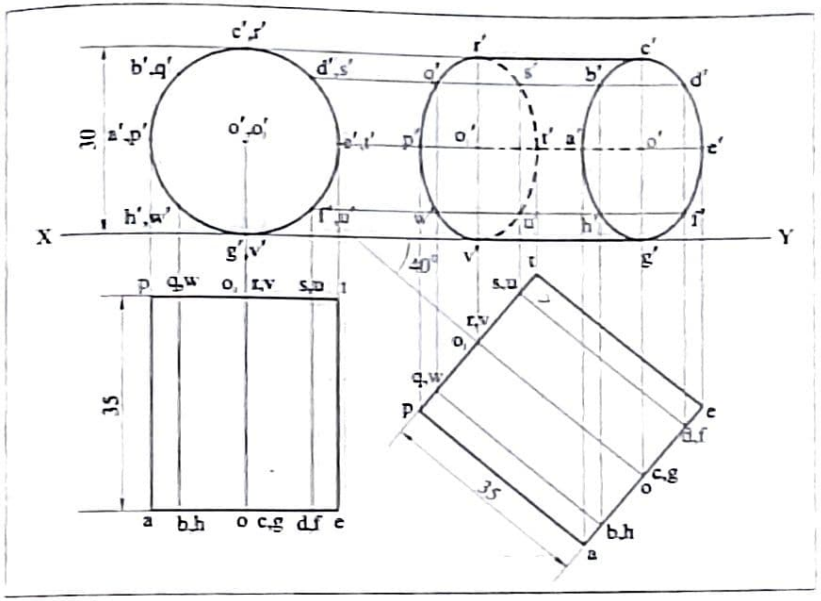


Fig. 3.27.

abcdefgh is far away from XY line compared to the other end face pqrstuvw. Hence the face a' b' c' d' e' f' g' h' is visible in the final elevation.

Problem for practice.

A cylinder of diameter 50mm and height 60mm is kept with a point on its base on HP with axis inclined at 40° with HP and parallel to VP. Draw its projections.

Example 3.15.

An equilateral triangular prism side of base 25mm and axis height 30mm is kept with one of its rectangular faces on HP with axis inclined at 30° with VP. Draw its projections using,

(i) Change of position method and
(ii) Auxiliary method.

Solution.

Since the rectangular face of the prism is on HP, the axis is parallel to HP. It is given that the axis is inclined to VP. Therefore the axis is inclined to VP and parallel to HP. Hence in the initial position assume that the axis is perpendicular to VP and hence start with the elevation which is an equilateral triangle of side 25mm. Since one of the rectangular faces is on HP, keep one of the sides of the triangle on XY line. Draw the corresponding plan. In the elevation, b' q' is far away from XY line and hence in the plan the line bq is visible.

(i) Change of position method.

Redraw the plan with axis inclined at 30° with XY line. Complete the final elevation as shown in Fig.3.28. The various points in the second elevation are located by drawing vertical lines from the second plan and horizontal lines from the first elevation.

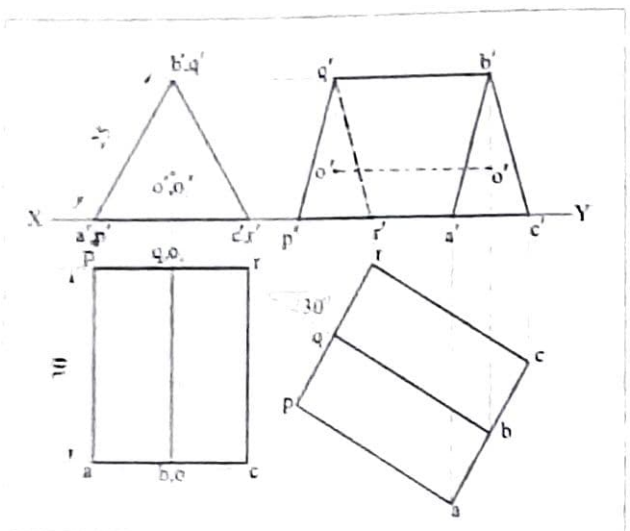


Fig. 3.28.

(ii) Auxiliary method.

Draw X_1Y_1 line inclined at 30° with the axis o - o_1. Draw projectors (line perpendicular to X_1Y_1 line) from a, b, c, p, q and r. The distance of b' from X_1Y_1 line is the distance of b' in the first elevation from XY line. Similarly, locate the other points. In the plan, the face ABC is far away from XY line compared to the face PQR and hence in the elevation the face a'b'c' is completely visible.

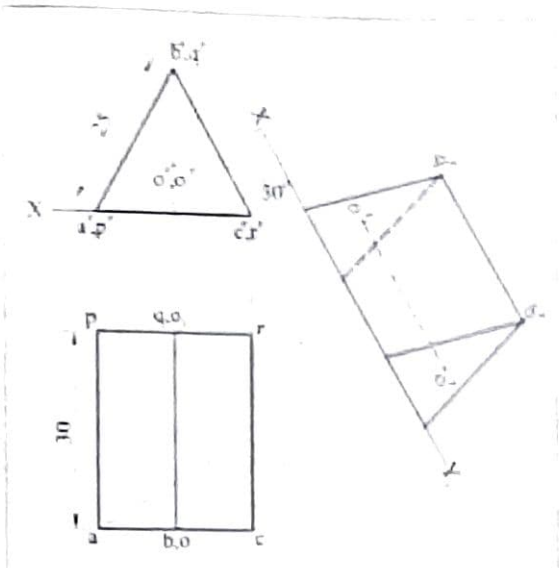


Fig. 3.29.

Problem for practice.

A hexagonal prism of side of base 20mm and axis height 50mm is kept with one of its vertical edges on HP with the axis perpendicular to VP. One of the rectangular faces containing the edge on HP is inclined at 10° with HP. Draw its projection using,

(i) Change of position method and
(ii) Change of reference axis method.

University questions.

1. A hexagonal prism of base side 25mm and height 60mm rests with one of its rectangular faces on HP. If the axis is inclined at 30° with VP, draw its projections. [CUSAT June 2013]
2. Draw the projections of a pentagonal prism of base side 30mm and axis length 70mm resting on one of its rectangular faces on HP with the axis inclined at 40° to the VP. [CUSAT June 2013]
3. Draw the projections of a cone base 40mm diameter and axis 65mm long, lying on a generator on the ground with the axis making an angle of 45° with the VP. [KU June 2005].
4. A square pyramid of base 30mm and height 50mm is standing on its apex on HP with the axis inclined at 45° to HP. Draw the projections [KU June 2006]

Edge condition for solids.

An object is said to be in edge condition when one of its base edges is on a reference plane or parallel to a reference plane with axis inclined to that reference plane.

When an object is in edge condition, that edge which is on or parallel to the reference plane should be kept perpendicular to XY line in the initial position. This is to get the view of this edge as a point in the other reference plane.

Corner condition.

An object is said to be in corner condition when one of its base corners is on a reference plane with axis inclined to that reference plane.

When the object is in corner condition, with the two base edges containing that corner on the reference plane are equally inclined to that reference plane, the imaginary line joining that corner and the centre of the base of the object should be kept parallel to XY line in the initial position.

Example 3.16.

A square pyramid side of base 20mm and axis height 30mm is kept with one of its base corners on HP with the axis inclined at 40° with HP and parallel to VP. Draw its projections.

Solution.

The axis is inclined to HP and parallel to VP. Therefore in the initial position assume

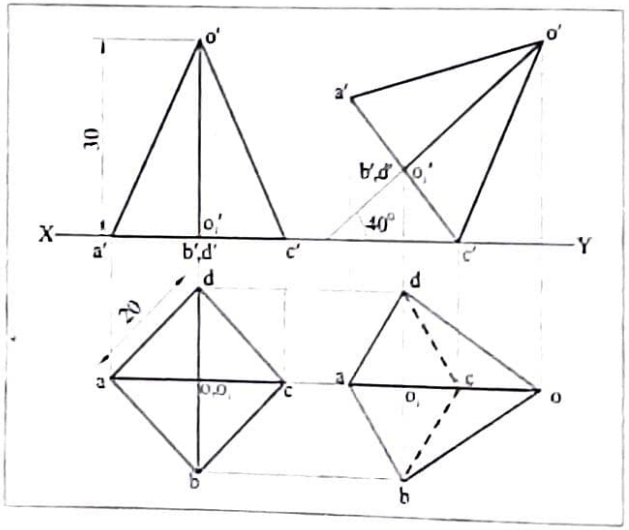


Fig. 3.30.

that the axis is perpendicular to HP and hence start with the top view which is a square of side 20mm. Since the corner condition exists, the line joining one of the corners and the centre of the square should be kept parallel to XY line. Join all the corners with the centre of the square. Draw the corresponding elevation. The base line a' b'c'd' can be kept either on XY line or parallel to XY line. $o_1'o' = 30$ mm. In this elevation the axis $o_1'o'$ is perpendicular to XY line. Redraw this elevation with c'on XY line and the axis o_1' o' inclined at 40° with XY line. When the axis is inclined to a reference plane, the base will also be inclined to that reference plane. Inclination of the base with a reference plane will be 90° minus inclination of the axis with the reference plane. Since the inclination of the axis with HP is 40°, the inclination of the base with HP is (90 - 40) = 50°. Therefore redraw the elevation with c' on XY line and the base line a'b'c'd' inclined at 50° with XY line. Complete the final plan by drawing vertical lines from various points in the second elevation and horizontal lines from the plan as shown in Fig.6.30. Since the centre of base o_1' is nearer to XY line, compared to the apex o', the base in the top view is invisible. In the top view the lines ab and ad are part of boundary of the view and hence these lines are visible lines.

Problem for practice.

A square prism side of base 20mm and axis height 30mm is kept with one of its base corners on HP with the vertical edge containing this corner inclined at 40° with HP and parallel to VP. Draw its projections.

[Hint- Since the vertical edge of the prism is inclined to HP and parallel to VP, the axis is also inclined to HP and parallel to VP].

Example 3.17.

A hexagonal prism side of base 15mm and axis height 35mm is kept with one of its base edges on HP with axis inclined at 50° with HP and parallel to VP. Draw its projections.

Solution.

Since the axis is inclined to HP and parallel to VP, in the initial position assume that the axis is perpendicular to HP and hence start with the plan which is a hexagon of side 15 mm. Since the edge condition exists, [edge on HP with axis inclined to HP] one of the sides of the hexagon should be kept perpendicular to XY line. Draw the corresponding elevation as shown in Fig.3.31. Redraw this elevation with r's'on XY line and base inclined at 40° with XY line. Now the inclination of the axis will be 50° with HP. Complete the final plan as shown in Fig.3.31.

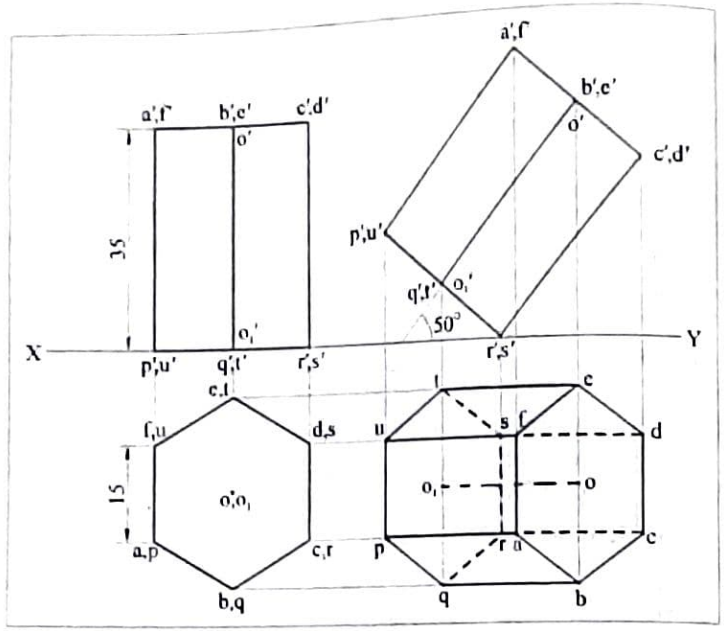


Fig. 3.31.

Problem for practice.

A hexagonal pyramid side of base 15mm and axis height 35mm is kept with one of its base edges on VP with axis inclined at 40° with VP and parallel to HP. Draw its projections.

3.5. Projection of solids with axis inclined to both HP and VP.

When the axis of the solid is inclined to both HP and VP, in the initial position the axis should be assumed to be perpendicular to that reference plane on which the solid rests. If the solid does not rest on a reference plane, then the axis should be assumed to be perpendicular to that reference plane about which the position of the solid is prescribed, such as one of the base edges is parallel to HP, parallel to VP etc. While drawing the initial position, the edge condition or corner condition, if any, should be satisfied. If the method of projection, such as change of position method or auxiliary method, is not specified in a problem, then it is convenient to draw the second plan and second elevation by change of position method and then the final plan or elevation whichever is required by auxiliary method.

When a solid is freely suspended from a point on the solid, the line joining this point and the centre of gravity of the solid will be perpendicular to HP. Hence in all the freely suspended problems, in the initial position assume that the axis is perpendicular to HP and

hence start with the top view.

Example 3.18.

A cone of base diameter 30mm and 35mm height is kept with a generator on HP. Draw its projections when the axis appears to be inclined at 30° with VP.

Solution.

Since the cone rests on HP with axis inclined to HP, in the initial position assume that the axis is perpendicular to HP and hence start with the top view which is a circle of diameter 30mm. Draw the elevation, as shown in Fig.3.32. Redraw this elevation with the generator o'e' on XY line.

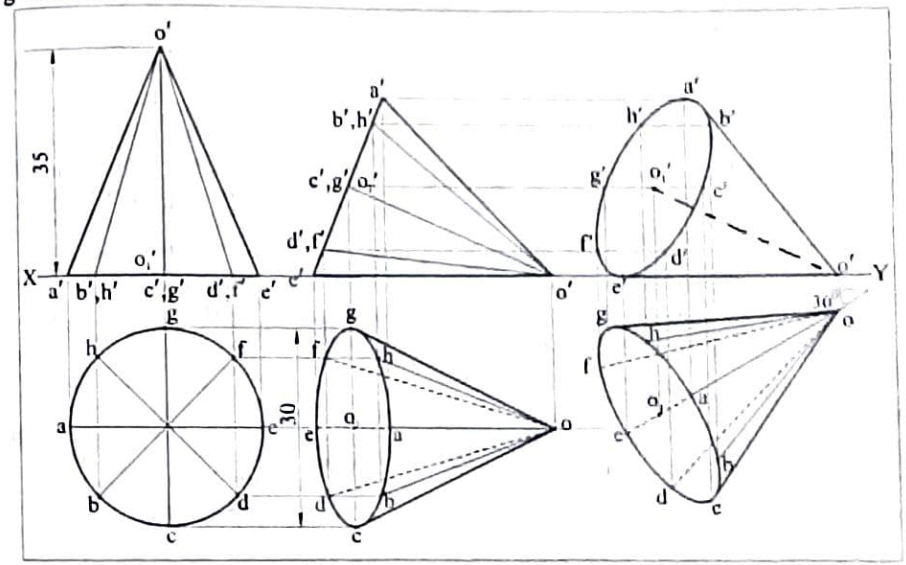


Fig. 3.32.

Draw the second plan. Points on this plan are obtained by drawing vertical lines from points on the second elevation and horizontal lines from the corresponding points in the first plan. In this second plan, the axis oo_1 is parallel to XY line. Redraw this second plan with the apparent length of axis oo_1 inclined at 30° with XY line. Complete the final elevation by drawing vertical lines from the third plan and horizontal lines from the corresponding points in the second elevation. In the final plan, the centre of base o_1 is far away from XY line compared to the apex o. Hence in the elevation the base is completely visible.

Problem for practice.

A cone of base diameter 50mm and height 60mm is kept on HP with its axis inclined at 40° with HP and 30° with VP. Draw its projections. [Hint : Since the true inclination of axis with VP is given, the second plan should be redrawn with its apparent length of axis oo_1 inclined at apparent inclination corresponding to the true inclination of 30°].

University questions.

1. A cone of base diameter 50mm and 60mm height, has one of its generators on HP. If the axis of the cone is seen as 45° inclined to XY line in the top view and the apex is nearer to VP, draw the projections of the cone. [CUSAT June 2013].
2. Draw the projection of a cone, base diameter 40mm and axis 65mm only, lying on a generator on the ground with the axis making an angle of 45° with the VP. [KU June 2005]
3. A frustrum of a cone of base diameter 80mm, top diameter 40mm and height 50mm is lying on HP on one of its generators. Draw its projections if the plane containing the axis and the generator makes an angle of 45° to VP. [CUSAT June 2009].
4. Draw the projections of a cone, base 45mm diameter and axis 50mm long, when it is resting on the ground on a point in its base circle with, (i) the axis making an angle of 30° with HP and 45° with VP (ii) the axis making an angle of 30° with HP and its top view making 45° with VP. [CUSAT June 2010].

Example 3.19.

A cylinder of base 30mm diameter, axis 35mm is kept with a point of its base on HP such that the axis is inclined at 30° with HP and 35° with VP. Draw its projections.

Solution.

Since the cylinder rests on HP with axis inclined to HP, start with the top view which is a circle. Draw the corresponding elevation. Redraw this elevation with c' on XY line and the line ae inclined at 60° with XY line. Draw the corresponding plan as shown in Fig.3.33. Redraw this plan with axis oo_1 inclined β degree with XY line. Angle β is the apparent inclination of the axis oo_1 corresponding to the true inclination of 35°. Draw the true length

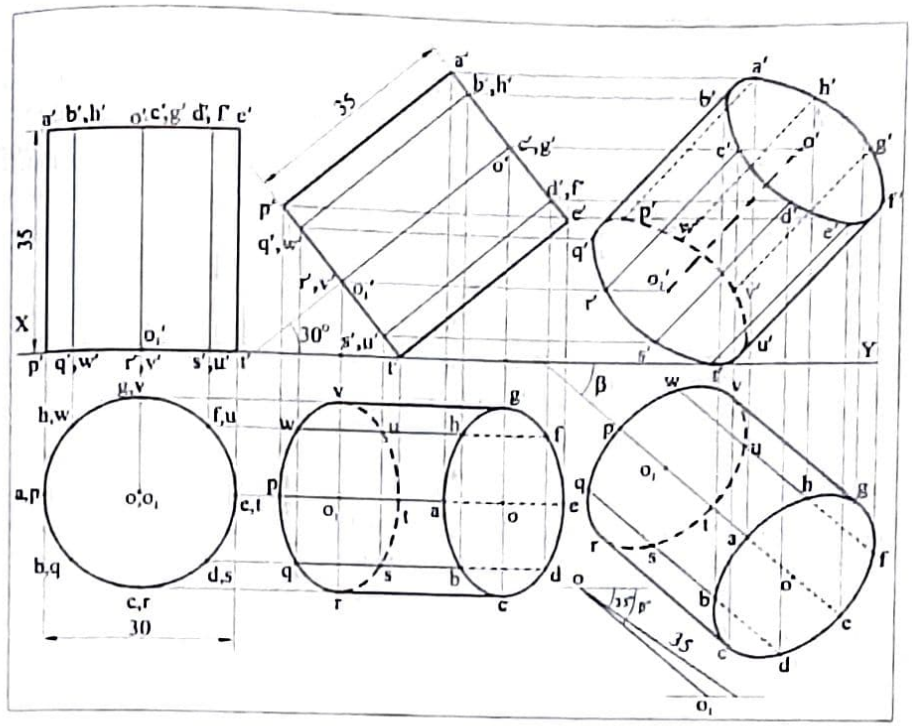


Fig. 3.33.

of axis (35mm) at true inclination with VP (35°) and from its lower end draw a horizontal line, as shown in Fig.3.33. With the top end of this line,o_1 as centre draw an arc with radious equal to apparant length of axis in the second plan, to cut the horizontal line at o. Inclination of this line is the apparent inclination of the axis corresponding to the true inclination of 35°. After redrawing the plan, the final elevation can be obtained by drawing horizontal lines from second elevation and vertical lines from the third plan as shown in Fig. 3.33. In the top view the abcd face is far away from XY line compared to the other end face pqrs. Hence in the final elevation, the end face a'b'c'd'e'f'g'h' is completely visible.

Problem for practice.

A cylinder of diameter 50mm and height 60mm is kept with a point on the base on VP with axis inclined at 40° with VP and appears to be inclined at 30° with HP. Draw its projections.

University questions.

1. Draw the projections of a cylinder, base 30mm diameter and axis 50mm long, resting with a point of its base circle on HP such that the axis is making an angle of 30° with HP and a vertical plane containing the axis is perpendicular to VP. [KU May 2009]
2. A hollow cylinder of external diameter 80mm, thickness 15mm and length 105mm is lying touching the ground in such a way that the axis of the cylinder makes 30° with HP and the top view of axis makes 60° with XY line. Draw its projections. [CUSAT June 2012].

Example 3.20.

A rectangular pyramid side of base 20mm x 25mm and axis height 35mm is kept with its 20mm edge on HP and parallel to VP. The triangular face containing this edge is perpendicular to HP. Draw its projections.

Solution.

Since the pyramid rests on HP, in the initial position assume that the axis is perpendicular to HP and hence start the drawing with the top view which is a rectangle of sides 20mm and 25mm. Since the edge condition exists with 20mm edge on HP, kept the 20mm edge of the rectangle perpendicular to XY line in the plan. Join all the corners with

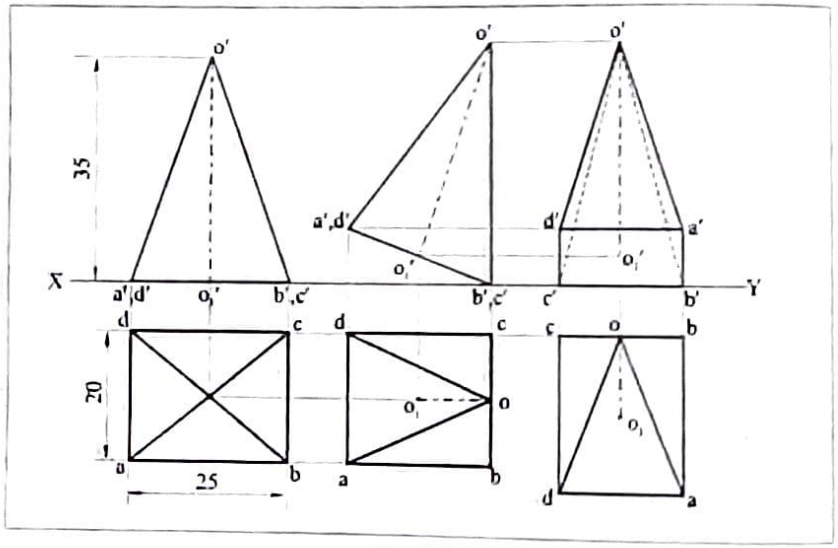


Fig. 3.34.

the centre. Draw the corresponding elevation as shown in Fig. 3.34. Redraw this elevation with b'c' on XY line and the triangular face b'c'o' perpendicular to XY line. Draw the

corresponding plan. In this plan the 20mm edge is perpendicular to XY line. Redraw this plan with line be parallel to XY line. Complete the final elevation as shown in Fig.3.34. In the final top view o_1 is far away from XY line, compared to o. Hence in the final elevation the base a'b'c'd' is completely visible.

Problem for practice.

A rectangular pyramid side of base 25mm x 30mm and axis height 60mm is kept with its 30mm edge on HP and inclined at 60° with VP. Draw its projections when triangular face containing the 30mm base edge is inclined at 40° with HP.

University question.

1. A rectangular pyramid of sides of base 40 x 50mm and height 70mm is lying on one of its longer triangular faces on HP. The longer edge of the base of the triangular face lying on HP is inclined at 60° to VP, with the apex of the pyramid being nearer to VP. Draw the front and top views of the pyramid. [KU June 2012].

Example 3.21.

A square pyramid side of base 25mm and axis 35mm long has one of its triangular faces in the VP and the edge of its base contained by that face makes an angle of 30° with the HP. Draw the projections of the pyramid. [KU June 2010].

Solution.

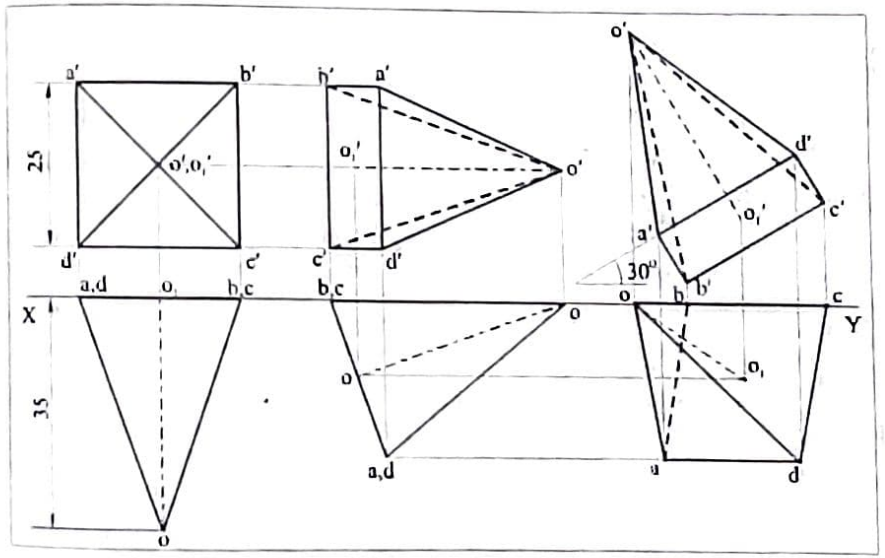


Fig. 3.35.

Since the pyramid lies on VP, start the drawing with the elevation which is a square of side 25mm. Join all the corners with the centre. Since the edge condition exists, [base edge on VP with axis inclined to VP], in the elevation keep one of the sides of the square perpendicular to XY line. Draw the corresponding plan. Redraw this plan with the line obc on XY line and draw the second elevation. Redraw this elevation with the line b'c' inclined at 30° with XY line as shown in Fig. 3.35. Draw the final plan by drawing vertical lines from the third elevation and horizontal lines from the second plan.

Problem for practice.

1. A square pyramid side of base 30mm and height 50mm is kept with one of its slant edges on VP with axis inclined at 30° with HP. Draw its projections using.

(i) Change of position method and

(ii) Auxiliary method.

University questions.

1. A square pyramid edge of base 50mm and height 70mm has its axis inclined at 45° to HP. Draw its projections if one of the base edges is on HP and is inclined at 60° to VP. [CUSAT June 2008].
2. A square pyramid, side of base 40mm and altitude 60mm is kept with a side of base parallel to VP and the triangular face containing that side of base being vertical. [KU Dec 2009].
3. A square pyramid side of base 30mm and height 60mm is resting on HP on its vertex in such a way that one of its slant edges is vertical and the triangular face containing that slant edge is perpendicular to VP. Draw the projections of the solid. [KU June 2013].

Example 3.22.

A pentagonal pyramid of side 15mm and height 35mm is kept with one of its triangular faces on HP with the edge of this triangular face inclined at 30° with VP. Draw its projections.

Solution.

Since the triangular face of pentagonal pyramid is on HP, the axis is inclined to HP. The solid rests on HP with axis inclined to HP. Hence start with the top view. Since the edge condition exists, keep on of the sides of pentagon perpendicular to XY line and join all the corners with the centre. Draw the elevation as shown in Fig. 3.36. In this elevation, the line o'c'd' is the elevation of triangular face OCD. Redraw the elevation with line o'c'd' on XY line. Draw the corresponding plan. In this plan the edge cd is perpendicular

to XY line. [CD is perpendicular to VP]. Redraw this plan with the edge cd inclined at 30° with XY line. Complete the final elevation as shown in Fig. 3.36. In the final plan the centre of base is nearer to XY line compared to the vertex. Hence in the final elevation base is

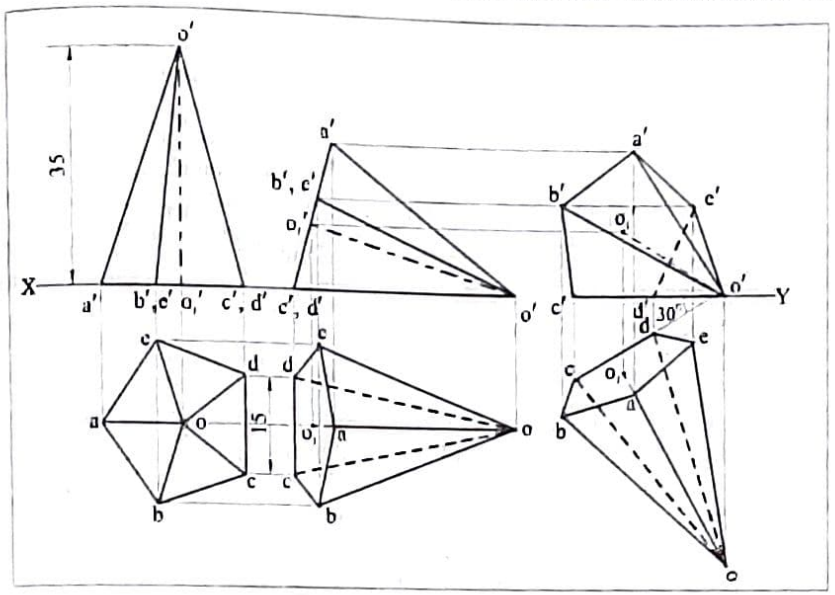


Fig. 3.36.

invisible second elevation from X_2Y_2 line are the distances of corresponding points in the first elevation from X_1Y_1 line.

Problem for practice.

1. A pentagonal pyramid having base with 30mm side and 70mm height rests on a corner of its base on HP such that the apex is 55mm above the ground and the top view of the axis is inclined at 30° to the VP. Draw its projections.
2. A pentagonal pyramid of side of base 25mm and axis height 60mm is kept with one of its base edges on HP with axis inclined at 40° with HP and the plane containing the axis is inclined at 30° with VP. Draw its projections.

University questions.

1. Draw the projections of a pentagonal pyramid 40mm side and axis 70mm long when it is resting on one of its base edges with the axis making an angle of 30° to HP and 45° to VP. [CUSAT June 2012].
2. A pentagonal pyramid edge of base 3cm and height 8cm rests on a corner of its base

in such a way that the slant edge containing the corner makes an angle of 45° with HP and 30° to VP. Draw its projections [CUSAT June 2013].

3. A pentagonal pyramid side of base 30mm and length of axis 60mm is placed such that one side of the base is on the HP and the triangular face containing that edge is vertical. Draw the projections when the triangular face is parallel to VP. The base of pyramid should be visible in the elevation. [KU June 2011].

4. A pentagonal pyramid edge of base 40mm and height 60mm resting on a corner of its base in such a way that the slant edge containing the corner makes an angle of 60° with HP and 30° with VP. Draw its projections. [KU June 2007].

5. A pentagonal pyramid, base 25mm side and axis 55mm long has one of its triangular faces on HP and the edge of the base contained by that face makes an angle of 30° with VP. Draw its projections. [KU May 2007].

Example 3.23.

A hexagonal pyramid side of base 15mm and height 35mm has an edge of the base in HP making 40° with VP. Its base makes 45° with HP and its apex away from VP than the base. Draw the projections of the pyramid.

Solution.

Pyramid rests on HP with axis inclined to HP. Hence start with the top view which is

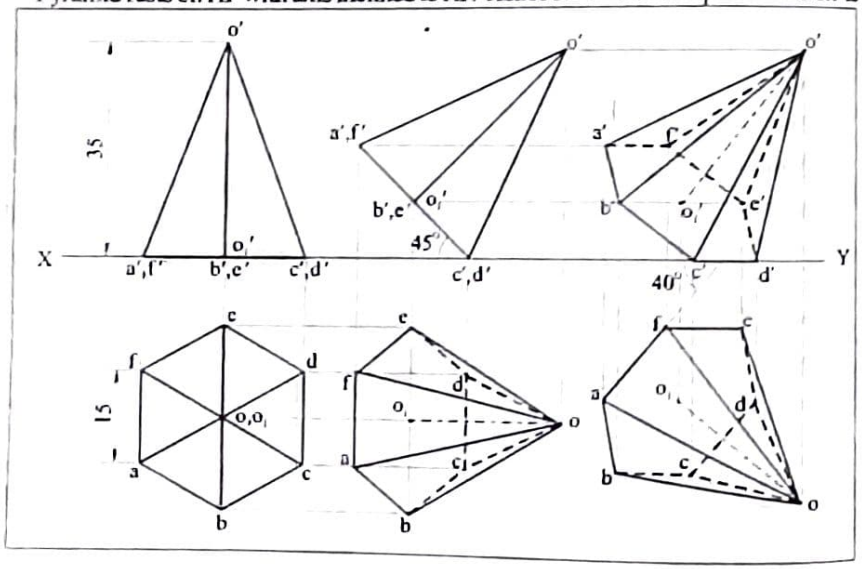


Fig. 3.37.

a hexagon of side 15mm. Join all the corners with the centre. Since the edge condition exists, one of the sides of hexagon should be kept perpendicular to XY line. Draw the elevation and redraw this elevation with the base inclined at 45° with XY line. Draw the corresponding plan. In this plan, the edge on HP, CD, is perpendicular to VP. Redraw this plan with cd inclined at 40° with XY line. Draw the final elevation by drawing vertical lines from the third plan and horizontal lines from the second elevation as shown in Fig.6.43. In the final plan, the base is away from XY line compared to the apex. Hence in the final elevation the base is completely invisible.

Problem for practice.

A hexagonal pyramid, side of base 20mm and axis height 50mm is kept with one of its base edges on VP with axis inclined at 40° with VP and 30° with HP. Draw its projections such that the base is visible in the plan.

University questions.

1. A hexagonal pyramid, base 25mm side and axis 55mm long, has one of its slant edges on the ground. A plane containing that edge and the axis is perpendicular to the ground and inclined at 45° to the VP. Draw the projections, when the apex is nearer to the VP than the base. [CUSAT June 2008, KU June 2011].

2. A hexagonal pyramid side of base 25mm long and height 70mm has one of its triangular faces perpendicular to HP and inclined at 45° to VP. The base side of this triangular face is parallel to HP. Draw its projections. [CUSAT June 2010].

3. A hexagonal pyramid side of base 25mm and height 60mm rests on a corner of its base in such a way that the slant edge containing that corner makes an angle of 45° with HP and top view of the axis makes an angle of 30° with VP. Draw the projections of the pyramid. [CUSAT June 2012].

Example 3.24.

An equilateral triangular prism side of base 25mm and height 30mm is kept with one of its base corners on HP with axis inclined at 45° with HP and 30° withVP. Draw its projections.

Solution.

The prism rests on HP with axis inclined to HP. Hence start with the top view which is an equilateral triangle of side 25mm. Since the corner condition exists, the imaginary line joining the corner and the centre of base should be kept parallel to XY line. For this keep one of the sides of the triangle perpendicular to XY line. Mark the corners as ap, bq, cr

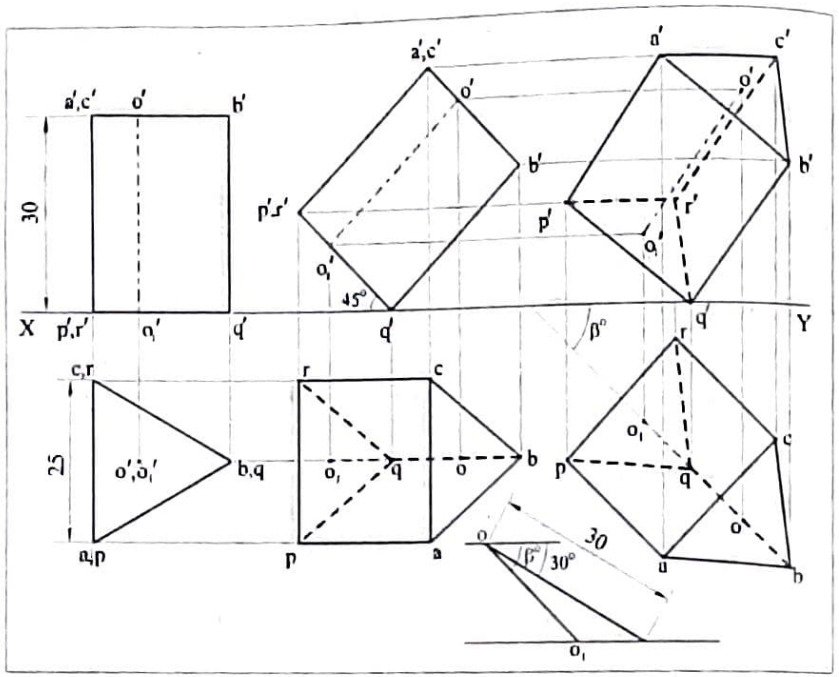


Fig. 3.38.

and the centre as o, o_1. Draw the elevation. Redraw this elevation with the point q' on XY line and base inclined at 45° with XY line. When the base is inclined at 45° with XY line, the inclination of axis will be, 90 - 45 = 45°. Draw the corresponding plan as shown in Fig. 3.38. In this plan, the face abc is visible because in the elevation a'b'c' is away from XY line compared to the other face p'q'r'. In this second plan, the apparent length of axis oo_1 is parallel to VP. Redraw this plan with oo_1 inclined at β° with XY line. β° is the apparent inclination of axis corresponding to the true inclination of 30°. Draw the final elevation as shown in Fig. 3.38. In the final elevation the face a'b'c' is visible because in the plan the face abc is away from XY line compared to the other face pqr.

Problem for practice.

An equilateral triangular prism side of base 40mm and axis height 50mm is kept with one of its base edges on VP with axis inclined at 40° with VP and 30° with HP. Draw its projections.

University question.

An equilateral triangular prism of side of base 25mm and axis 50mm long is resting on an edge of base on HP such that the face containing that edge is inclined at 30° to HP. Draw the projections of the prism, when the edge on which the prism rests is inclined at 60° with VP. [KU June 2012].

Example 3.25.

A pentagonal prism side of base 15mm and axis height 35mm is kept with one of its base edges on HP with axis inclined at 40° with HP. Draw its projections when the top view of axis is inclined at 35° with VP.

Solution.

Prism rests on HP, with axis inclined to HP. Hence start with the top view which is a regular pentagon of side 15mm. Since the edge condition exists, one of the sides of the pentagon should be kept perpendicular to XY line. Draw the elevation. Redraw this elevation with edge r',s' on XY line and axis inclined at 40° with XY line. Draw the corresponding plan. In this plan the axis is parallel to XY line. Redraw this plan with axis oo_1 inclined at 35° with XY line. Draw the final elevation as shown in Fig. 3.39.

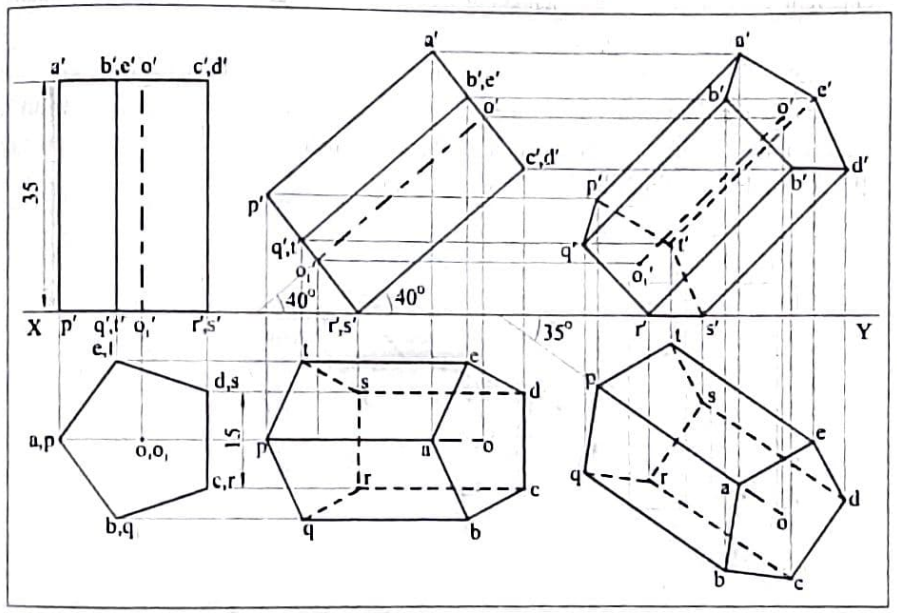


Fig. 3.39.

Example 3.26.

A pentagonal prism side of base 15mm and axis height 35mm is kept with one of its base corners on HP with the vertical edge containing this corner inclined at 40° with HP and 30° with VP. Draw its projections.

Solution.

The prism rests on HP with axis inclined to HP. Hence start with the top view which is a regular pentagon of side 15mm. Since the corner condition exists, (base corner on HP with axis inclined to HP) the imaginary line joining this corner and the centre of the pentagon should be kept parallel to XY line in the plan. For this keep one of the sides of pentagon perpendicular to XY line. Draw the elevation and redraw this elevation with r' on XY line and r'c' line inclined at 40° with XY line. Draw the second plan as shown in Fig. 3.40. In this plan the the line cr is parallel to XY line. Redraw this plan with the line cr inclined at β° with XY line. β° is the apparent inclination of the vertical edge CR corresponding to the actual inclination of line CR with VP. [30°]. The top view of line CR is apparent length and hence the inclination of cr should be apparent inclination. To obtained the apparent inclination β , draw a line of length 35mm inclined at 30° with horizontal. Through the lower end of this line, draw of horizontal line. With the upper end of the line, r as centre, apparent length of the lines CR (cr from second plan) as radius draw an arc to cut the horizontal line at c. The inclination this apparent line rc is the apparent inclination β . Complete the final elevation as shown in Fig. 3.40

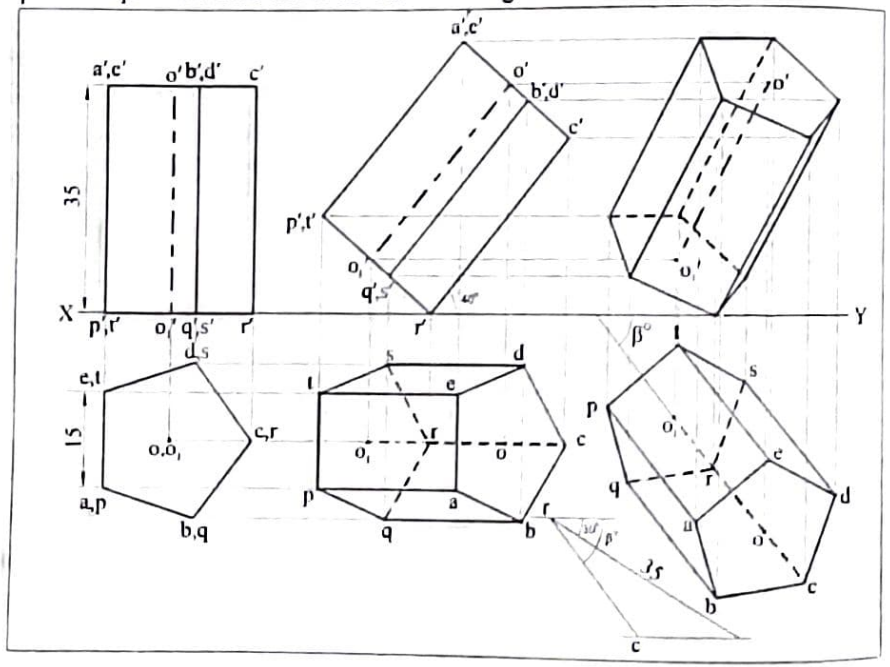


Fig. 3.40.

Problems for practice.

1. A pentagonal prism side of base 25mm and axis height 50mm is kept with one of its base edges on VP with axis inclined at 40° with VP and 30° with HP. Draw its projections.
2. A pentagonal prism side of base 25mm and axis height 50mm is kept with one of its base corners on VP with the vertical edge containing this corner inclined at 40° with VP and 30° with HP. Draw its projections.

University questions.

1. A pentagonal prism, edge of base 30mm and height 55mm resting on a corner of its base on HP and 45mm in front of VP. The longer edge containing that corner is inclined at 45° to HP and the plane containing that edge and the axis is inclined at 30° to VP. Draw the projections of the prism. [KU May 2009].
2. A pentagonal prism edge of base 30mm and height 60mm is resting on a corner of its base on HP and 45mm infront of VP. The longer edge containing that corner inclined at 45° to HP. Draw the projections of the prism, if the axis of the prism is inclined at 30° to VP. [KU Jan. 2009].

Example 3.27.

A hexagonal prism side of base 15mm and height 35mm is kept with one of its base edges on HP with axis inclined at 40° with HP and the plane containing the axis is inclined at 35° with VP. Draw its projections.

Solution.

Since the prism rests on HP, with axis inclined to HP, start with the top view which is a regular hexagon of side 15mm. The prism is in edge condition. Therefore one of the edges of the hexagon should be kept perpendicular to XY line. Draw the elevation and redraw this elevation with r's' on XY line and axis $o'o_1'$ inclined at 40° with XY line. Draw the corresponding plan. In this plan the axis oo_1 is parallel to XY line. It should be inclined at 30° with XY line. Therefore redraw the second plan with axis oo_1 inclined at 35° with XY line. Complete the final elevational as shown in Fig. 3.41.

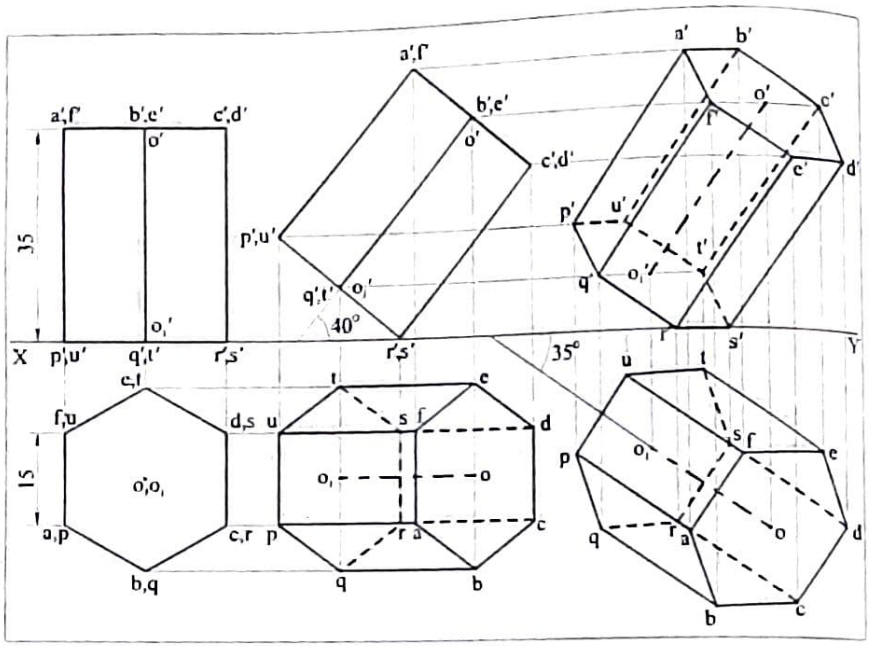


Fig. 3.41.

Problem for practice.

A hexagonal prism side of base 25mm and axis height 50mm is kept with one of its base corners on HP with the axis inclined at 45° with HP and 30° with VP. Draw its projections.

University questions.

1. A hexagonal prism of base 25mm side and axis 45mm long is positioned with one of its base edges on HP such that the axis is inclined at 30° to HP and 45° to VP. Draw its projections. Follow the change of position method. [CUSAT June 2011].
2. A hexagonal prism, edge of base 30mm and height 65mm is resting on a corner of its base in HP and 50mm in front of VP. The longer edge containing that corner inclined at 45° to HP and a vertical plane containing that edge and the axis inclined at 30° to VP. Draw the projections of the prism [CUSAT June 2013].
3. A hexagonal prism, base 20mm side and axis 50 mm is placed on one of its base edges on HP such that the axis is inclined at 30° to VP and 60° to HP. Draw the projections [KU June 2005].

Example 3.28.

A cube of side 25mm is kept with one of its edges on HP with axis inclined at 40° with HP. Draw its projections when the edge on HP is inclined at 35° with VP.

Solution.

The object rests on HP with axis inclined to HP. Therefore start with the top view which is a square of side 25mm. Since the edge condition exists, (edge on HP with axis inclined to HP) one of the sides of the square should be kept perpendicular to XY line in

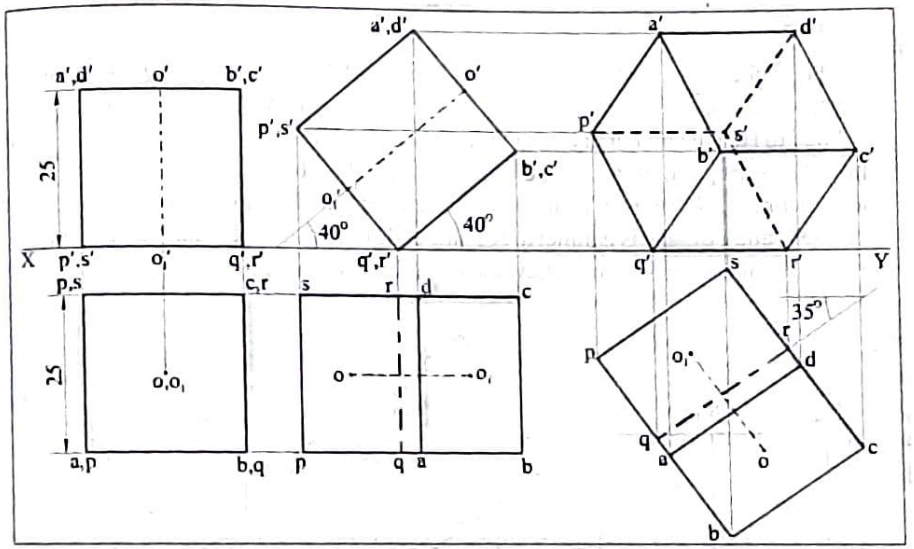


Fig. 3.42.

the top view. Draw the elevation and redraw the elevation with q'r' on XY line and the base p'q'r's' inclined at (90° - 40°) = 50° with XY line. Draw the corresponding plan. In this plan the line cr is invisible line and line ad is visible line. The edge on HP, CR is perpendicular to VP. Redraw the plan with cr inclined at 35° with XY line. Draw the final elevation by drawing vertical lines from the points in the third plan and horizontal lines from the points in the second elevation.

Problems for practice.

1. A cube of side 30mm is kept with one of its corners on HP with axis inclined at 40° with HP and appears to be inclined at 35° with VP. Draw its projections.
2. A cube of side 30mm is kept with one of its base edges on VP with axis inclined at 40° with VP and the edge on VP inclined at 35° with HP. Draw its projections.

University question.

A cube of 30mm side rests with one of its edges on HP such that one of the square faces containing that edge is inclined at 30° to HP and the edge on which it rests being inclined at 60° to VP. Draw its projections. [KU May 2009].

Example 3.29.

A cube of side 25mm is kept with one of its corners on HP with one of its body diagonals perpendicuar to VP. Draw its projection using change of position method.

Solution.

The cube rests on HP with axis inclined to HP. Therefore start with the top view which is a square of side 25mm. Since the corner condition exists, (corner on HP with axis inclined to HP) the imaginary line joining a corner of the square and centre of the square should be kept parallel to XY line in the top view. For this draw the square with all the sides inclined at 45° with XY line. Draw the elevation and redraw this elevation such that the line joining p and c is parallel to XY line and at a distance r'e' from the XY line. The point r' should be on XY line. Draw the second plan by drawing vertical lines from the

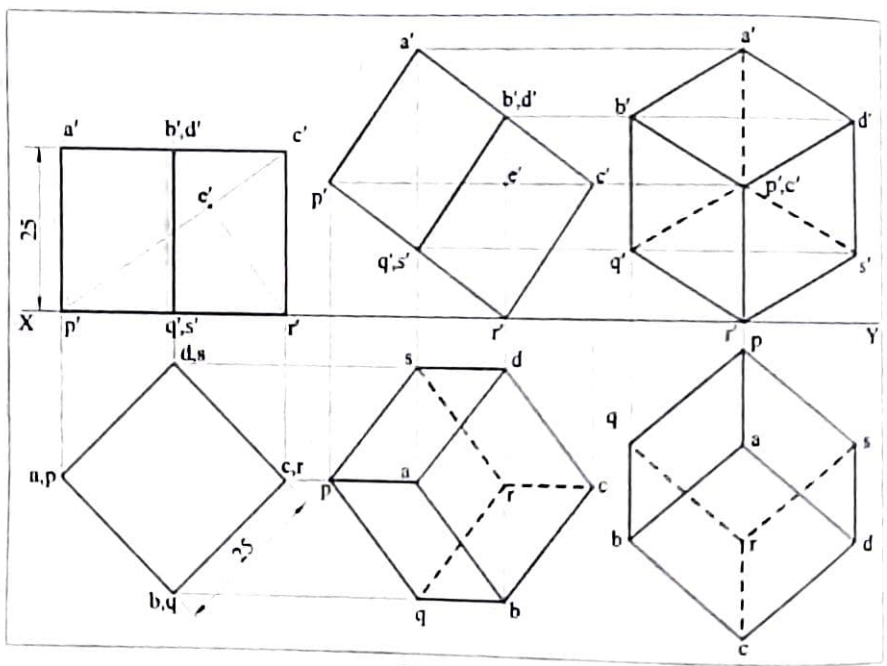


Fig. 3.43.

second elevation and horizontal lines from the first plan. In this second plan pc is parallel to XY line, showing that the body diagonal PC is parallel to VP. This body diagonal should be perpendicular to VP. Hence redraw the plan with pc perpendicular to XY line. Complete the final elevation as shown in Fig.3.43.

University Question

A cube of 30mm side resting on ground on one of its corners in such a way that a solid diagonal is perpendicular to VP. Draw its projection using auxiliary plane projections. [CUSAT June 2012].

Example 3.30.

A pentagonal pyramid side of base 15mm and axis height 35mm is freely suspended from one of its base corners. Draw its projections when the axis appears to be inclined at 30° with VP.

Solution.

When a solid is freely suspended from a point on the solid, the position of the axis will be such that the line joining that point of suspension and the centre of gravity of the solid will be perpendicular to HP. Even though the pyramid does not rest on HP, there exists a

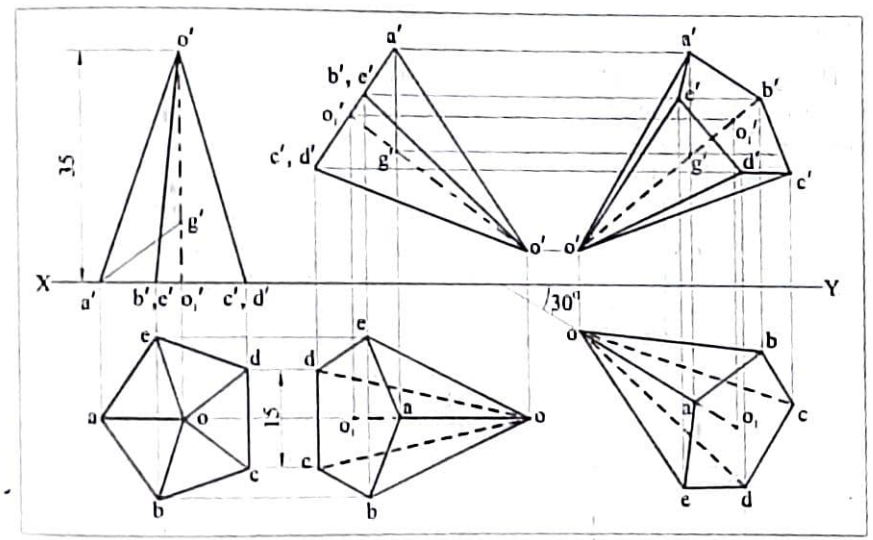


Fig. 3.44.

condition with respect to HP, ie, the line joining the point of suspension and the centre of gravity is perpendicular to HP. Hence, in the initial position assume that the axis is perpendicular to HP and start with the top view. Draw the pentagon with the line joining one of

the corners and the centre parallel to XY line, For this, keep one of the sides of pentagon perpendicular to XY line, as shown in Fig. 3.44. Draw the elevation. Mark g', which is the elevation of centre of gravity, $o_1'g' = \frac{o_1'o'}{4}$. Join a' and g'. Redraw the elevation with a'g' line perpendicular to XY line. Draw the corresponding plan. In this plan, the plan of axis o_1o is parallel to XY line. Redraw this plan with o_1o line inclined at 30° with XY line. Complete the final elevation by drawing vertical lines from the third plan and horizontal lines from the second elevation as shown in Fig.3.44.

University question.

A square pyramid base 4cm side and axis 6cm long is freely suspended from one of the corners of its base. Draw its projections, when the axis on a vertical plane makes an angle of 45° with the VP. [KU May 2008].

Example 3.31

A square pyramid 50mm base edge and 70mm height is on HP with one of its base edges such that the axis is making 45° with HP and the base edge making 30° with VP. Draw the projections.

Solution

The pyramid rests on HP with axis inclined to HP. Therefore start the drawing with view on HP, plan. Since edge condition exists [edge on HP with axis inclined to HP], one of the

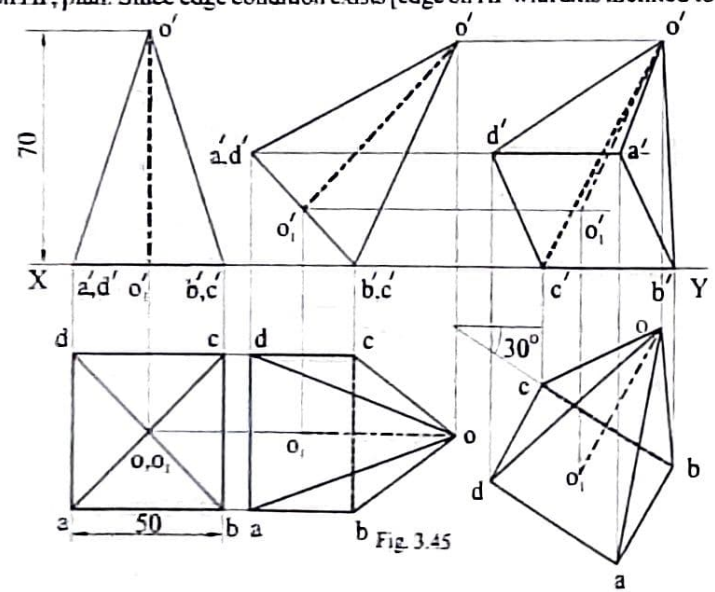


Fig. 3.45

sides of the square should be kept perpendicular to XY line. Draw the corresponding elevation and redraw this elevation with b'c' on XY line with the base inclined at (90–45) =45° with XY line. Draw the second plan. In this plan the edge on HP, bc, is perpendicular to VP Redraw this second plan with line bc inclined at 30° with XY line. Draw the final elevation. In the third plan, the centre of the base is away from XY line compared to the apex of pyramid. Hence the base is completely visible in the final elevation.

Example 3.32

A square prism of base side 40mm and length 60mm has a base edge on VP, axis inclined at 35° to VP and the resting base edge is inclined at 45° to HP. Draw the projections of the solid.

Solution

The prism rests on VP with axis inclined to VP. Therefore start the drawing with the view on VP, elevation. Since the edge condition exists, [edge on VP with axis inclined to VP], one of the sides of the square in the elevation should be kept perpendicular to XY line. Draw the corresponding plan. Redraw this plan with base edge qr on XY line. Draw the second elevation. In this elevation the edge on HP, q'r' is perpendicular to HP (perpendicular to XY line). Redraw this elevation with q'r' inclined at 45° with XY line. Draw the final plan. In the final plan the face abcd is visible because in the elevation the face a'b'c'd' is away from XY line compared to the face p'q'r's'.

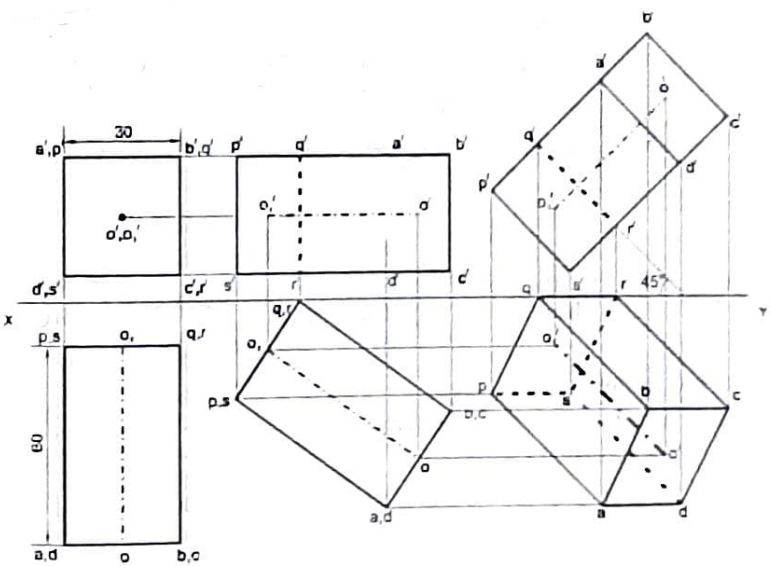


Fig. 3.46

Example 3.33

A cone of base diameter 50mm and axis height 60mm is freely suspended from a point on the circumference of its base. Draw the projections when the axis appears to be inclined at 35° with VP.

Solution

Draw the plan and elevation of the cone, assuming that the axis is perpendicular to HP [Object is freely suspended]. Mark a point g' on the axis such that its distance from the base is one-fourth of the height of axis. (15mm). Redraw the elevation with the line a'g' perpendicular to XY line. Draw the second plan. In this plan the axis is parallel to VP. Redraw the second plan with axis inclined at 35° with XY line. Draw the final elevation as shown in Fig. 3.47

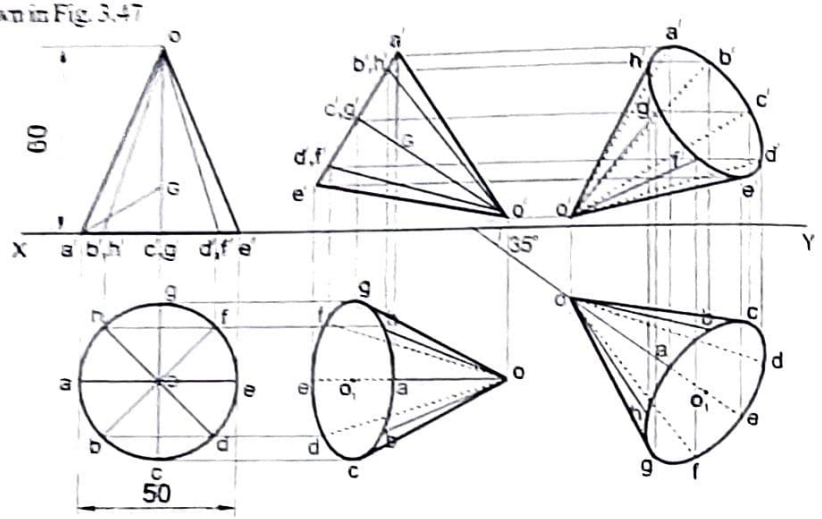


Fig. 3.47

Solutions of additional problems

Case(i). Problems with axis perpendicular to one of the reference planes (Object is in simple position).

Points to be remembered

* When the base of an object is on a reference plane or parallel to a reference plane, the axis will be perpendicular to that reference plane.
* The view on that reference plane to which the axis is perpendicular will be the true shape of the base of the object.
* Drawing should be started with the view on that reference plane to which the axis is perpendicular ie, the drawing should be started with the true shape of the base of the object.
* All the boundary lines of a view are visible lines.
* Points, lines, faces, etc. which are far away from a reference line in one of the views are visible in the other view.
* All the lines meeting at an invisible point are invisible lines
* Two visible lines never cross each other.

Problem 3.1

A pentagonal prism of 35mm base side and 70mm axis height is resting on the HP on one of its base corners with its axis inclined at 40° to HP and parallel to the VP. Draw its projection when the base sides containing the resting corner are equally inclined to the HP.

Solution

1. Draw the xy line and draw the plan satisfying the corner condition, ie, the line joining the corner and centre of pentagon parallel to xy line. For this keep one of the base edges perpendicular to xy line.
2. Draw the elevation

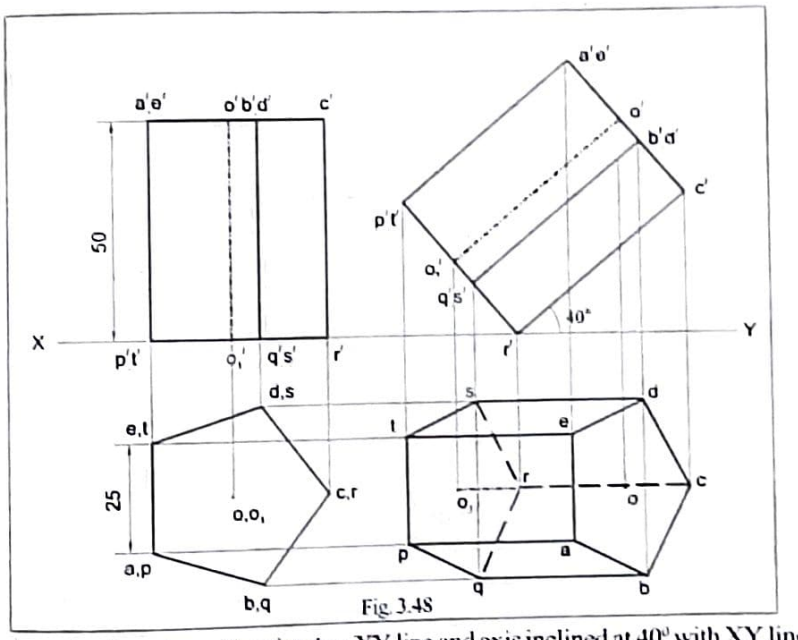


Fig. 3.48

3. Redraw the elevation with point r' on XY line and axis inclined at 40° with XY line. (r'c' inclined at 40° with XY line)

4. Draw the plan. In this plan the axis is parallel to VP.

Problem 3.2

A square pyramid of base side 30mm and axis lingth 60mm is resting on HP on one of its triangular faces with its axis parallel to VP. Draw its projections

Solution

Since the triangular face of a pyramid is on HP, one of the base edges is on HP and the axis is inclined to HP. Therefore the edge condition exists.

1. Draw the XY line and draw the plan satisfying edge condition.
2. Draw the elevation
3. Redraw the elevation with the triangular face o'b'c' on XY line.
4. Draw the final plan. In this plan the axis is parallel to VP.

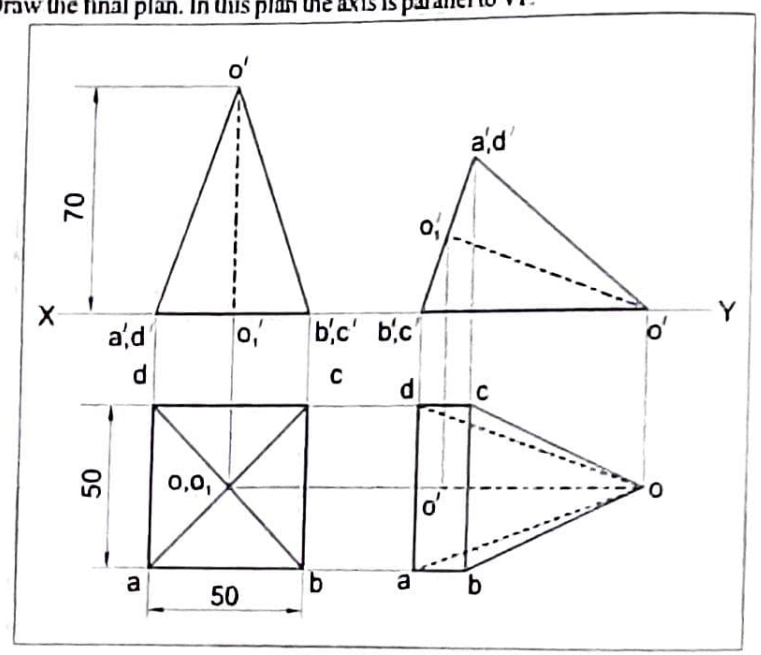


Fig. 3.49

Problem 3.3

A square pyramid of base side 40mm and axis height 60mm is suspended by means of a starting from one of its base corners with its axis parallel to VP. Draw its projections.

1. Draw the XY line and draw the plan satisfying corner condition.
2. Draw the elevation and mark a point g' on the axis such that the distance of g' from the base is one fourth of axis height. $o_1'g'$=15mm

3. Redraw the elevation with a'g' line perpendicular to XY line.
4. Draw the plan. In this plan the axis is parallel to VP.

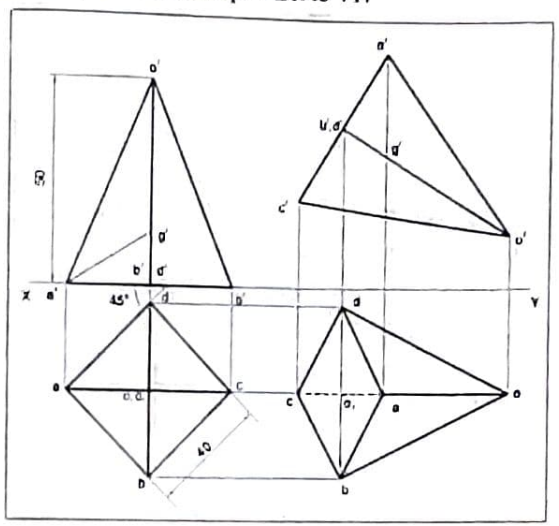


Fig. 3.50

Problem 3.4

A cone of base diameter 50mm and axis height 60mm is kept on VP with its axis inclined at 40° with VP and the plane containing the axis is inclined at 30° with HP. Draw its projections.

Solution

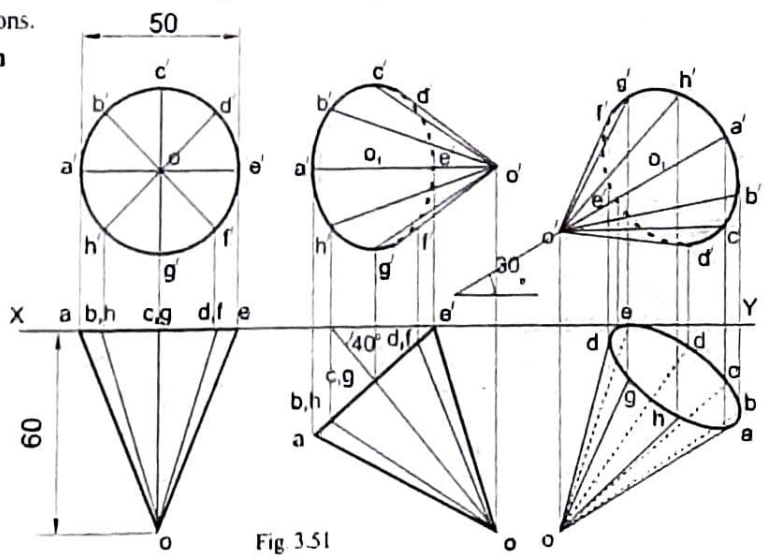


Fig. 3.51

Since the cone rests on VP with axis inclined to VP, in the initial position assume that the axis is perpendicular to VP and hence start the drawing with the view on VP, elevation.

1. Draw the elevation and the plan
2. Redraw the plan with the point e on XY line and the base inclined at 90 - 40 = 50° with XY line.
3. Draw the second elevation. In this elevation the axis is parallel to HP (Parallel to XY line).
4. Redraw this elevation with the axis inclined at 30° with XY line.
5. Draw the final plan as shown in Fig.3.51

Problem 3.5

A square pyramid, side of base 25mm and axis height 40mm is kept with its apex on HP. One of the slant edges is kept perpendicular to HP and the plan of the axis is inclined at 30° with VP. Draw its projections

Solution

The pyramid rests on HP with axis inclined to HP. Therefore start with the view on HP, plan

1. Draw the XY line and draw the plan, satisfying the corner condition.
2. Draw the elevation

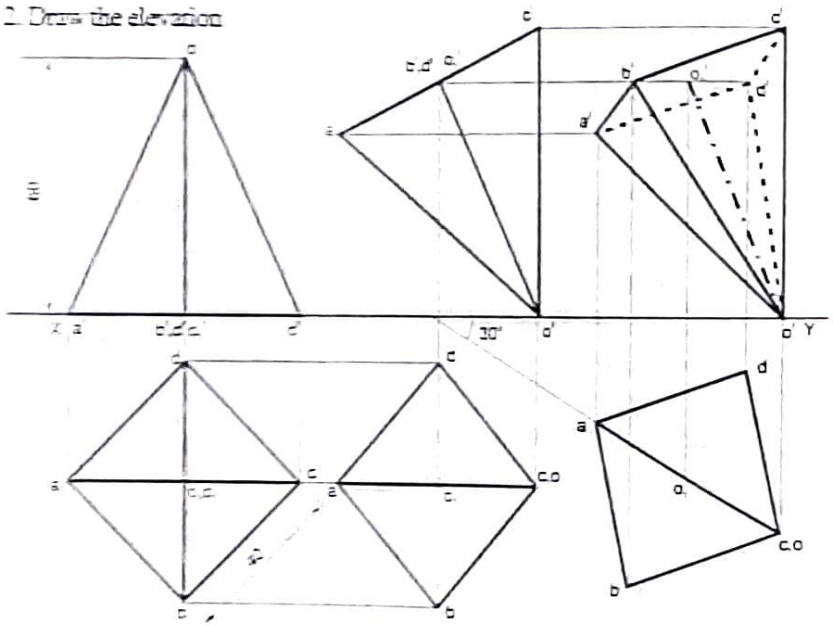


Fig.3.52

3. Redraw the elevation with vertex o' on XY line and the slant edge o'c' perpendicular to XY line.
4. Draw the second plan. In this plan the axis o_1o is parallel to VP (Parallel to XY line).
5. Redraw the second plan with axis o_1o inclined at 30° with XY line.
6. Draw the final elevation as shown in Fig. 3.52

Problem 3.6

A cone of base diameter 50mm and axis height 60mm is kept on HP with its axis inclined at 40° with HP and appears to be inclined at 30° with VP. Draw its projections.

Solution

Since the object rests on HP with axis inclined to HP, in the initial position assume that the axis is perpendicular to HP and hence start the drawing with the plan.

1. Draw the plan and elevation.
2. Redraw the elevation with point e' on XY line and the base inclined at 90–40=50° with XY line.
3. Draw the second plan. In this plan the axis is parallel to VP (Parallel to XY line).
4. Redraw the second plan with axis inclined at 30° with XY line.
5. Draw the final elevation as shown in Fig. 3.53.

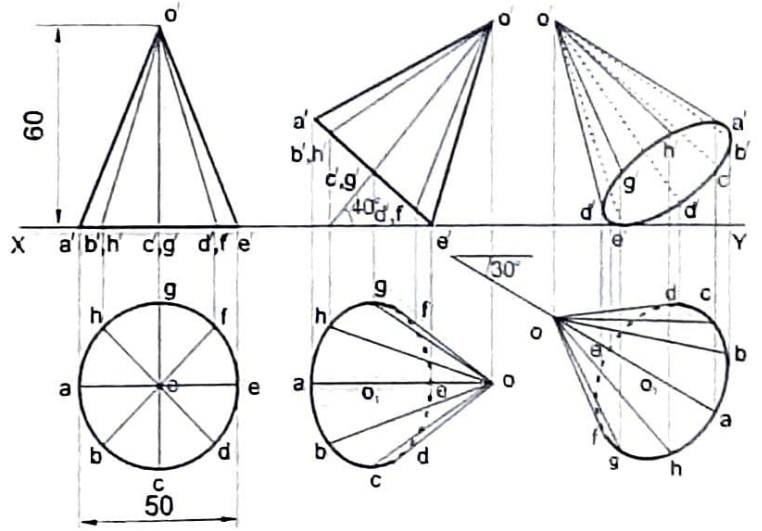


Fig. 3.53

Problem 3.7

A cone of base diameter 50mm and axis height 60mm is kept on VP with its axis inclined at 40^0 with VP and 30^0 with HP. Draw its projections.

Solution

Since the cone rests on VP with axis inclined to VP, start the drawing with the view on VP, elevation.

1. Draw the elevation and the plan
2. Redraw the plan with the point e on XY line and the base inclined at $90 - 40 = 50^0$ with XY line.
3. Draw the second elevation. In this elevation the axis is parallel to HP (Parallel to XY line).
4. Redraw this elevation with axis inclined at α^0 with XY line (α is the apparant inclination of axis corresponding to the actual inclination of 30^0)
5. Draw the final plan as shown in Fig. 3.54.

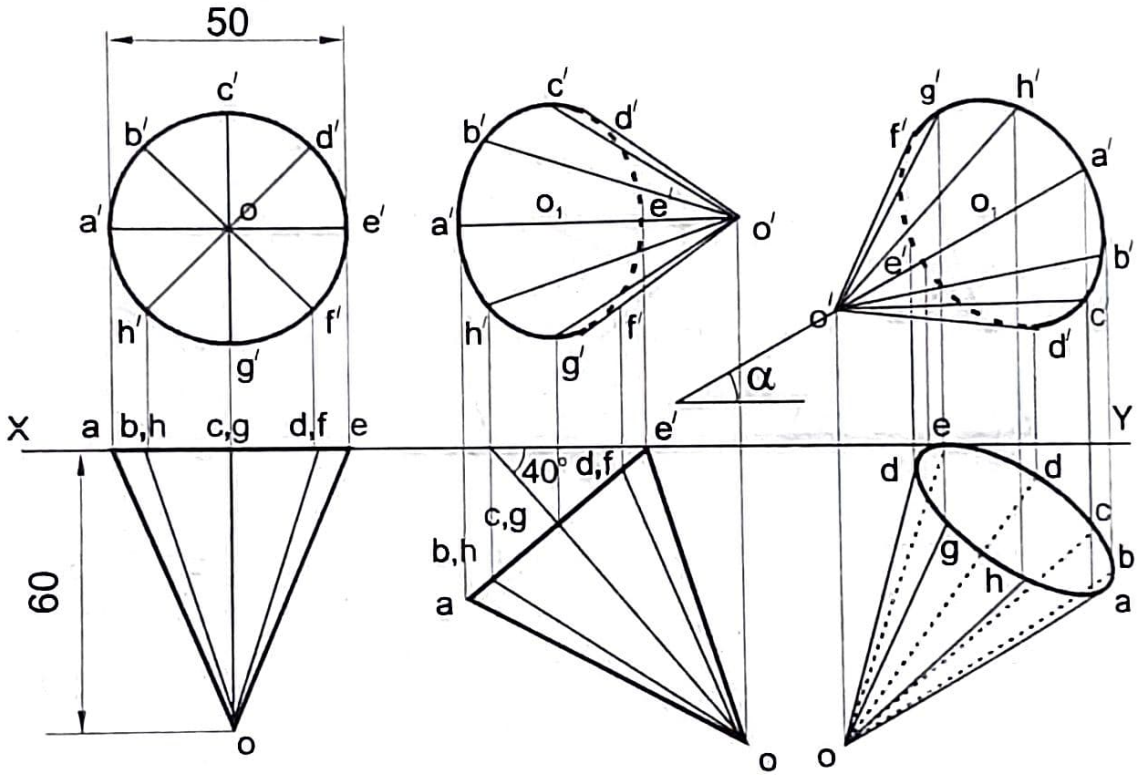


Fig. 3.54