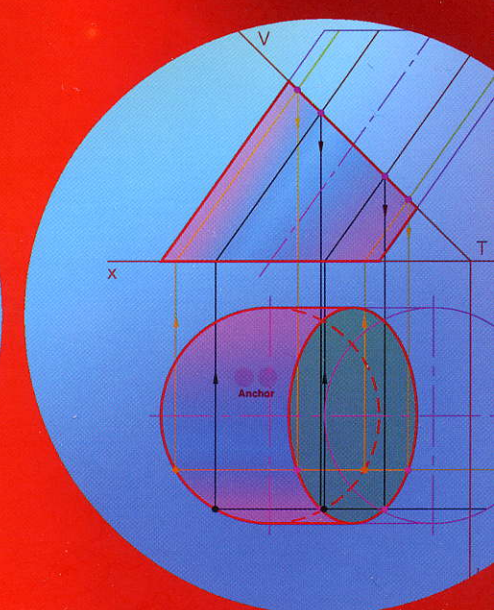
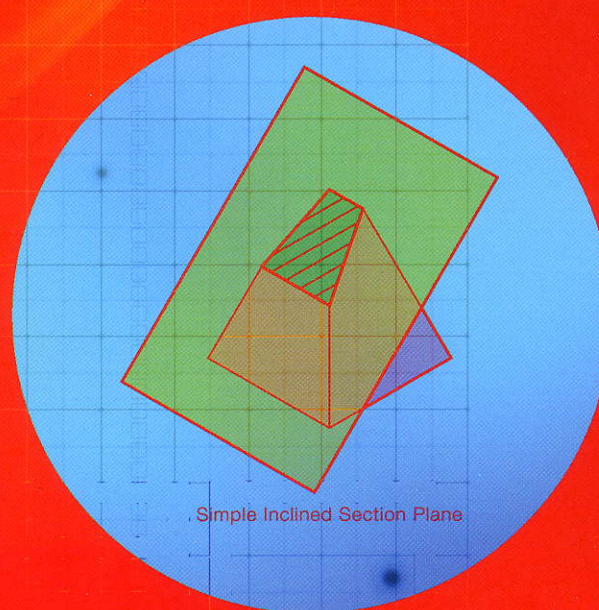
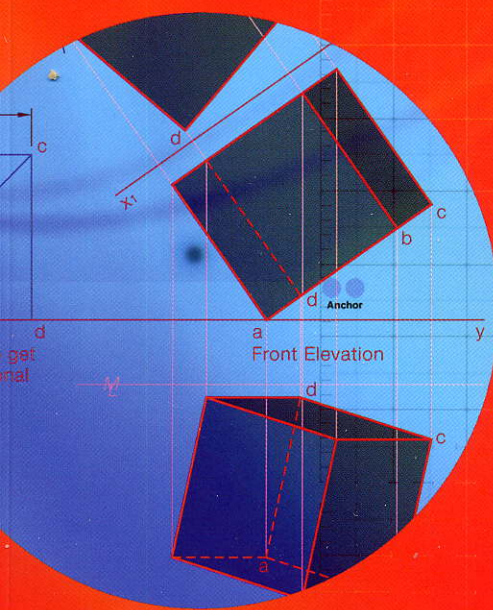


GRAPHICS IN DESIGN & COMMUNICATION

1

PLANE AND DESCRIPTIVE GEOMETRY



DAVID ANDERSON

10

Intersection of Solids

SYLLABUS OUTLINE

Areas to be studied:

- Intersection of surfaces of prisms, pyramids¹ and spheres, their frustra and composite solids and development of same.
 - *Intersection of right and oblique solids and their surface development.*

Learning outcomes

Students should be able to:

Higher and Ordinary levels

- Find the intersection of given lines and planes with given planes and curved surfaces.
- Establish the surface intersections of prisms, pyramids, spheres, their frustra and composite solids, where the intersecting solids have their axes parallel to at least one of the principal planes of reference².

Higher level only

- *Complete the intersection details of regular and oblique solids wherein their axes are parallel to one of the principal planes of reference.*

- 1 Pyramid and prism are taken to include the cone and cylinder respectively.
- 2 Principal planes of reference refers to the horizontal and vertical planes.

Interpenetrations

Everyday life throws up numerous examples of solids joining into other solids. When these solids join we get a **line of interpenetration**. The line of interpenetration will be either straight or curved depending on the types of solids joining together.

Solids made up of flat or plane surfaces penetrated by a similar solid, will produce straight lines as join lines. Solids with curved surfaces, penetrated by other solids will produce curved lines of penetration. In this chapter we investigate various methods of finding the lines of intersection between solids.

Method One: Limits Method

For some of the less complex interpenetrations, involving solids with plane surfaces, this is the best method. The solids involved will produce an interpenetration line made up of straight lines. If we can find the start, bend points and finish of each penetration line, we can find the full line of interpenetration.

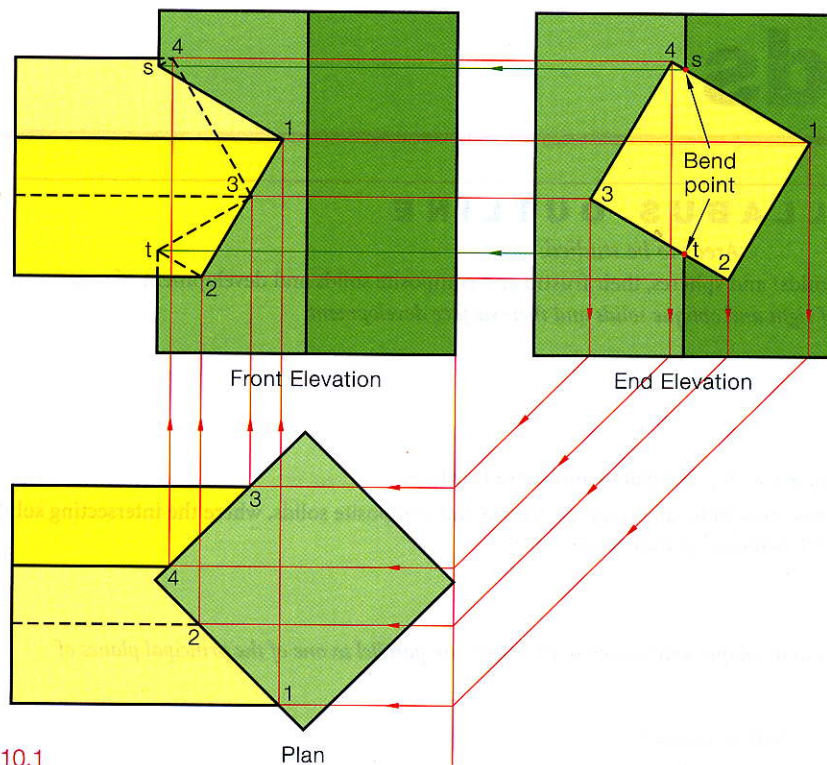


Fig. 10.1

The orthographic projection shown in Fig. 10.1 is a good example of the use of this method. Two square-based prisms are joined and the line of intersection between them is to be found. Information is found from the end elevation and the plan to complete the front elevation. The penetration points of edges 1, 2, 3 and 4 can be clearly seen in plan and are projected to elevation. Where a penetrating surface straddles two surfaces, the line of intersection will have a bend in it. An example of this is the surface containing 2 and 3. The bend point is found in the end view and is point t. The penetration line goes from '2' to 't' to '3'. The pictorial, Fig. 10.2, may help in the visualisation of this.

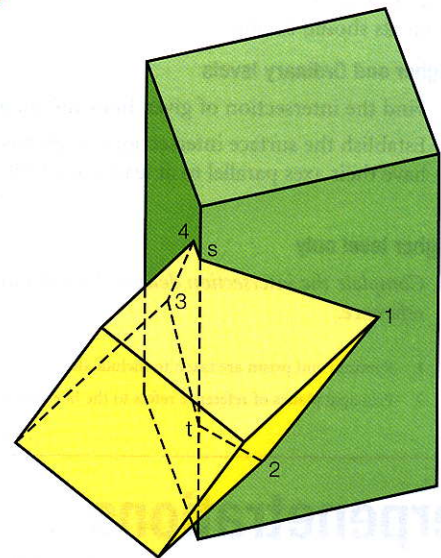


Fig. 10.2

Given the plan and end elevation of two intersecting solids, a hexagonal prism and a triangular prism. Draw the given views and complete the front elevation of the solids, Fig. 10.3.

- (1) Draw the given views. Both the plan and end view are complete and provide the necessary information for the front elevation.
- (2) Identify the bend points r, s, t and u in the end elevation. Project these across to the front elevation.
- (3) The end points for edges 1 and 2 are seen in plan and projected up to the front elevation.
- (4) Edge 3 does not make contact with the triangular prism.
- (5) It is important to use indexing in this type of question, Fig. 10.4.

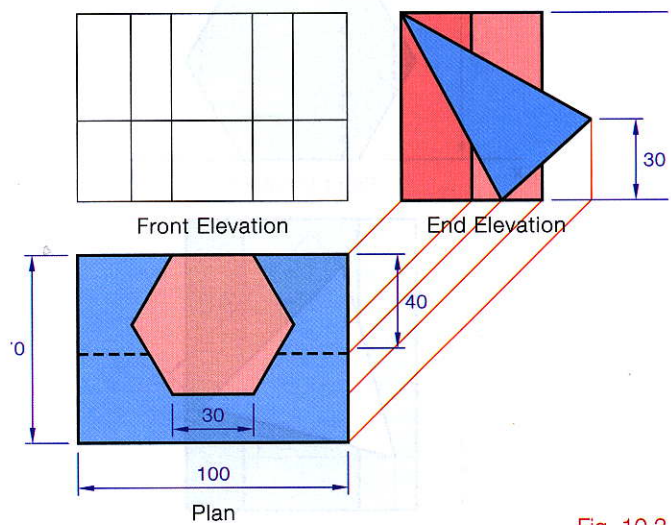


Fig. 10.3

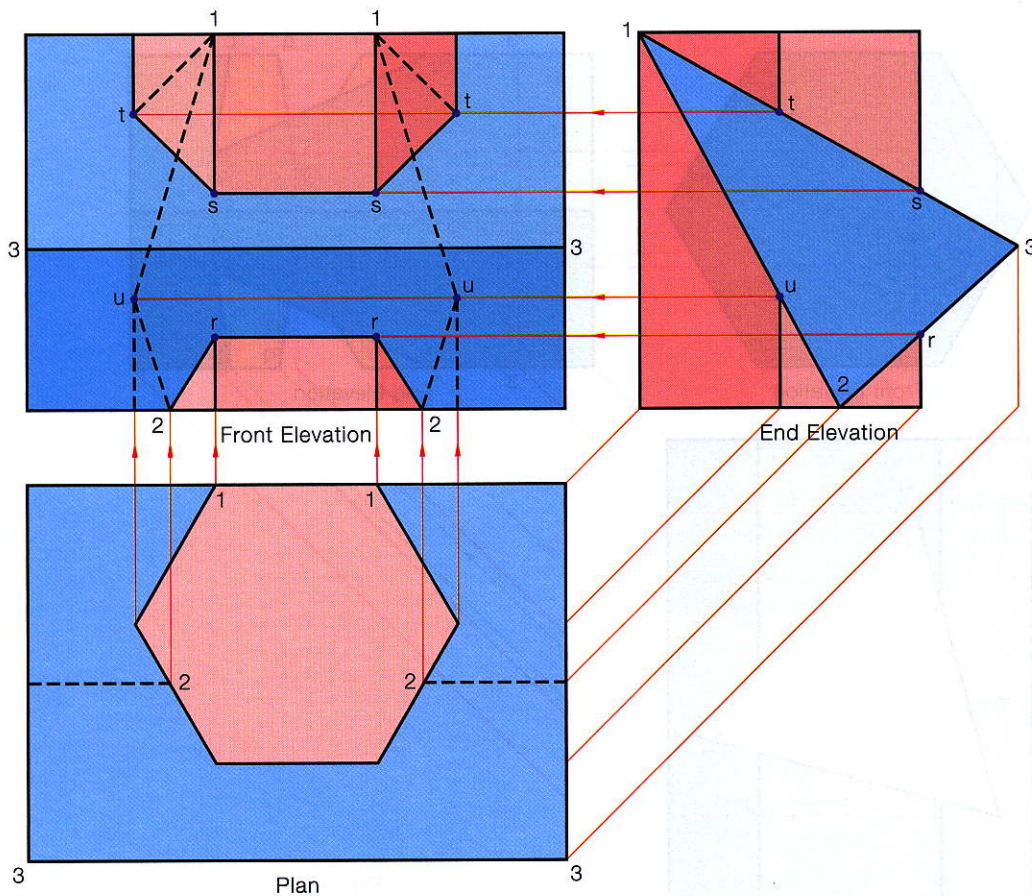


Fig. 10.4

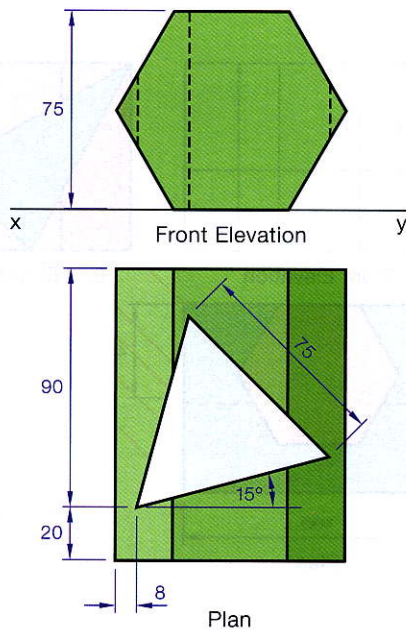


Fig. 10.5

Given the plan and elevation of a hexagonal prism with an equilateral triangular hole cut through it. Draw the given views and project an end view of the solid, Fig. 10.5.

- (1) Draw the plan and elevation as given. Both of these views are complete.
- (2) By projecting points from both of these views onto the end view we can build it up.
- (3) Note the bend points p, q, r and s where one of the cutting planes crosses two or more planes.
- (4) When all the points are found they are joined up in order. The order in which they are joined is best seen in the plan. 1 → p → q → 2 → r → 3 → s → 1, Fig. 10.6.

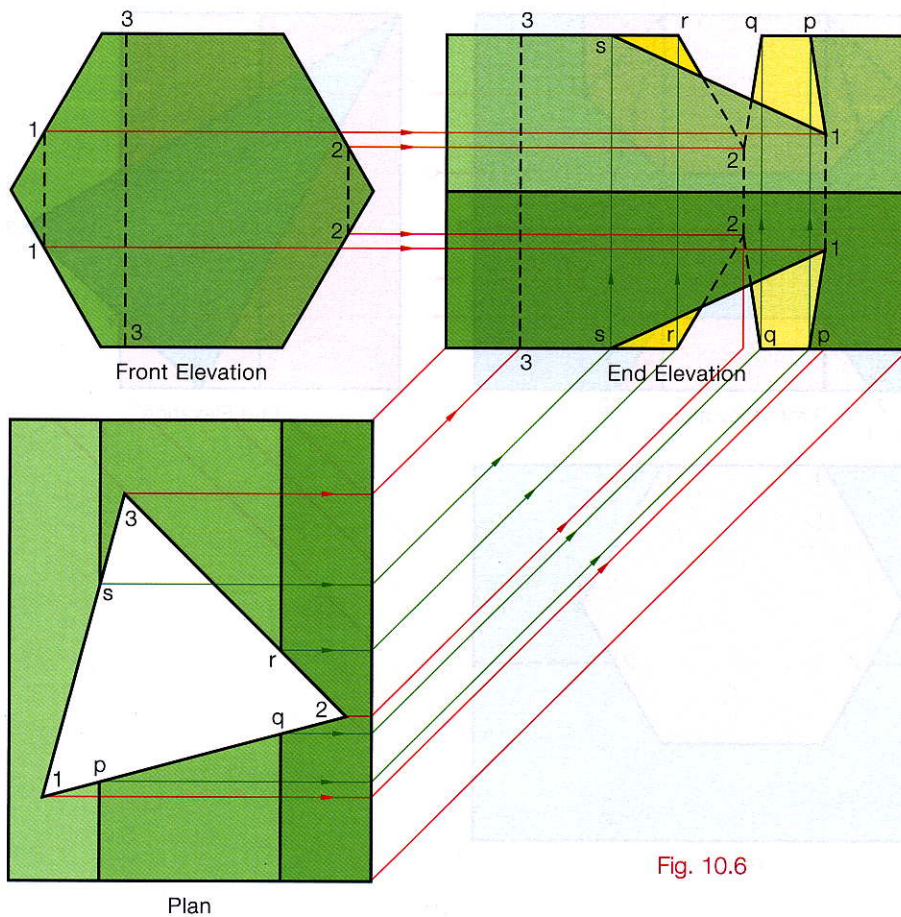


Fig. 10.6

Given the plan and end view of two intersecting prisms. Draw the given views and project the front elevation, Fig. 10.7.

- (1) Draw the given views.
- (2) The edge, 1 of the square prism intersects the triangular prism in two places. Similarly for edge 2 and edge 3 of the square prism. It can be seen from the end view that edge 4 does not intersect the triangular prism. All six of these points are found in plan and projected to elevation.
- (3) The bend points p, q, r and s are seen in end view and projected across to the front elevation.
- (4) The sequence of joining the points is found from the end elevation, s, 1, p, 2, q, 3, r, 3, 2, 1, s, Fig. 10.8.

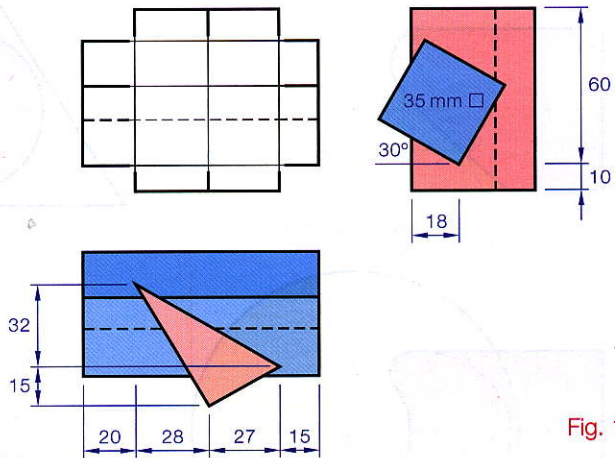


Fig. 10.7

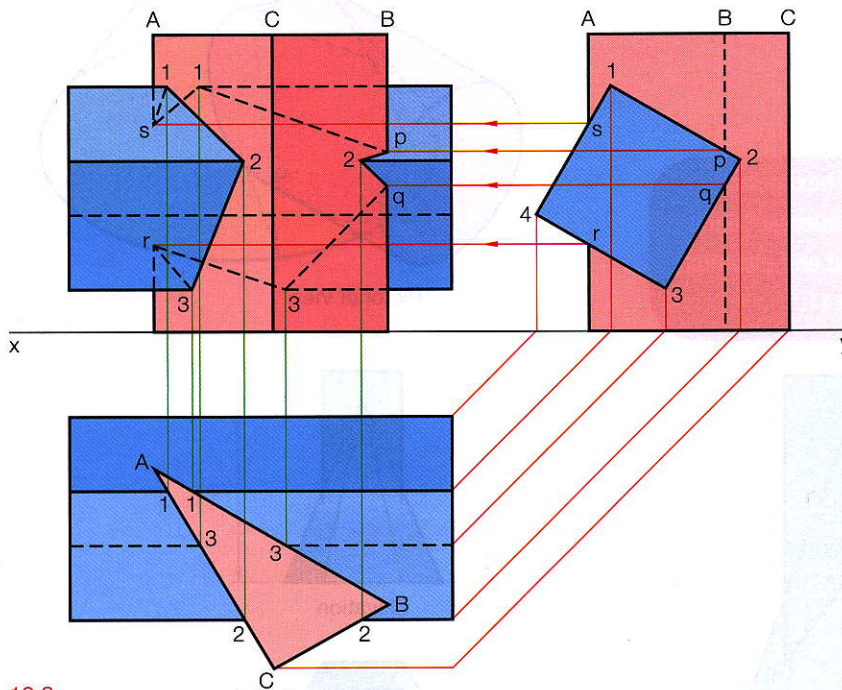


Fig. 10.8

Method Two: Radial Elements Method

This method can be very useful when cones or pyramids are being penetrated by other solids. The limits method used in the previous examples will not work for these types of solids.

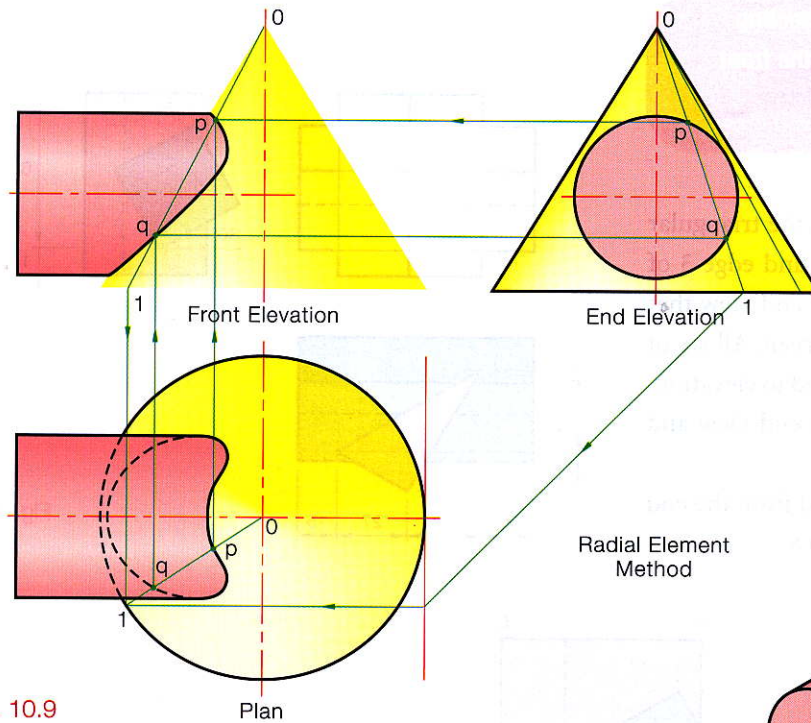


Fig. 10.9

Given the plan and partial elevation of a hexagonal-based pyramid and a square prism which intersect each other. Draw the complete plan, elevation and end elevation of the intersecting solids, Fig 10.11.

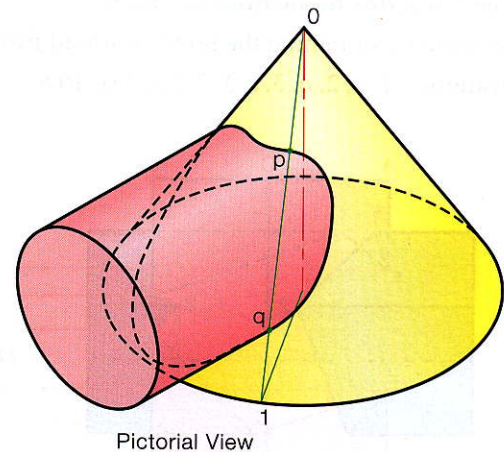


Fig. 10.10

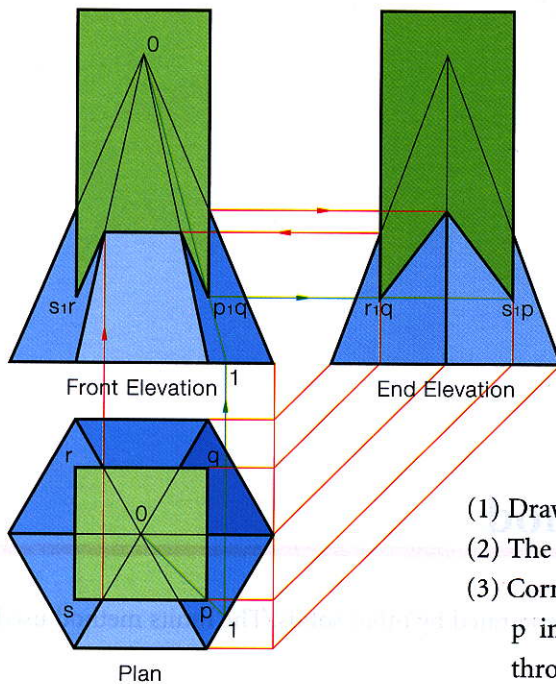


Fig. 10.12

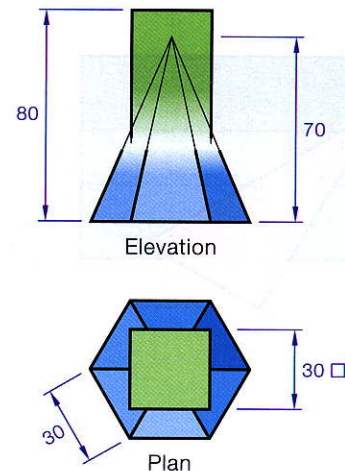


Fig. 10.11

- (1) Draw the given plan and elevation.
- (2) The bend points are easily found.
- (3) Corners p, q, r and s fall on the sloping faces of the pyramid. To find point p in elevation we draw an element from the pyramid apex in plan, through point p to hit the pyramid base at point 1. This element 0, 1 can be found in elevation and p found on it.
- (4) The front elevation and end elevation can now be completed. There is no necessity for any more elements as the answer is symmetrical, Fig. 10.12.

Fig. 10.13 shows the plan of a hexagonal-based pyramid of height 80 mm. The pyramid has a square hole cut through it. Draw the given plan and project a front elevation and end elevation.

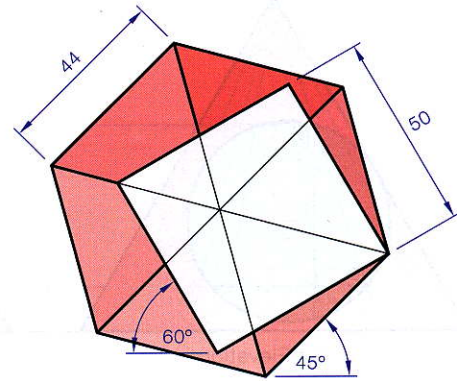


Fig. 10.13

- (1) The construction is as before.
- (2) Draw the front elevation and end elevation simultaneously as some of the bend points are easier to find in one than the other.
- (3) An element is drawn through point b in plan. This element is found in the front elevation and point b is found.
- (4) Another element is drawn through point d in plan. This element is found in the end elevation and point d is found, Fig. 10.14.

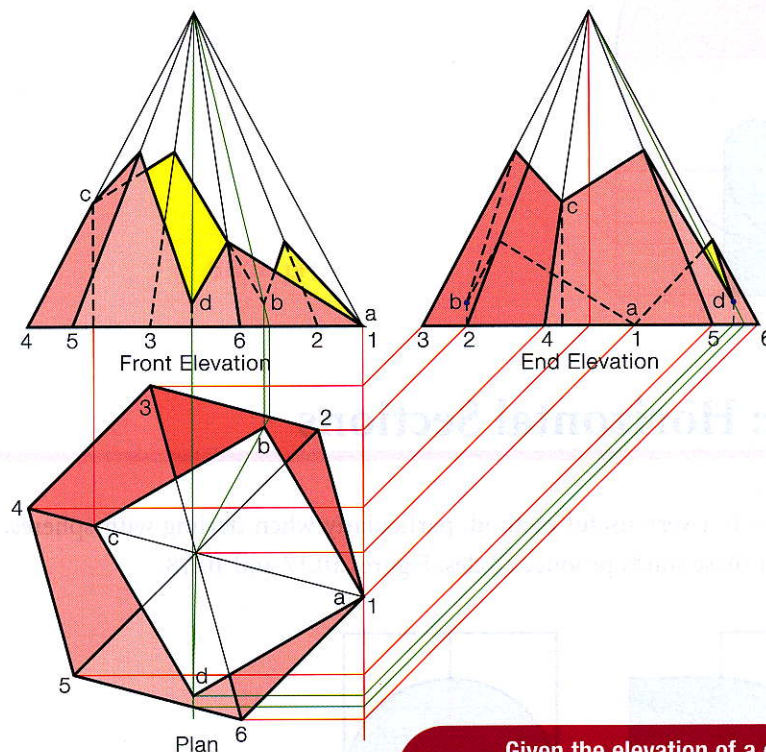


Fig. 10.14

Given the elevation of a cone and a cylinder intersecting each other. Draw the given view and project a plan and end view. The cylinder projects 10 mm beyond the base of the cone, Fig. 10.15.

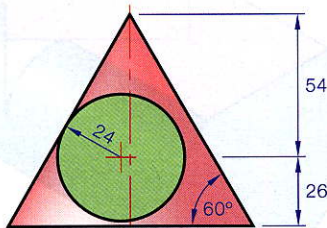


Fig. 10.15

When drawing in the elements on the cone in front elevation, it is advisable to space them equidistant each side of the centre line. This ensures there are less elements to project across to end view. Do not draw in too many generators as it can complicate the drawing. The method is clear from the drawing Fig. 10.16.

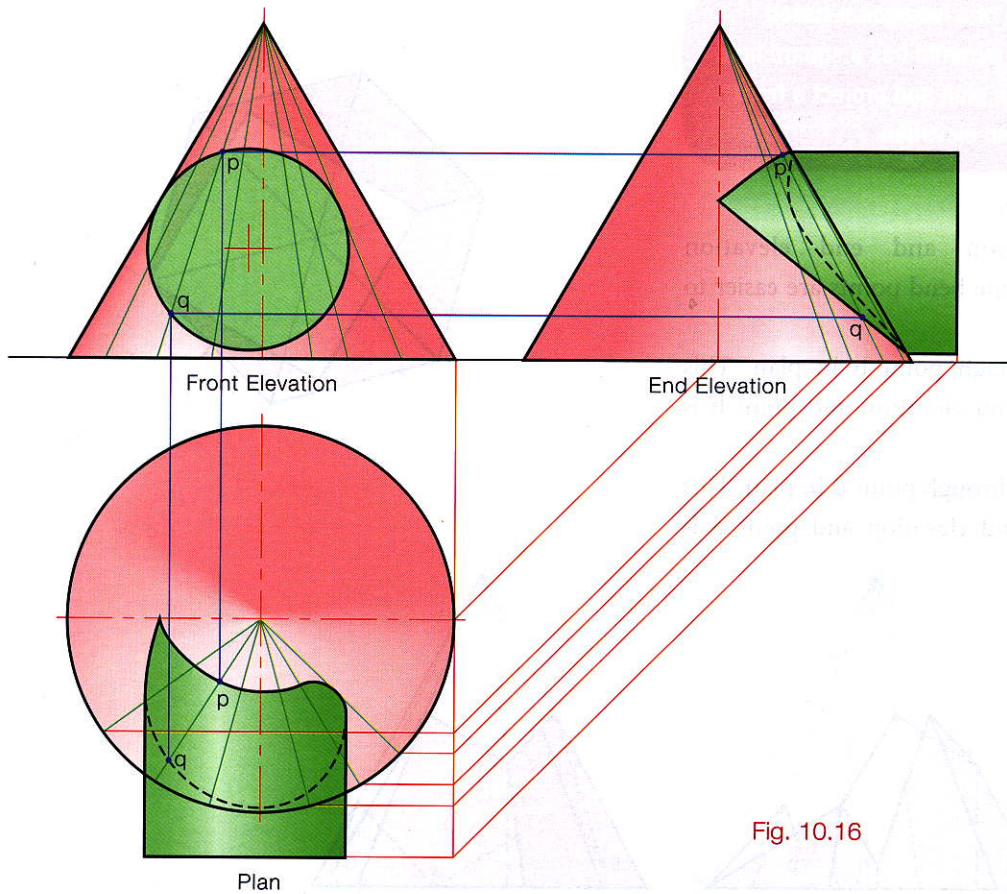


Fig. 10.16

Method Three: Horizontal Sections

The use of horizontal planes is a very useful method, particularly when dealing with spheres, cones and cylinders. The horizontal section of each of these solids produce circles, Figures 10.17 and 10.18.

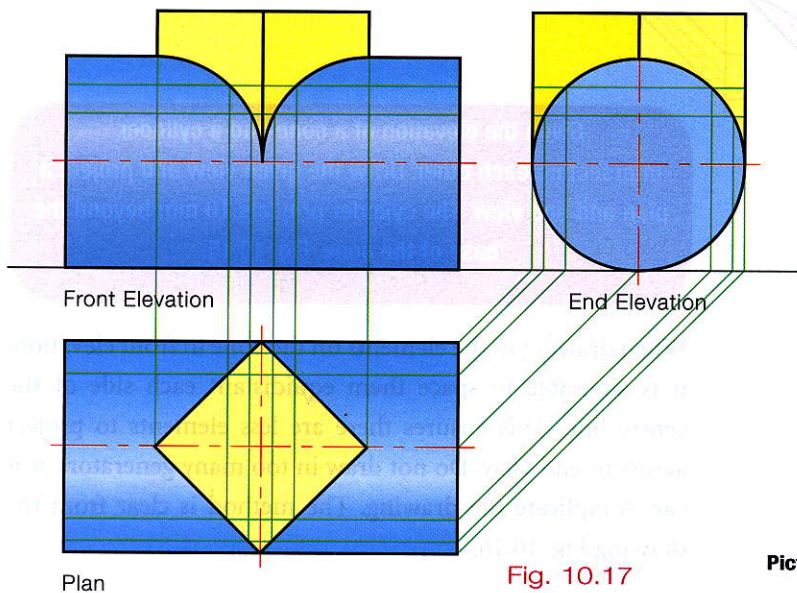
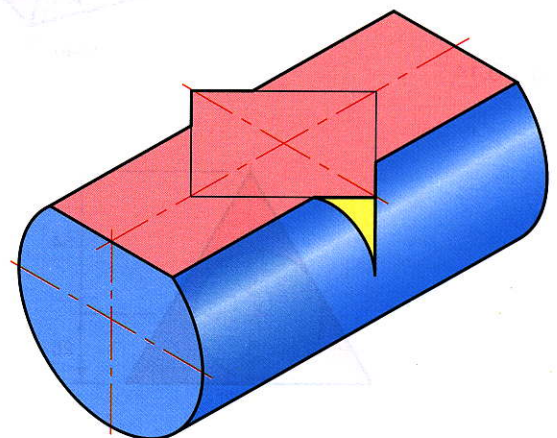


Fig. 10.17



Pictorial showing horizontal section

Fig. 10.18

To draw the plan and elevation of a cylinder piercing a sphere, showing clearly the line of intersection, Fig. 10.19.

- (1) A horizontal section through these two solids will produce two intersecting circles. Draw the plan which is complete and draw the partial elevation.
- (2) Take any horizontal section in elevation, e.g. at 1.
- (3) The section of the sphere is a circle in plan which intersects the plan of the cylinder at points p and q.
- (4) Project p and q onto the section line in elevation. Repeat for other sections.
- (5) It is worth noting that if the section lines are taken too high or too low the circles produced will not intersect.
- (6) The elevation is symmetrical about the horizontal axis, Fig. 10.20.

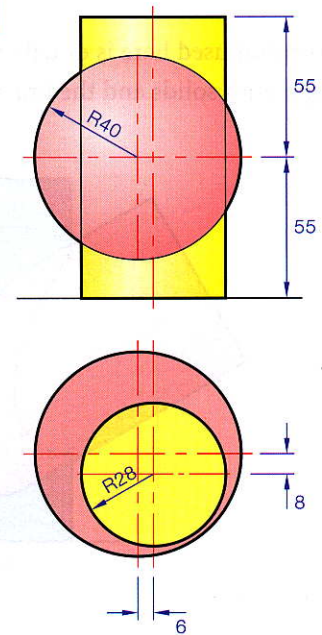


Fig. 10.19

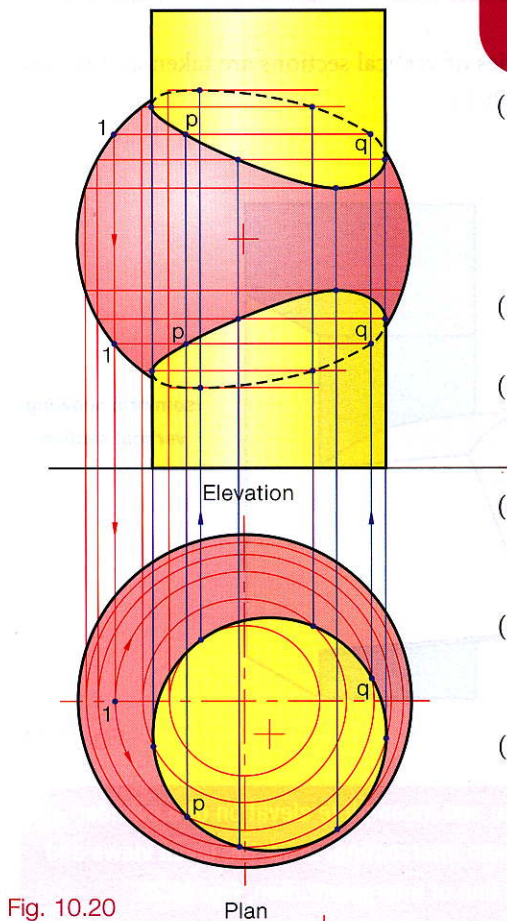


Fig. 10.20

Given the plan and elevation of a sphere and a cone which intersect each other. Draw the given views and find the line of interpenetration, Fig. 10.21.

- (1) Draw the plan and elevation as given.
- (2) It is advisable to space the horizontal sections at equal intervals each side of the sphere centre line.
- (3) The intersections of the cone sections in plan with their corresponding sphere sections gives the points for the curve on the plan.
- (4) Project these points of intersection to their corresponding horizontal sections to obtain the curve points on the front elevation, Fig. 10.22.

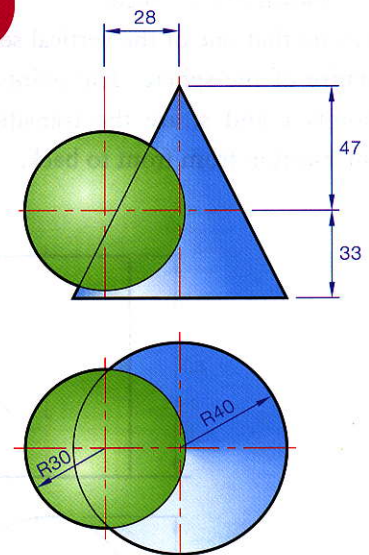


Fig. 10.21

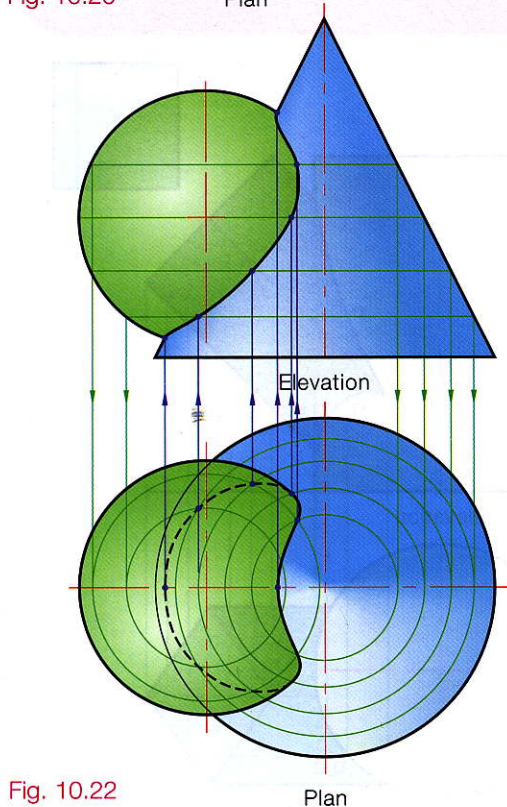


Fig. 10.22