Graphics in Design & Communication

One Volume Edition

David Anderson

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CONTENTS

PART 1

PLANE AND DESCRIPTIVE GEOMETRY

AREA 1

PROJECTION SYSTEMS

1 Orthographic and Auxiliary Projection

Syllabus Outline

Areas to be studied:

- Definition of a plane.
- Principal planes of reference.
- Auxiliary views, including second and subsequent auxiliary views.
- True shapes of surfaces and true lengths of lines.

Learning Outcomes

Students should be able to:

Higher and Ordinary levels

- Represent three-dimensional objects in logically arranged two-dimensional views.
- Apply their knowledge of reference planes and auxiliary projection planes to solving problems using a first auxiliary view.
- Present drawings in first-angle orthographic conventional views.
- Determine the projections, inclinations, true length and true shape of lines and planes.

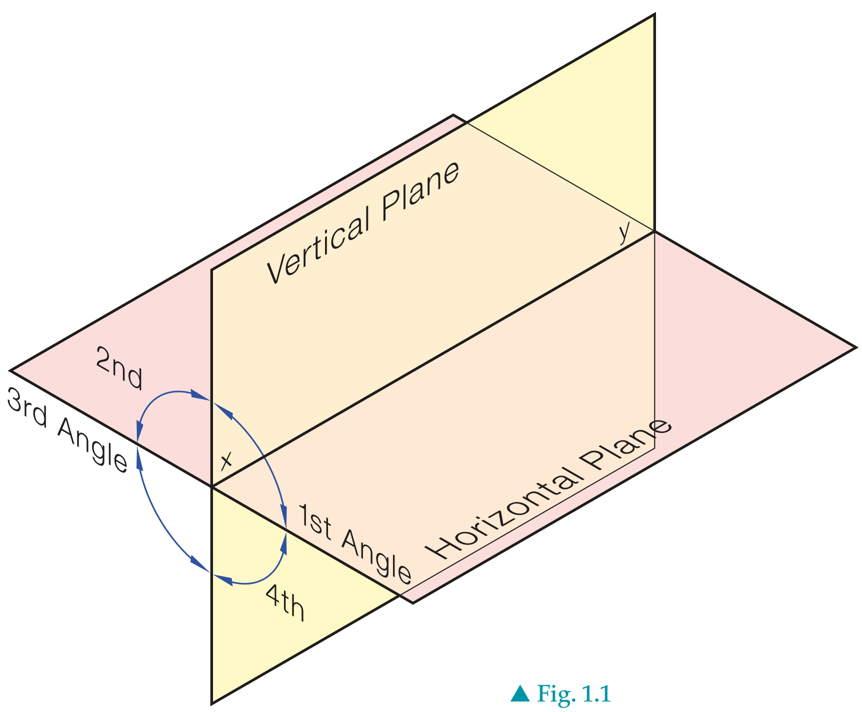
Higher Level only

- Apply their knowledge of reference planes and auxiliary projection planes to solving problems using a first auxiliary view and subsequent auxiliary views.
- Present drawings in third-angle orthographic conventional views.
- Determine the projections of lines given the angles of inclination to the principal planes of reference.

Plane

A plane is a flat surface with no thickness. If two points are selected on a plane and joined with a straight line, then the straight line will lie on the plane along its full length. Planes are considered to have no boundaries, to be limitless. We usually draw edges to the planes to help our visualisation of them.

Fig. 1.1 shows the principal planes of reference. Two planes, one vertical and one horizontal, intersect along the straight line xy. These planes divide space into four sections: first, second, third and fourth angles. When representing objects we generally place them in the first angle or the third angle and project their image onto the horizontal plane and the vertical plane. This gives first-angle projection and third-angle projection.



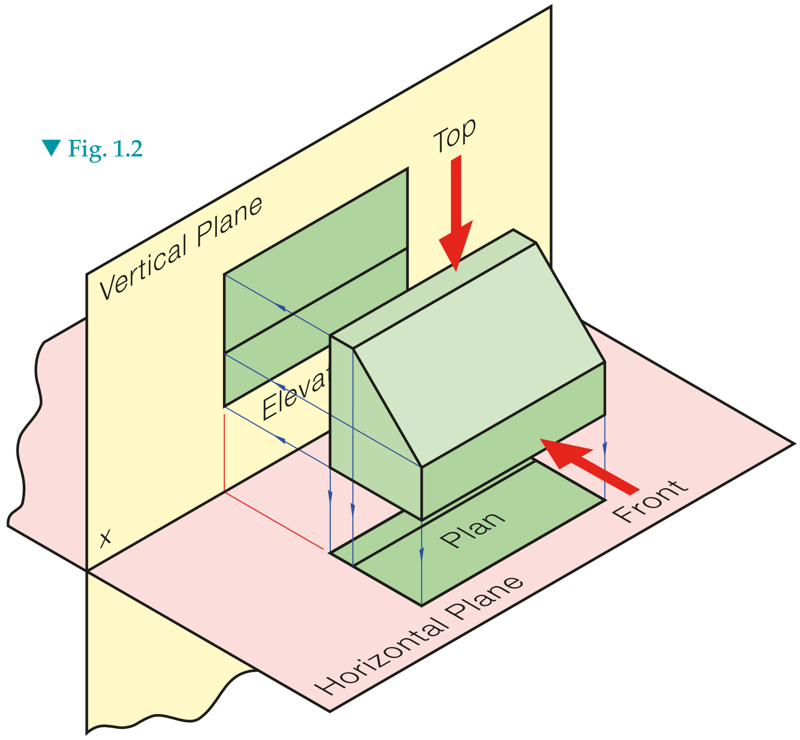
▲ Fig. 1.1

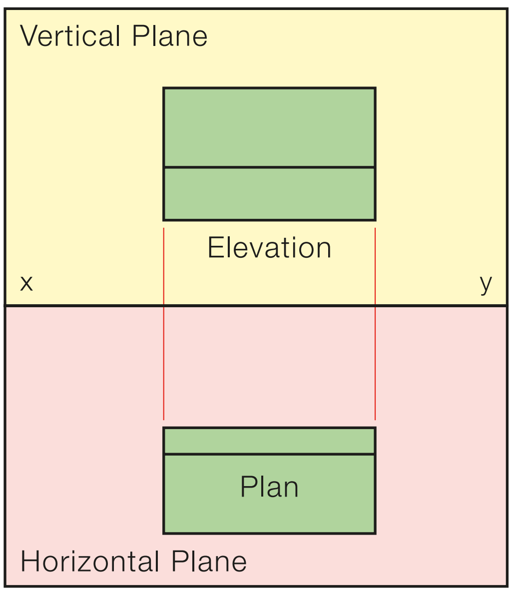
First-angle Projection

The object to be drawn is positioned in the First Angle of the intersecting vertical and horizontal planes. When we view from directly in front of the object we see the **Front Elevation**. The view that we see is projected onto the vertical plane behind. When we view from directly above the object we see the **Plan**. The view that we see is projected onto the horizontal plane below, see Fig. 1.2.

Note: The plane that we project onto must always be perpendicular to our line of sight.

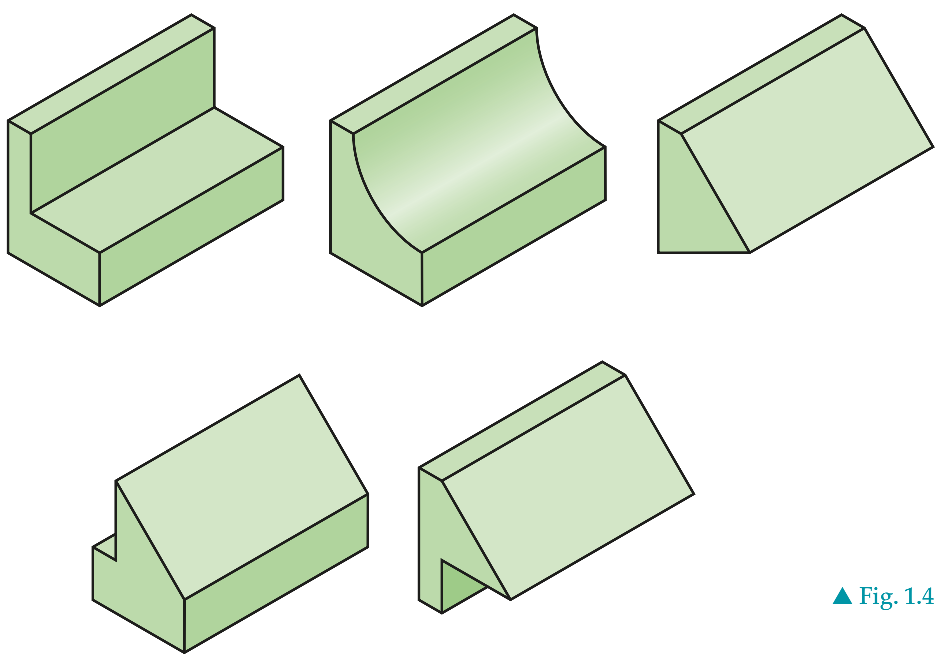
▼ Fig. 1.2





◀ Fig. 1.3 We now fold the horizontal plane down in line with the vertical plane. The plane is hinged about the xy line. This gives two views of the one object. The elevation is always directly above the plan.

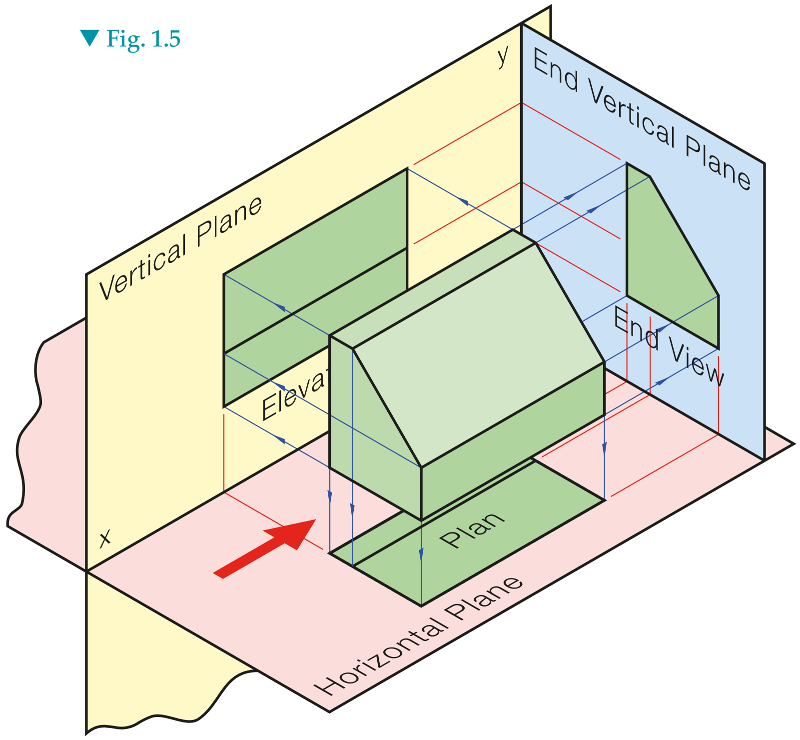
The two drawings together give us a lot of information about the object but not the complete picture. This plan and elevation could represent any of the objects in Fig. 1.4. To represent the object completely we need a third view, a view from the side. When viewing from the side we need to introduce a new vertical plane onto which we project our image.



▲ Fig. 1.4

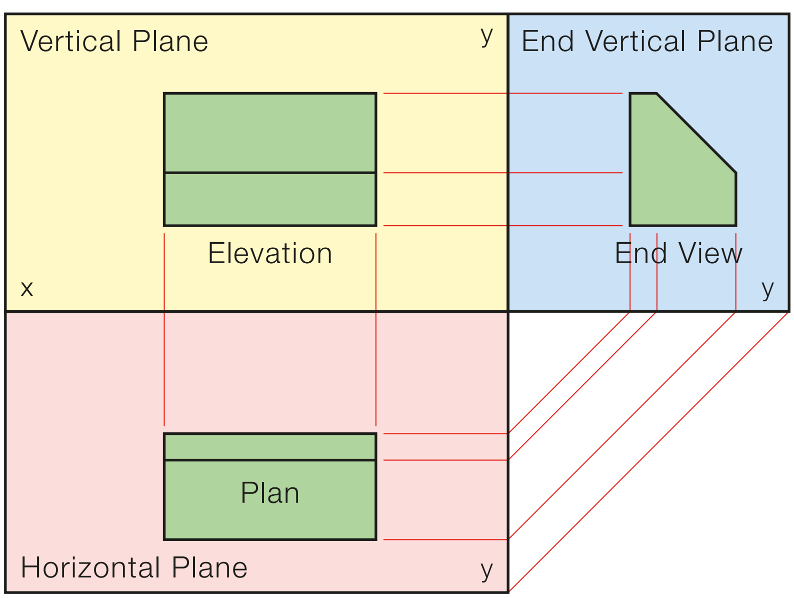
The plane must be perpendicular to the line of sight (Fig. 1.5). When we consider all three views together we have a complete representation of the object.

▼ Fig. 1.5



The line of intersection between the two vertical planes is called the yy line. All three planes are folded out flat as seen in Fig. 1.6. The horizontal plane is folded down, hinging along the xy line, and the end vertical plane swings back, hinging along the yy line. All three planes now lie on one plane.

As was mentioned earlier, the vertical planes and horizontal plane are limitless in size. When drawing objects in this format, **orthographic projection**, we dispense with the plane edges and just use the hinge lines, i.e. the xy line and yy line. In this example, for clarity, the object was raised up above the horizontal plane. Usually the object is placed on the horizontal plane. This means that the elevations will be on the xy line.



◀ Fig. 1.6

The XY Line

It is worth noting at this stage that the xy line represents several things:

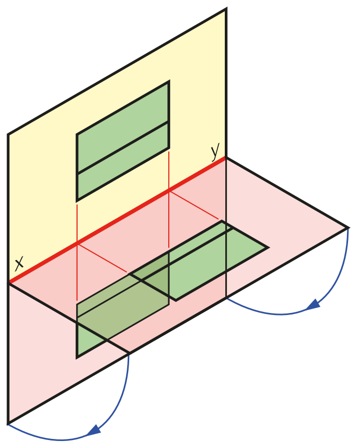
(1) The line of intersection between the vertical and horizontal planes, Fig. 1.7.

(2) The xy line is the hinge line about which the horizontal plane drops down in line with the vertical plane, Fig. 1.7.

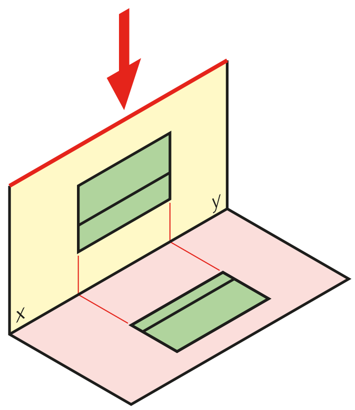
(3) When looking straight down to see the plan, the xy line represents the edge of the vertical plane, Fig. 1.8.

(4) When looking in horizontally to see the front elevation or the end elevation, the xy line represents the edge of the horizontal plane, Fig. 1.9.

▼ Fig. 1.7



▼ Fig. 1.8



▼ Fig. 1.9

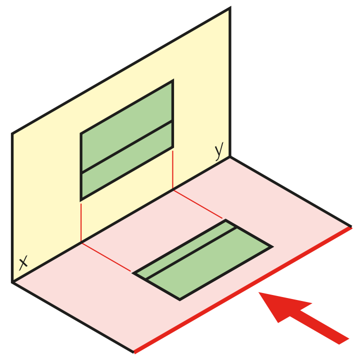


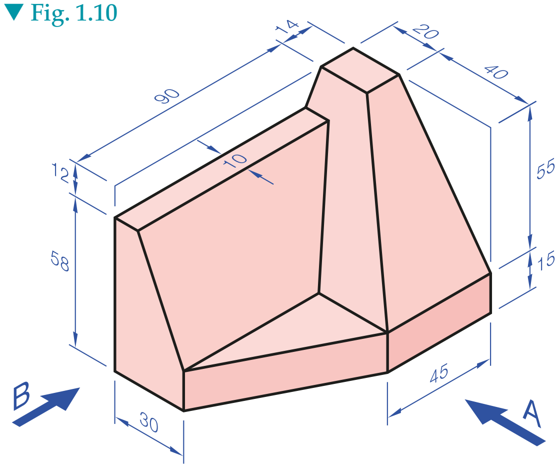
Fig. 1.10 shows a pictorial view of an object.
(i) Draw a front elevation of the object looking in the direction of arrow A.
(ii) Project a plan from the front elevation.
(iii) Project an end elevation looking in the direction of arrow B.

(1) Draw the xy line first.

(2) Set up a box that will contain the front elevation on this xy line. The height will be 70 mm and the length will be 104 mm.

(3) The box for the plan is usually drawn next. The plan will be the same length and directly below the front elevation. The size of the gap between the plan and the xy line is chosen to give a good drawing layout.

▼ Fig. 1.10

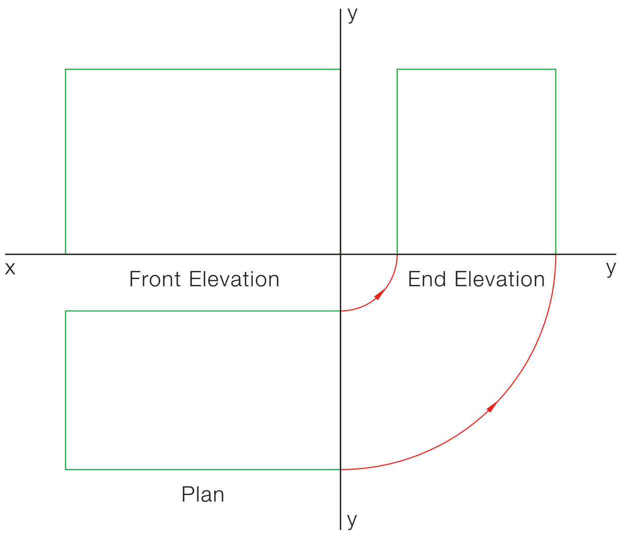


(4) The height of the box for the end elevation is projected across from the front elevation. The intersection between the xy line and the yy line gives the centre for the arcs swung up from the plan, Fig. 1.11.

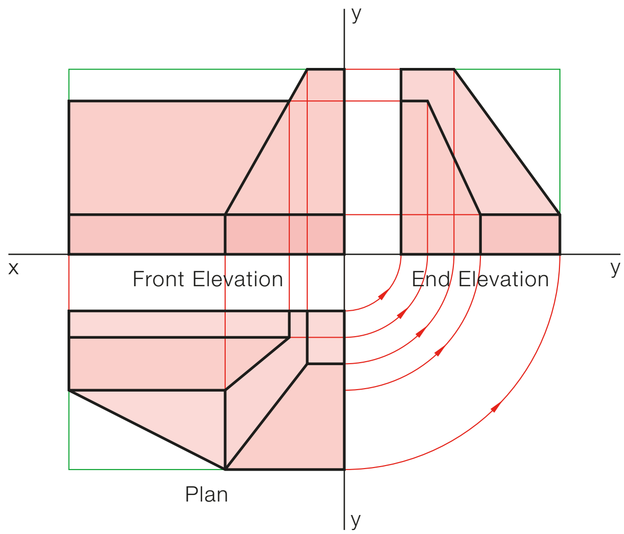
These arcs represent the end vertical plane as it swings around into place.

(5) The details of the three views are built up as shown in Fig. 1.12.

▼ Fig. 1.11

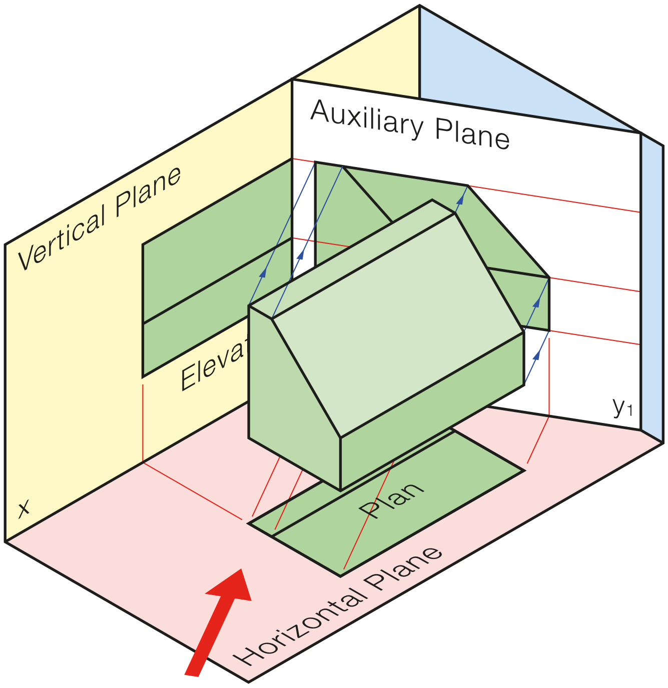


▼ Fig. 1.12



Auxiliary Elevation

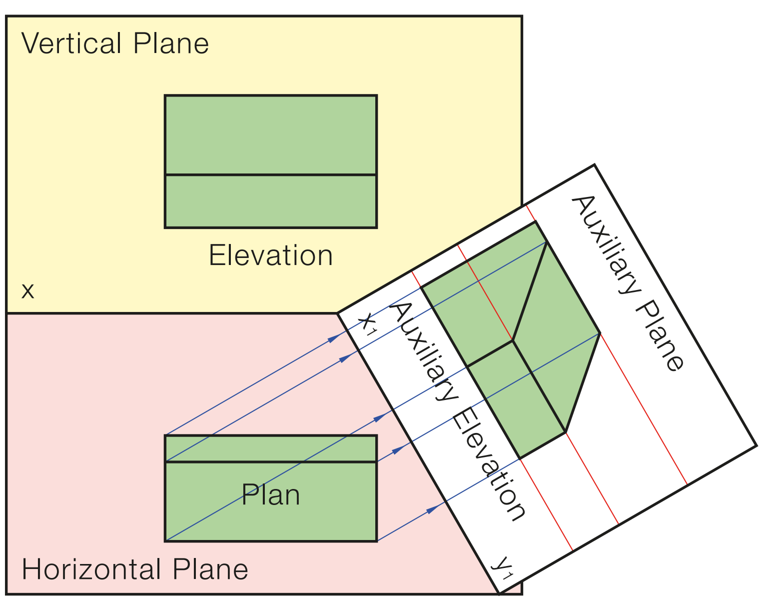
The front elevation, end elevations and plan together give a huge amount of information about the object being drawn. We looked from in front of the object, from the sides and from above the object to obtain these views. The views themselves were projected onto the principal planes of reference. An object can of course be viewed from any direction and the image projected onto a new plane. Remember, the plane onto which an image is projected must be perpendicular to the line of sight. An image projected onto a vertical plane is an elevation. To see an image on a vertical plane we must view horizontally. An auxiliary elevation, therefore, is a view parallel to the horizontal plane and at an angle between 0° and 90° to the vertical plane.



▲ Fig. 1.13

Fig. 1.13 shows the principal planes of reference. The front elevation and plan are projected in the normal way. To view in the direction of the arrow we must introduce a new vertical plane, as shown, perpendicular to the line of sight. This auxiliary plane intersects the horizontal plane along a line which we call the x_1y_1 line. The view of the object may now be projected onto this plane.

Since the line of sight is horizontal, the image is an elevation. The heights used in the auxiliary elevation will be the same heights as in all the other elevations. Fig. 1.14 shows the planes folded down flat. The projection lines are always perpendicular to the xy line. It should be noted that the auxiliary plane can be close to the object or far away from the object, it will not affect the image in any way because the projection lines are parallel.

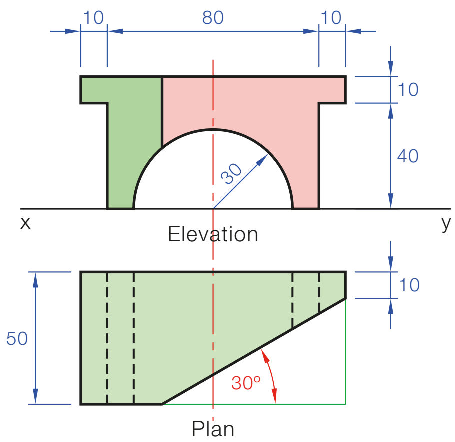


▶ Fig. 1.14

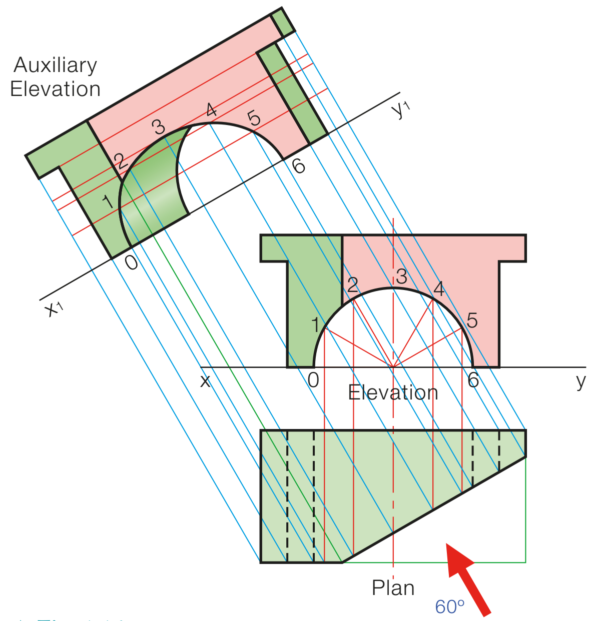
Fig. 1.15 shows the plan and elevation of an object which has been cut by a vertical plane as shown.

(i) Draw the given views.

(ii) Draw an auxiliary elevation of the object that will show the cut surface as a true shape.



▲ Fig. 1.15



▲ Fig. 1.16

(1) Divide the semicircle into six and index the points.

(2) The cut surface is at 30° in the plan so the x_1y_1 will be at 30° and the viewing angle at 60°.

(3) Project the points from the plan and take heights from the elevation.

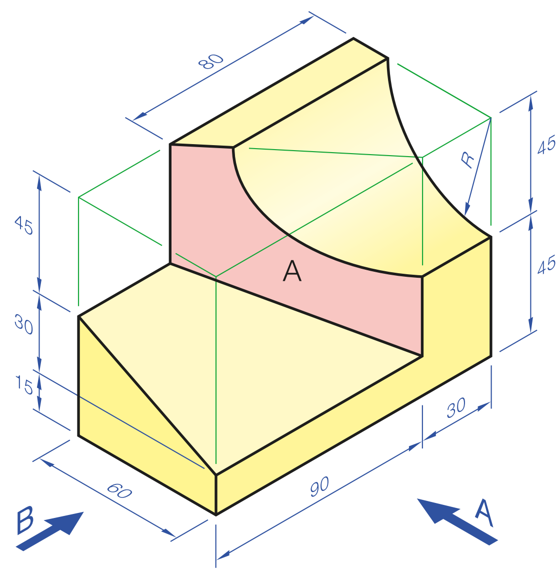
A pictorial drawing of a solid is shown in Fig. 1.17.

(i) Draw an elevation of the solid, viewing in the direction of arrow A.

(ii) Project a plan.

(iii) Draw an end elevation, viewing in the direction of arrow B.

(iv) Project a new elevation that will show the true shape of surface A.

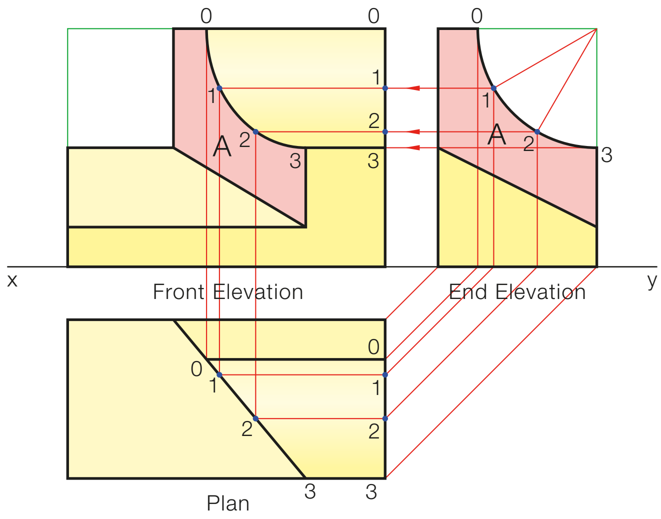


▲ Fig. 1.17

(1) Draw the xy line and set up the boxes for the views. The front elevation will be on the left and the end elevation to the right.

(2) The end elevation and the plan can be completed without difficulty.

(3) The curve in the front elevation is found by dividing the quadrant in the end elevation giving 0, 1, 2 and 3. These points are projected down to the plan and up to the front elevation. They are then projected across from the end view. Where the lines intersect gives points on the curve, Fig. 1.18.



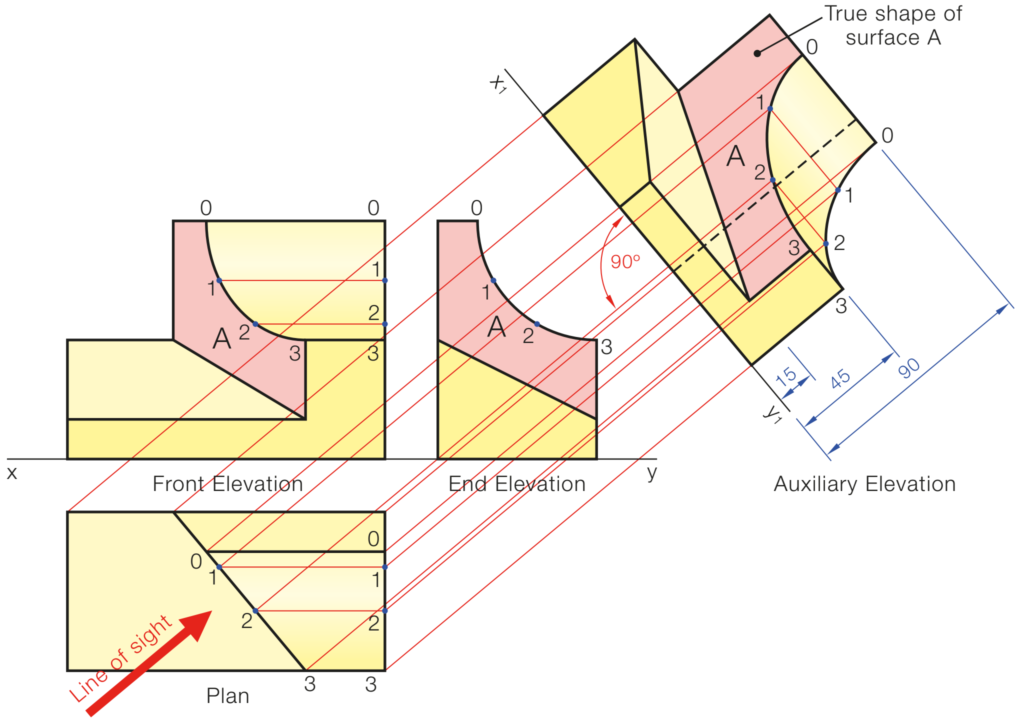
▲ Fig. 1.18

(4) In order to see the surface A as a true shape we must view it straight on. Surface A is seen as an edge view in the plan. We view perpendicular to this edge view in Fig 1.19.

(5) Draw x_1y_1 (the new vertical plane) parallel to surface A in plan and perpendicular to the line of sight.

(6) Project the points as for an ordinary elevation. Every point must be brought up including the two sets of points on the curves.

(7) The heights of all points on the auxiliary elevation will be the same as the corresponding points on the other elevations. The true shape is found in the auxiliary.



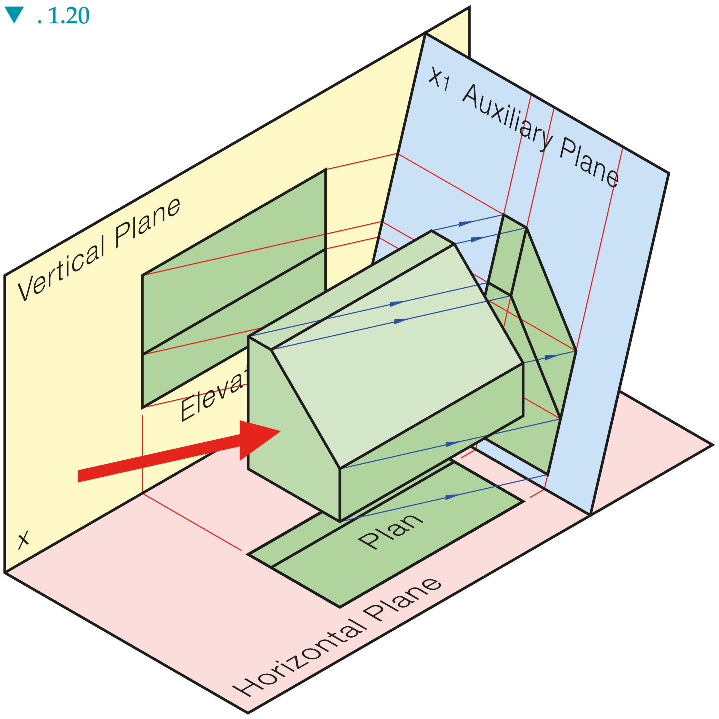
▲ Fig. 1.19

See worksheet 1.1

Auxiliary Plans

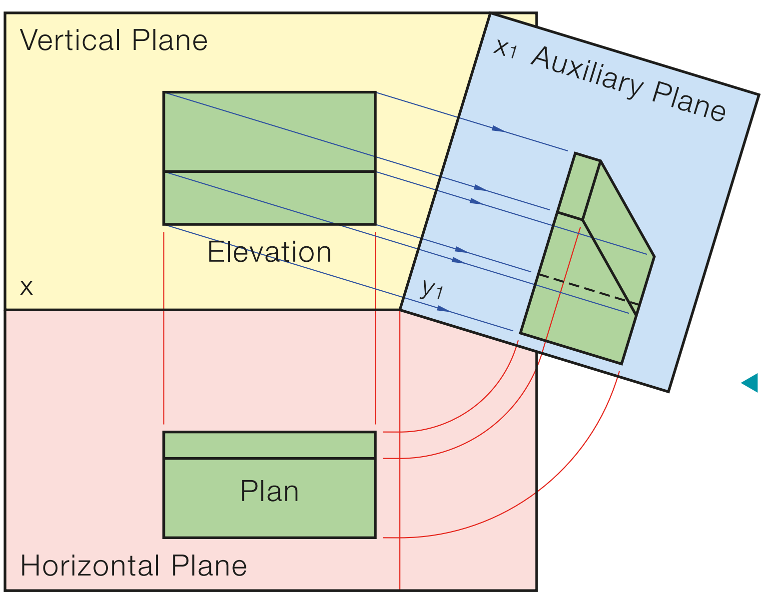
When viewing an object to see its plan we are viewing from directly above that object. The line of sight is vertical and is therefore parallel to the vertical plane. The view is projected onto the horizontal plane. When viewing an object to get an auxiliary plan we continue to view parallel to the vertical plane, but at an angle between 0° and 90° to the horizontal plane. As is always the case, the view is projected onto a plane that is perpendicular to the line of sight.

▼ . 1.20



The diagram Fig.1.20 shows the principal planes of reference. The front elevation and plan of an object are shown. These are projected in the normal way. To view in the direction of the arrow we introduce a new plane perpendicular to the line of sight. The line of sight is inclined to the horizontal plane and parallel to the vertical plane. The auxiliary plane is inclined to the horizontal plane and perpendicular to the vertical plane. The x_1y_1 is the line of intersection between the auxiliary plane and the vertical plane. Since the line of sight is parallel to the vertical plane, the auxiliary plan which is produced will be the same distance from the x_1y_1 as the ordinary plan is from the xy line.

As before, the plane itself can be positioned close to, or far away from, the object as long as it is at the correct angle. Fig. 1.21 shows the planes folded back.



◀ Fig. 1.21

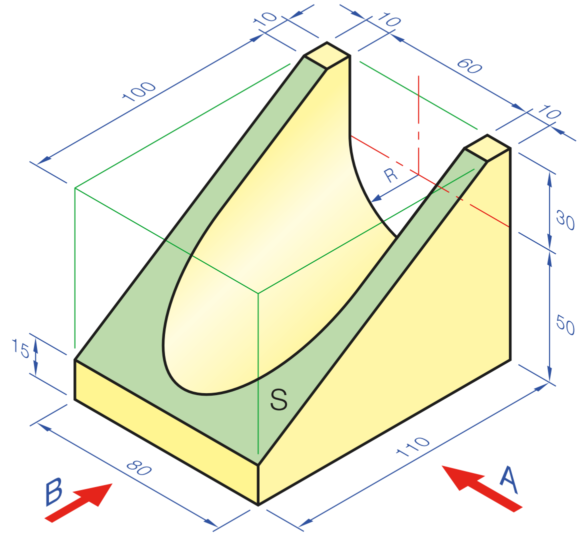
The pictorial drawing of a solid is shown in Fig. 1.22.

(i) Project a front elevation of the solid, viewing in the direction of arrow A.

(ii) Draw an end elevation, viewing in the direction of arrow B.

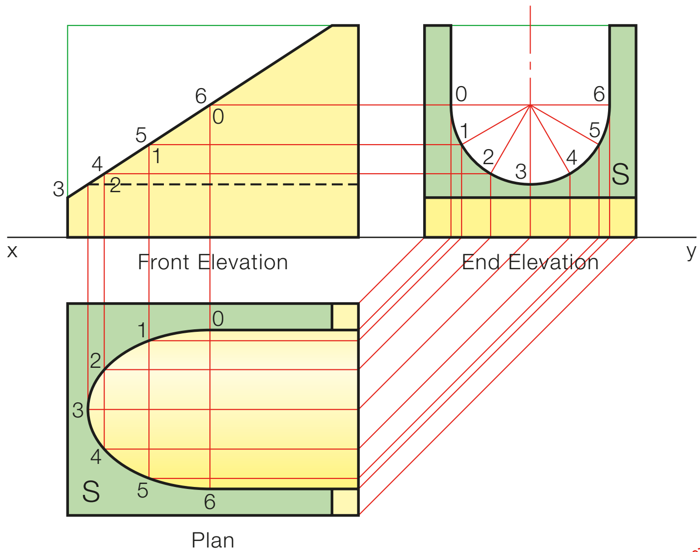
(iii) Project a plan.

(iv) Project a new plan of the solid showing the true shape of surface S.



▲ Fig. 1.22

Always think through the problem before starting to plan how the various components of the solution will be positioned on the sheet.



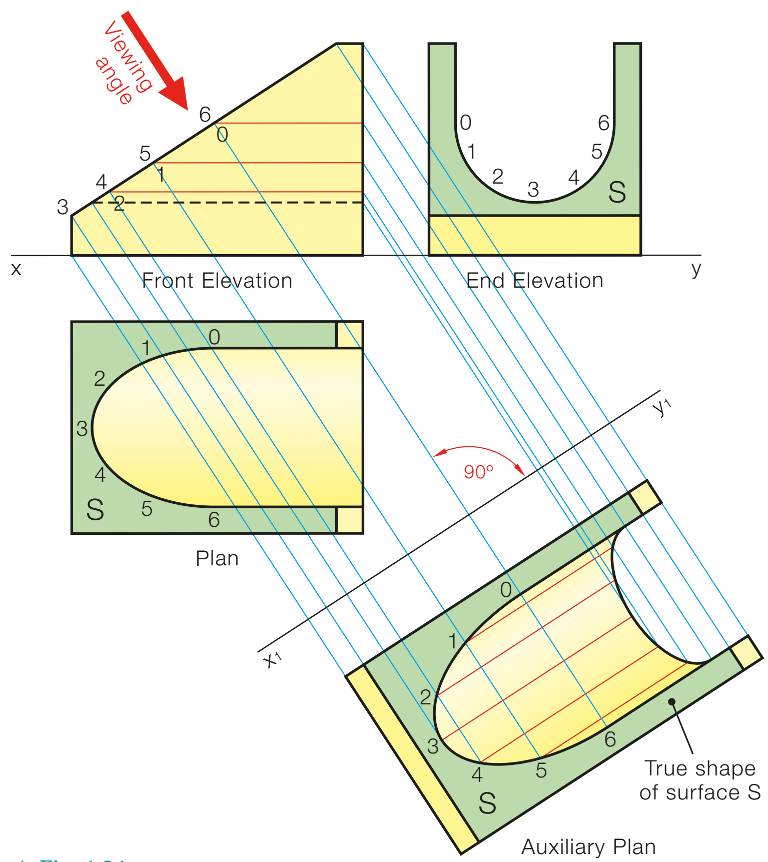
▲ Fig. 1.23

(1) Front elevation will be on the left and the end elevation to its right, Fig 1.23.

(2) Both elevations need to be completed before the plan. The curve in the plan is found in the usual way.

(3) To see the true shape of a surface we view perpendicular to the edge view.

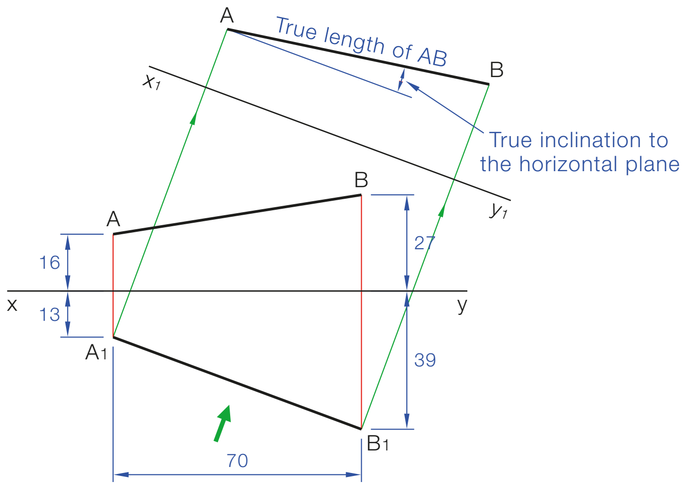
(4) The construction is clearly shown from the illustration Fig. 1.24.



▲ Fig. 1.24

See worksheet 1.2

Further Uses of Auxiliary Views



▲ Fig. 1.25

To find the true length of a line AB and to find its inclination to the horizontal plane.

(1) To see the true inclination of the line to the horizontal plane we use an auxiliary elevation. We view perpendicular to the plan of the line.

(2) Draw the x_1y_1 line parallel to the line in plan.

(3) Project the new elevation, which shows both the true length and the true inclination to the horizontal plane (HP).

To find the true length of a line AB and to find its inclination to the vertical plane.

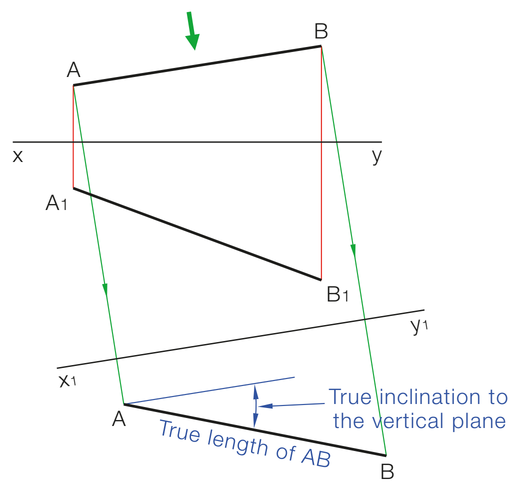
(1) Set up the plan and elevation to the same measurements as Fig. 1.26.

(2) To see the true inclination to the vertical plane an auxiliary plan must be projected.

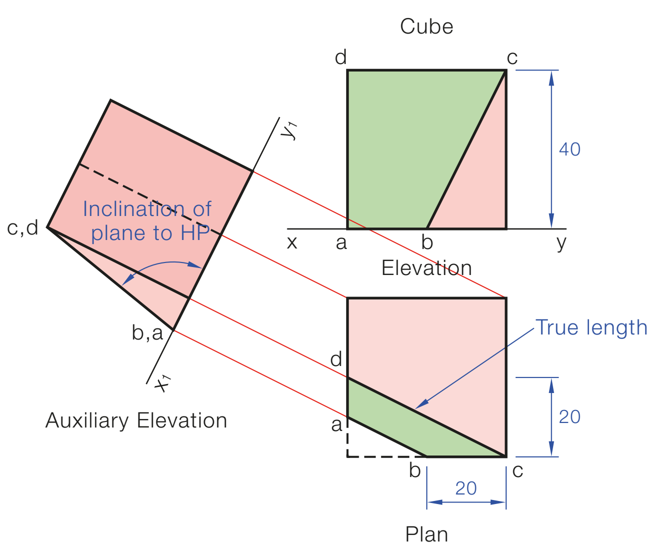
(3) View perpendicular to line AB in elevation.

(4) Draw x_1y_1 parallel to line AB in elevation.

(5) Project the auxiliary plan showing the true length and the required inclination.



▲ Fig. 1.26



▲ Fig. 1.27

To find the inclination of a plane abcd to the horizontal plane.

Lines dc and ab are horizontal, and are therefore seen as true lengths in the plan. Project an auxiliary elevation, viewing in the direction of the true lengths. The plane abcd will appear as an edge view in the auxiliary and the angle can be seen.

Note:

(1) A line on a plane parallel to the xy line in elevation will appear as a true length in plan.

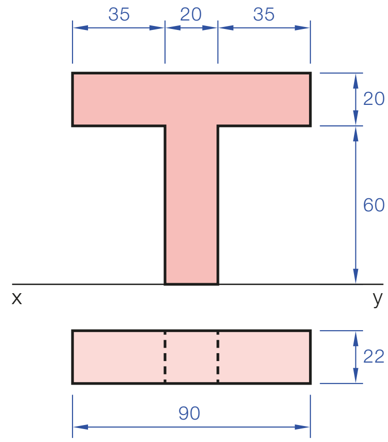
The converse is also true.

(2) A line on a plane parallel to the xy line in plan will appear as a true length in elevation.

(3) When a line on a plane appears as a true length, viewing along the true length will show an edge view of that plane.

Activities

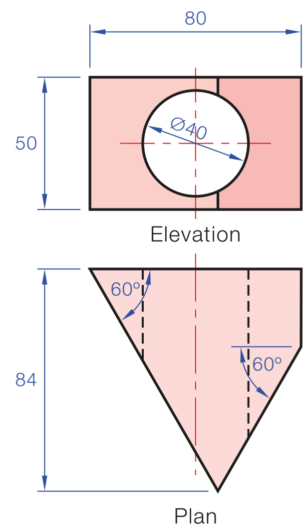
Q1. Fig. 1.28 shows the plan and elevation of an object. Make a pictorial drawing showing the planes of reference and demonstrating how the views are projected.



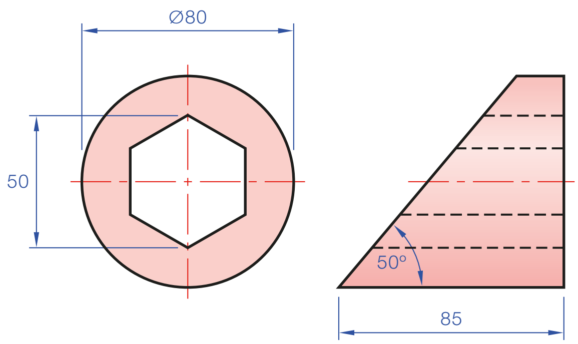
▲ Fig. 1.28

Q2. Make a pictorial drawing showing the planes in question one rebatted in line with the vertical plane. Show the elevation and plan in their respective positions on the planes.

Q3. Fig. 1.29 shows the elevation and plan of a solid. Draw the given views and project an end view looking from the left.



◀ Fig. 1.29



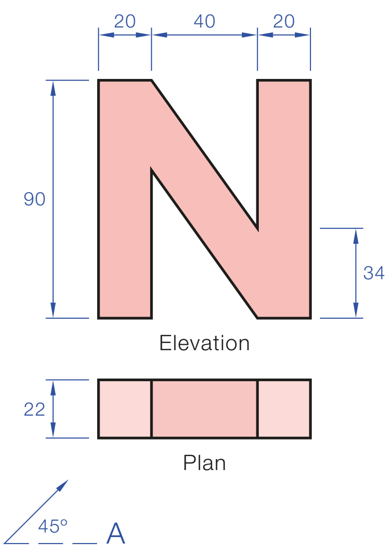
▲ Fig. 1.30

Q4. Two views of a shaped cylinder are shown in Fig. 1.30. Draw the given views and project a plan.

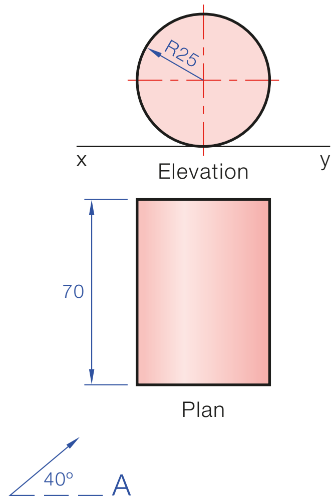
Auxiliary elevations

Q5. Given the plan and elevation in Fig. 1.31. Draw the given views and project an auxiliary elevation in the direction of arrow A.

Q6. The diagram Fig. 1.32 shows the plan and elevation of a cylinder lying on the horizontal plane. Draw the given views and project an auxiliary elevation of the solid viewing in the direction of arrow A.

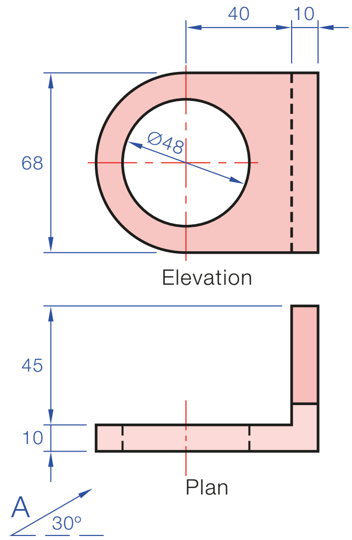


▲ Fig. 1.31



▲ Fig. 1.32

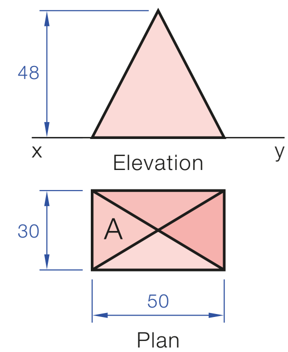
Q7. The diagram **Fig. 1.33** shows the plan, elevation and end view of a solid. Draw the given views and project an auxiliary elevation in the direction of the arrow A.



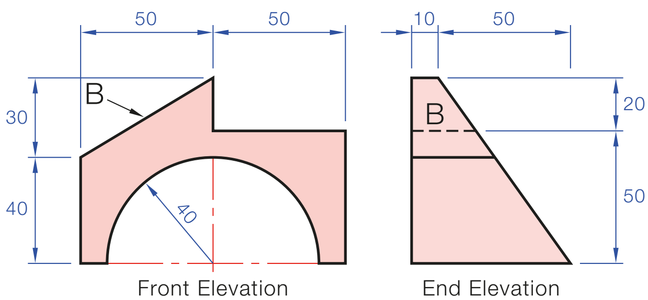
▶ **Fig. 1.33**

Auxiliary plans

Q8. Draw the given views, **Fig. 1.34**, of a rectangular-based pyramid. Project a new plan that will show the true shape of surface A.



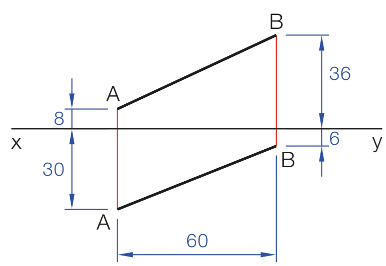
▶ **Fig. 1.34**



▲ **Fig. 1.35**

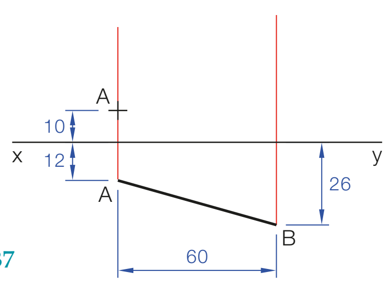
Q9. Given the front elevation and end elevation, **Fig. 1.35**. Draw the given views and project a plan. Project a new plan of the solid showing the true shape of surface B.

Q10. Given the plan and elevation of a line AB, **Fig. 1.36**. Find the true length of the line and its true inclination to the horizontal plane using an auxiliary view.



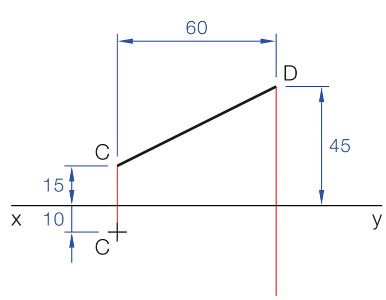
◀ **Fig. 1.36**

Q11. Given the plan of a line AB and the elevation of one end of the line, A, **Fig.1.37**. The true inclination of this line is to be 30° to the horizontal plan. Draw the elevation.



▶ **Fig. 1.37**

Q12. Given the elevation of a line CD and the plan of one end of the line, C, **Fig. 1.38**. If the true length of this line is to be 80 mm, complete the plan.

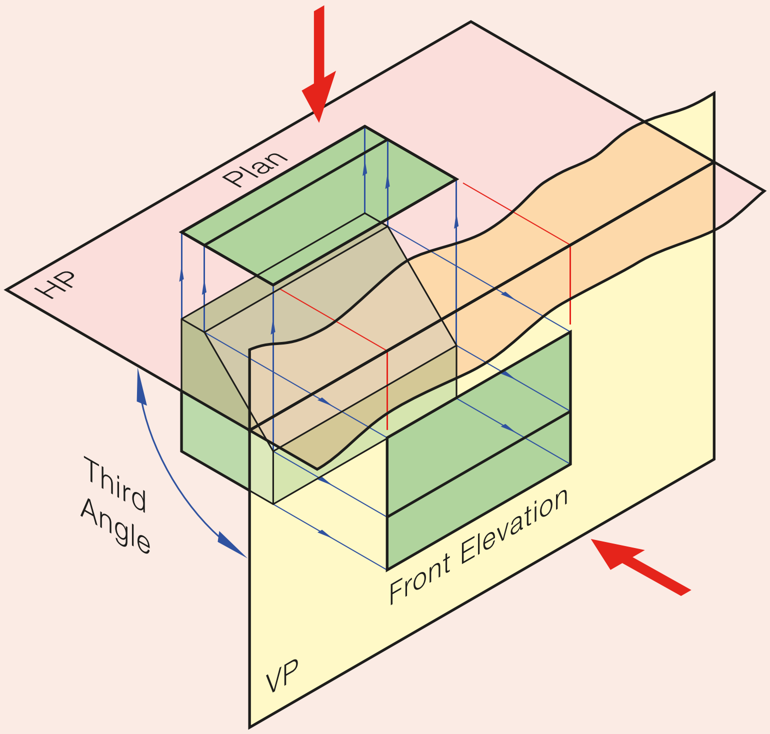


◀ **Fig. 1.38**

HIGHER LEVEL

Third-angle Projection

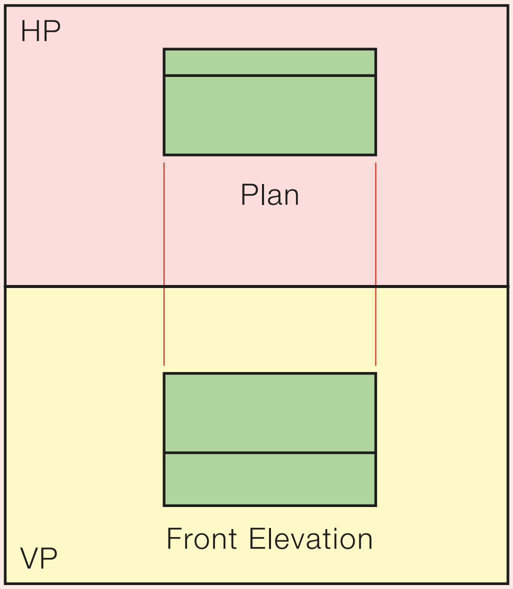
Third-angle projection is the system of orthographic projection which is more favoured in America whereas first-angle projection is more favoured in Europe. The object to be drawn is placed in the third angle of the intersecting reference planes. The views are found by looking **through** the planes.



▲ Fig. 1.39

Fig. 1.39 shows the arrangement of planes and object. The front elevation is found by looking through the vertical plane. The view that is seen is what is projected onto the plane. Similarly, for the plan, we look down through the horizontal plane. The view that is seen is projected up to the horizontal plane.

The horizontal plane is hinged about the xy line until it is vertical. The plan, therefore, is above the xy line and the front elevation is below the plan and the xy line.

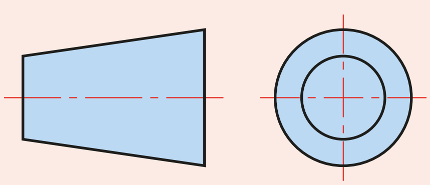


▲ Fig. 1.40

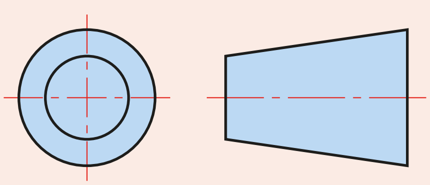
The two end views are drawn in line with the front elevation, Fig. 1.40. They can be projected in a similar way as was done in first-angle projection. It should be noted that we are viewing through the plane and then projecting the image back onto the same plane. The end elevation on the left, therefore, will be the view from the left and the end elevation to the right of the front elevation will be the view from the right of the object.

Symbol

The angle of projection must be stated on a drawing either by using text or by using the appropriate symbol, Figures 1.41a and 1.41b.



▲ Fig. 1.41a First-angle Projection



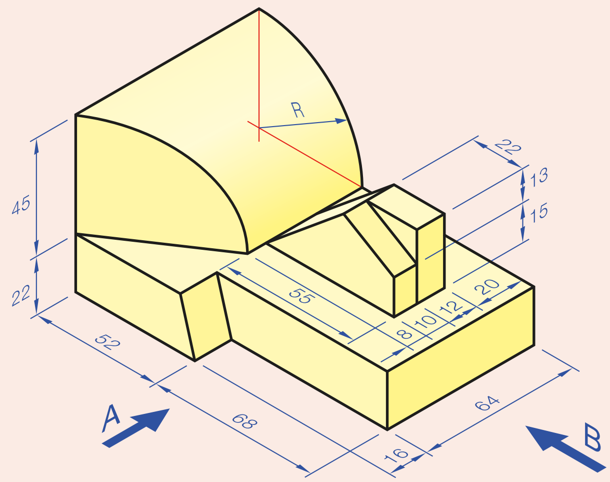
▲ Fig. 1.41b Third-angle Projection

A pictorial drawing of an object is shown in **Fig. 1.42**. Using third-angle projection draw:

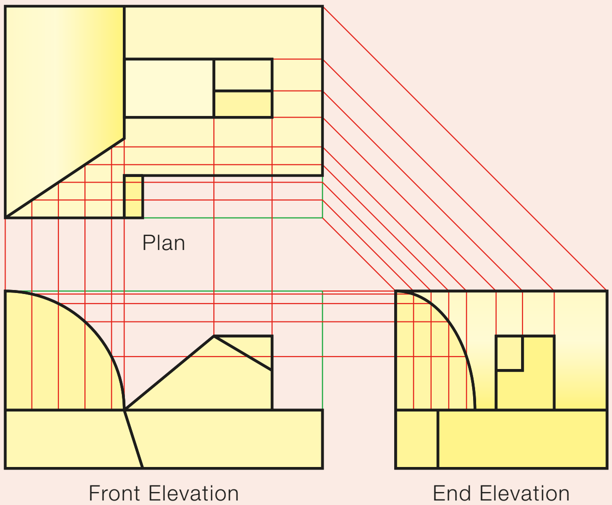
(i) A front elevation looking in the direction of arrow A.

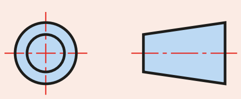
(ii) A plan.

(iii) An end elevation projected from the other two views.



▲ Fig. 1.42





▲ Fig. 1.43

(1) Set up the relative positions of the three views. The arrow A is pointing from the left so the front elevation will be drawn on the left.

(2) The plan is directly above the front elevation.

(3) The arrow B is viewing from the right so the end elevation will be to the right of the front elevation.

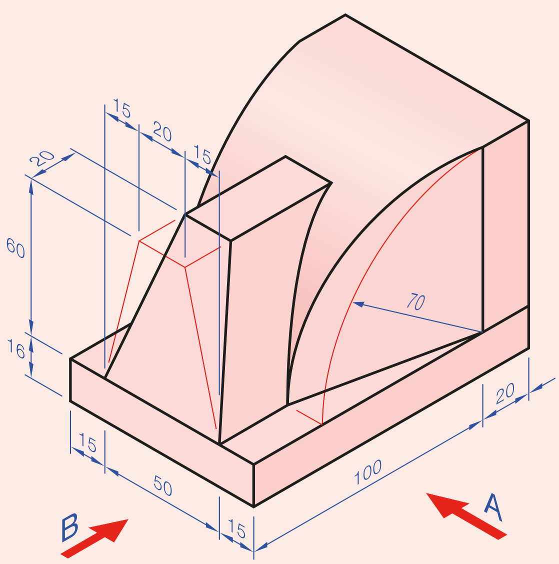
(4) The symbol must be used to indicate third-angle projection, Fig. 1.43.

Fig. 1.44 shows a pictorial view of a shaped block. Using third-angle projection draw:

(i) A front elevation viewing in the direction of arrow A.

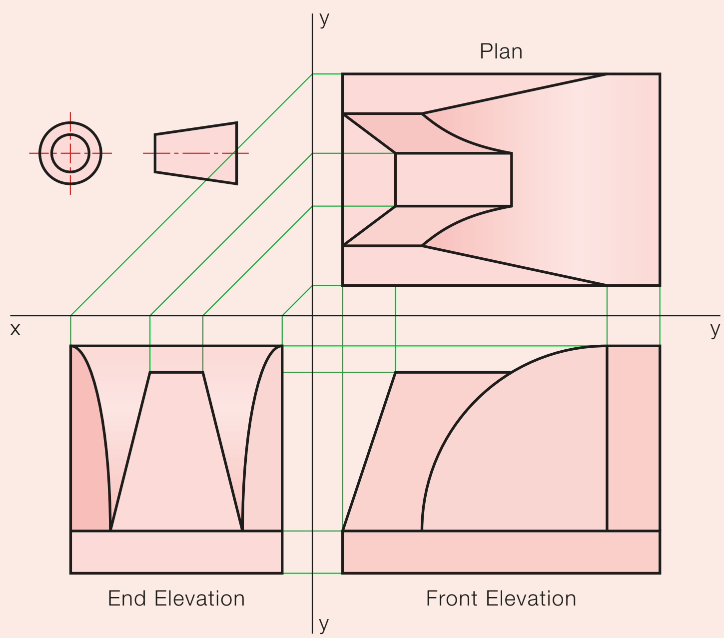
(ii) A plan.

(iii) An end elevation viewed in the direction of arrow B.



▲ Fig. 1.44

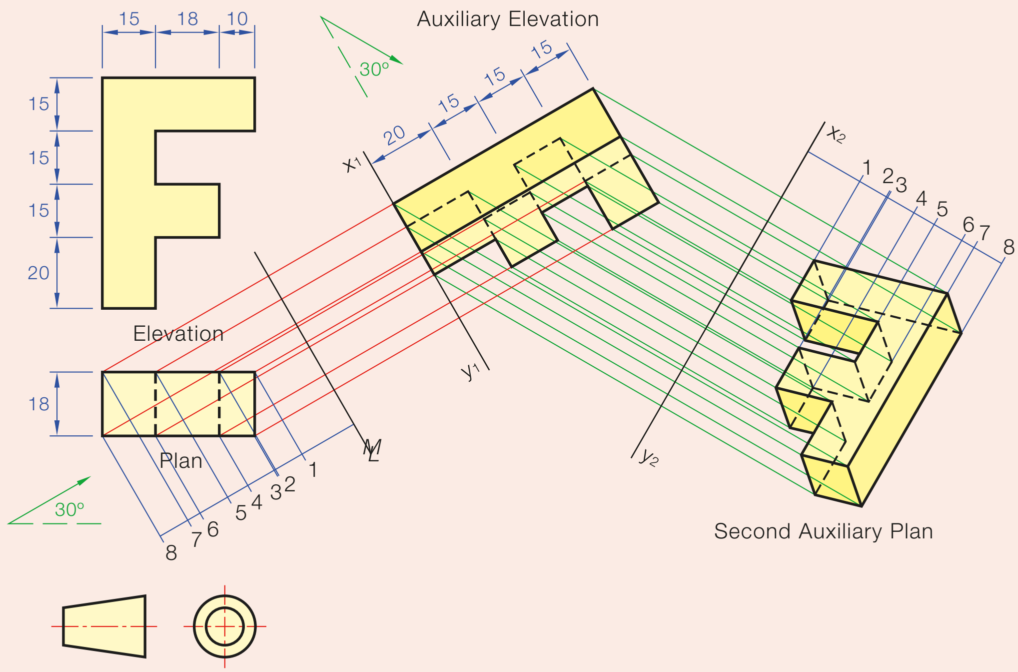
Fig.1.45 shows a possible arrangement for the xy line and the yy line. The construction of the views themselves should be straightforward.



▲ Fig. 1.45

Second Auxiliary Views

Once an auxiliary view is constructed it can be used as a basis for another auxiliary. The second auxiliary can be used to get a third auxiliary view and so on. An auxiliary plan can only be projected from an elevation or an auxiliary elevation. Similarly, an auxiliary elevation can only be projected from a plan or an auxiliary plan.



▲ Fig. 1.46

(1) Draw the elevation, plan and auxiliary elevation in the normal way, Fig. 1.46.

(2) The new line of sight is shown at 30° to the x_1y_1. Set up the x_2y_2 perpendicular to this line of sight.

(3) Points are projected from the auxiliary elevation in the direction of the line of sight.

(4) The distances for the second auxiliary plan are measured from the x_1y_1 back to the plan for each point. It is often useful to put a line, parallel to the x_1y_1 line, closer to the plan. This line is called a **measuring line** or a **datum line**. Measuring from the measuring line to the plan instead of from the x_1y_1 line to the plan has the effect of bringing the second auxiliary plan closer to the x_2y_2 line.

Note:

- **Lines that are parallel remain parallel in all views.**
- **When finding distances for an auxiliary you measure from the xy line before the one for the view being found, e.g. if projecting a fourth auxiliary we would be drawing it from x_4y_4.Measurements would be taken from the previous xy line, i.e. x_3y_3.**
- **When finding distances for an auxiliary you measure to the view before the view being projected from, e.g. if projecting a fourth auxiliary, the view would be projected from the third auxiliary, therefore the measurements are taken from the second auxiliary.**

HIGHER LEVEL

Applications of Second Auxiliary View

To project the point view of a line.

A point view of a line is when a view is taken down the length of the line and the whole line is only seen as a point. Only the end of the line is seen and it is a dot.

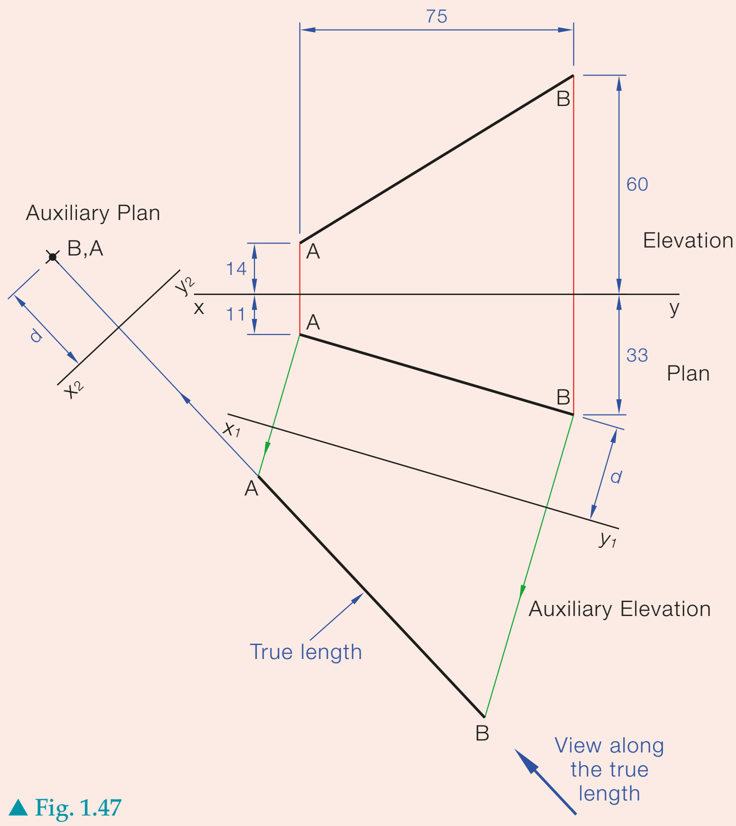
To obtain a point view of a line, a view is projected to show the true length of the line. A subsequent view is then taken viewing along the true length.

(1) Project the plan and elevation of the line.

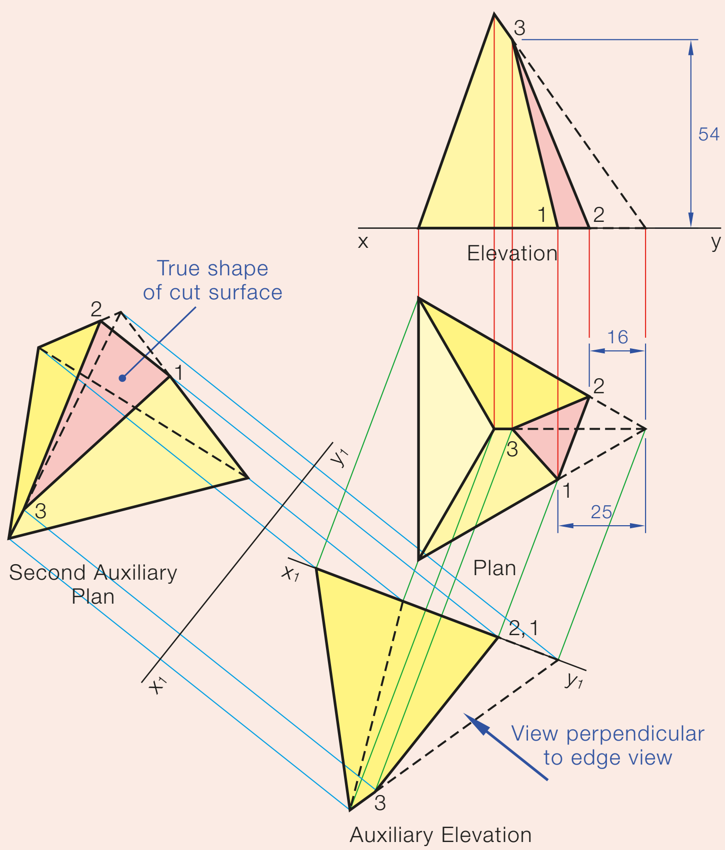
(2) Draw x_1y_1 parallel to the line in plan and project an auxiliary elevation. This auxiliary elevation shows line AB as a true length.

(3) The second auxiliary is projected from the first, viewing along the true length. The x_2y_2 is perpendicular to the true length.

(4) Both A and B end on the same point, as they are both distance d from the x_1y_1 in the plan.



▲ Fig. 1.47



Given a tetrahedron of 75 mm side which is cut as shown in Fig. 1.48. Project a view of the given solid showing the true shape of the cut surface.

(1) The edge 1,2 is horizontal and is therefore seen as a true length in plan.

If we view along the true length of a line, the plane on which the line rests will be seen as an edge view.

Project the auxiliary elevation with x_1y_1 perpendicular to 1,2 in plan.

(2) Project perpendicular to the edge view to show the true shape. Draw x_2y_2 parallel to the edge view. Distances for the second auxiliary plan are taken from the x_1y_1 back to the plan.

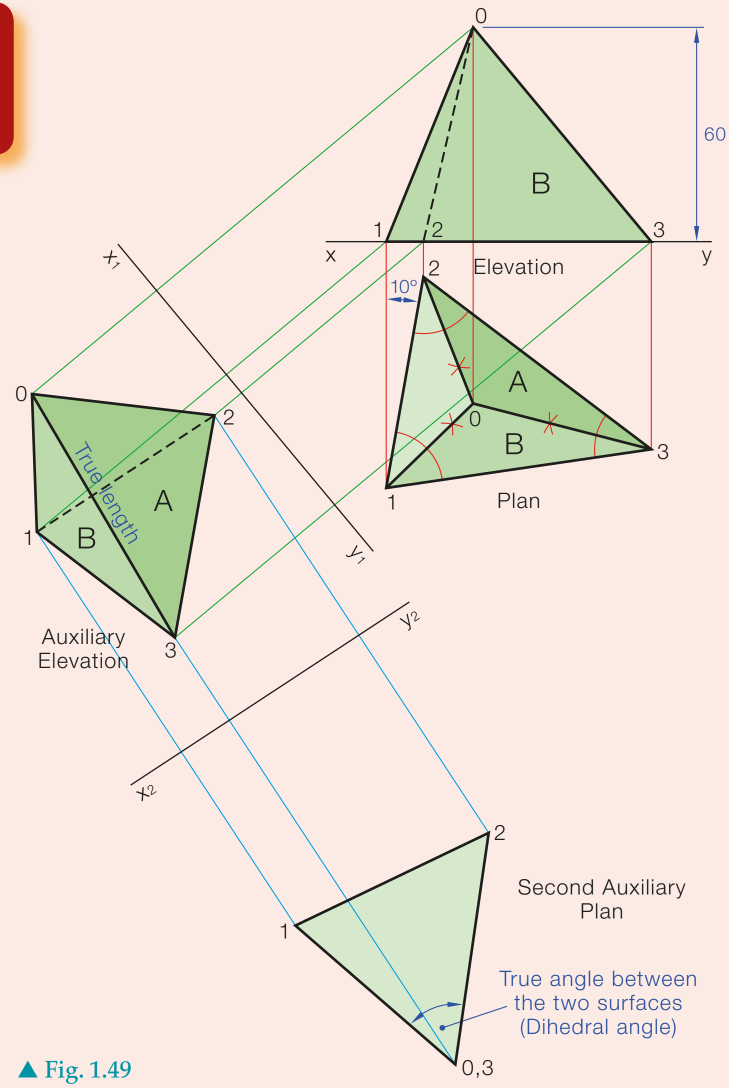
◀ Fig. 1.48

Given the solid, Fig. 1.49.
Side 1,2 = 60 mm, side 1,3 = 75 mm, side 2,3 = 80 mm.
Find the true angle between surfaces A and B.

(1) Line 0,3 is the line of intersection between the two planes. Project either an auxiliary elevation or auxiliary plan to show this line as a true length. In Fig. 1.49 x_1y_1 is drawn parallel to 0,3 in the elevation. The auxiliary plan will show 0,3 as a true length.

(2) Project a point view of 0,3. View in the direction of the true length. The x_2y_2 line is perpendicular to the true length. When this view is projected, both plane A and plane B are seen as edge views. The angle between the planes is clearly seen. This angle is called the **dihedral angle**.

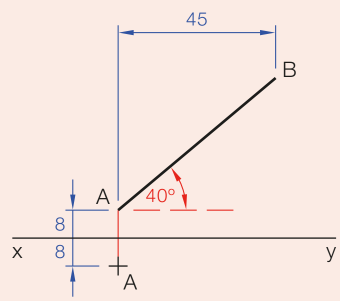
See worksheet 1.3



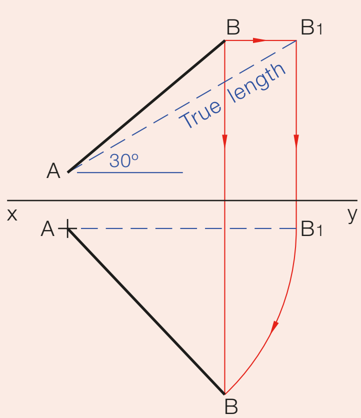
▲ Fig. 1.49

Projection of Lines Given Angles of Inclination

Given the elevation of a line AB and its true inclination to the horizontal plane as 30°. Draw the plan of the line given one point.



◀ Fig. 1.50



▲ Fig. 1.51

(1) The heights of A and B will remain the same. Draw a line starting at A in elevation and at the correct angle.

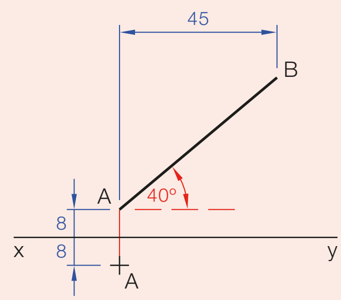
(2) Project B across to intersect this line at B.

(3) Project to plan. Since it is a true length in elevation it must be parallel to the xy line in plan.

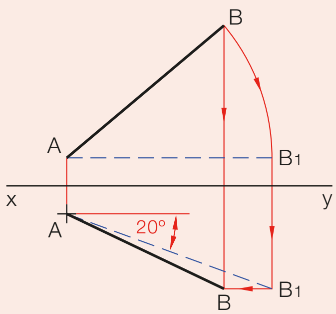
(4) Rotate the line about point A in plan.

(5) Drop point B from elevation to intersect the rotation.

Given the elevation of a line AB and its true inclination to the vertical plane as 20°. Given one point on the plan, complete the plan.



▶ Fig. 1.52



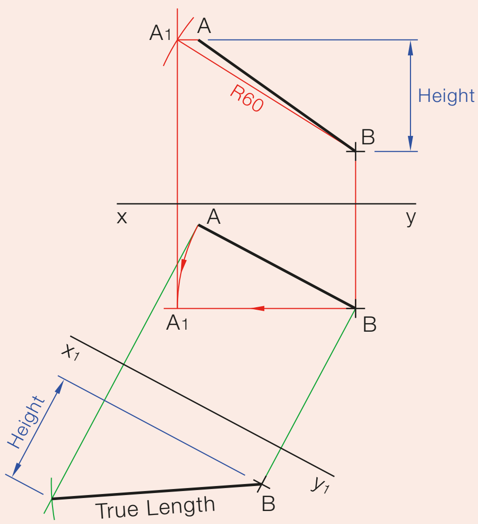
▲ Fig. 1.53

(1) Rotate line AB about A in elevation until it is horizontal.

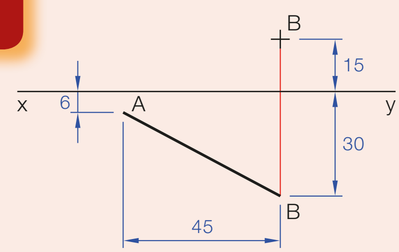
(2) Project to plan. The line when horizontal will make an angle of 20° to the xy line. Draw the line from A at 20° to the xy line, locating point B.

(3) B1 can be projected across locating B in plan as shown in Fig.1.52.

Given the plan of a line AB and the elevation of point B. The true length of the line is 60 mm. Find the elevation of the line.



▲ Fig. 1.55

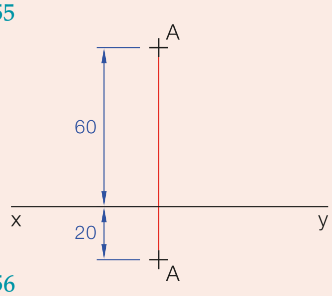


▲ Fig. 1.54

(1) Two approaches to solving this problem are shown in Fig. 1.55.

(2) The line is rotated about point B in plan until it is parallel to xy, giving A. A projection line is brought vertically from A1 to elevation. The true length of AB is swung from B in elevation finding A1. Point A is found in elevation by projection.

(3) The alternative method uses an auxiliary view. The construction is self-explanatory.



▲ Fig. 1.56

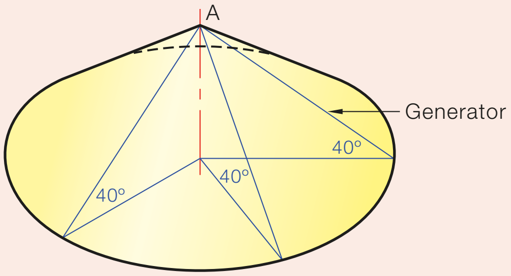
Given the true length of a line AB, its true angle to the vertical plane and its true angle to the horizontal plane. Draw a plan and elevation of the line in Fig. 1.56.

Length = 60 mm, Angle to vertical plane (VP) = 20°, Angle to HP = 40°.

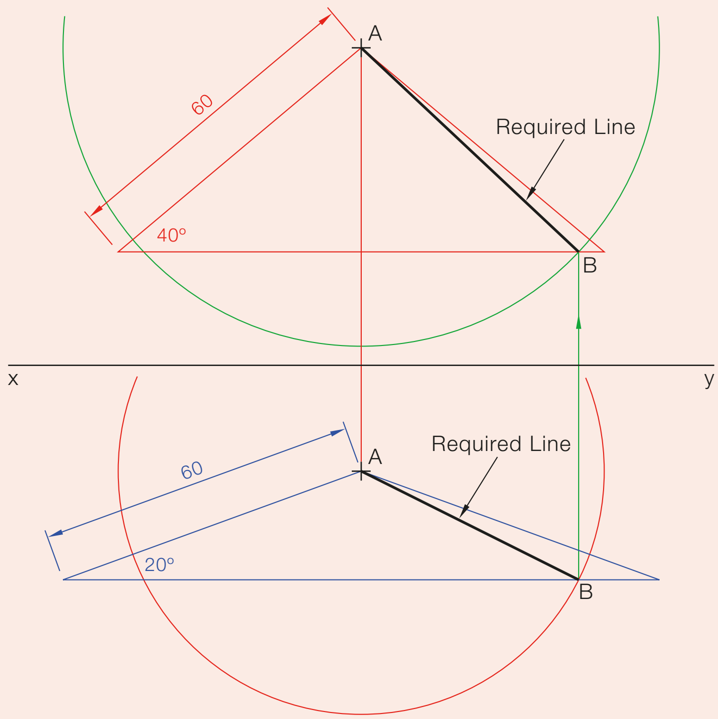
(1) Locate point A in plan and elevation.

(2) From A in the elevation, draw a line that is 60 mm long and is inclined at 40° to the horizontal plane.

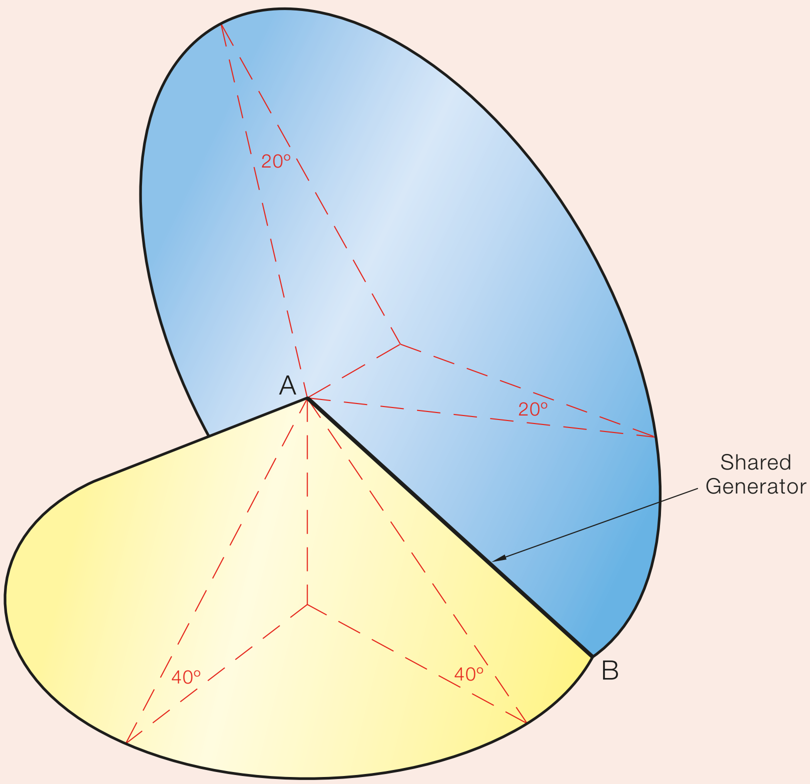
(3) Rotate this line about a vertical axis through A. This forms a cone with A as apex having every generator 60 mm long and inclined at 40° to the horizontal plane, Figures 1.57 and 1.58.



▲ Fig.1.58



▲ Fig. 1.57



▲ Fig. 1.59

(4) Draw the cone in plan.

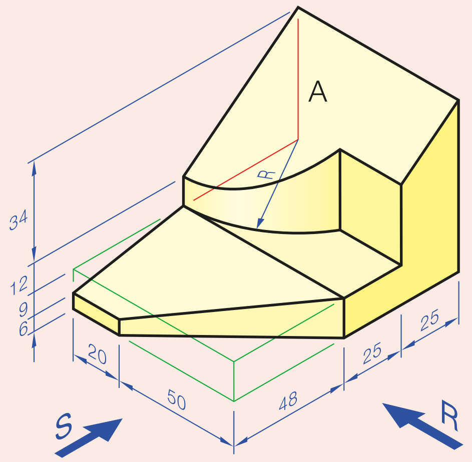
(5) From A in plan draw a line that is 60 mm long and is inclined at 20° to the vertical plane.

(6) Rotate this line about a horizontal axis through A. This forms a cone with A as apex having every generator 60 mm long and inclined at 20° to the vertical plane.

(7) The two cones produced will intersect along a shared generator in two locations. Either of these is the required line, Fig. 1.59.

Activities

Third-angle projection



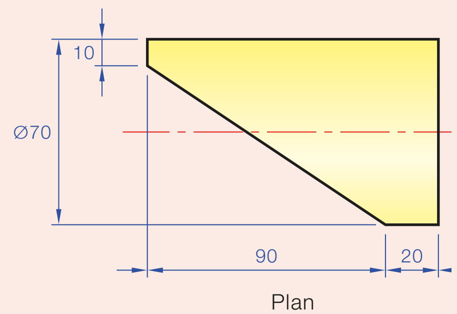
▲ Fig. 1.60

Q1. The diagram, **Fig. 1.60**, shows a shaped solid.

(i) In third-angle projection draw a front elevation viewing in the direction of arrow R.

(ii) Draw an end view looking in the direction of arrow S.

(iii) Project a plan from these views.



▲ Fig. 1.61

Q2. The diagram, **Fig. 1.61**, shows the plan of a cylinder which has been cut by a vertical plane. In third-angle projection draw:

(i) The front elevation.

(ii) An end elevation viewing from the left.

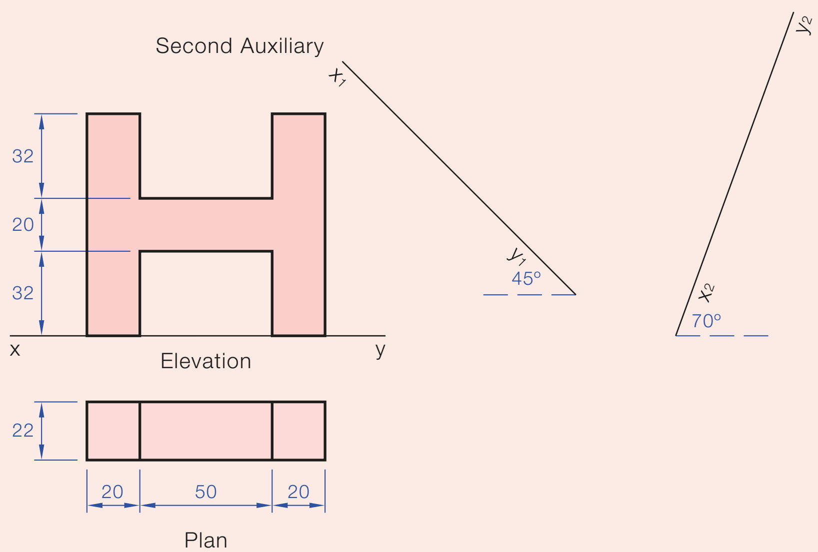
(iii) An auxiliary elevation viewing perpendicular to the cut surface. Include hidden detail and the third-angle symbol.

Q3. The diagram in **Fig. 1.62** shows the elevation and plan of a letter.

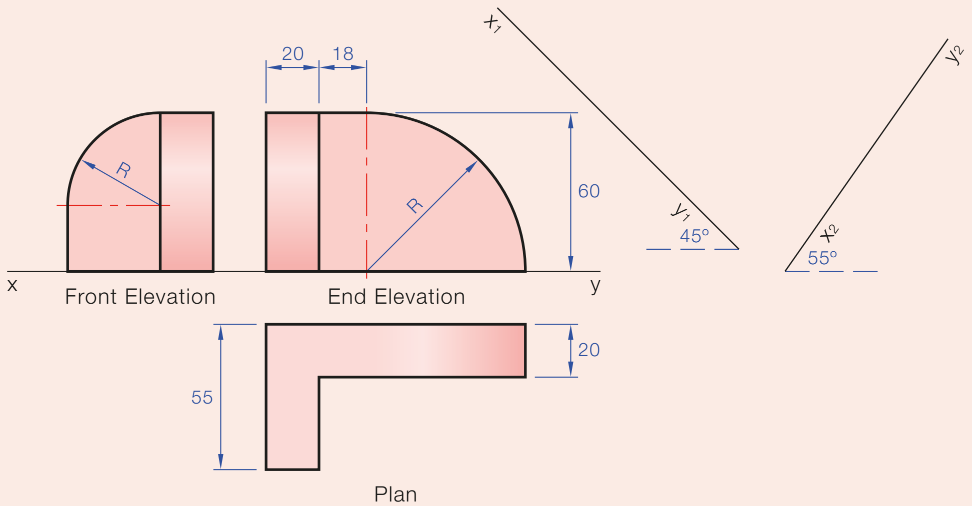
(i) Draw the given views.

(ii) Project an auxiliary elevation onto the x_1y_1.

(iii) Project a second auxiliary plan onto x_2y_2.



▲ Fig. 1.62



▲ Fig. 1.63

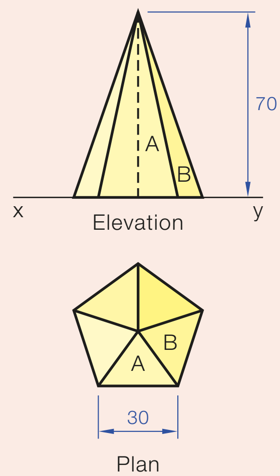
Q4. Draw the views indicated in **Fig. 1.63** and project an auxiliary elevation and a second auxiliary plan on the xy lines shown.

Q5. The diagram, **Fig. 1.64**, shows the plan and elevation of a regular pentagonal prism.

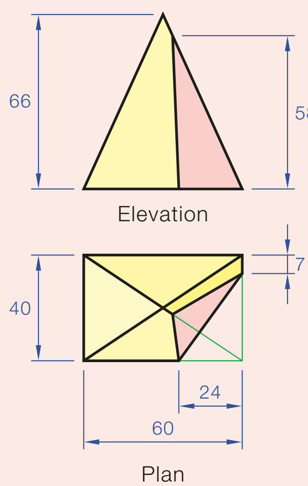
(i) Draw the given views.

(ii) Project a new elevation showing the true length of the line of intersection between surfaces A and B.

(iii) Project a second auxiliary plan showing the dihedral angle between surfaces A and B.



▲ Fig. 1.64



▲ Fig. 1.65

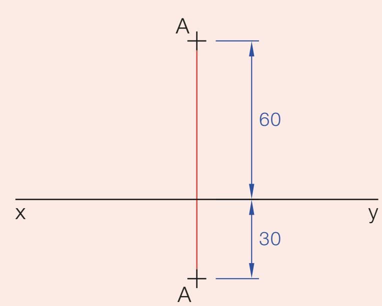
Q6. A rectangular-based pyramid has been cut by a plane as shown in **Fig. 1.65.**

(i) Draw the given views.

(ii) Project an auxiliary elevation which will show the true angle the cutting plane makes with the horizontal plane.

(iii) Project a second auxiliary plan showing the true shape of the cut surface.

Q7. Given the true length of a line as 70 mm, its true angle to the horizontal plane as 45° and its true angle to the vertical plane as 30°, **Fig. 1.66**. Given the projections of one end of the line, complete the plan and elevation.



▲ Fig. 1.66