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Engineering Drawing with Worked Examples

Second Edition

F. Pickup and M. A. Parker

ENGINEERING DRAWING

WITH WORKED EXAMPLES 2

PREFACE

In view of the change-over to the metric (SI) system this book has been reviewed. The topics discussed remain the fundamentals of the subject and continue to cater for many courses in Engineering Drawing, such as those provided for National Certificate, Mechanical Technicians, Trade and Craft Courses.

Many aspects of change to the metric system are relatively straightforward—an actual length is still the same, even though the number associated with it may vary from one system to another. Any field in which parts must fit each other is more complex however, probably the most difficult being that of screw threads and the standardization of threads. It is for this reason that existing thread forms such as B.S.F., Whitworth and B.A. threads have again been used throughout Book 2 and data relating to these threads given on pages 247 and 248.

The same method of presenting the subject has been followed as in Book 1. The text has been kept to a minimum sufficient to outline the general principles of the subject, and worked examples have been freely used to enlarge on it. Each example shows the method of obtaining the solution together with additional explanatory notes. For some topics where a solution on one drawing would have been difficult to understand, the solution has been drawn in step-by-step form. Sufficient problems for class use and homework for one year are also given for the lecturer.

The authors' thanks are again due to those of their colleagues at the Rolls Royce Technical College who read and criticised the manuscript and checked the drawings. The British Standards Institution again permitted information form some of their Standards to be reprinted.

CONTENTS

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AUXILIARY PROJECTION

CASES arise in practice where views of an object projected on to the principal planes of projection are either insufficient to describe the object or are difficult to draw or dimension. Such cases include objects with inclined faces of a complex nature and are best drawn using auxiliary views. An auxiliary view is one which is drawn on a plane other than a principal plane of projection. An auxiliary view which is projected from a normal elevation or plan is called a first auxiliary elevation or plan. Other auxiliary views may be projected from first auxiliary views. These are called second auxiliary elevations or plans. It should be noted that an elevation can only be projected from a plan and vice versa.

First Auxiliary Elevations

Figure 1(a) illustrates the method of projecting these views, using First Angle projection. The standard elevation and plan are first drawn with an XY line or datum line between them. It may be convenient to use the centre line of the plan or the base line of the detail as the XY line. The first auxiliary elevation is required in the direction of arrow Q, so points on the plan view are projected parallel to the arrow to cross the new datum line X^1Y^1 at right angles. This new datum line may be placed in any convenient position. The heights above the XY line, A, B and C, of points in the original elevation, are then transferred to the appropriate projectors above the new X^1Y^1 line and the view is lined in. To avoid confusion between full lines and hidden detail lines it is best to complete first those faces which are seen completely in the auxiliary view.

Figure 1(b) shows the same views drawn in Third Angle projection. The method of using the same heights in both elevations is identical with views drawn in First Angle projection.

First Auxiliary Plan Views

The method for these views is similar to that used for first auxiliary elevations and is shown using First Angle projection, in Figure 2(a). Projectors from points on the normal elevation are drawn parallel to the new direction of viewing, given by arrow Q, and cross the new datum X^1Y^1 at right angles. Depths W and Z, from the XY line to points in the original

AUXILIARY PROJECTION.

FIRST AUXILIARY ELEVATIONS.

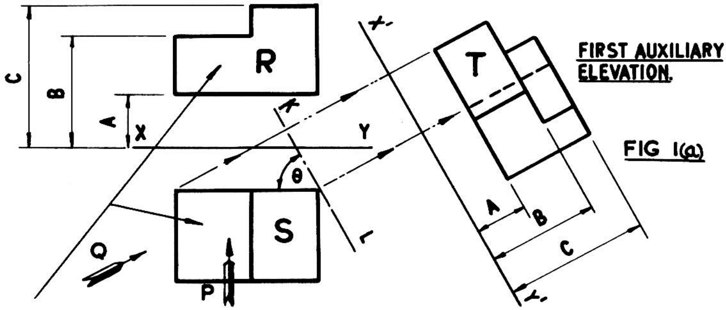


FIG 1(a)

VIEWS R AND S. – STANDARD ELEVATION AND PLAN VIEW IN FIRST ANGLE ORTHOGRAPHIC PROJECTION.

X,Y. LINE. – RELATIVE TO THE ELEVATION REPRESENTS THE HORIZONTAL PLANE.
RELATIVE TO THE PLAN REPRESENTS THE VERTICAL PLANE.

NOTE – VIEWING GIVEN PLAN IN DIRECTION OF ARROW P WILL PRODUCE THE ELEVATION R.
VIEWING GIVEN PLAN IN DIRECTION OF ARROW Q WILL PRODUCE A NEW ELEVATION T.

THE NEW ELEVATION T IS PROJECTED HAVING VERTICAL HEIGHTS EQUAL TO THE GIVEN HEIGHTS IN ELEVATION R. THUS THE PROJECTION OF A FIRST AUXILIARY ELEVATION DOES NOT ALTER THE DETAIL'S POSITION RELATIVE TO THE H.P.

THE DETAIL'S POSITION RELATIVE TO THE V.P. HAS BEEN CHANGED SUCH THAT IT IS NOW SET AT AN ANGLE θ TO THE V.P. LINE K.L. PARALLEL TO X.Y.' BEING THE NEW GROUND LINE.

VIEWS R AND S. – STANDARD ELEVATION AND PLAN IN THIRD ANGLE ORTHOGRAPHIC PROJECTION.

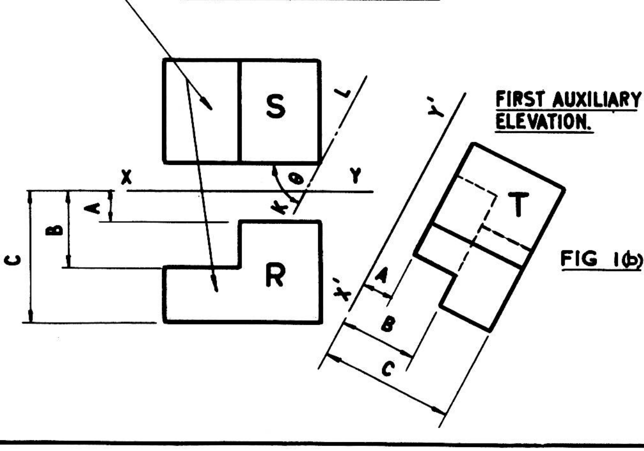


FIG 1(b)

AUXILIARY PROJECTION.

FIRST AUXILIARY PLANS.

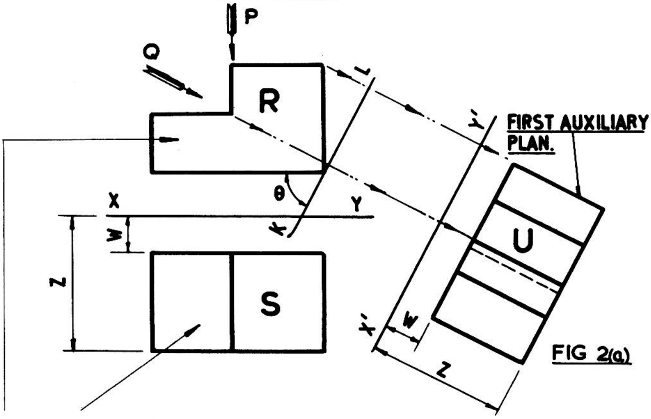


FIG 2(a)

VIEWS R AND S — STANDARD ELEVATION AND PLAN VIEW IN FIRST ANGLE ORTHOGRAPHIC PROJECTION.

X.Y. LINE. — RELATIVE TO THE ELEVATION REPRESENTS THE HORIZONTAL PLANE.
RELATIVE TO THE PLAN REPRESENTS THE VERTICAL PLANE.

NOTE — VIEWING GIVEN ELEVATION IN DIRECTION OF ARROW P WILL PRODUCE THE PLAN S.
VIEWING GIVEN ELEVATION IN DIRECTION OF ARROW Q WILL PRODUCE A NEW PLAN U.

THE NEW PLAN U IS PROJECTED HAVING DEPTHS EQUAL TO THE GIVEN DEPTHS IN PLAN S.
THUS THE PROJECTION OF A FIRST AUXILIARY PLAN VIEW DOES NOT ALTER THE DETAIL'S POSITION RELATIVE TO THE V.P.

THE DETAIL'S POSITION RELATIVE TO THE H.P. HAS BEEN CHANGED SUCH THAT IT IS NOW SET AT AN ANGLE θ TO THE H.P. LINE K L PARALLEL TO X Y BEING THE NEW GROUND LINE.

VIEWS R AND S — STANDARD ELEVATION AND PLAN IN THIRD ANGLE ORTHOGRAPHIC PROJECTION.

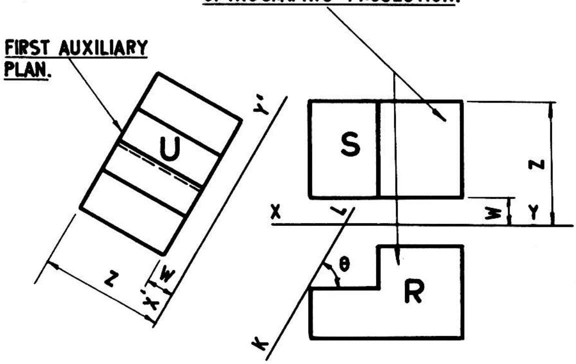


FIG 2(b)

AUXILIARY PROJECTION.
SECOND AUXILIARY ELEVATIONS.

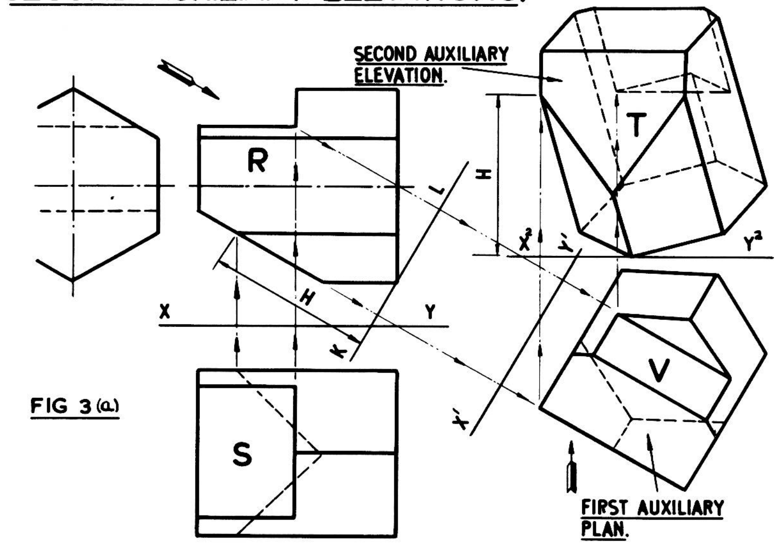


FIG 3 (a)

FIRST AND SECOND AUXILIARY VIEWS IN FIRST ANGLE ORTHOGRAPHIC PROJECTION.

NOTE. — IGNORE THE ORIGINAL PLAN S WHEN PROJECTING THE SECOND AUXILIARY ELEVATION, THE GROUND LINE BEING CHANGED TO X¹Y¹.

VIEWS R. AND V. — REPRESENTING A PLAN AND ELEVATION DRAWN IN THEIR CONVENTIONAL POSITIONS RELATIVE TO THE GROUND LINE X.Y¹

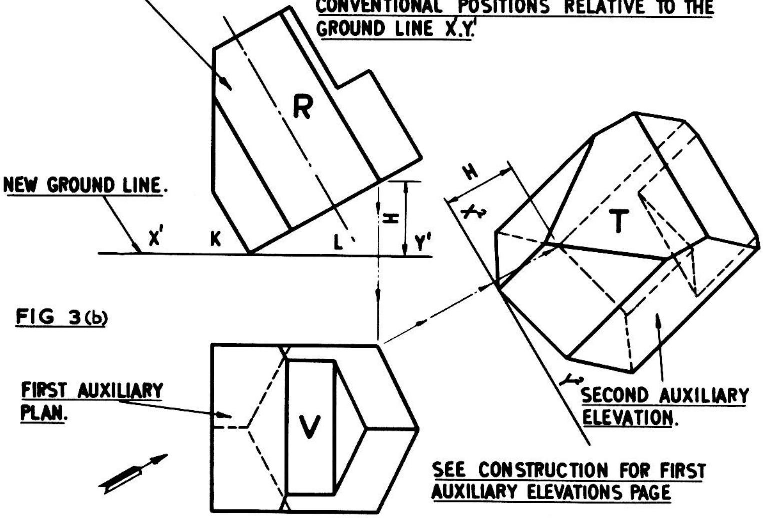


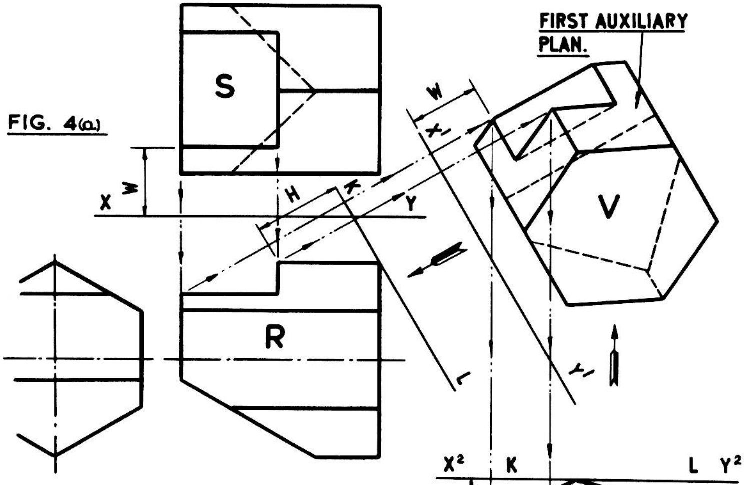
FIG 3 (b)

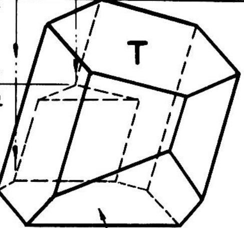
SEE CONSTRUCTION FOR FIRST AUXILIARY ELEVATIONS PAGE

AUXILIARY PROJECTION.

SECOND AUXILIARY ELEVATIONS.

FIG. 4(a)





FIRST AND SECOND AUXILIARY VIEWS IN THIRD ANGLE ORTHOGRAPHIC PROJECTION.

NOTE—IGNORE THE ORIGINAL PLAN S WHEN PROJECTING THE SECOND AUXILIARY ELEVATION, THE GROUND LINE BEING CHANGED TO X^1Y^1.

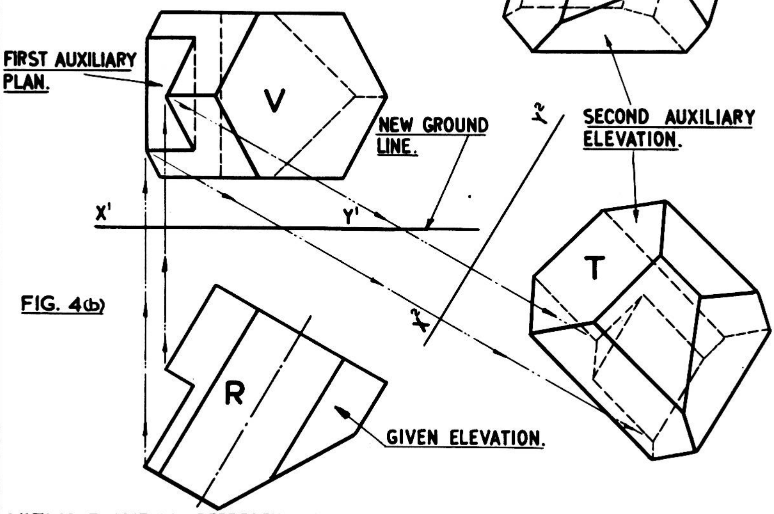


FIG. 4(b)

VIEWS R AND V—REPRESENTING A PLAN AND ELEVATION DRAWN IN THEIR CONVENTIONAL POSITIONS RELATIVE TO THE GROUND LINE X^1Y^1.

SEE CONSTRUCTION FOR FIRST AUXILIARY ELEVATIONS PAGE

plan, are then transferred to the appropriate projectors from the X^1Y^1 line and the view is completed.

Figure 2(b), in Third Angle projection, shows the method to be the same in this system of projection.

Second Auxiliary Elevations

These views are projected from first auxiliary plans and the method is shown in Figure 3(a). The first auxiliary plan view is first drawn as described above and projectors from points on this view are drawn parallel to the direction of viewing and crossing the new datum X^2Y^2 at right angles. Heights above X^1Y^1, such as H, of points in the original elevation R are transferred above X^2Y^2 on the appropriate projectors. To complete the second auxiliary view in the available space it is sometimes necessary to move X^1Y^1 to the position KL, as has been done in Figure 3(a).

It is important to realise that the original plan view S is not required in the projection of the second auxiliary elevation. This is illustrated in Figure 3(b) which shows the original elevation and first auxiliary plan drawn in the conventional positions relative to a horizontal ground line. The projection of the second auxiliary elevation T is identical with the projection of a first auxiliary elevation as outlined above and the original plan view S is not needed.

Figures 4(a) and 4(b) show the above construction in Third Angle projection. As before, the use of Third Angle projection makes no difference to the method.

Second Auxiliary Plan Views

These views are projected from first auxiliary elevations as shown in Figures 5(a) and 5(b). From the normal elevation R and plan S the first auxiliary elevation T is projected as described above. Projectors parallel to the direction of viewing and crossing the new datum line X^2Y^2 at right angles are drawn from this auxiliary elevation. Depths W from datum X^1Y^1 to the original plan are transferred to the projectors from the new datum X^2Y^2. Note that to save space X^1Y^1 has been moved to KL. The original elevation R is ignored in the projection of the second auxiliary plan, this being demonstrated in Figure 5(b).

The above construction in Third Angle projection is shown in Figures 6(a) and 6(b).

Projection of Arcs of Circles and Other Curves

This is performed by projecting a series of points on the curve in the same way that the points at the ends of straight lines are projected. The resulting curves in the auxiliary views can then be filled in with french

AUXILIARY PROJECTION.

SECOND AUXILIARY PLANS.

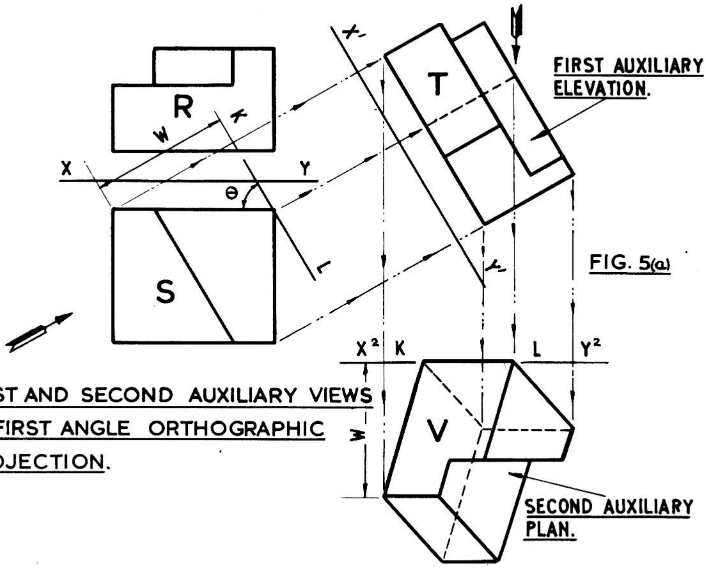


FIG. 5(a)

FIRST AND SECOND AUXILIARY VIEWS IN FIRST ANGLE ORTHOGRAPHIC PROJECTION.

SEE CONSTRUCTION FOR FIRST AUXILIARY PLANS PAGE

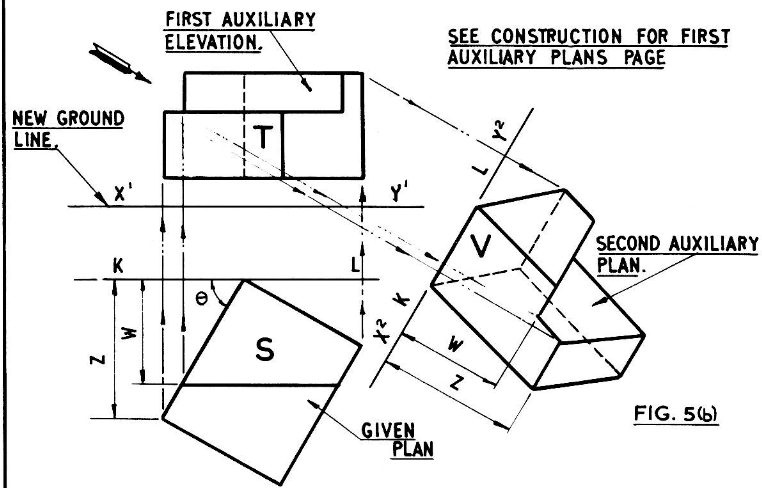


FIG. 5(b)

VIEWS S AND T — REPRESENTING A PLAN AND ELEVATION DRAWN IN THEIR CONVENTIONAL POSITIONS RELATIVE TO THE GROUND LINE X'Y'

NOTE — IGNORE THE ORIGINAL ELEVATION R WHEN PROJECTING THE SECOND AUXILIARY PLAN, THE GROUND LINE BEING CHANGED TO X'Y'.

AUXILIARY PROJECTION.

SECOND AUXILIARY PLANS.

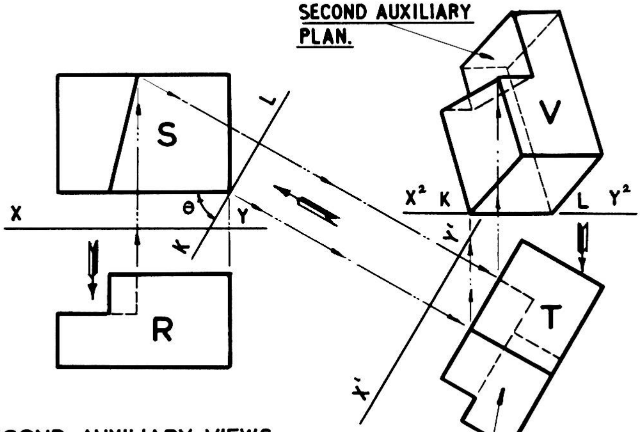


FIG. 6(a)

FIRST AND SECOND AUXILIARY VIEWS IN THIRD ANGLE ORTHOGRAPHIC PROJECTION.

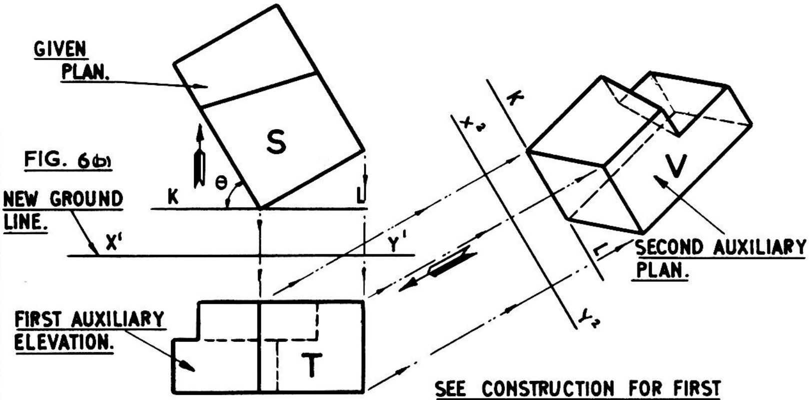


FIG. 6(b)

SEE CONSTRUCTION FOR FIRST AUXILIARY PLANS PAGE

VIEWS S AND T—REPRESENTING A PLAN AND ELEVATION DRAWN IN THEIR CONVENTIONAL POSITIONS RELATIVE TO THE GROUND LINE X'Y'.

NOTE —IGNORE THE ORIGINAL ELEVATION R WHEN PROJECTING THE SECOND AUXILIARY PLAN, THE GROUND LINE BEING CHANGED TO X'Y'.

curves. If too many points are projected the work becomes tedious and there is no increase in accuracy.

The Solution of Problems

The solutions of auxiliary projection problems are obtained more easily if the following points are observed:

All XY lines should be marked in some way to distinguish them from each other.

The XY line for the first auxiliary view can be moved to a new position to reduce to a manageable size the distances to points in the second auxiliary view. Also, this will often enable the second auxiliary view to be drawn in the available space. The new position of the XY line must, of course, be parallel to its original position.

Views of symmetrical details are drawn more quickly if centrelines are used as XY lines.

When distances to points on an object are transferred from one XY line to another, they must be laid off in the same direction relative to the linking view. For example, in Figure 5(a) the first auxiliary elevation links the normal plan and the second auxiliary plan. Dimension W on the normal plan is laid off from X^1Y^1 away from the first auxiliary elevation. When it is transferred to X^2Y^2 it is again laid off away from the first auxiliary elevation. Observance of this rule will prevent views being drawn upside down or reversed.

It is unnecessary to project all the points in an auxiliary view since lines which are parallel in the normal elevation and plan remain parallel in the auxiliary views. Thus a few lines can be projected in an auxiliary view and the view completed by making the remainder parallel to them.

Some worked examples follow, and further problems will be found on page 29.

EXAMPLE 12:

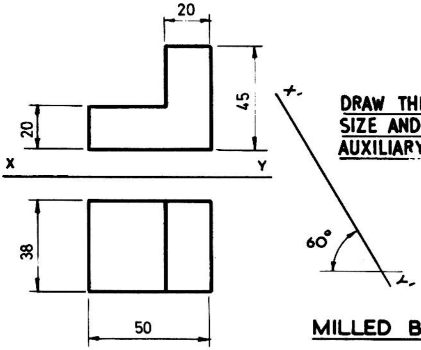
The details for a small Jig Assembly are shown in Third Angle projection on page 25. Copy the given elevation and plan of the Base, full size, in First Angle projection, and complete the views with the Inclined Slide and the Holder. Hidden detail may be omitted from the elevation but not from the plan.

EXAMPLE 13:

Views are given in First Angle projection on page 27 of the details for a Setting Block Assembly. When assembled the Support Plate is mounted on the Base Plate as shown in the part sectional view. Draw full size in First Angle projection an elevation and plan of the assembly, corresponding to the given elevation and plan of the Base Plate. The Slide Block

AUXILIARY PROJECTION.

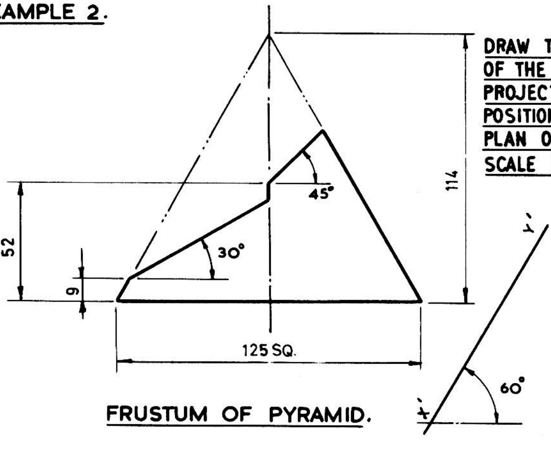
EXAMPLE 1.



DRAW THE GIVEN VIEWS FULL SIZE AND PROJECT A FIRST AUXILIARY ELEVATION ON X'Y'.

MILLED BLOCK

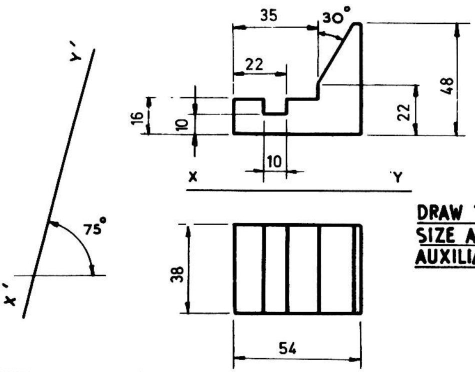
EXAMPLE 2.



DRAW THE GIVEN ELEVATION OF THE SQUARE PYRAMID. PROJECT A PLAN IN THE NORMAL POSITION AND A FIRST AUXILIARY PLAN ON X' Y'.
SCALE FULL SIZE.

FRUSTUM OF PYRAMID.

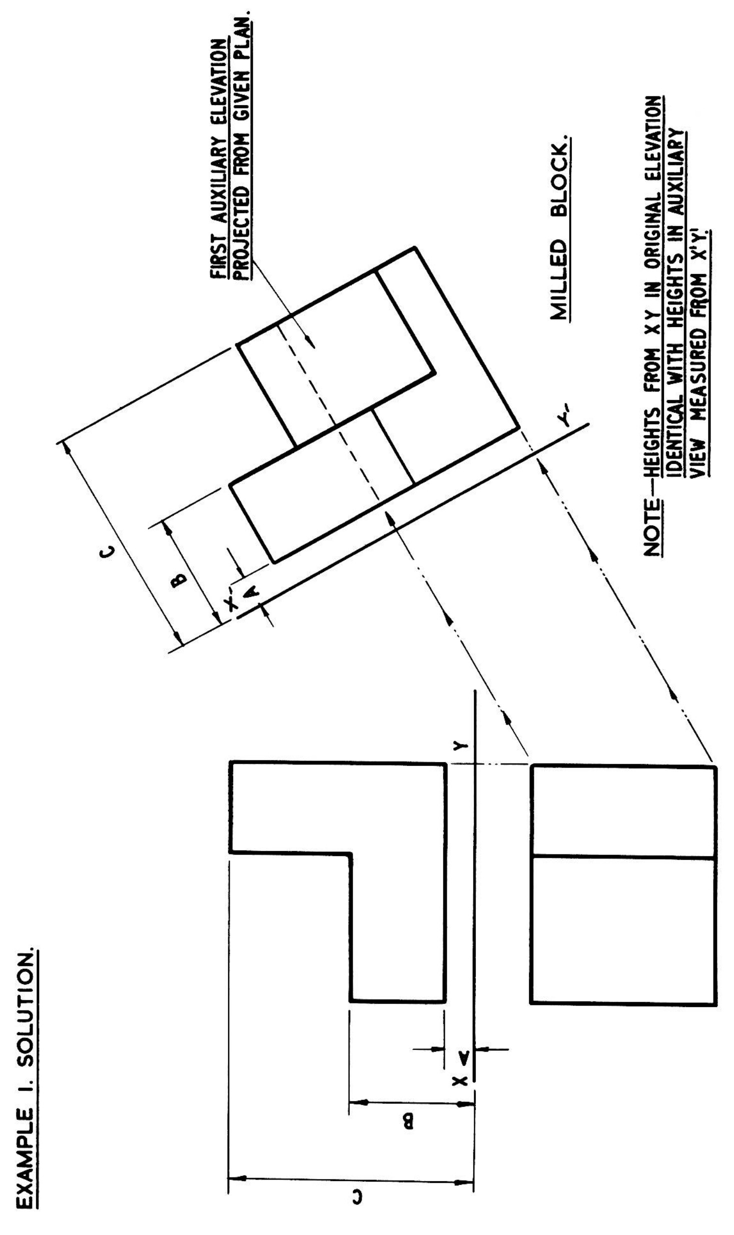
EXAMPLE 3.



GAUGE BLOCK.

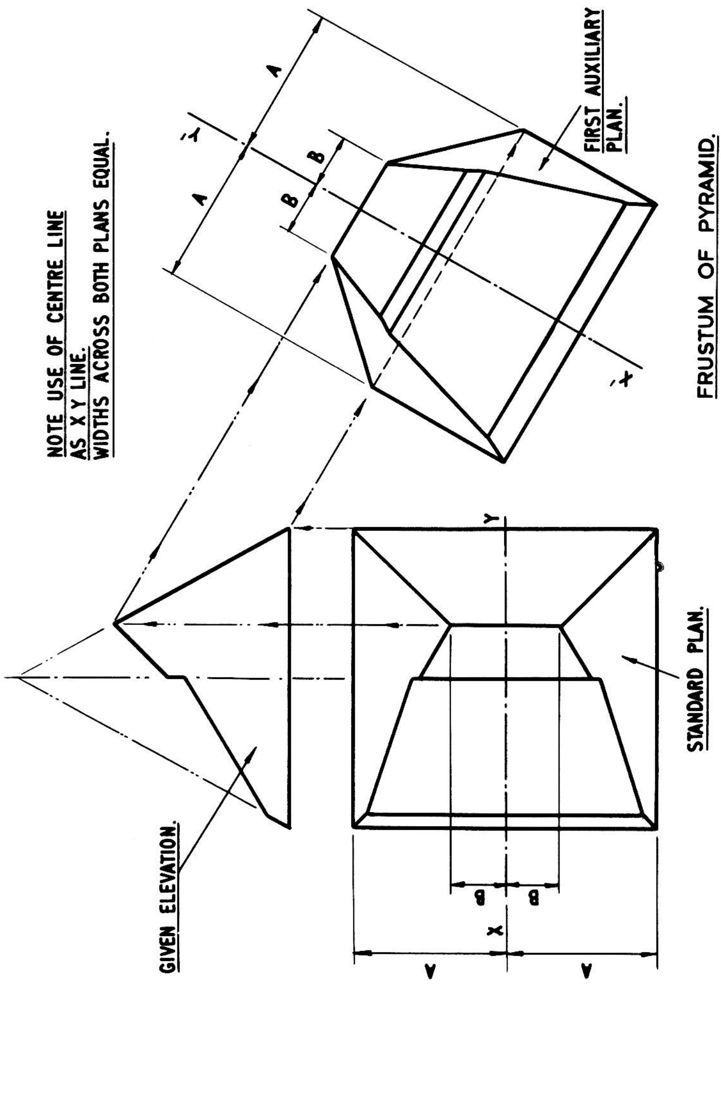
DRAW THE GIVEN VIEWS FULL SIZE AND PROJECT A FIRST AUXILIARY ELEVATION ON X'Y'.

AUXILIARY PROJECTION.



AUXILIARY PROJECTION.

EXAMPLE 2. SOLUTION.



AUXILIARY PROJECTION.