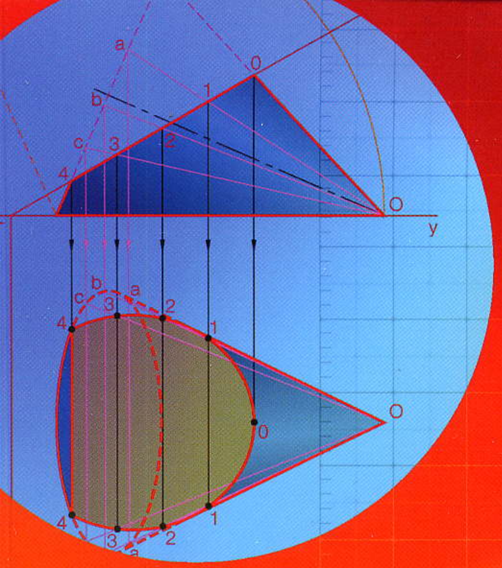
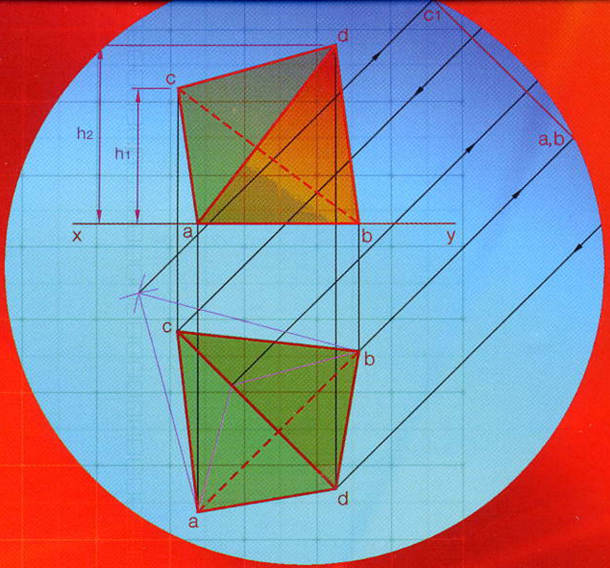
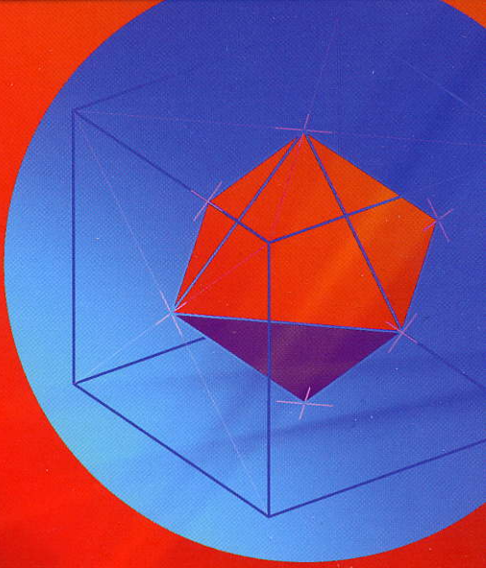


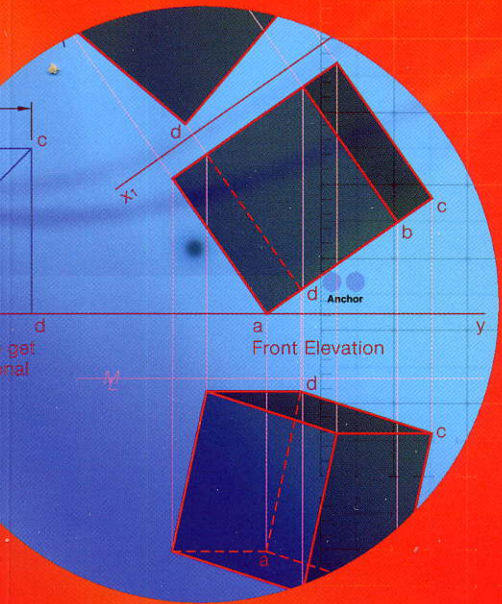


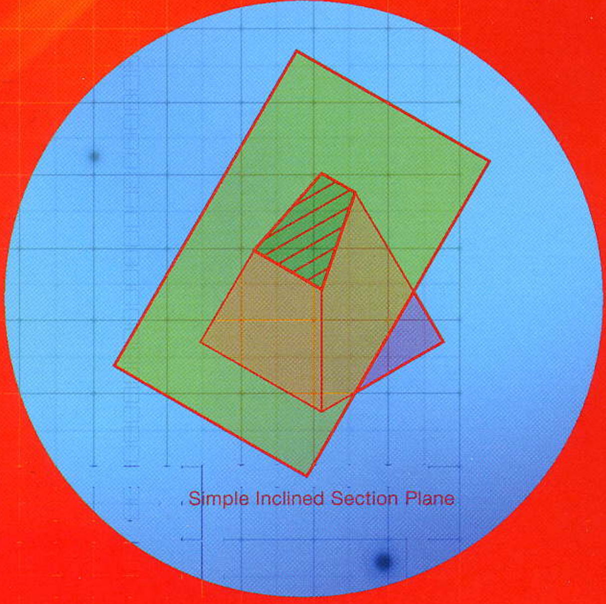


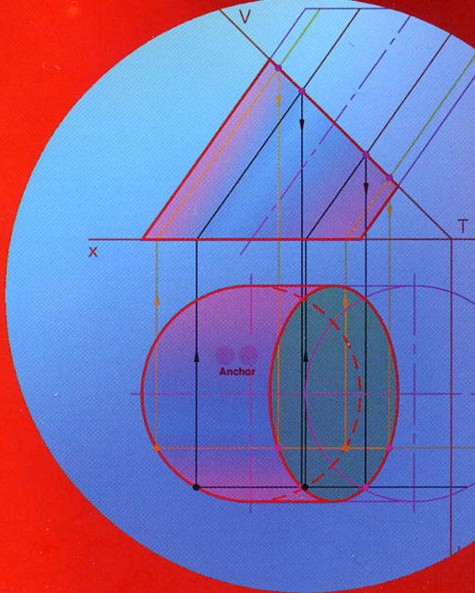
GRAPHICS IN DESIGN & COMMUNICATION

1

PLANE AND DESCRIPTIVE GEOMETRY







DAVID ANDERSON

7 Pictorial Projection 2

SYLLABUS OUTLINE

Areas to be studied:

• Principles of pictorial perspective drawing. • Parallel and angular perspective. • Vanishing points for horizontal lines. • *Derivation of vanishing points for inclined lines.*

Learning outcomes

Students should be able to:

Higher and Ordinary levels

- Demonstrate a knowledge of vanishing points, picture plane, ground line and horizon lines.
- Determine the vanishing points and height lines for horizontal lines.
- Complete perspective drawings of given objects.

Higher level only

- *Determine the vanishing points for sets of inclined lines (auxiliary vanishing points).*

Perspective

Perspective is a pictorial representation of objects which very closely matches the view from the human eye. It is different from all other projection systems because the projection rays radiate from/to a single point. In the other systems of projection the projection rays are parallel. The effect this has on the pictorial is that objects that are in the distance will appear smaller than the same objects closer to the observer. If you walk up close to an object it appears bigger than if you see the same object from a large distance away. We see everything in perspective and are therefore used to making the adjustment for size. Look down a straight street of houses. The house in the distance appears very small compared to the house nearby, yet we know that all the houses are the same size. The sides of the street appear to narrow in the distance yet we know they stay parallel, Fig. 7.1.

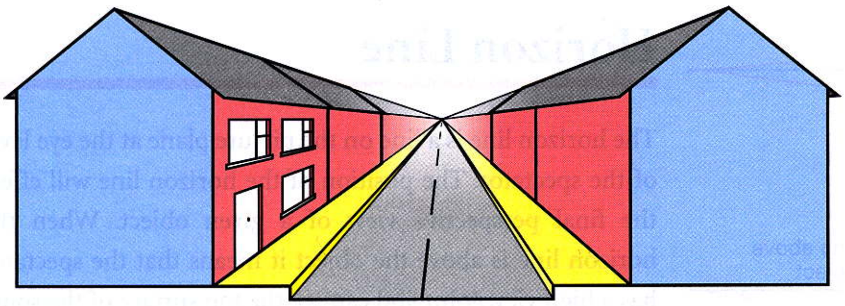


Fig. 7.1

Perspective gives a very realistic view of objects and is very useful for that reason but it should not be used to give sizes as it does not show true lengths.

Terms Associated with Perspective

Picture Plane

As with all projection systems the image is projected onto a plane. This plane is called the picture plane. The picture plane may be passing through the object, may be between the object and the observer or may be behind the object. Fig. 7.2 shows each of these arrangements. It can be seen that the placing of the picture plane does not effect the proportions of the perspective, only the size of the perspective.

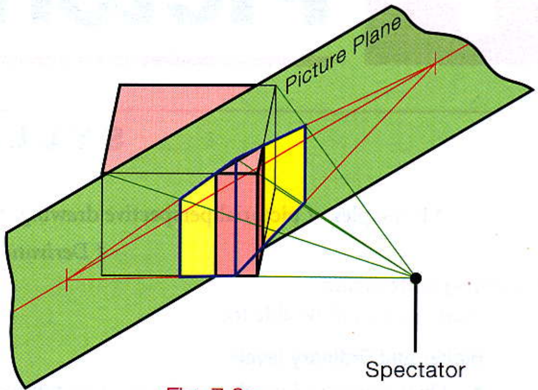


Fig. 7.2a

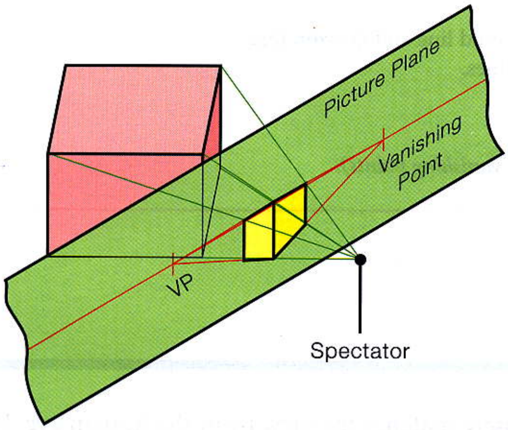


Fig. 7.2b

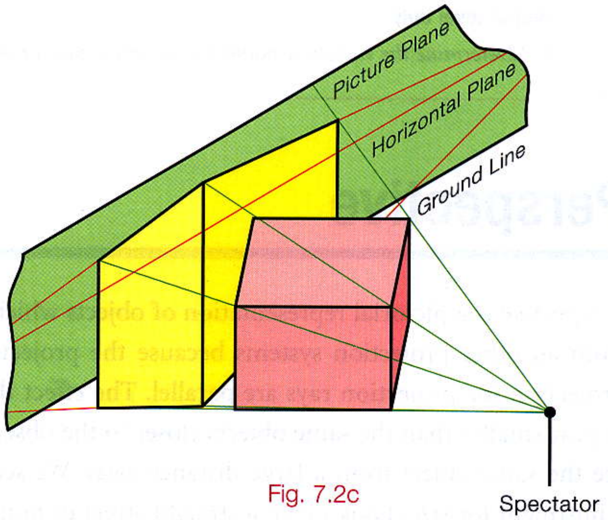


Fig. 7.2c

When the picture plane is in front of the object the perspective drawing is smaller than the object. Having the picture plane behind the object means that the perspective projects larger than the object.

Horizon Line

The horizon line is a line on the picture plane at the eye level of the spectator. The position of the horizon line will effect the final perspective view of a given object. When the horizon line is above the object it means that the spectator has a high viewpoint and can see the top surface of the solid. Having the horizon below the object results in a perspective that shows the bottom surface of the object, Fig. 7.3 demonstrates how horizon level changes the perspective.

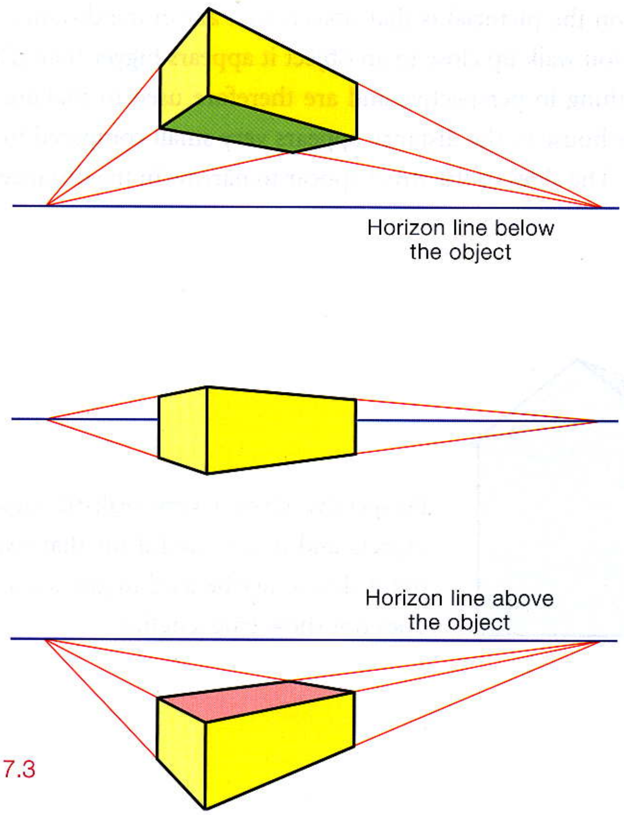


Fig. 7.3

The upper diagram shows a perspective with the spectator lower than the object, the horizon line is below the perspective of the object and therefore we see its bottom surface. The lower diagram shows the other extreme – the spectator's viewpoint is high, the horizon is therefore high and so we see the upper surface of the object.

Position of the Station Point

The position of the station point (SP) relative to the object also has a huge effect on the final perspective. When the SP is close to the object we are viewing the object from nearby and when the SP is far away we are viewing the object from a large distance away. Fig. 7.4 shows two perspective views of the same object. The upper diagram is produced by having the spectator near the object and the view we get is quite distorted. The lower diagram is produced having the spectator further away. The sides of the box are closer to being parallel. It is worth noting that the perspective produced when the spectator (S) is further from the object, the second perspective, is actually larger than the first.

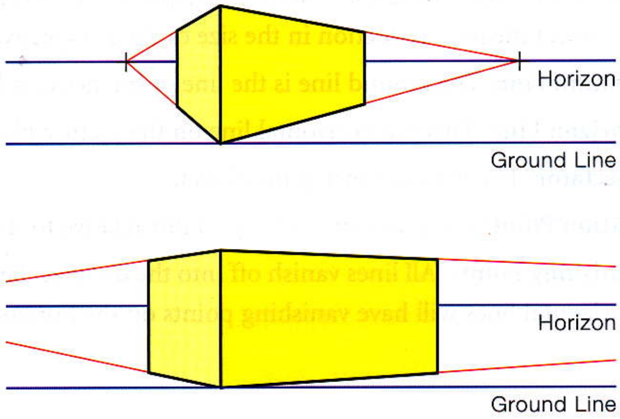


Fig. 7.4

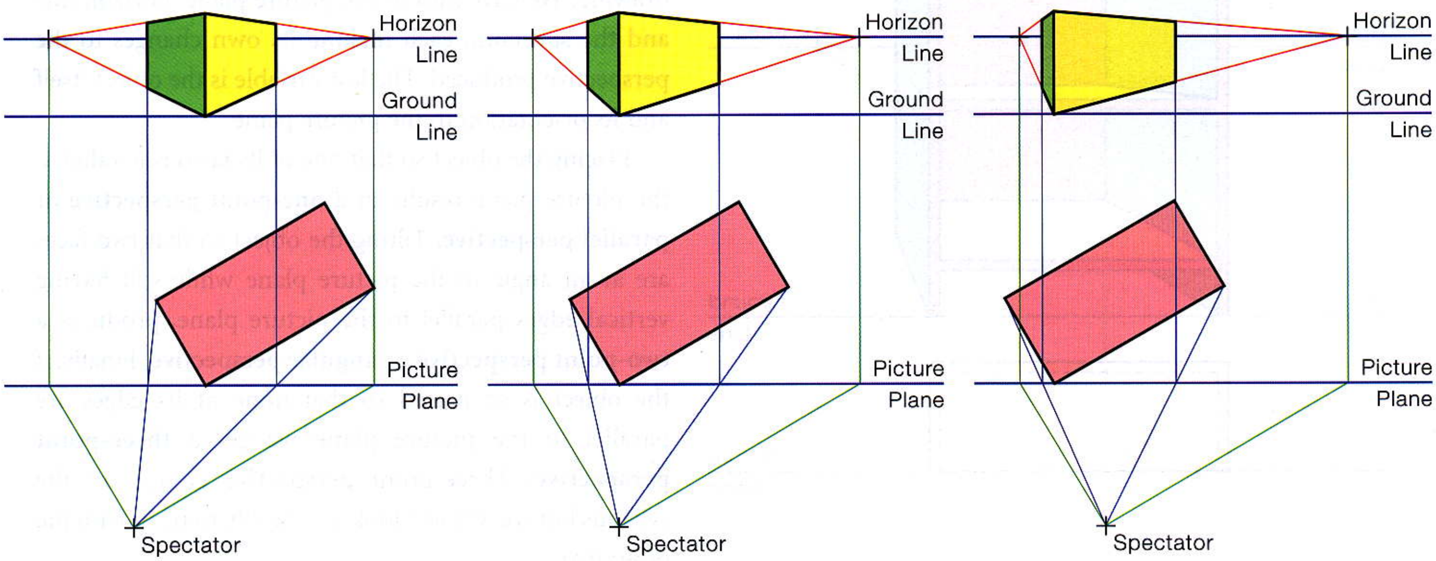


Fig. 7.5

This would appear to break the rules. Objects in the distance should appear smaller than objects nearby. It is, however, the position of the picture plane that determines the size of the perspective, not the position of the spectator.

The spectator can be moved from left to right, and again this will effect the final view. In general, the centre line of the cone of visual rays should be directed toward the centre of the object, or the centre of interest of the object, see Fig. 7.5.

Terms Used in Perspective

Just a quick recap on some of the terminology.

Picture Plane: The image is projected onto the picture plane. It is a vertical plane and can be moved. The position of the picture plane, relative to the object being viewed, affects the size of the finished perspective. Having the picture plane behind the object means an enlarged perspective, a view larger than the actual object. Having the picture plane in front of the object means a reduction in the size of the perspective.

Ground Line: The ground line is the line of intersection between the picture plane and the horizontal plane.

Horizon Line: This is a horizontal line on the picture plane that matches the height of the spectator's eyes.

Spectator: The person viewing the object.

Station Point: The position of the spectator relative to the object and the picture plane.

Vanishing Points: All lines vanish off into the distance. Sets of parallel lines vanish off to the same point, a vanishing point. Horizontal lines will have vanishing points on the horizon line.

The Three Types of Perspective

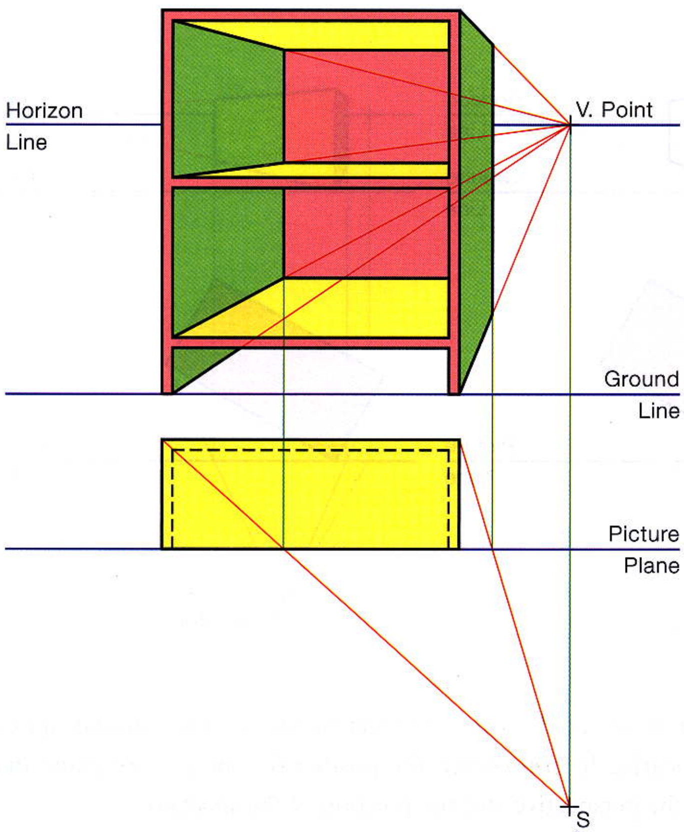


Fig. 7.6

So far we have been experimenting with the various elements of perspective to see how they affect the final drawing. We have moved the picture plane, horizon line and the spectator, each making its own changes to the perspective produced. The last variable is the object itself and its orientation to the picture plane.

Placing the object so that one of its faces is parallel to the picture plane results in a **one-point perspective** or **parallel perspective.** Tilting the object so that two faces are at an angle to the picture plane while still having vertical edges parallel to the picture plane, produces a **two-point perspective** or **angular perspective.** Finally, if the object is so placed so that none of its edges are parallel to the picture plane we get a **three-point perspective.** Three-point perspective is not on the syllabus but we will just look at it briefly to tie in with the other two.

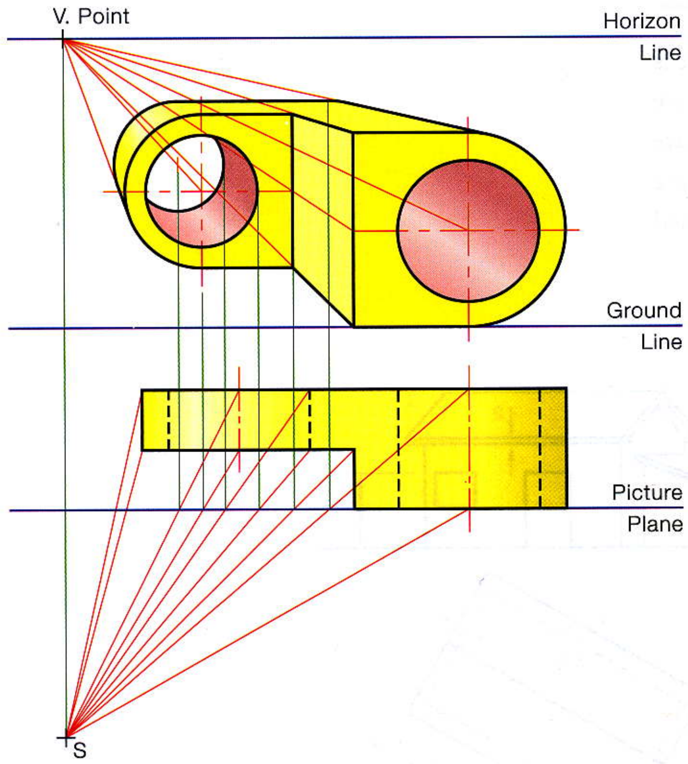


Fig. 7.7

One-point Perspective

Two of the object's principal axes must be parallel to the picture plane, leaving the third to vanish off to a single vanishing point. This is the least complicated of the perspectives and is quick to produce. Useful for presentation work and for representing the interior of a room. It is also useful for solids containing circular curves. Position the object so that the surface(s) containing the circles are parallel to the picture plane and the perspective view of these circles can be drawn with the compass, Figures 7.6, 7.7 and 7.8.

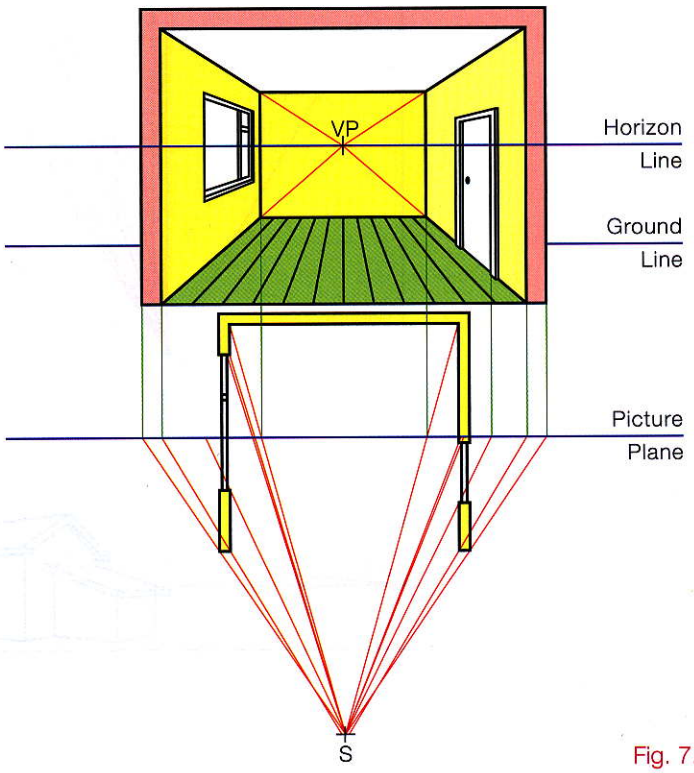


Fig. 7.8

Two-point Perspective

This is the most commonly used perspective. The object is placed so that one set of edges is vertical and therefore parallel to the picture plane and the other two sets are inclined to the picture plane, thus giving two vanishing points. It produces a very realistic view and is used extensively to represent buildings in architecture, Fig. 7.9.

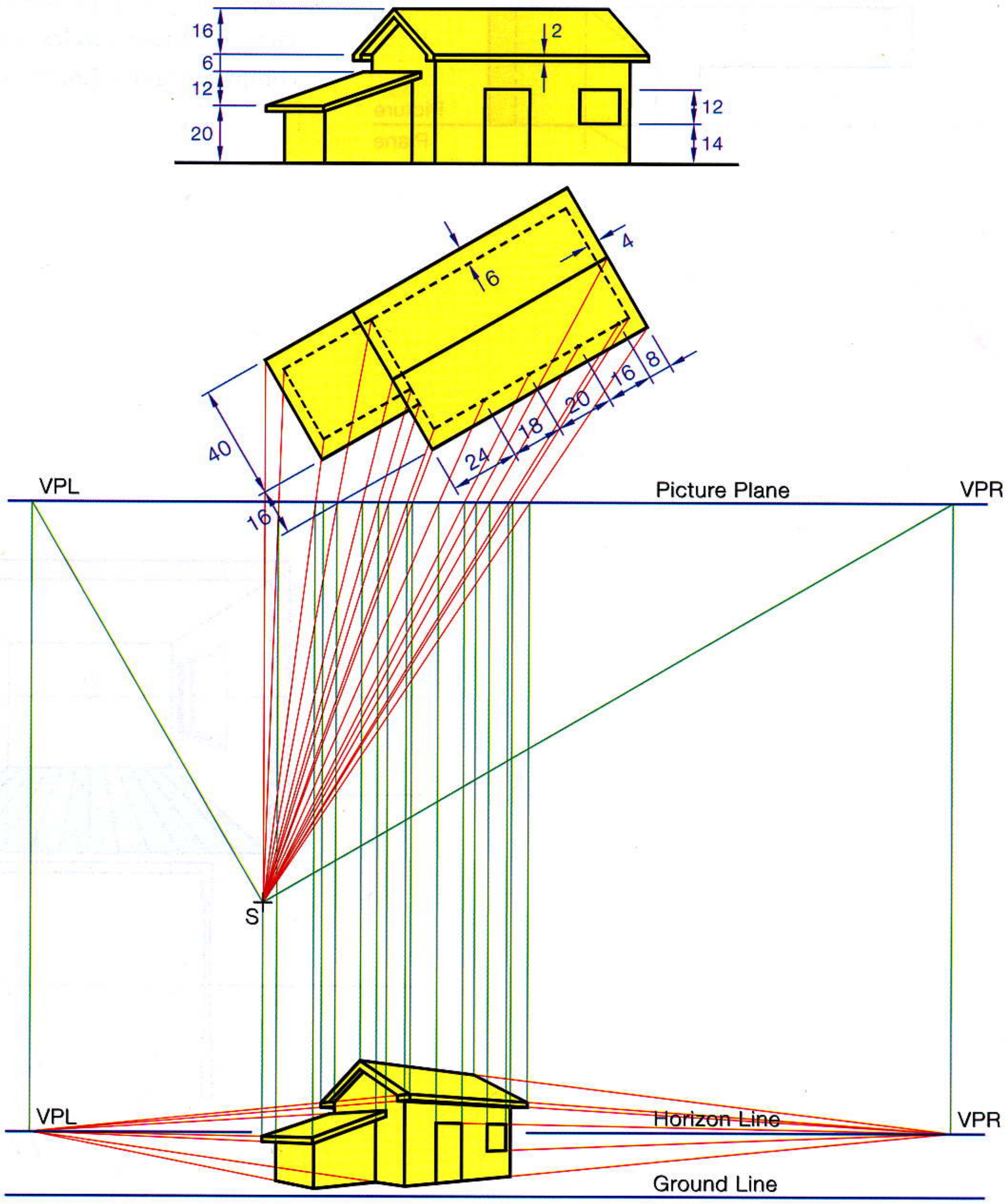
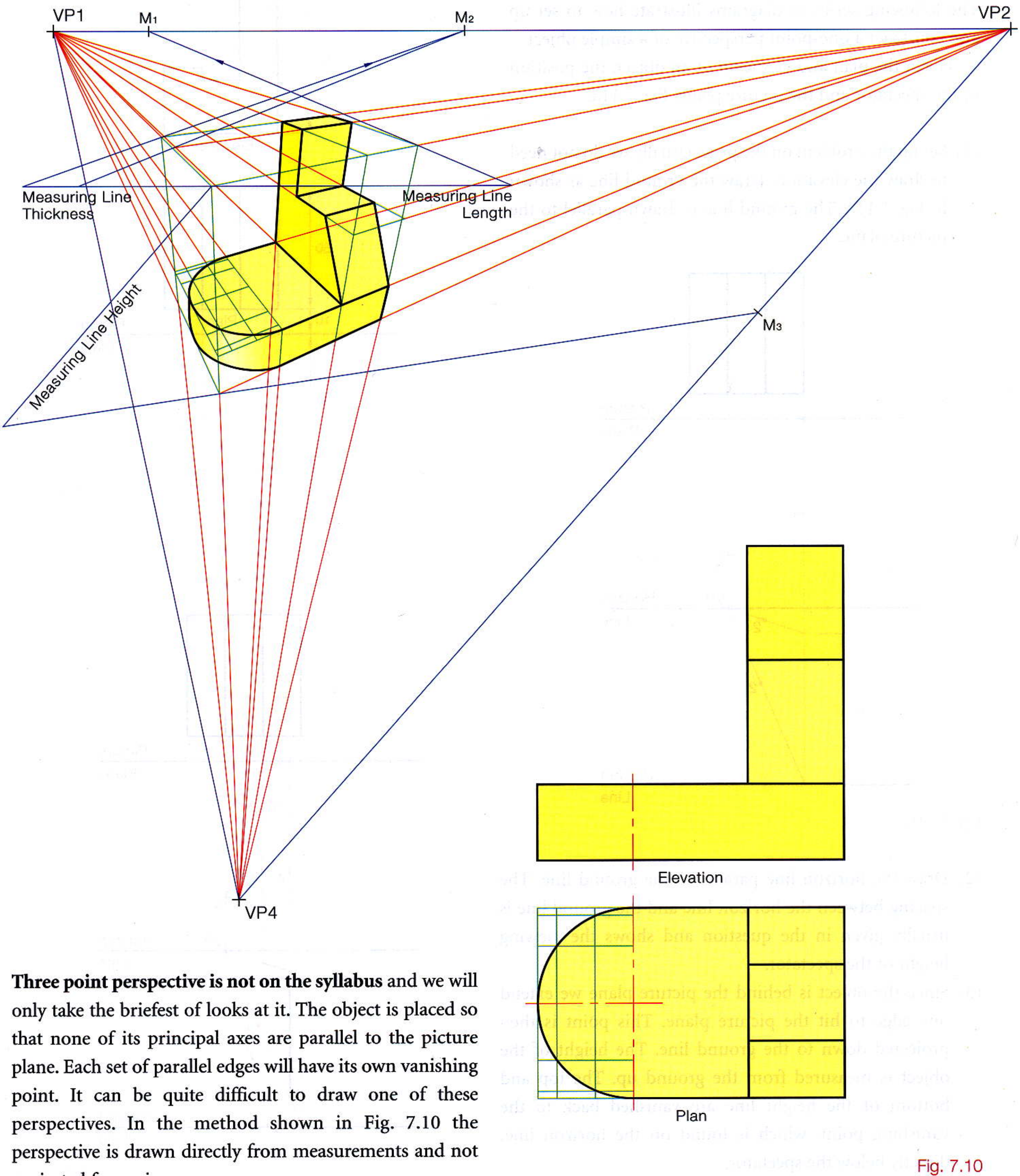


Fig. 7.9

Three-point Perspective



Three point perspective is not on the syllabus and we will only take the briefest of looks at it. The object is placed so that none of its principal axes are parallel to the picture plane. Each set of parallel edges will have its own vanishing point. It can be quite difficult to draw one of these perspectives. In the method shown in Fig. 7.10 the perspective is drawn directly from measurements and not projected from views.

Fig. 7.10

Method of constructing a one-point perspective.

The following series of diagrams illustrate how to set up and construct a one-point perspective of a simple object.

Given the plan and elevation of an object, the position of the spectator and the picture plane, Fig. 7.11a:

(1) Set up the problem on the page. Usually we do not need to draw the elevation. Draw the ground line as shown in Fig. 7.11b. The ground line is drawn parallel to the picture plane.

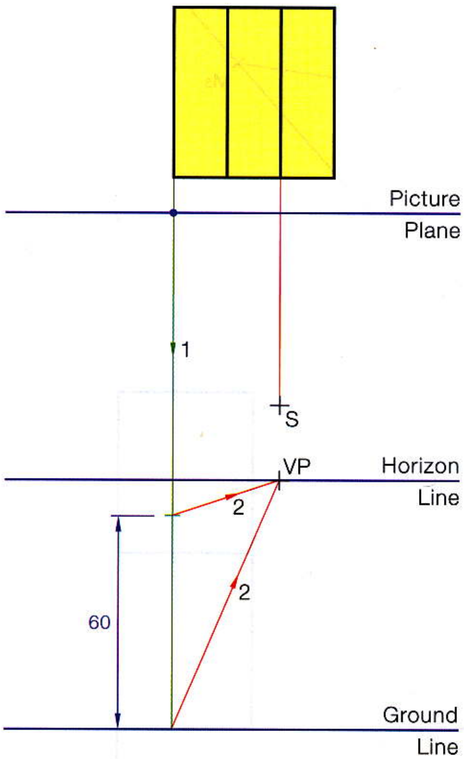


Fig. 7.11b

(2) Draw the horizon line parallel to the ground line. The spacing between the horizon line and the ground line is usually given in the question and shows the viewing height of the spectator.

(3) Since the object is behind the picture plane we extend one edge to hit the picture plane. This point is then projected down to the ground line. The height of the object is measured from the ground up. The top and bottom of the height line are vanished back to the vanishing point, which is found on the horizon line, directly below the spectator.

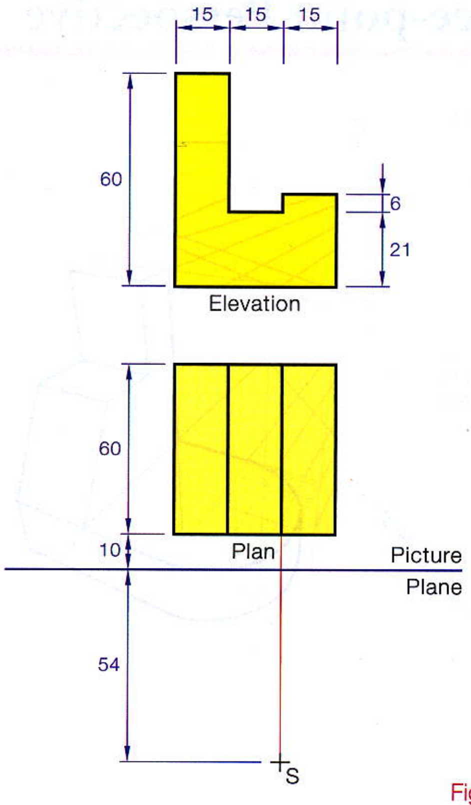


Fig. 7.11a

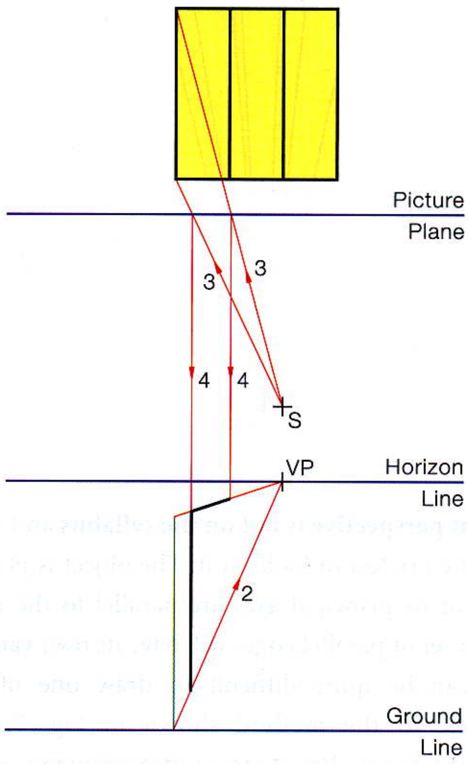


Fig. 7.11c

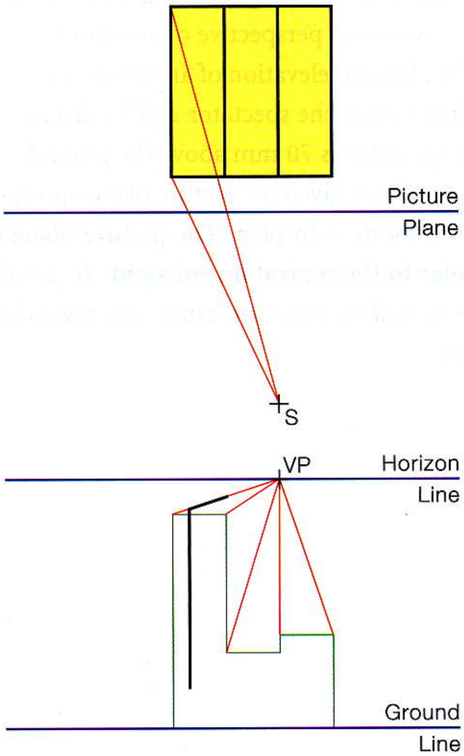


Fig. 7.11d

(4) A visual light ray is brought from the two corners of the plan to the spectator, as shown in Fig. 7.11c. Where these light rays pierce the picture plane they are dropped down to the perspective finding the front left edge and the back corner.

(5) The elevation of the object is built up using the height line as one of its edges as shown in Fig. 7.11d.

(6) What we have done is lengthened the object until it hits the picture plane. **Objects in the picture plane show their true sizes.** That is why we can draw the elevation full size on the ground line. The corners of this elevation are vanished back to the vanishing point.

(7) Corners of the perspective are located by using rays of light as in Step 4. Rays are brought from the two corners on the right. Where they pass through the picture plane they are projected into the perspective view as shown in Fig. 7.11e.

Note: In the top half of the drawing we are looking at the plan of the object, the plan of the picture plane (we are seeing it edge on) and we are seeing the plan of the spectator. In the lower half of the drawing we are seeing through the spectator's eyes and looking at the picture plane. The ground line is the line of intersection between the picture plane and the horizontal plane. The horizon line is at the spectator's eye level. The perspective itself is the projection of an image of the object, onto the picture plane, using rays of light.

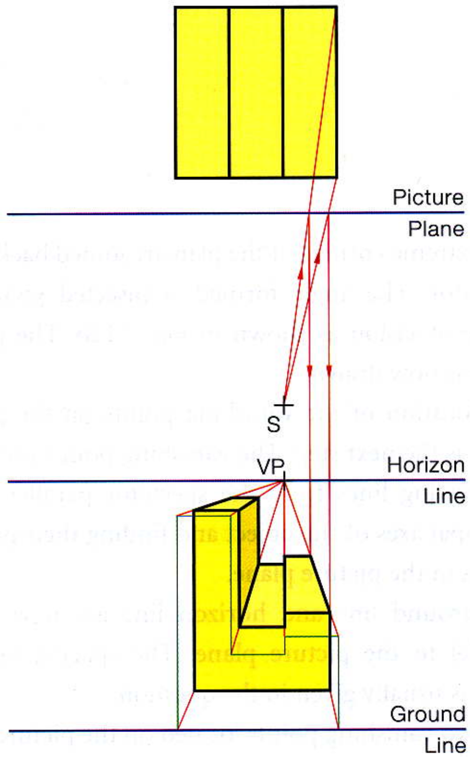


Fig. 7.11e

Method of constructing a two-point perspective.

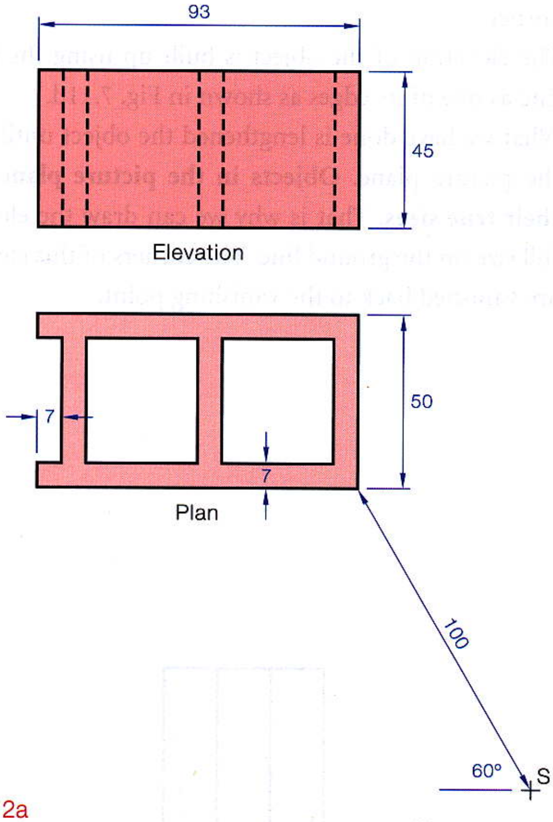


Fig. 7.12a

(1) The extreme corners of the plan are joined back to the spectator. The angle formed is bisected giving the centre of vision as shown in Fig. 7.12b. The picture plane is now drawn.

(2) The location of the vanishing points on the picture plane is the next step. The vanishing points are found by drawing lines from the spectator parallel to the principal axes of the object and finding their piercing points in the picture plane.

(3) The ground line and horizon line are now drawn parallel to the picture plane. The spacing between them is usually given in the question.

(4) The two vanishing points located on the picture plane are now projected onto the horizon line.

(5) To start the perspective we need a height line. One edge ab is extended to hit the picture plane at c. This point c is projected down to the ground line. The height of the object is measured on this line.

The following series of diagrams illustrate the process of producing a two point perspective of an object.

Given the plan and elevation of an object (Fig. 7.12a). Also given the direction of the spectator and its distance from the corner. The spectator is 70 mm above the ground.

We have not been given the picture plane's position so our first step is to locate it in plan. **The picture plane is always perpendicular to the central line of sight.** To get a balanced perspective we will have the spectator view toward the centre of the object.

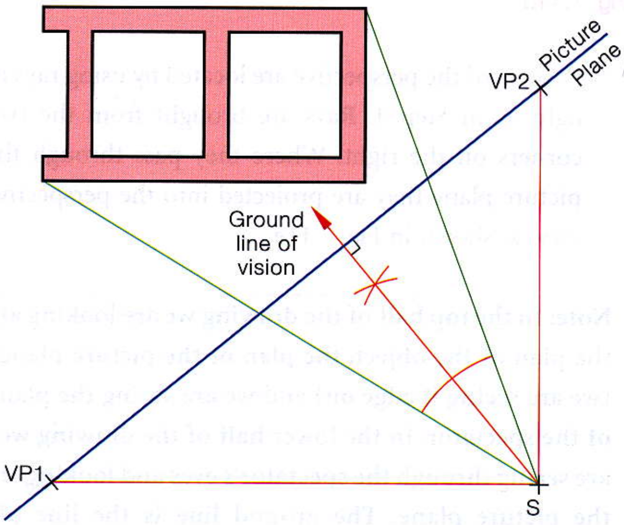
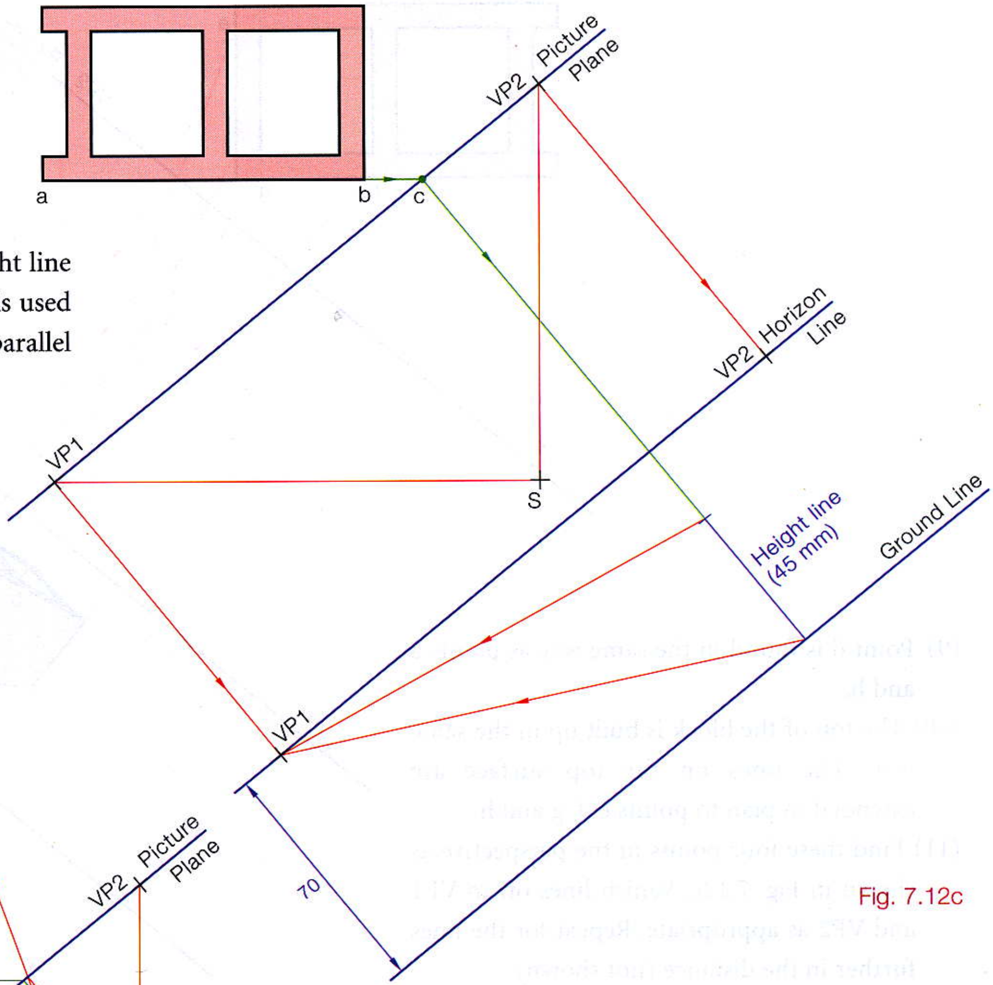


Fig. 7.12b



(6) The top and bottom of the height line are vanished back to VP1. VP1 is used because edge ab and all edges parallel to it vanish to VP1, Fig 7.12.c.

Fig. 7.12c

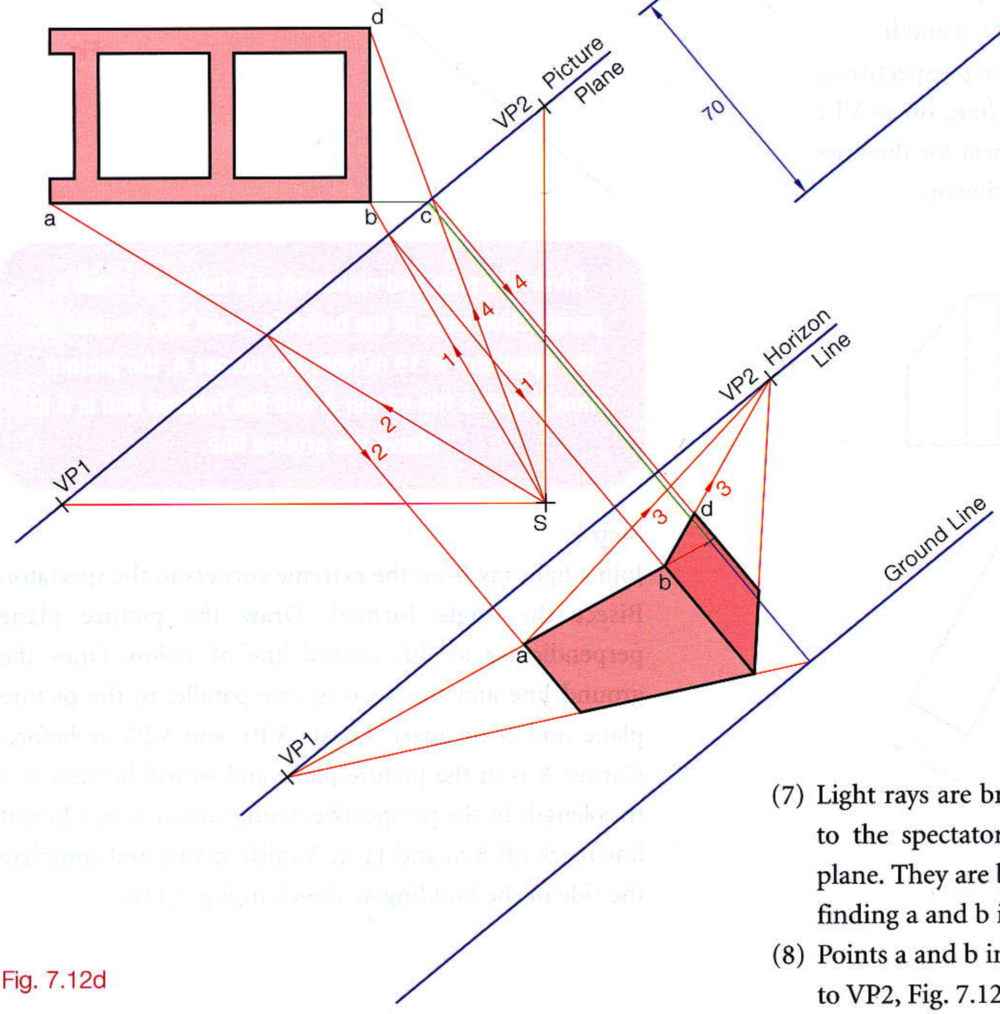
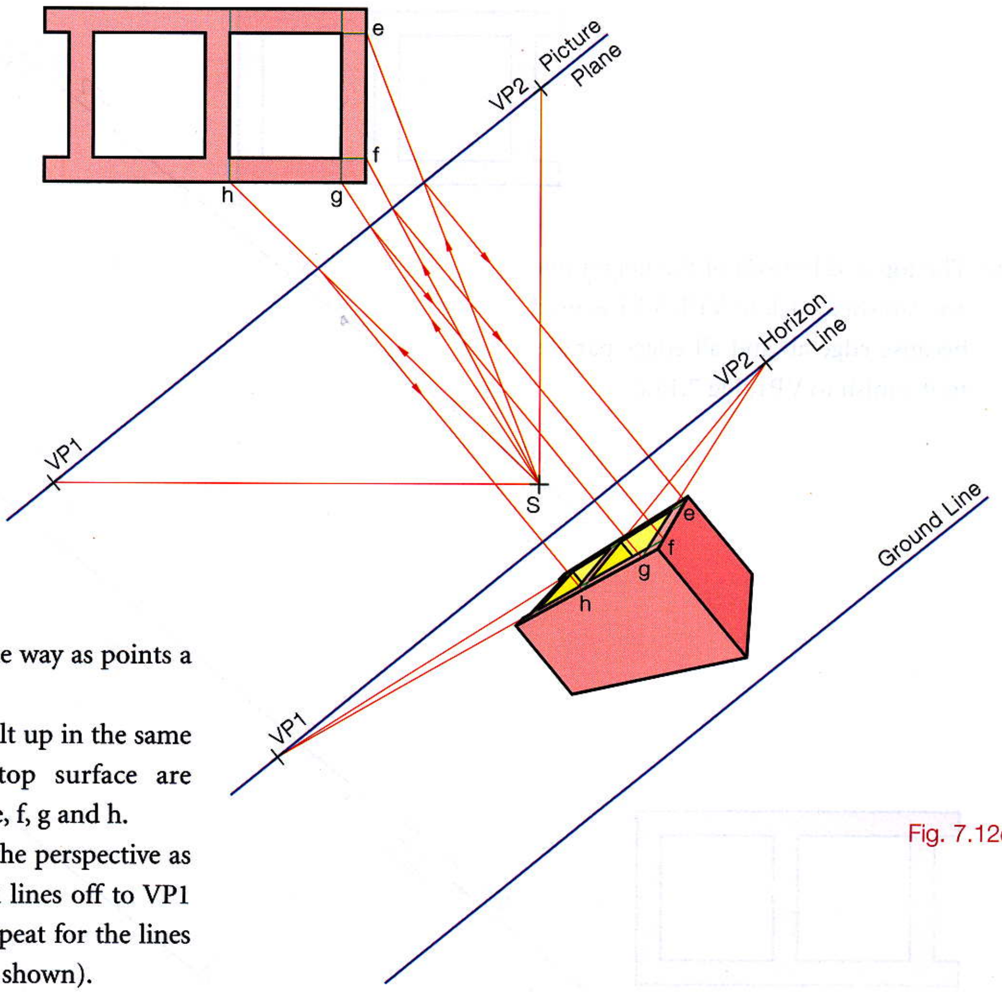


Fig. 7.12d

(7) Light rays are brought from points a and b back to the spectator where they pierce the picture plane. They are brought down to the perspective, finding a and b in the perspective view.

(8) Points a and b in the perspective are vanished off to VP2, Fig. 7.12d.



(9) Point d is found in the same way as points a and b.

(10) The top of the block is built up in the same way. The lines on the top surface are extended in plan to points e, f, g and h.

(11) Find these four points in the perspective as shown in Fig. 7.12e. Vanish lines off to VP1 and VP2 as appropriate. Repeat for the lines further in the distance (not shown).

Fig. 7.12e

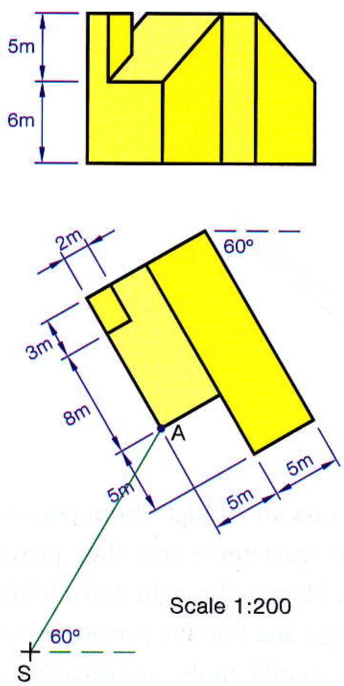


Fig. 7.13a

Given the plan and elevation of a building. Draw a perspective view of the building when the position of the spectator is 19 m from the corner A, the picture plane touches the corner A and the horizon line is 5 m above the ground line.

Step 1

Join a light ray from the extreme corners to the spectator. Bisect the angle formed. Draw the picture plane perpendicular to this central line of vision. Draw the ground line and the horizon line parallel to the picture plane and 5 m apart. Locate VP1 and VP2 as before. Corner A is in the picture plane and so will be seen as a true length in the perspective. Using corner A as a height line mark off 6 m and 11 m. Vanish to VP1 and complete the side of the building as shown in Fig. 7.13b.

Step 2

The end of the roof is constructed next by vanishing to VP2. The end of the ridge in the distance will be hidden behind the chimney. The base of the chimney is constructed as shown in Fig. 7.13c.

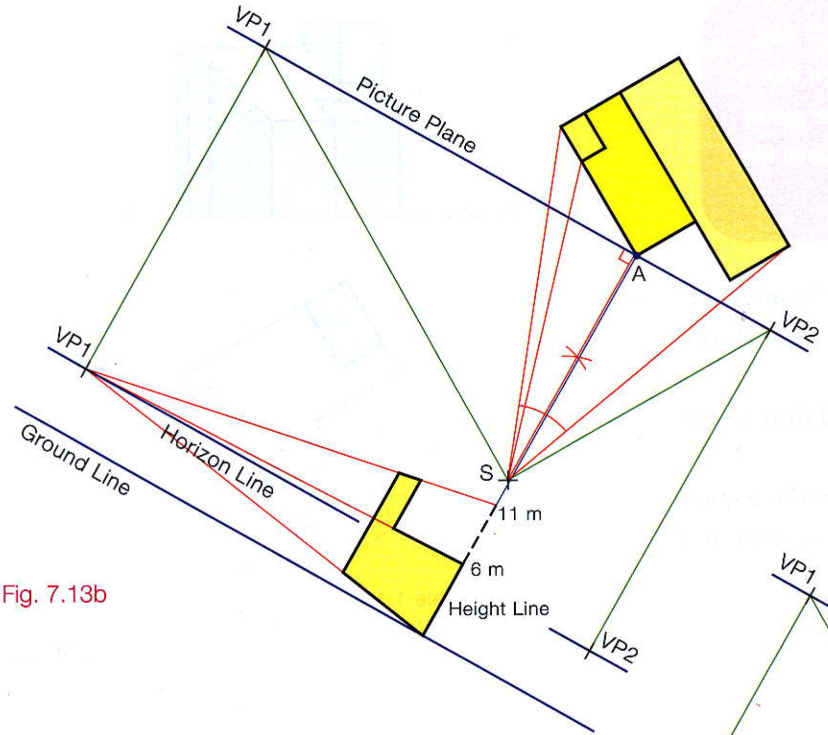


Fig. 7.13b

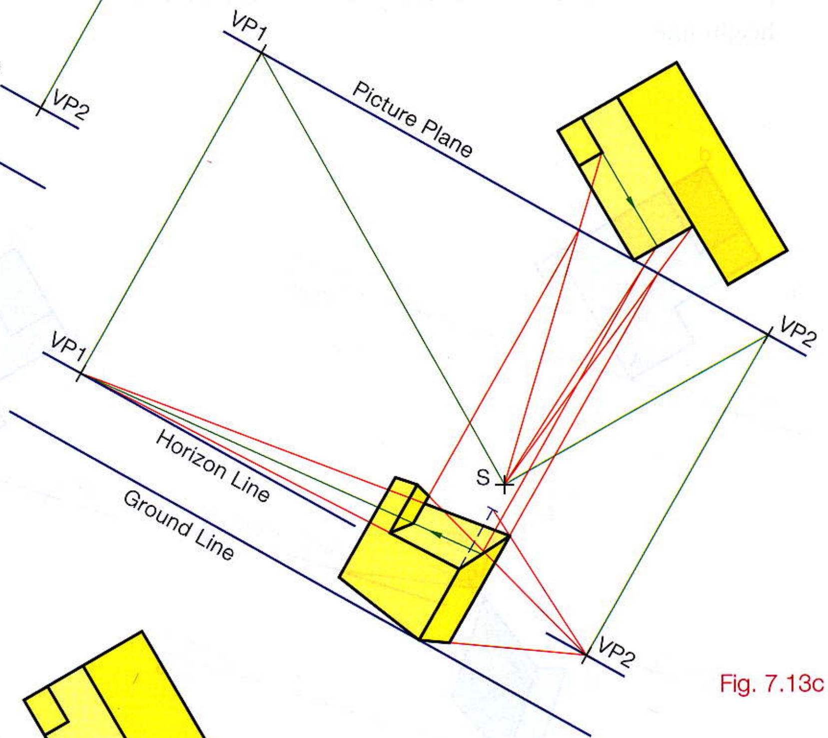


Fig. 7.13c

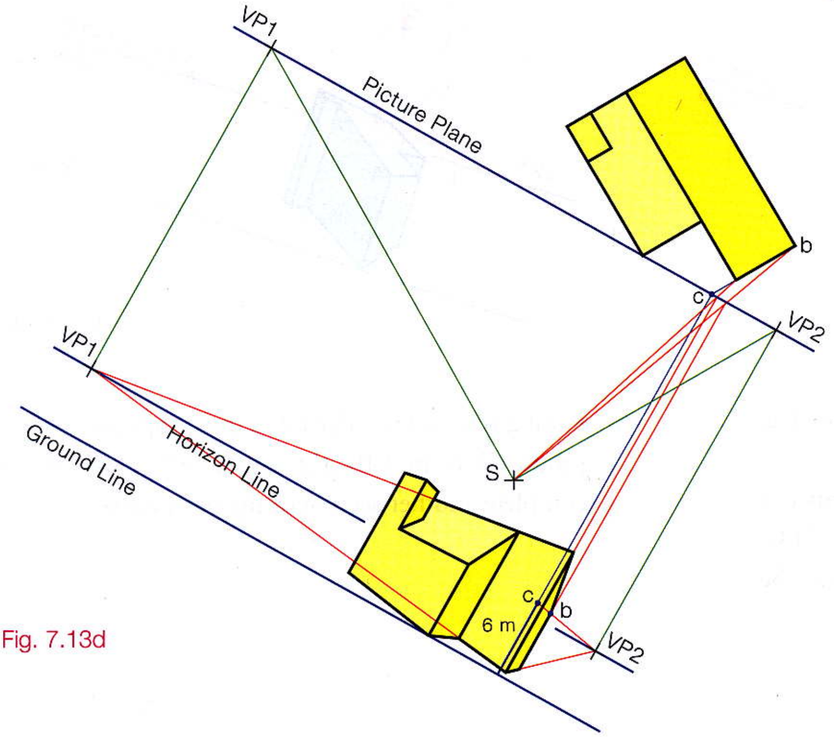


Fig. 7.13d

Step 3

The other part of the building is built up as shown in Fig. 7.13d.

The only difficulty is the 6 m wall at the back at b. The quickest way to get the height of this corner is to get a height line. Extend one of the edges passing through corner b until it hits the picture plane at c. Drop c down to the perspective and use as a height line as shown.

Given the plan and elevation of a building, Fig. 7.14a. Make a perspective view of the building when the spectator is 10 m from the corner A, the picture plane touches corner A and the horizon line is 8 m above the ground line.

(1) Join the extreme corners of the plan back to the spectator. Bisect the resulting angle giving the central line of vision. Draw the picture plane parallel to this.

(2) Find VP1 and VP2 on the picture plane and drop to the horizon.

(3) Start the perspective at corner A which is in the picture plane and therefore is a true length. Use this corner as a height line.

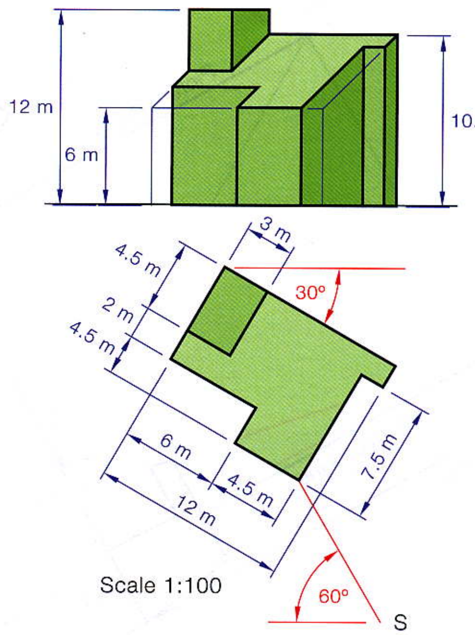


Fig. 7.14a

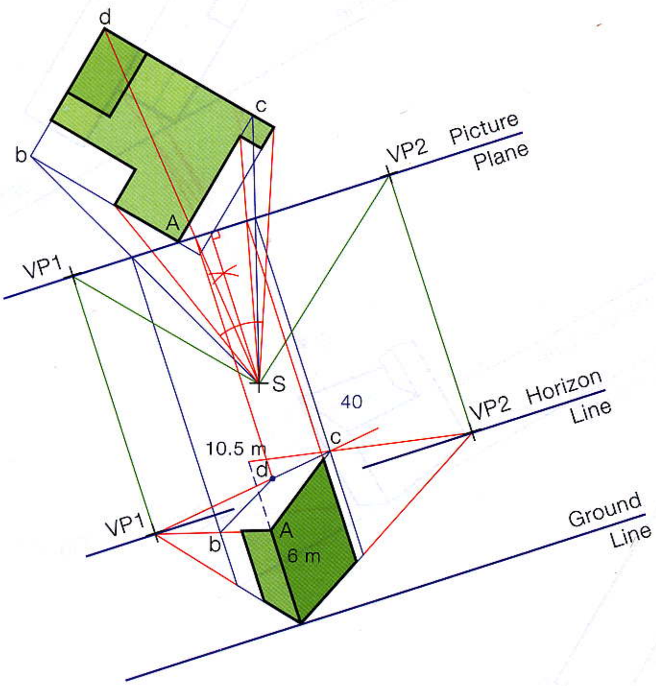


Fig. 7.14b

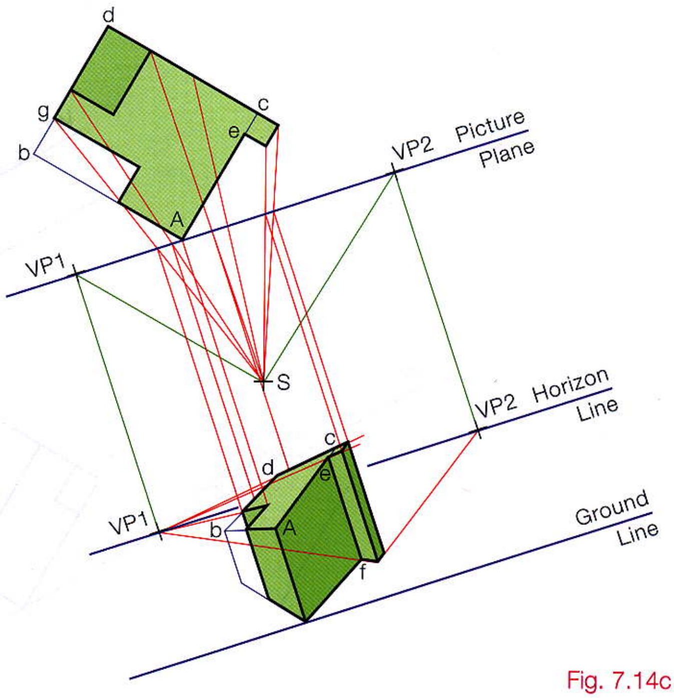


Fig. 7.14c

(4) Find the corners A, b, c and d as shown in Fig. 7.14b.

(5) Lines are projected from VP1 through points c, e and f in the perspective, as shown in Fig. 7.14c. The small protrusion from the building can be completed.

(6) Point g is found on edge bd in the perspective. A line produced from VP1 through g will allow us to complete another section of the perspective.

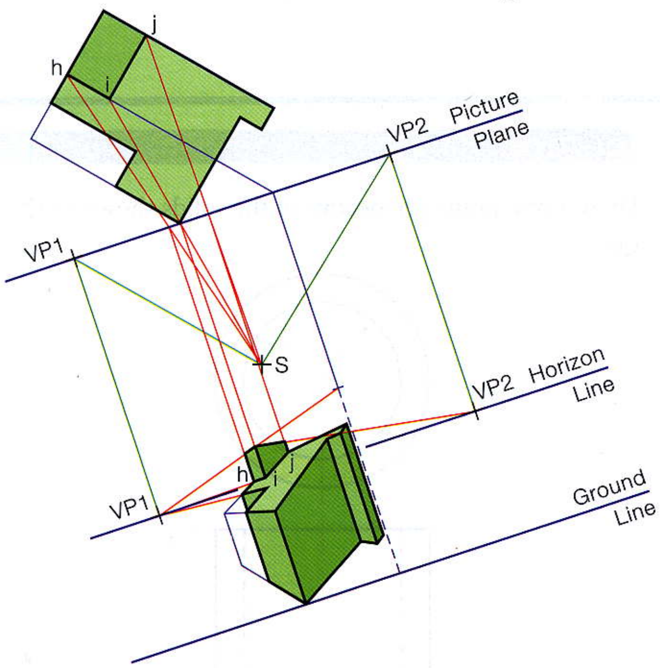


Fig. 7.14d

(7) The three visible edges of the chimney can be found in the perspective, edges h, i and j.

(8) In order to find the height of the chimney we need a 12 m height line. The edge hi is extended to hit the picture plane. Where it hits the picture plane it is dropped to the perspective. 12 m is measured on this line and vanished to VP1. The height line is vanished to VP1 because the edge that was extended, edge hi is parallel to S, VP1. The perspective is finished as shown in Fig. 7.14d.

Circles and Curves in Perspective

We have already established that if a circle is parallel to the picture plane the perspective view of it will be circular. If the circle is inclined to the picture plane we generally get an ellipse.

Fig. 7.15 shows how the circle is divided up into ordinates and from these the circle is built up point by point. The height line is found first by extending the front face of the cylinder to intersect the picture plane. Half the elevation is constructed on this height line in order to find heights for the perspective. The elevation is divided up into divisions using ordinates. The same ordinate spacing is used in the plan and the perspective is built up as shown using these ordinates.

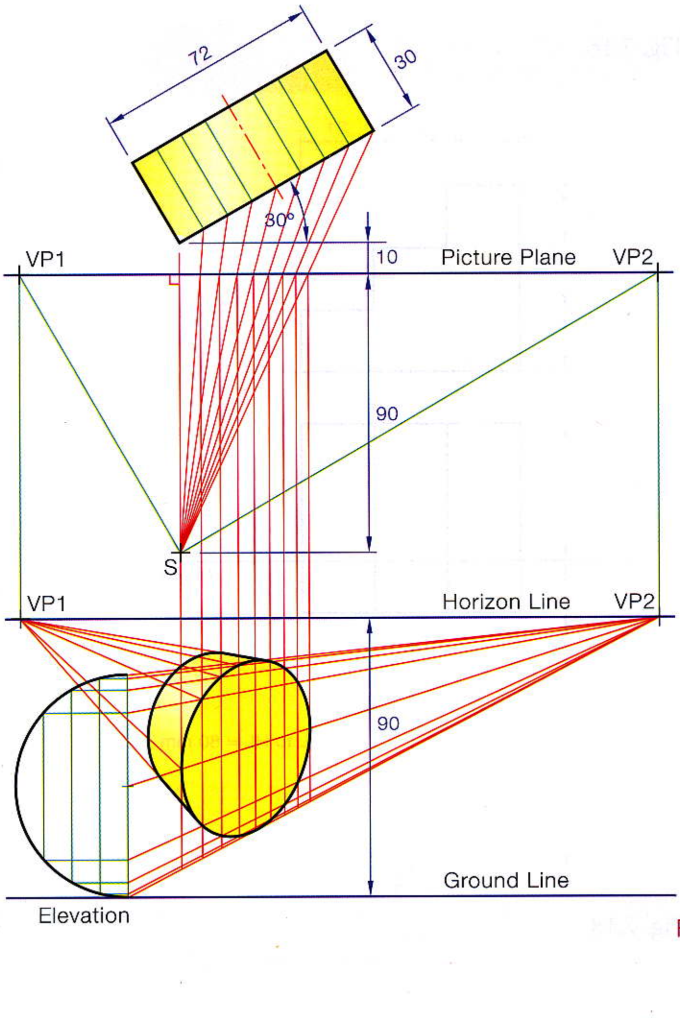


Fig. 7.15

Activities

Q1. TO Q6.

Draw a one-point perspective of the solids shown in Q1. to Q6.

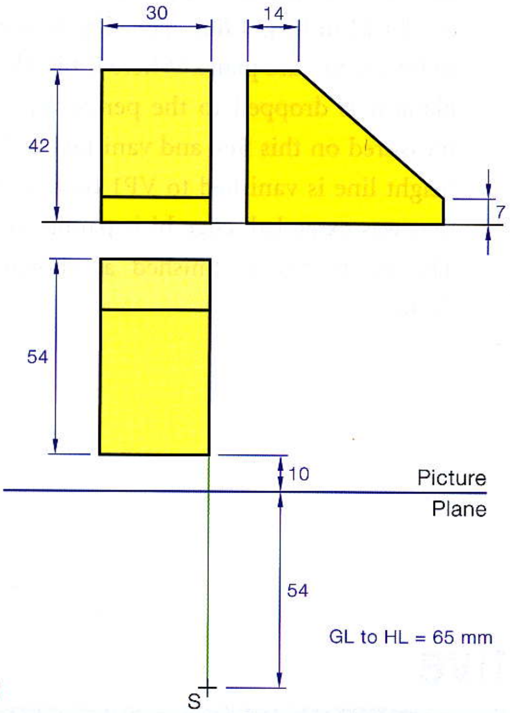


Fig. 7.16

Q1. Fig. 7.16

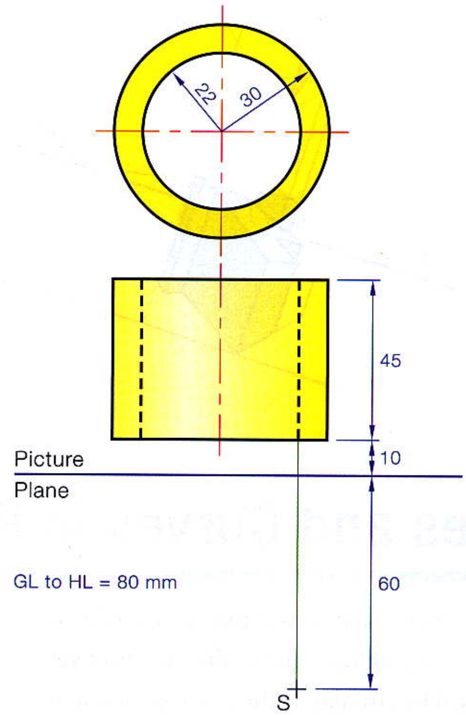


Fig. 7.17

Q2. Fig. 7.17

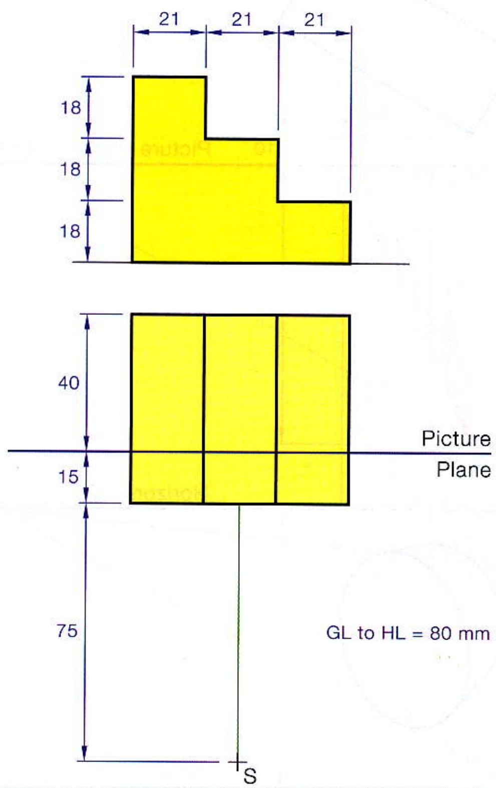


Fig. 7.18

Q3. Fig. 7.18

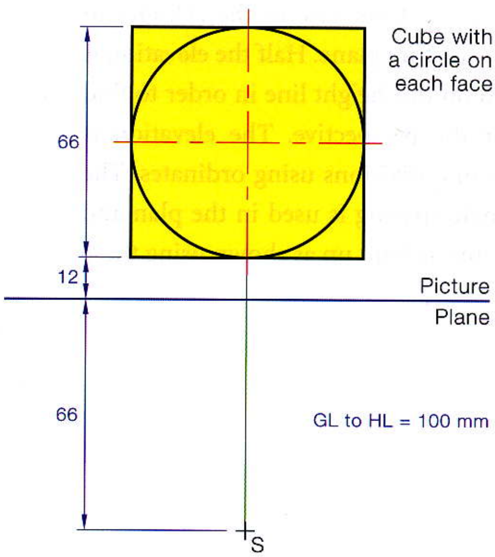


Fig. 7.19

Q4. Fig. 7.19

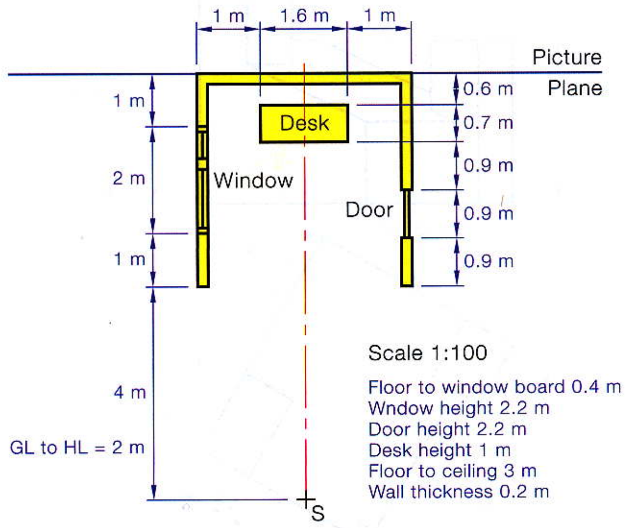


Fig. 7.20

Q5. Fig. 7.20

Q7. TO Q12.

Make a two-point perspective of the various objects using the information given. The picture plane is to pass through corner A.

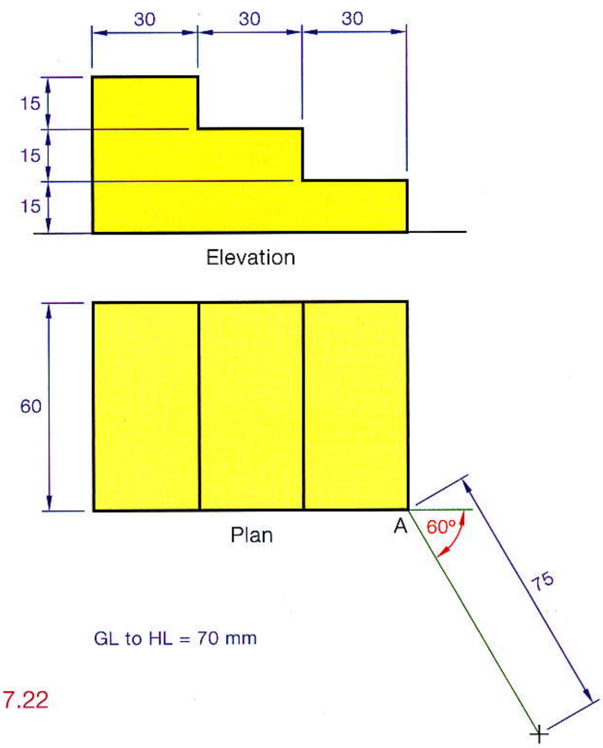


Fig. 7.22

Q7. Fig. 7.22

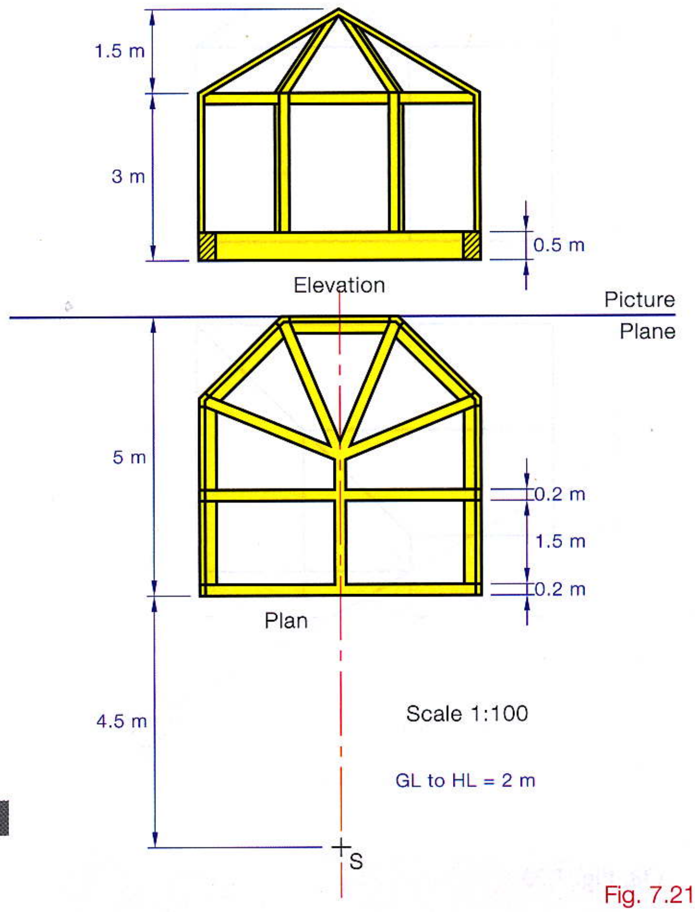


Fig. 7.21

Q6. Base wall is 0.3 m thick. The plan is based on an octagon. Conservatory frame is 0.1 m thick, Fig. 7.21.

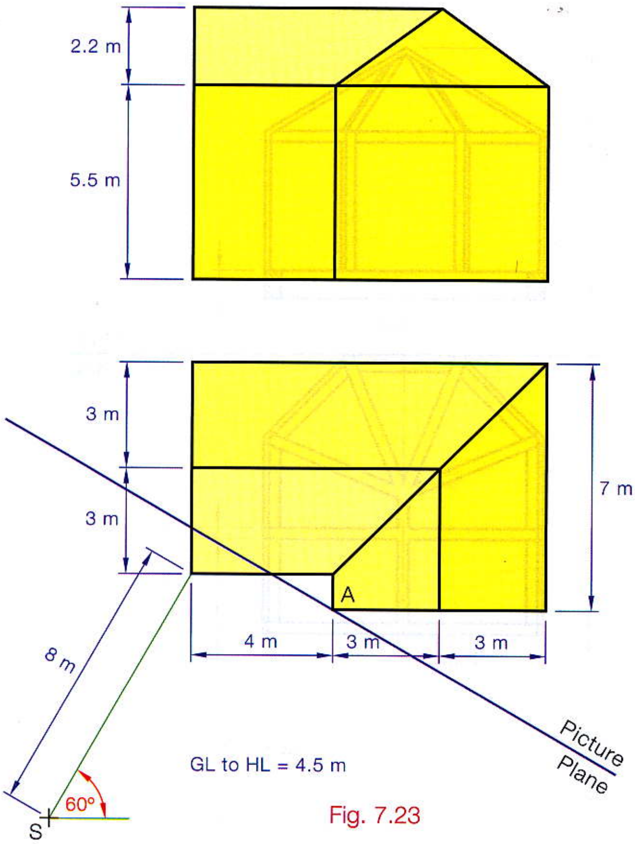


Fig. 7.23

Q8. Fig. 7.23

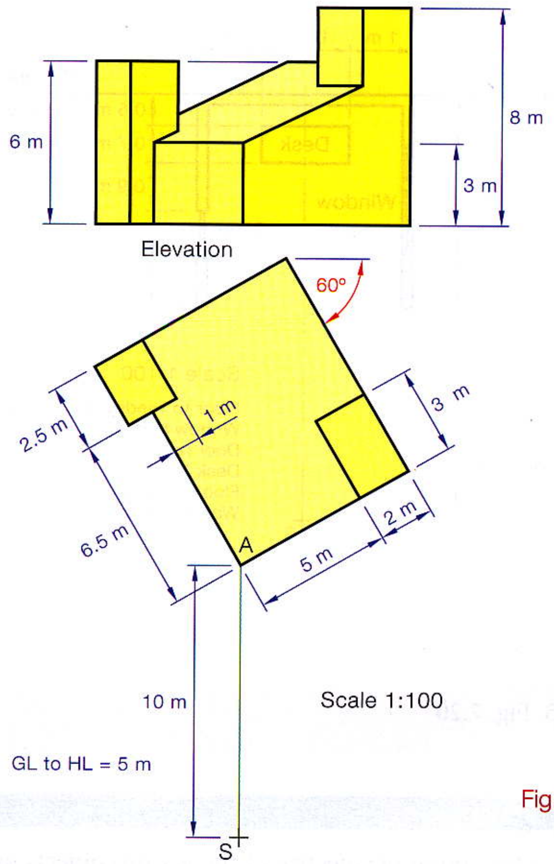


Fig. 7.24

Q9. Fig. 7.24

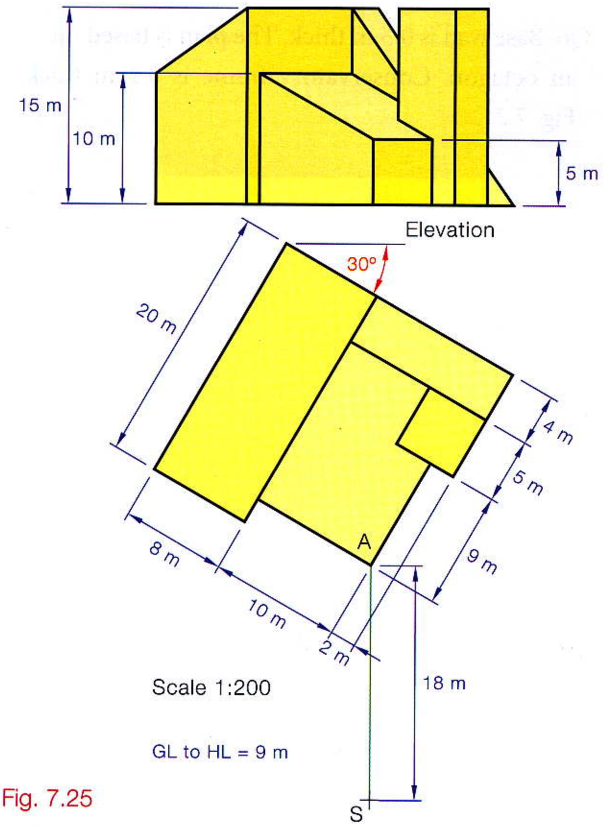


Fig. 7.25

Q10. Fig. 7.25

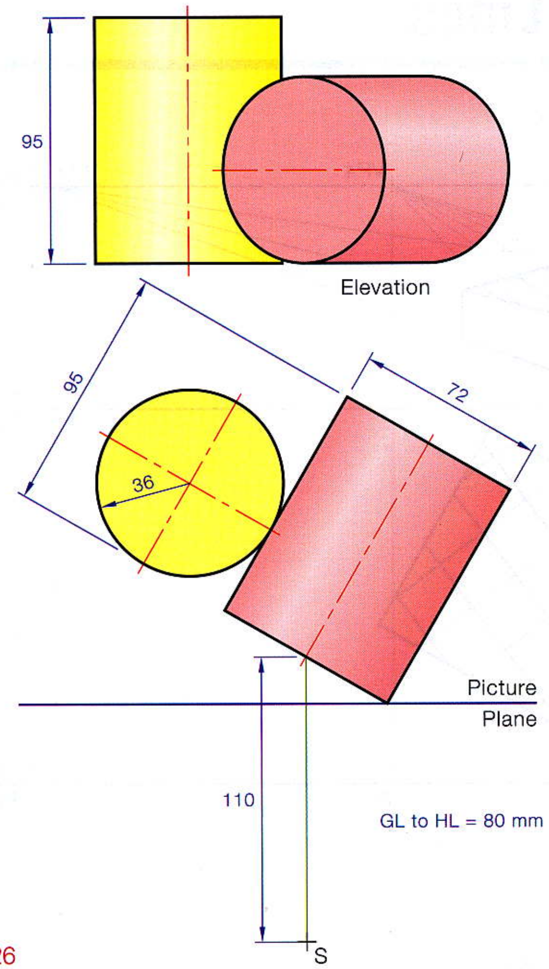


Fig. 7.26

Q11. Fig. 7.26

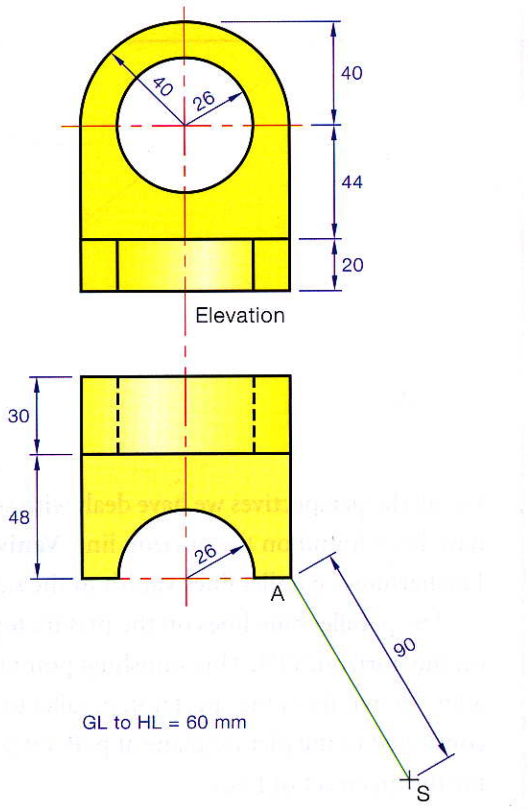


Fig. 7.27

GL to HL = 60 mm

Q12. Fig. 7.27

Vanishing Points of Inclined Lines

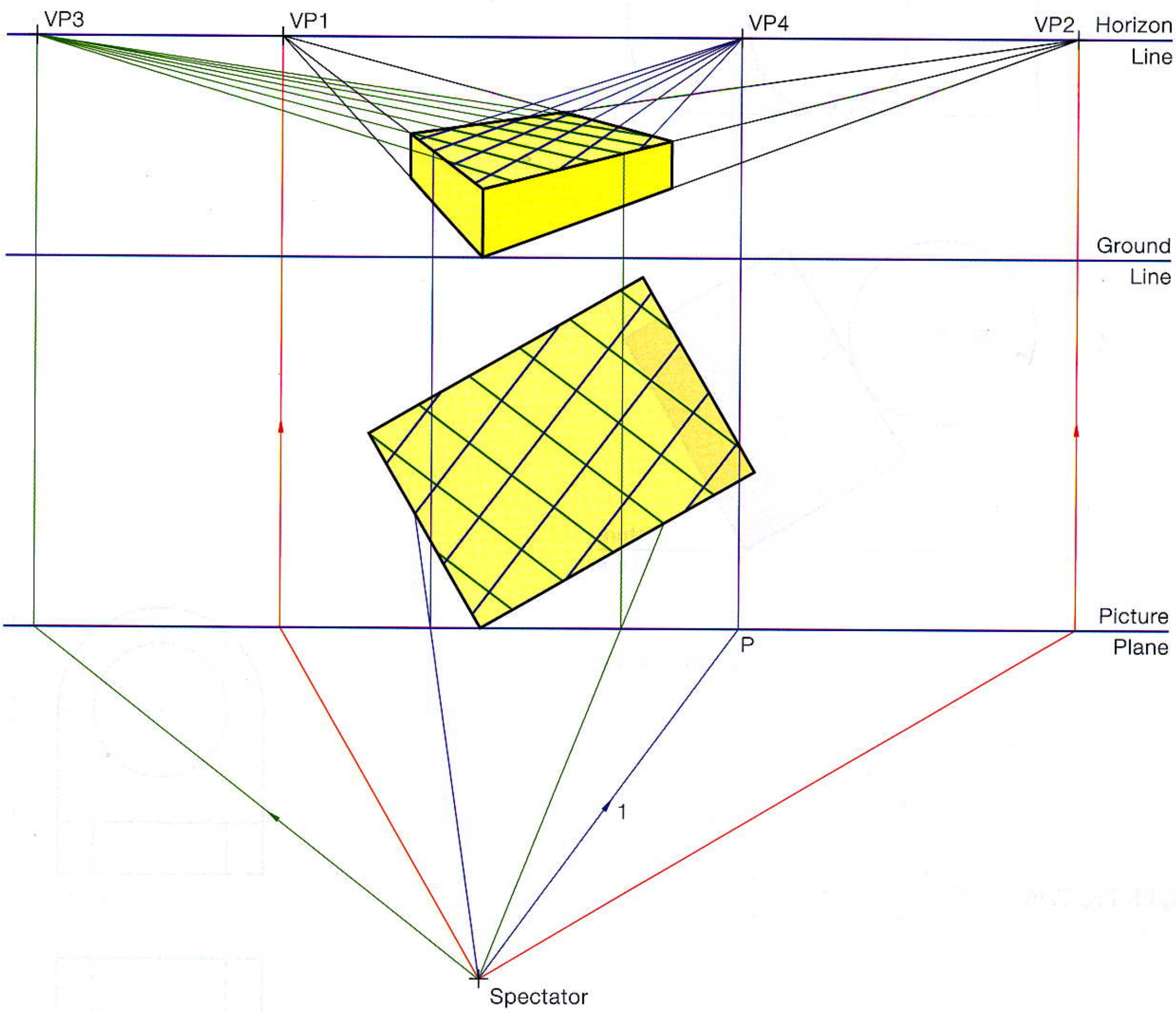


Fig. 7.28

HIGHER LEVEL

For all the perspectives we have dealt with so far we have used vanishing points of horizontal lines. The vanishing points have been found on the horizon line. **Vanishing points for horizontal lines will always be found on the horizon line.** Furthermore, parallel lines vanish to the same vanishing point, see Fig. 7.28.

The parallel blue lines on the prism's top surface are horizontal and therefore will vanish to a vanishing point (VP) on the horizon, VP4. This vanishing point is found, as for all lines, by finding the piercing point in the picture plane of a line drawn from the spectator, parallel to the given line. A line is drawn from S parallel to the blue set of lines and is continued to the picture plane at p. Point p is projected to the horizon line giving VP4. A similar approach can be used for the green set of lines.

Sets of parallel inclined lines vanish to vanishing points either above or below the horizon line and these vanishing points, are called **auxiliary vanishing points.**

Lines which are sloping upwards as they go away from the spectator will have an auxiliary vanishing point above the horizon.

Lines which are sloping downwards as they go away from the spectator will have an auxiliary vanishing point below the horizon.

Finding Auxiliary Vanishing Points

(1) Identify the set of sloped lines for which we will need the auxiliary vanishing point. If they are sloping upwards as they go away from the spectator then the vanishing point will be above the horizon. If the lines are sloping downwards as they go away from the spectator then the vanishing point will be below the horizon.

(2) Draw a line from S parallel to this set of lines as they appear in plan. Extend this line until it hits the picture plane.

Note: In this example it will be the same line as that used to find VP2. The auxiliary vanishing point will be in line with VP2.

(3) In this step we find how high the auxiliary VP is above the horizon. Step the length of one of the sloped lines (as it appears in plan) out from the spectator, length ab. Step the difference in height between the start and finish of this sloped line, height bc, out perpendicular to the 'length' at b.

(4) This triangle abc is now continued on and enlarged giving the height, at the picture plane, that the auxiliary VP is above the horizon, see Fig. 7.29.

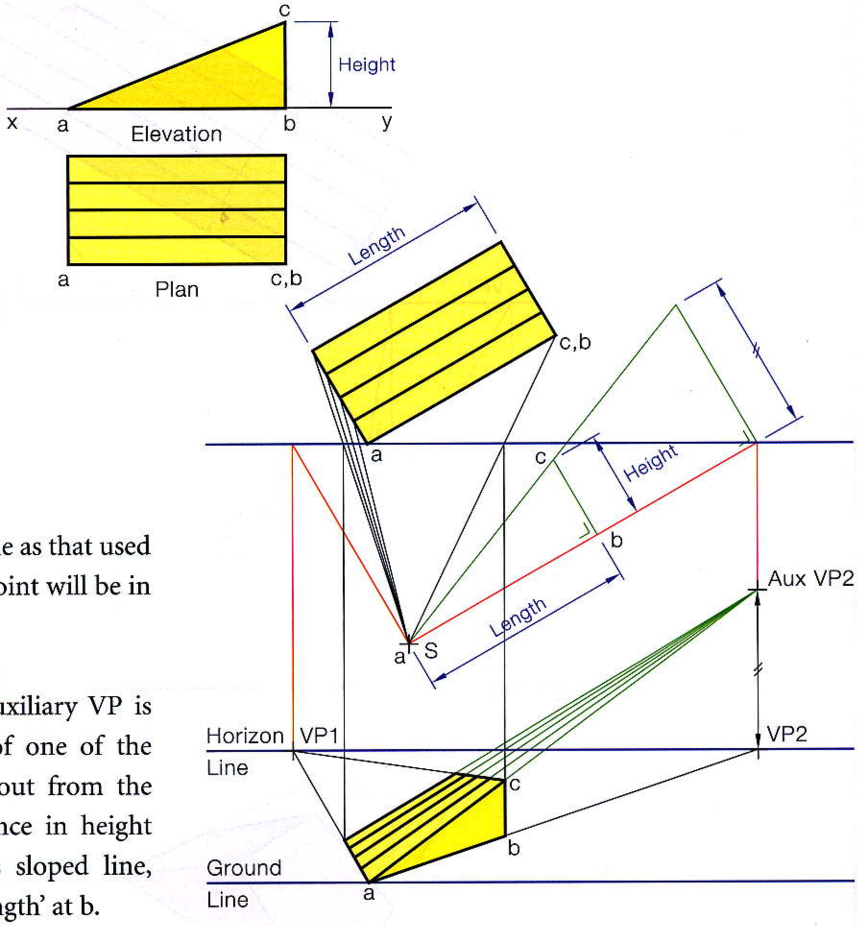


Fig. 7.29

Finding Auxiliary Vanishing Points (Alternative Method)

This method of finding auxiliary vanishing points is almost identical to the first method but uses true angles instead of distances.

Given the solid shown in Fig. 7.30 draw a two-point perspective of this solid using auxiliary vanishing points where appropriate.

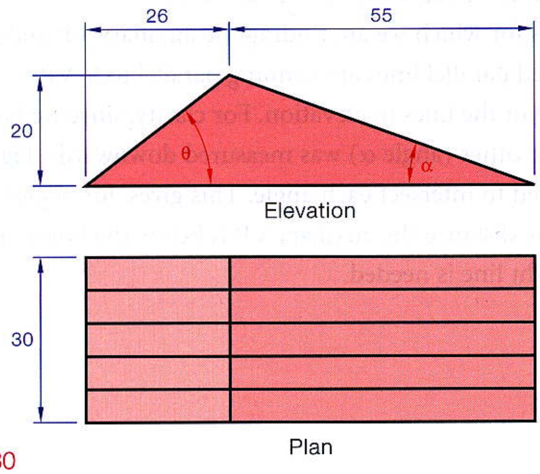


Fig. 7.30

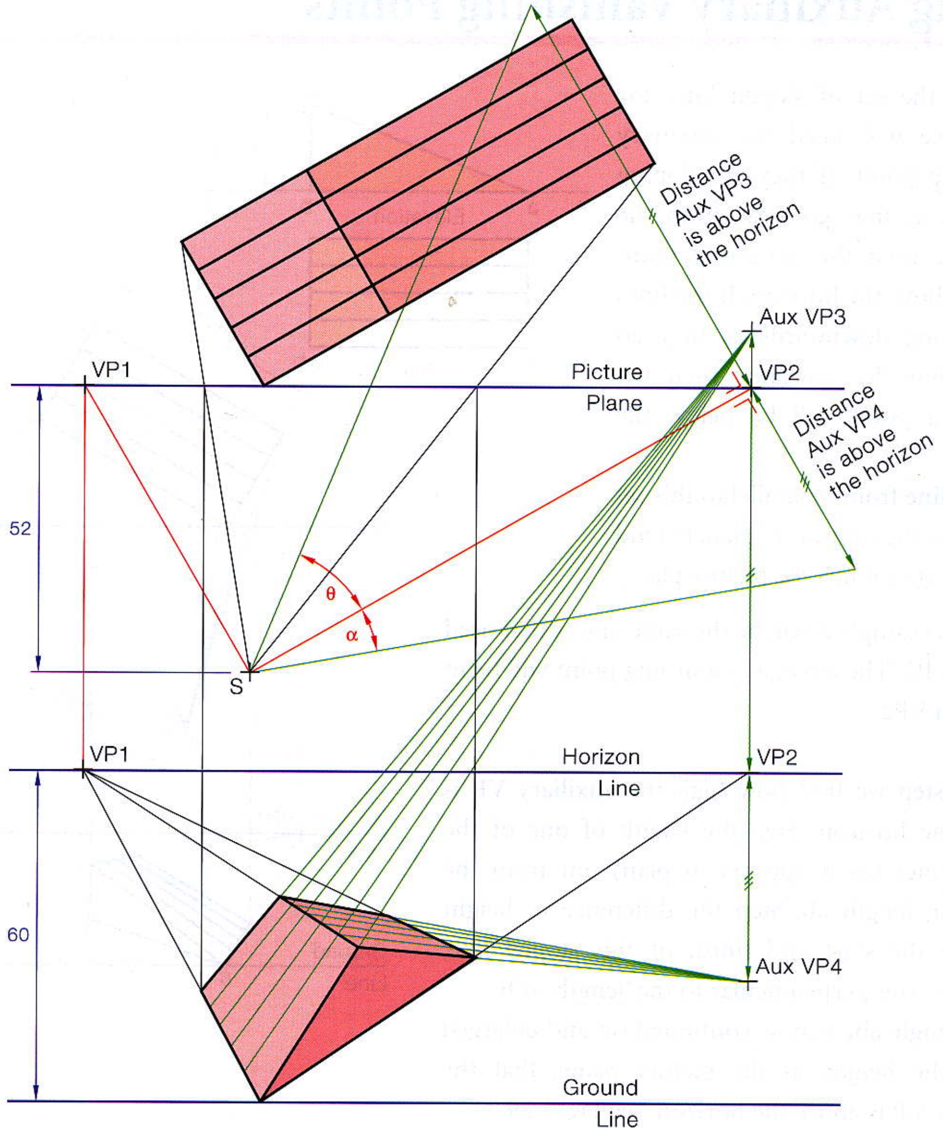


Fig. 7.31

(1) It is worth noting that all perspectives can be drawn by using height lines and avoiding the use of auxiliary vanishing points but the perspective can be completed quicker and more accurately if they are used.
Draw a line from the spectator parallel to the set of lines for which we are finding the auxiliary VP and continue it to hit the picture plane. In this example both sets of inclined parallel lines are running parallel to S, VP2.

(2) From this line create an angle at S equal to the true slope of the lines in elevation. For clarity, since we have two sets of lines, one angle (angle θ) was measured upwards and the other (angle α) was measured downwards, Fig. 7.31

(3) A perpendicular to S, VP2 at the picture plane is produced to intersect each angle. This gives, for angle θ, the distance the auxiliary VP is above the horizon and for angle α, the distance the auxiliary VP is below the horizon.

(4) The perspective is completed in the normal way. No height line is needed.

Worked Example

It should be noted that extra care should be taken when using angles so that it is the **true angle** that is used, not the apparent angle. The following example will attempt to demonstrate the difference.

Given the solid shown in Fig. 7.32. Draw a two-point perspective of this solid when the position of the spectator is as shown and the horizon line is 24 mm above the ground line. Use auxiliary vanishing points where appropriate.

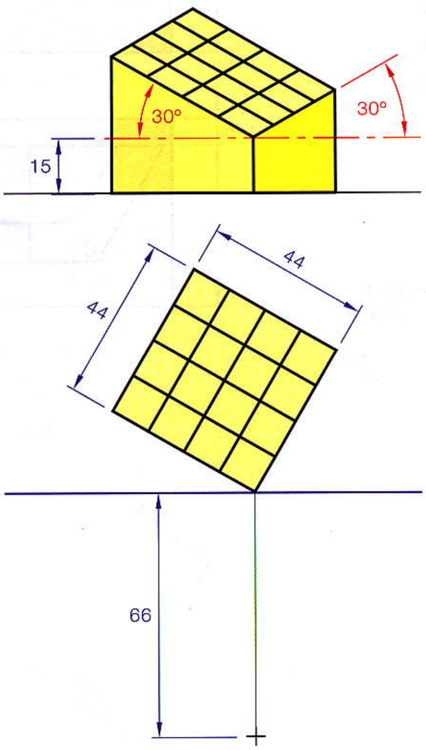


Fig. 7.32

(1) In elevation, edge ab and all lines parallel to it appear to make an angle of 30° to the horizontal plane but their true angle is much less, as shown in Fig. 7.33.
Line ab has a true angle of θ to the horizontal plane and line ac has a true angle of α to the horizontal plane.

(2) The perspective is completed using these angles as shown in Fig. 7.34.

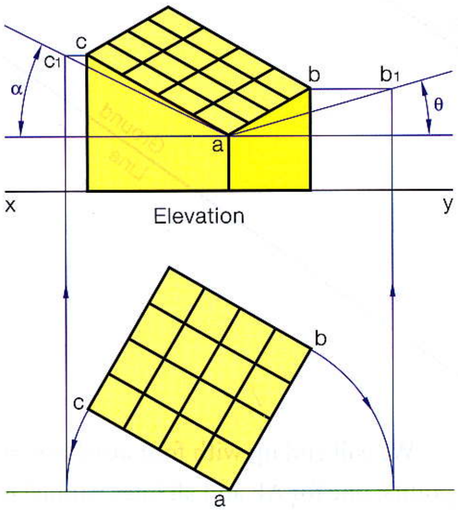


Fig. 7.33

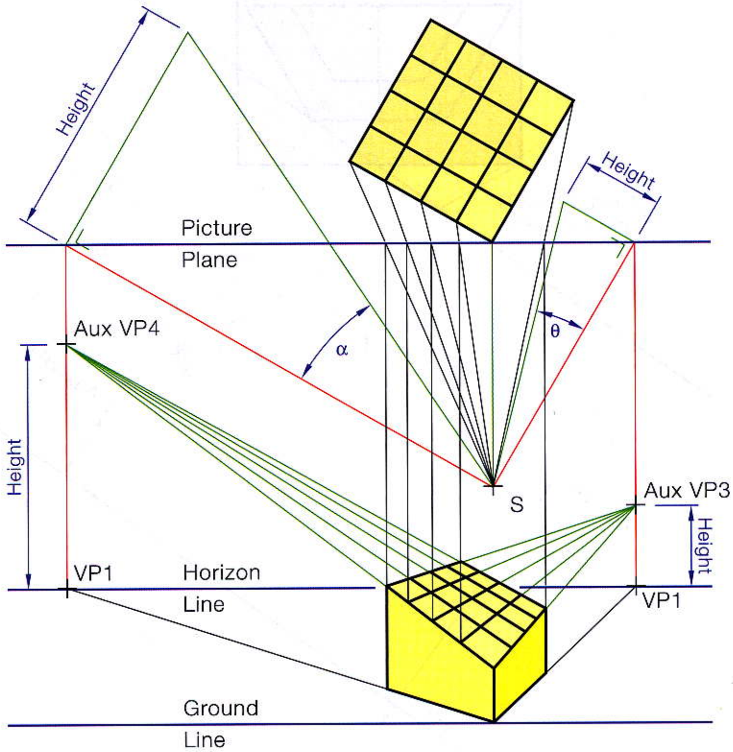


Fig. 7.34

HIGHER LEVEL

Given the structure shown in Fig. 7.35 which has a plan based on semi-hexagonal prisms. Draw a perspective view of the structure. The picture plane passes through corner A. The spectator is 10 m from corner A and the horizon line is 10 m above the ground line. Use auxiliary vanishing points where appropriate.

On examining this question it can be seen that edges AE and CE and all edges parallel to them have a true angle of 30° to the horizontal plane. It should be noted however that neither edge AB nor edge CD have a true angle of 30° to the HP even though they appear to be inclined at 30° in the elevation.

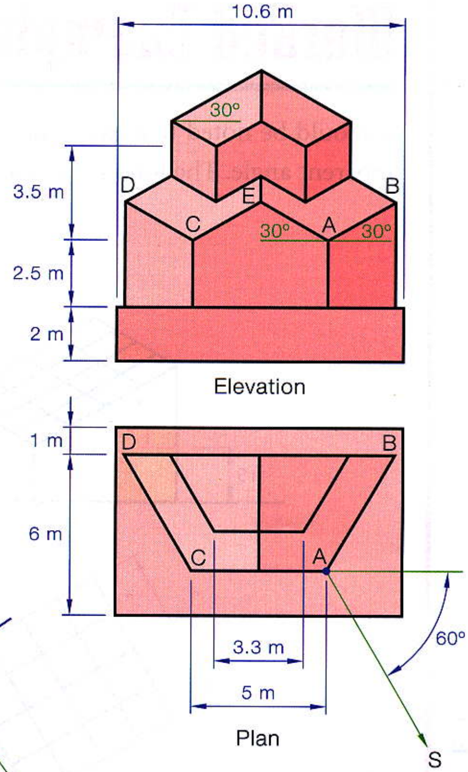


Fig. 7.35

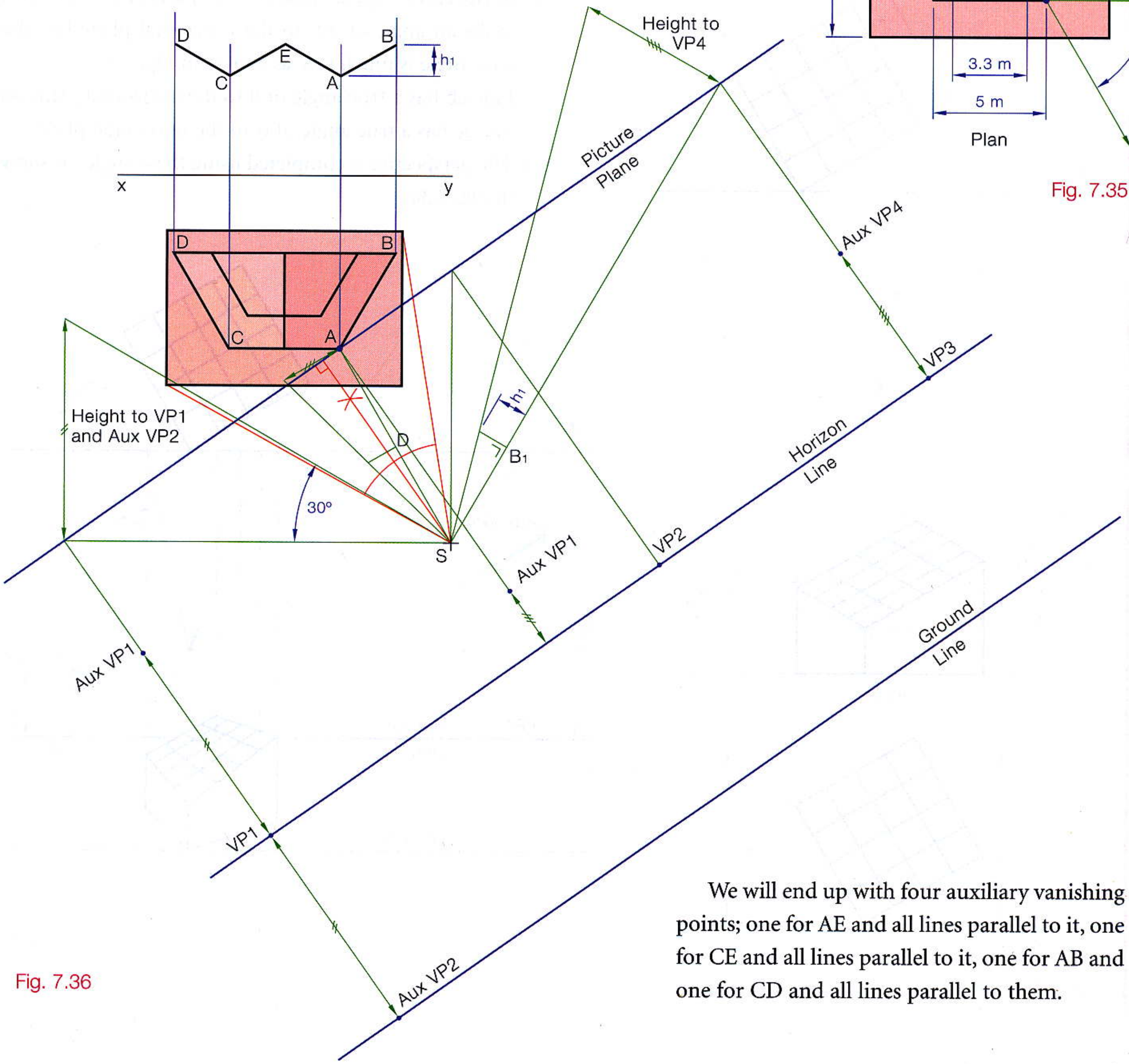


Fig. 7.36

We will end up with four auxiliary vanishing points; one for AE and all lines parallel to it, one for CE and all lines parallel to it, one for AB and one for CD and all lines parallel to them.

(1) The first step is to locate the picture plane. Join the outer corners of the plan back to the spectator. Bisect the angle formed to give the centre of vision. The picture plane is drawn perpendicular to this.
(2) Draw the ground line and horizon line and locate VP1 and VP2, the vanishing points for the horizontal base lines. These vanishing points will be on the horizon.
(3) Vanishing points for edges AE and CE will be on the VP1 line. The auxiliary vanishing point for AE will be above the horizon and the auxiliary vanishing point for CE will be below the horizon. The construction is as shown in Fig. 7.36. We can use the 30° as it is a true angle.
(4) Auxiliary vanishing point for edge AB is found as shown. A line is drawn from S parallel to AB in plan, to hit the picture plane. The length of AB in plan is stepped away from S on this line giving B_1. A perpendicular to SB_1 is drawn at B_1. The difference in height between A and B is found in elevation (h_1) and stepped out on this perpendicular. Complete the triangle and enlarge to the picture plane. We thus find the height of Aux VP4 above the horizon.
(5) Aux VP3 is found in a similar way.
(6) The perspective is completed in Fig. 7.37.

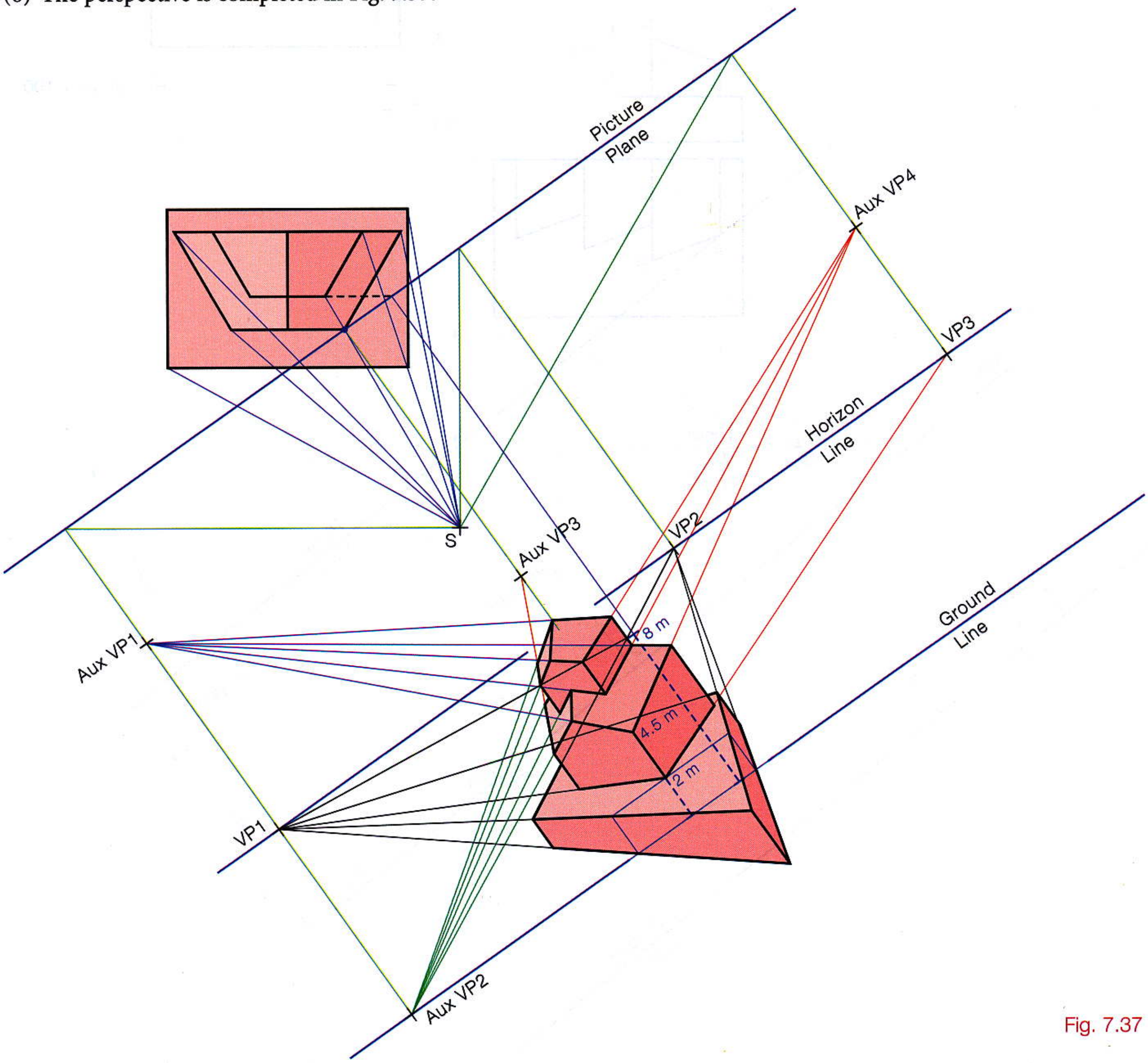


Fig. 7.37

Draw a perspective view of the structure shown in Fig. 7.38. The picture plane passes through corner A. The spectator is 10 m from corner A and the horizon line is 10 m above the ground line. Use auxiliary vanishing points where appropriate.

As before we will start by locating the picture plane, ground line and horizon line. We will also find all necessary vanishing points. It should be noted that the elevation is not needed, we only draw a small portion of it as in the previous example.

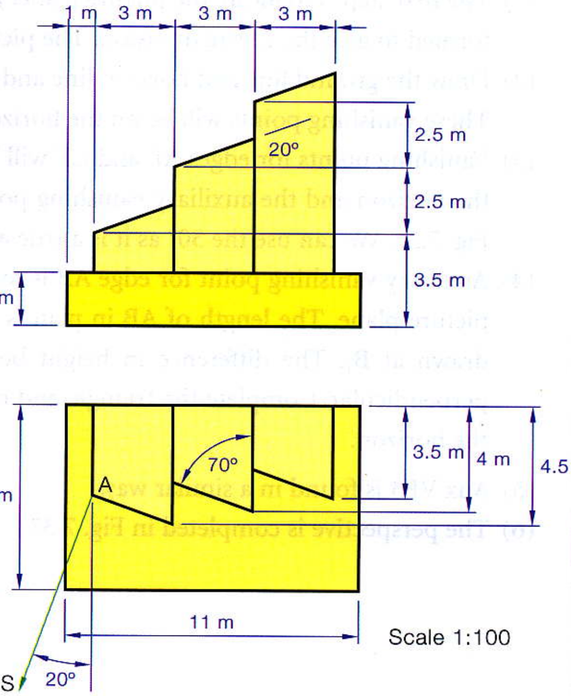


Fig. 7.38

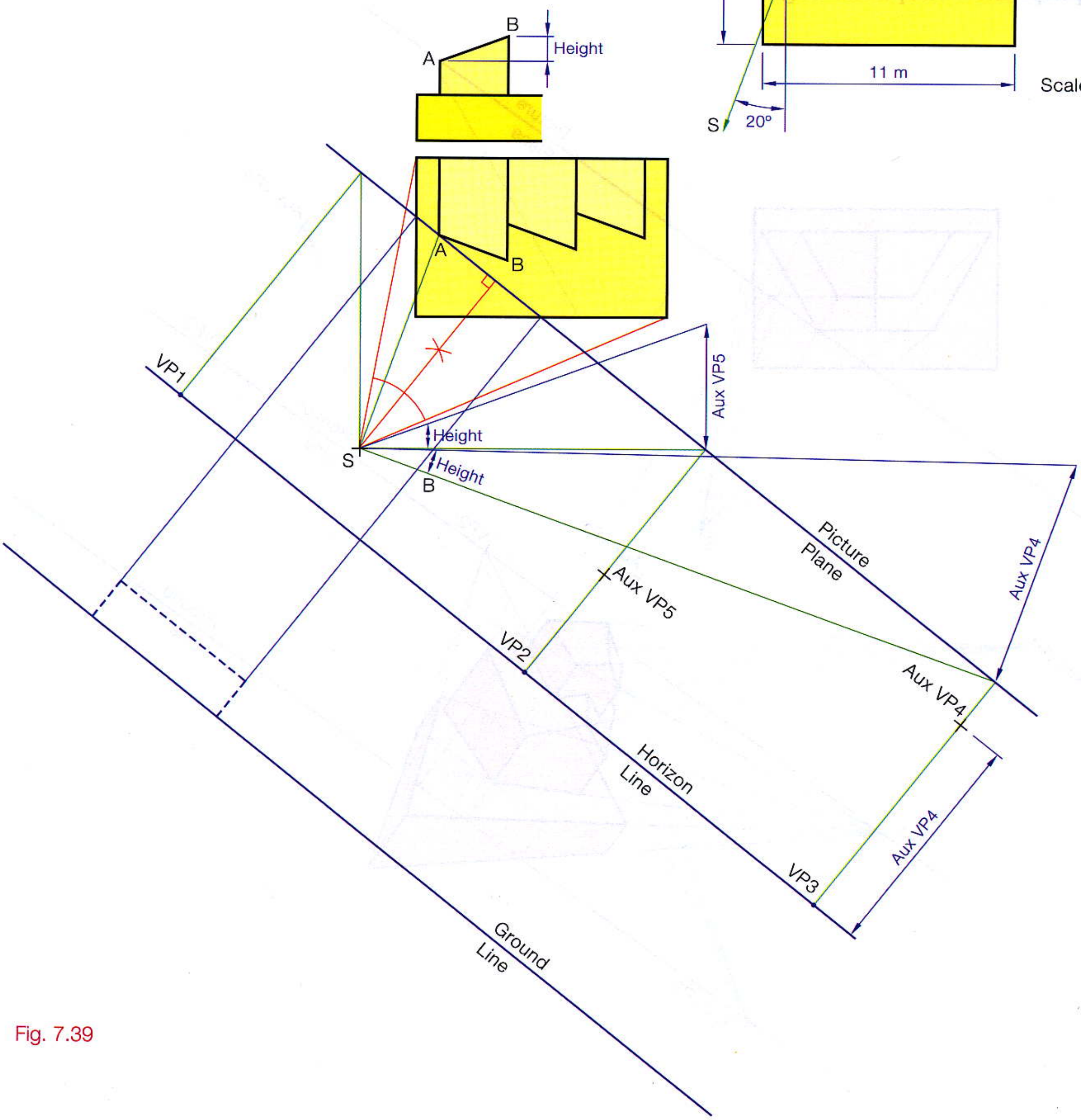


Fig. 7.39

(1) Rays are projected from the two outer corners back to S. The angle formed is bisected, giving the centre of vision. The picture plane is drawn perpendicular to this, Fig. 7.39.
(2) Horizon line and ground line are 10 m apart and parallel to the picture plane.
(3) VP1 and VP2 are vanishing points for the rectangular base. These vanishing points will be on the horizon line because they are vanishing points for horizontal lines.
(4) The line AB in plan actually represents two lines. One of these is running along the top surface of the base, is horizontal, and therefore has a vanishing point on the horizon, VP3. The other is sloping upwards as it goes away from the spectator and will therefore have an auxiliary vanishing point above the horizon.
(5) Draw a line from S parallel to AB in plan. Extend to hit the picture plane. Step the distance AB, from the plan, out from the spectator along this line, giving point B.
(6) Step the difference in height between A and B (obtained from the elevation) out perpendicularly. Create a triangle and enlarge to the picture plane. This gives the height Aux VP4 will be above the horizon. Auxiliary VP5 is found in a similar way.
(7) The perspective is finished as before. See Fig. 7.40.

Note: Height lines always vanish to vanishing points on the horizon line.

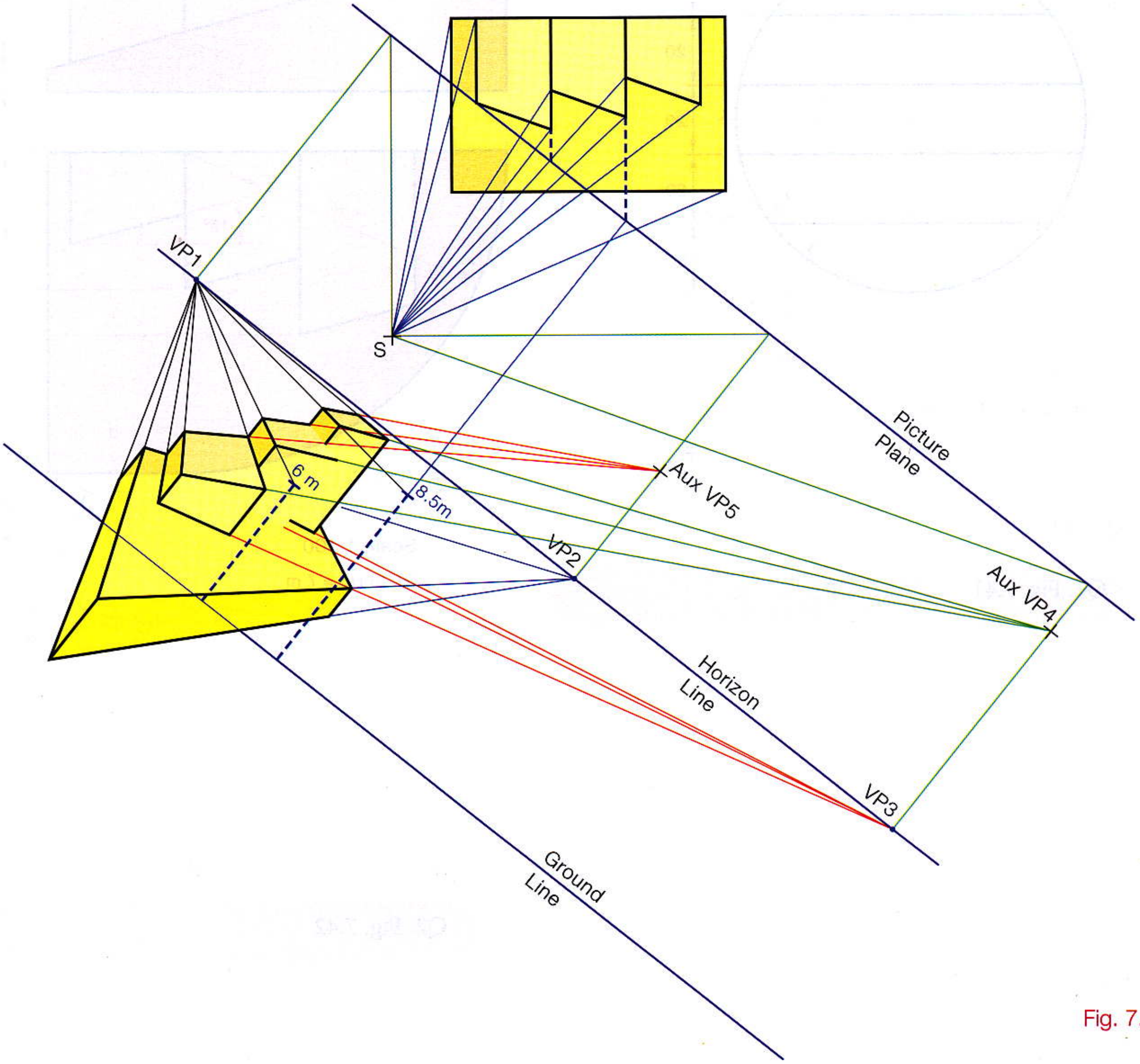


Fig. 7.40

Activities

For each of these questions draw a perspective view using auxiliary vanishing points where appropriate. Picture plane to pass through point A.

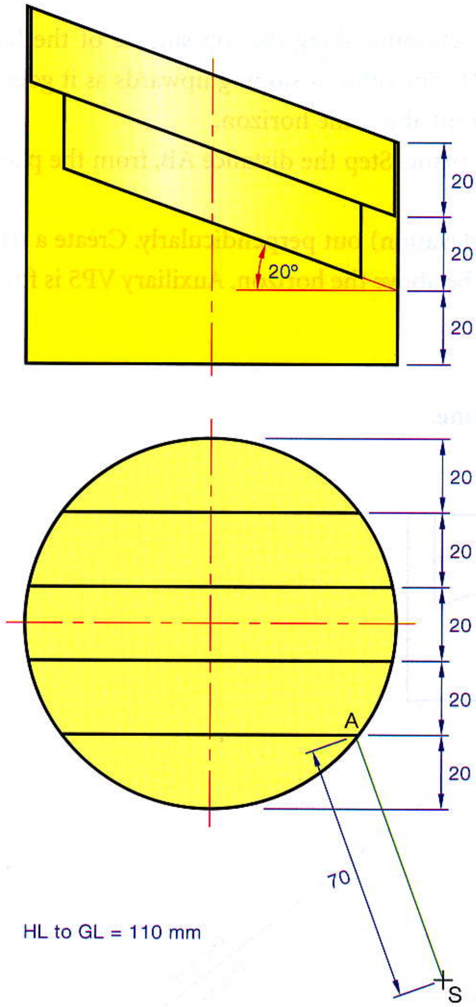


Fig. 7.41

Q1. Fig. 7.41

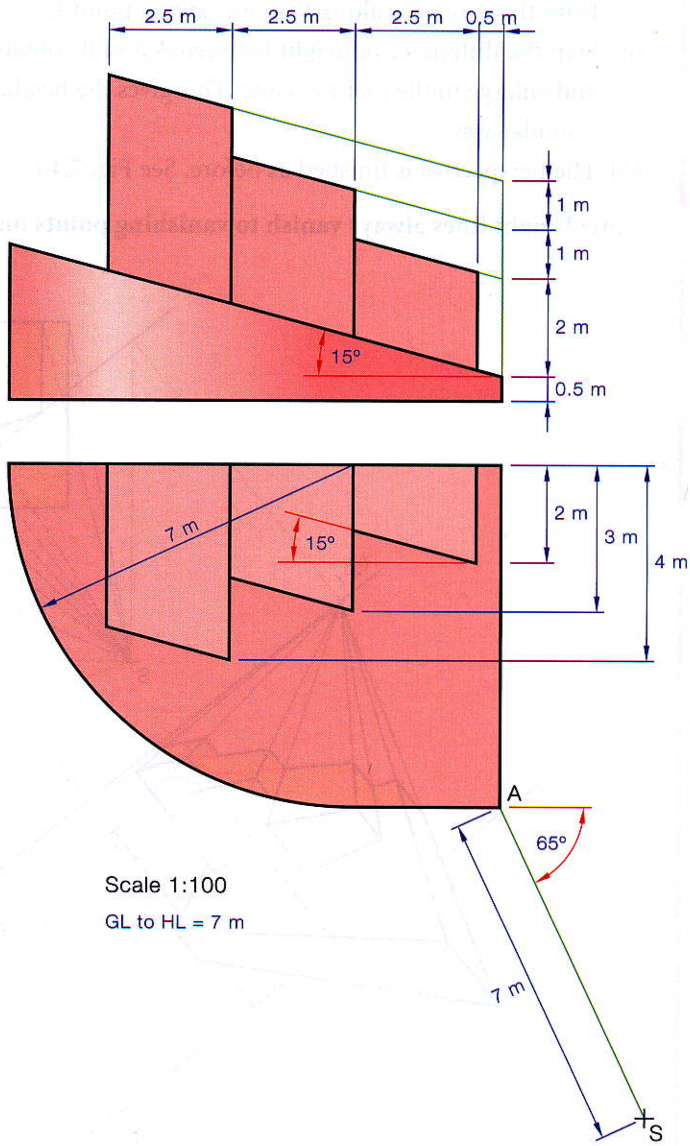


Fig. 7.42

Q2. Fig. 7.42

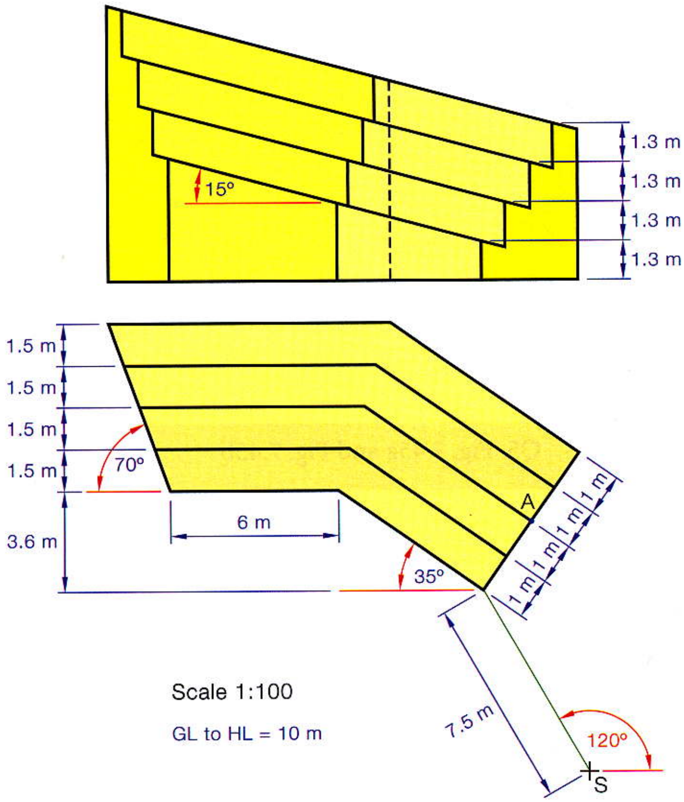


Fig. 7.43

Q3. Fig. 7.43

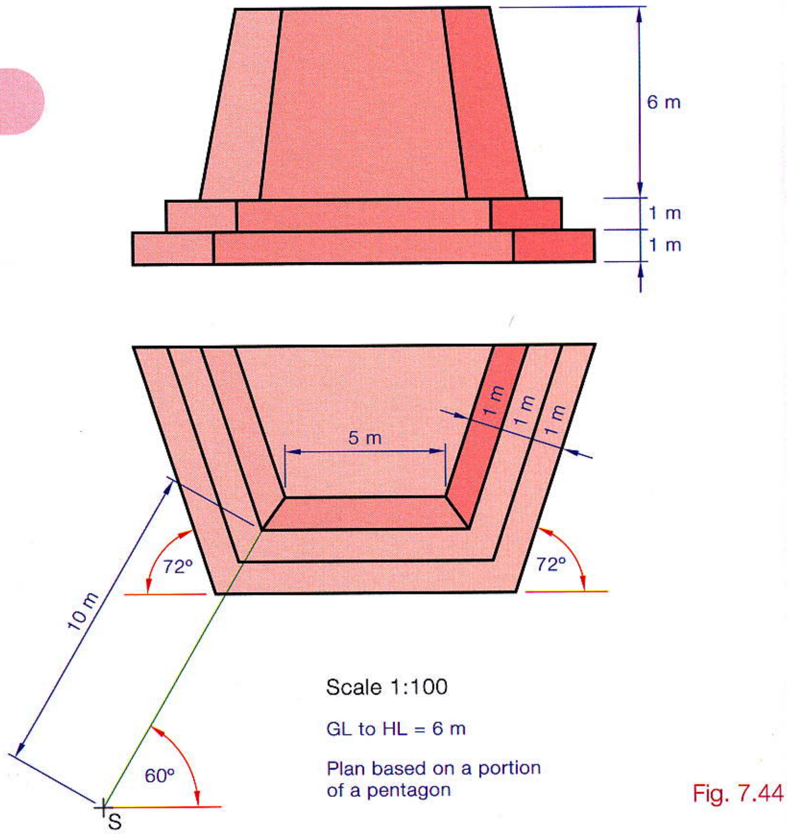


Fig. 7.44

Q4. Fig. 7.44

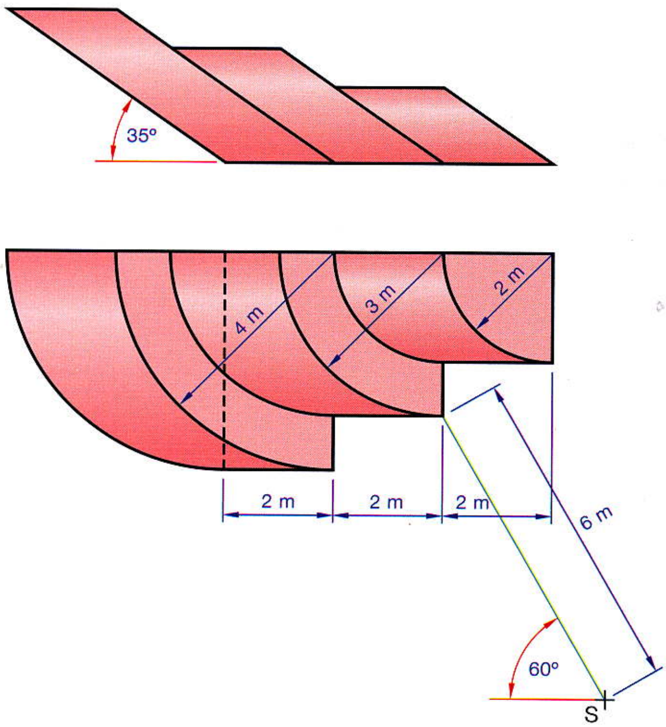


Fig. 7.45a

Q5. Fig. 7.45a and Fig. 7.45b

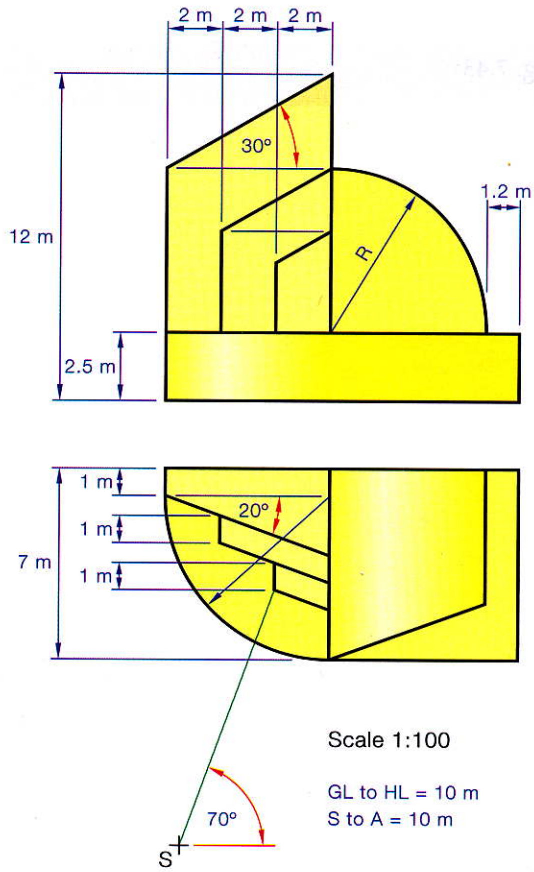


Fig. 7.45b