International Correspondence Schools, Scranton, Pa.

Elementary Architectural Drawing

Prepared Especially for Home Study

By

WILLIAM S. LOWNDES, Ph. B.

Member, American Institute of Architects

5893C-4 **Part 3** **Edition 3**

(4 Assignments)

International Correspondence Schools, Scranton, Pennsylvania

International Correspondence Schools, Canadian Ltd., Montreal, Canada

Most careers are made or marred
in the hours after supper.

—C. R. Lawton

* * *

Every time you sit down after supper for your solitary struggle with your assignments, be cheered by the certainty that every hour adds another brick to the solid structure of a successful career.

Architecture home study course

ELEMENTARY ARCHITECTURAL DRAWING,

V.7 PART 3

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What This Text Covers . . .

5893C

Elementary Architectural Drawing

PART 3

DRAWING EXERCISES

ISOMETRIC DRAWING

1. Introduction.—The work in *Elementary Architectural Drawing*, Part 3, is similar to that required in Part 2. The Exercises are to be drawn on sheets of transparent bond paper, $10'' \times 13\frac{1}{2}''$ in size. A cutting line is to be drawn around the edge of the sheet enclosing a rectangle $9\frac{1}{4}'' \times 12\frac{3}{4}''$ in size. Border lines are to be drawn $\frac{3}{8}$ inch in from the cutting lines. Inside the border lines a space $8\frac{1}{2}'' \times 10\frac{3}{8}''$ is to be used for the drawings. Each exercise is one assignment; all the sheets in that Exercise must be sent together.

The drawing work required for this text is as follows:

Exercise I; Sheets I, II, and III
Exercise II; Sheets I and II
Exercise III; Sheets I, II, and III
Exercise IV; Sheet I

All drawings are to be carefully made in lead pencil. All lettering, including titles and the student's class letters and number, is to be drawn. Show the construction lines, all the given lines, and all the required lines as shown in the exercise in the text. With the exception of Exercise III, Sheet III dimensions need not be included. Your drawings should be carefully inspected and compared with the models in the text. When no errors can be discovered, the drawings may be submitted in pencil. Complete all the sheets of each exercise before sending them in for correction. Drawings are to be folded and forwarded to the Schools in envelopes.

The student is expected to obtain two things from the study of this text. One is a knowledge of the subjects of Isometric, Oblique, and Projection Drawing. The second is skill in draw-

ing that will be helpful in doing the advanced drawing in this course. The first objective will constitute a mental training. The second will include mental together with a technical or manual training that will lead to skill in drawing.

EXERCISE I, SHEET I

2. **Definition.**—Isometric drawing is a method of making drawings of objects in such a manner that the three principal dimensions, width, height, and length, are all shown at the same scale and may be measured directly from the drawing. This method of drawing furnishes a pictorial view of the object that is easily understood by persons who do not understand architectural drawings.

3. **Isometric Drawing Problems.**—In the problems in Exercise I, Sheet I, and also in Sheet II, the fundamental principles of isometric drawing may be seen as applied to the representation of simple objects. When these principles are thoroughly understood and when the necessary amount of practice has been obtained in applying them, any object, simple or complex, may be represented by isometric drawing.

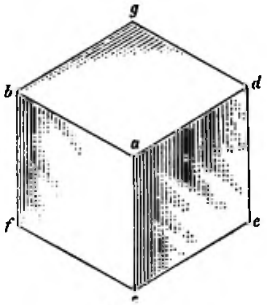

FIG. 1

The essential idea of isometric drawing is illustrated in Fig. 1, which represents a cube so placed that three sides are shown as equal in shape and size. Equal distances measured on the lines *ab*, *ac*, and *ad* represent the same lengths. This same principle is illustrated in Problem I, Sheet I, of Exercise I, in which the point *a* is common to all three sides of a rectangular prism. Equal distances measured along the edges *ab*, *ac*, and *ad* represent the same lengths on the prism.

Sheet I of Exercise I comprises six problems in all of which straight lines are used.

4. PROBLEM 1. *To make an isometric drawing of a brick.* This figure is to be drawn to the scale of $3'' = 1'\,0''$, measured along the vertical and 30° lines, as indicated in the figure. The

30° triangle is extremely useful in this kind of drawing, as all the 30° lines and all the vertical lines can be drawn by means of it. The dimensions of the brick are $2\frac{1}{2}'' \times 4'' \times 8''$.

Draw a vertical line *ac*, making it $2\frac{1}{2}$ inches long at the scale of $3'' = 1'\,0''$. Through the points *a* and *c* draw the lines *ab*. *ad*, *cf*, and *cg*, at 30° to the line *xy*. Lay off *ab* and *cf* 4 inches in length, and *ad* and *cg* 8 inches in length, always using the 3-inch scale. Draw the lines *be* and *de* at 30° to the horizontal, then draw the vertical lines *bf* and *dg*. These lines will outline the brick *cfbedg*.

Dimensions may be measured, and also laid off, along the lines *ab*, *ac*, and *ad* or any lines parallel to them, the same scale being used in each case. On the model sheet. the drawing of this problem is shown at a scale of $2'' = 1'\,0''$.

PROBLEM 2. *To draw an isometric view of a brick wall.*

Lay off the vertical line *ab* in units of $2\frac{1}{2}$ inches, using the scale $1\frac{1}{2}'' = 1'\,0''$. Through *a*, *b*, and the unit points draw lines at 30° to *xy* in two directions as shown. On these lines lay off, as shown, 4-inch and 8-inch spaces, and draw the vertical joints. The face of the wall will thus be shown. The wall is to be 4 inches in thickness; therefore, draw *ac* and *cd* each equal to 4 inches, and prolong these lines as far as desired. This is a simple application of the method described in Problem 1, and should be easily understood.

PROBLEM 3. *To draw a slab.*

This problem is to be drawn at the scale of $1\frac{1}{2}'' = 1'\,0''$. Draw *ab* equal to 4 inches. Lay off *bf*, *bg*, *ac*, and *ad* at 30° to *xy*. Make these lines 12 inches long. Draw *ce* and *de*, *cf* and *dg*, as shown on the model sheet. By drawing the broken lines *ae* and *cd*, the intersection *a'* at the center of the upper surface of the slab is found.

Additional Problem. *To cut a 4-inch cube from one corner of the prism.*

Lay off *dj*, *ji*, *hi*, *gk*, and *hk*, each equal to 4 inches. These will indicate the visible outlines of the cube. Additional lines *jm*, *gm*, *kl*, *lm*, and *li* may be dotted in to indicate the invisible outlines of the cube, and thus the entire cube will be represented.

Additional Problem. *To cut a three-sided prism from the large prism.*

Draw the lines *cn*, *co*, and *fq* each equal to 3 inches. Draw *oq*, *fp*, and *on*. The triangular prism is shown at *conqfp*. These additional problems are to be shown on the Sheet I sent to the Schools.

PROBLEM 4. *A study in prisms.*

Use the methods already described, and the $1\frac{1}{2}'' = 1'\,0''$ scale, and lay out the dimensions shown. There should be no difficulty about making this drawing, which will illustrate clearly the application of isometric principles.

PROBLEM 5. *A study of a pyramid.*

The prism *agdbef* and the triangles *ahi*, *gkj*, and *fml* at the corners are drawn as in Problem 3. Draw *cn* equal to 12 inches at the scale of $1\frac{1}{2}'' = 1'\,0''$. Draw the lines *kn*, *jn*, *in*, *hn*, *ln*, and *mn*. These lines will outline the visible mass of the pyramid. The remaining edges are indicated by the dotted lines *on*, *op*, and *pn*.

As none of the lines *hn*, *in*, *jn*, *kn*, *pn*, *on*, *mn*, and *ln*, are parallel to *ab*, *af*, and *ag*, they cannot be scaled.

PROBLEM 6. *To draw a mortise joint.*

Problem 6 is a special application of isometric drawing to the representation of a mortise and tenon. By following closely and accurately the dimensions given and using the scale $1\frac{1}{2}'' = 1'\,0''$, this drawing should be easily made.

5. Inking in the Drawings.—After the drawings have been accurately drawn in pencil, they may be inked in. Heavy lines are used for the final figures, broken lines for the construction lines, and thin lines for dimension lines. Mark the pen as described in *Elementary Architectural Drawing*, Part 1, and use these marks in making lines of uniform thickness.

EXERCISE I, SHEET II

6. Exercise I, Sheet II, comprises six problems, of which the first four show methods of drawing circles in isometric projection.

7. PROBLEM 1. *To draw a circle in isometric projection.*

Lay out a square *abcd* with the sides 8 inches in length at the scale of $3'' = 1'\,0''$. Bisect the sides at *e*, *f*, *g*, and *h*. From the points *a* and *c* draw lines *ae*, *ah*, *cf*, and *cg* to the centers of the opposite sides. These lines will intersect as shown at *i* and *j*. With *i* and *j* as centers, draw the arcs *ef* and *gh*. With *a* and *c* as centers draw the arcs *eh* and *fg*. If carefully drawn, this curve will be an ellipse-like figure that will represent a circle in isometric.

PROBLEM 2. *To draw a cylinder in isometric projection.*

Draw the square *abcd* in isometric, making the sides $5\frac{1}{2}$ inches long at the scale of $3'' = 1'\,0''$. Draw *ae* equal to $5\frac{1}{2}$ inches. Draw the square *efgh* directly under the upper square. In *abcd* and *efgh* inscribe circles as was done in Problem 1. Draw lines *ij* and *kl* tangent to both ellipses. The cylinder required will thus be formed.

PROBLEM 3. *To draw a cube in isometric projection, with circles on the three visible sides.*

Draw the cube *abcdefg* with the sides $5\frac{1}{2}$ inches in length, at the scale of $3'' = 1'\,0''$. Draw circles in the three sides as described in Problem 1.

PROBLEM 4. *To draw a cone on a cylinder on a prism.*

Draw the isometric squares *abc* and *def*, making the distance *ad* equal to 4 inches at the scale of $1\frac{1}{2}'' = 1'\,0''$. The sides of the square are to be 10 inches. Draw the circle *ghji* in the square as in Problem 1. Draw a similar circle *ijk*, making the distances *ig* and *jh* equal to 5 inches. Lay off any point *l* on the axis of the cylinder prolonged, and draw lines *lm* and *ln* tangent to the upper circle. Darken the visible lines and erase the construction lines.

PROBLEM 5. *To draw an isometric view of a flat arch.*

From the small elevation of the flat arch shown at the left, draw an isometric view, from the dimensions given, using a scale of $\frac{3}{4}'' = 1'\,0''$. Draw the line *ab*, at 30° to the horizontal, making it 3′ 6″ in length. Draw the vertical lines *ac* and *bd*. Divide the line *ab* into seven equal parts. Draw the line *gh*

12 inches above *ab*. Locate *e* midway between *a* and *b*. Locate *f* 4 feet vertically below *e* by extending the line below to the margin of the drawing. Draw radii from *f* through *a, i, b,* etc., bounding the arch stones. Draw the line *jk* 4 inches above the line *gh*. Draw the lines *lm* and *ln*. Draw the lines showing the joints between the under surfaces of the arch stones.

PROBLEM 6. *The capital of a pier.*

The capital is to be drawn at the scale of $1\frac{1}{2}'' = 1'\,0''$. In (*a*) lay out a section through the cap with the moldings carefully drawn. The horizontal distances *a, b, c, d,* and *e* are shown at the right of the drawing of the figure. The vertical dimensions of the parts of the capital are shown at the right of the profile in (*a*).

Draw the broken line *xy* in (*b*). Point off on this line the vertical dimensions shown in (*a*). Through these points draw lines at 30° to the horizontal as at *fg*. Draw the profile of the moldings of the capital in isometric as indicated by the dotted lines, laying off the distances *a, b, c,* etc. as shown. Draw the line *vw*, which will be the miter line of the cap. Through the points *h, i, j,* etc., draw 30° lines as shown at *vn, ko qp,* etc. From the points *v, k, q, l,* etc., draw the lines of the left side of the capital.

The lines *vm* and *vn* are each equal to the width of the pier, which is 8 inches, plus twice the projection of the cap, or $8+2\frac{1}{2}+2\frac{1}{2}=13$ inches. From *v* lay off *vm* and *vn* each equal to 13 inches. The lines *qp* and *qs* are each equal to the width of the pier plus twice the projection *b*, or $8+2+2=12$ inches. Draw *qp* and *qs* each equal to 12 inches. The lengths of the other lines *lr, lt,* etc., can be calculated and drawn in the same manner.

Through the points *m, s, t* and *n, p, r,* draw the profiles of the corners of the capitals.

Study this problem very carefully, as it shows a very important principle that is used in laying off moldings in isometric drawing.

OBLIQUE DRAWING

EXERCISE I, SHEET III

8. In oblique drawing the true profile of a figure is shown, and from this figure oblique lines are drawn which create a perspective effect that visualizes the object in a very satisfactory manner.

Thus, in Exercise I, Sheet III, Problem 1, are shown cylinders the ends of which are drawn as true circles. These circles are in the plane of the drawing paper and on them distances can be measured vertically or horizontally, or in any other direction.

The third dimension is along oblique lines such as *ef*, which may be drawn at 30°, or any other angle, with the horizontal. Distances are laid off and measured with the same scale as along *ab* or *cd*. The circles at *g, h,* and *j* are true circles.

A careful study of the Problems shown on Sheet III will teach the student the simple process used in this style of drawing.

9. PROBLEM 1. *Drawings of pipes.*

Draw lines *ab* and *cd* of any convenient length. These lines will intersect at *e*. With *e* as a center and radii of $\frac{1}{2}$ inch and $\frac{3}{4}$ inch, actual lengths, draw two circles. Draw *ef* at 30° with the horizontal. Make *ef* equal 1 inch. With *f* as a center and radii of $\frac{3}{4}$ inch and 1 inch draw two arcs *g* and *h*. Lay off *fi* equal to 1 inch. With *i* as a center and 1 inch as a radius draw the arc *j*. Draw lines *k, l, m,* and *n* tangent to the circles as shown. Draw the pipes with lines of uniform weight and blackness.

PROBLEM 2. *An oblique drawing of a molding.*

Draw a rectangle *abcd*, making *ab* 2 inches in length and *bc*, $1\frac{5}{8}$ inches in length. In the rectangle draw a molding similar to that shown. This molding will be a true cross-section of the molding. Draw *ce* at 30° with the horizontal and $1\frac{1}{4}$ inches long as shown. Draw the rectangle *efgh* $2'' \times 1\frac{5}{8}''$, and draw the profile of a molding *jh* exactly like *ia*. Draw the lines *ij, kl, mn, op,* and *ah*, using the 30° triangle on the T-square. There will

then be shown an oblique drawing of a section of a molding that has a realistic appearance.

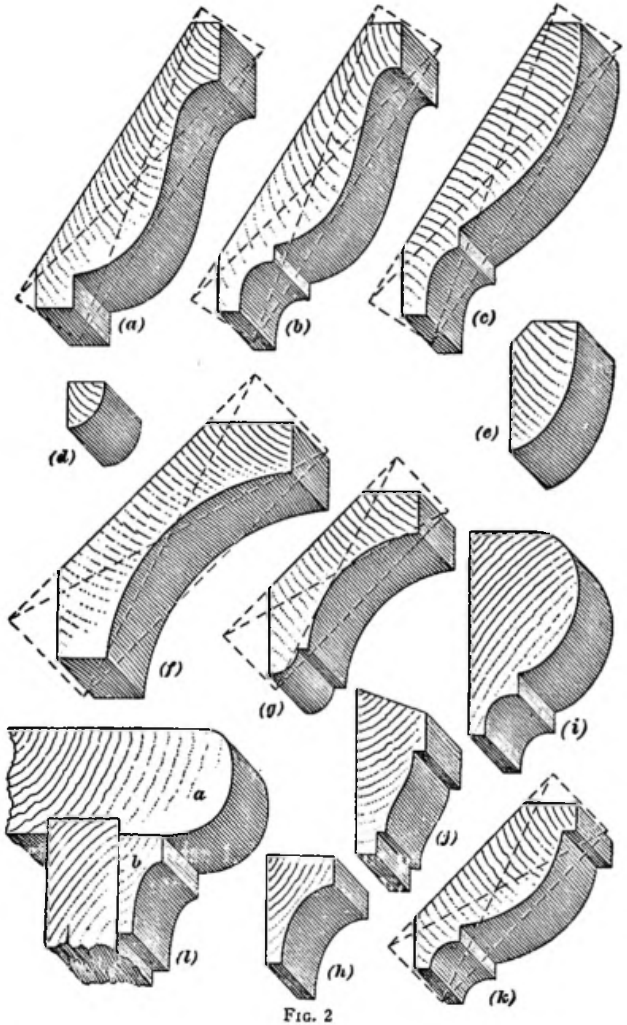

FIG. 2

PROBLEM 3. *Oblique drawings of moldings.*

In Fig. 2 are shown views of many standard moldings. The broken lines show the sizes of the rectangular strips of wood from

which these moldings are made. The straight back lines indicate one face of the strip, while the other face is cut away to form the curved surfaces.

For the purpose of this drawing the lines *ef* in Problem 3 may be drawn at 53° with the horizontal. This angle may be laid out with a protractor. Draw dotted lines *kl* ½ inch away from and parallel with the lines *ef*. The section through the moldings must be contained within this ½ inch. The heights of the moldings must be 2 inches as shown by the horizontal lines *ab* and *cd*. The points *e* must be 1¾ inches apart. Draw the moldings similar to those shown in the text. The curves may be drawn freehand or by mechanical means. From *g* and *h* draw 30° lines ½ inch long to *i* and *j*. Draw moldings like *hg* between the points *j* and *i*. Finish the drawing as shown.

PROBLEM 4. *Oblique drawings of four moldings.*

Draw the four moldings shown, in which the curves are to be elliptical. Follow as far as possible the instructions already given. The curves may be drawn freehand or by mechanical means.

The groove at *a* in the panel molding is known as a quirk.

The completion of Sheet III will conclude this exercise. The three sheets are to be sent in at one time to the Schools.

PROJECTION DRAWING

EXERCISE II, SHEET I

10. Exercise II will consist of problems that illustrate the principles of projection drawing. In this kind of drawing, an object is shown from two or more points of view and in its actual proportions. The object is usually shown at a fraction of its actual size, which means that it is drawn to scale. These drawings can therefore be measured by the scale at which they were drawn.

In architectural drawing, the principal drawings are plans, elevations, and sections. In Fig. 3 a perspective view of a simple building is shown; below it is the plan; to the left is the front elevation, and to the right is a side or end elevation.

In this instance, as in the case of most buildings, the plan is really a horizontal cut, or section, through the building. The

cut is taken through the door and windows as though the building were cut by a large plane, the part above the plane then being removed so as to show the internal arrangement, such as walls, windows, and doors. A plan may show the entire object without cutting through it, as in the problems in this Exercise.

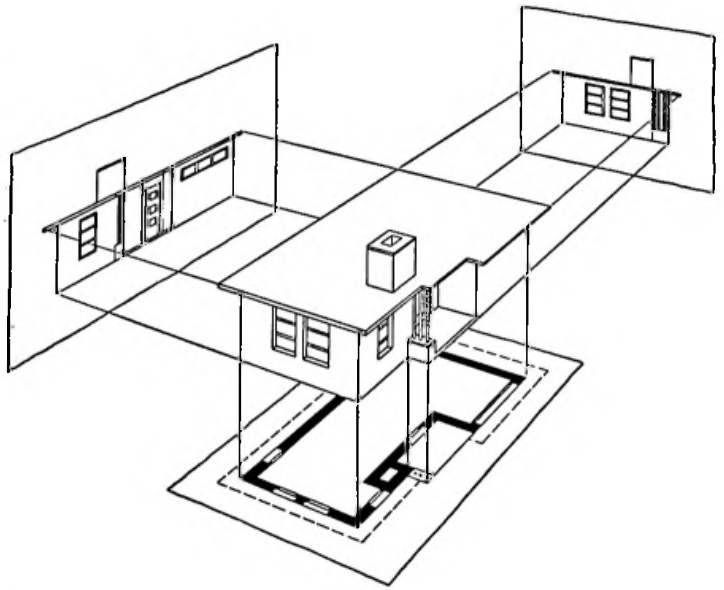

FIG. 3

In Exercise II, only simple cases are shown, partly to teach the simplest methods of projection drawing, and partly to give the student practice in accuracy of drawing and lettering. More complicated problems in projection drawing will be given in later exercises.

11. Problems 1, 2, 3, and 4 of Sheet I consist of drawing plans and elevations of triangular, square, hexagonal, and octagonal prisms.

Divide the $8\frac{1}{2}''\times10\frac{3}{8}''$ drawing space on the sheet into two spaces $5\frac{3}{16}''\times8\frac{1}{2}''$, by means of the line *xy*, and each of these

spaces into four equal parts $2\frac{1}{8}''\times5\frac{3}{16}''$ in size, as shown. Each of the eight resulting parts is to contain one plan and one elevation. In order to draw the plans, lay off all the centers *c*, $1\frac{3}{8}$ inches above the bottom of and in the middle of each space. With the bow compass set to a radius of $\frac{3}{4}$ inch, draw the four circles. Also draw the polygons as shown. These will be plans of the prisms.

To draw the triangle in the circle in Problem 1, draw the lines *ab* and *ad* from the point *a* at 60° to the horizontal. These lines intersect the circle at *b* and *d*. Connect *b* and *d* and the triangle *abd* will be formed.

To draw the square in the circle in Problem 2 lay off two lines through the center of the circle *c* at 45° with the horizontal. These lines will cut the circumference of the circle at the corners of the square. Unite these corners as shown and a square will be formed.

To draw the hexagon in Problem 3 draw a horizontal line through the center of the circle. From the intersections of this line with the circumference of the circle draw lines at 60° to the horizontal. Where these 60° lines cut the circumference will be the corners of the hexagon. Connect these corners by horizontal lines and a hexagon will be formed. The sides of the hexagon are equal to the radius of the circle.

To draw an octagon as shown in Problem 4, draw horizontal, vertical, and 45° lines tangent to the circle and an octagon will be obtained.

Having drawn these polygons, draw lines *ef* and *gh* $2\frac{1}{2}$ inches and 5 inches, respectively, above the line *xy*. Placing the T-square with its top edge slightly below the plans, draw, with the triangle, vertical lines through the points *a*, *b*, and *d* in Problem 1, and extending between *ef* and *gh*. Looking at the prism in the direction indicated by the arrows, the observer will see edges *a'*, *b'*, and *d'* in the elevation.

The same general method is used in drawing elevations of the other prisms. The lines or parts that are visible are shown on the elevations, and are *projected* upwards from the plans. The plan may be considered as projected downwards from the elevation.

Problems 5, 6, 7, and 8 in Sheet I are similar to Problems 1, 2, 3, and 4, except that triangular, square, hexagonal, and octagonal pyramids are shown instead of prisms.

Draw the plans in the same general way that was used for the first four problems. In looking down on a pyramid the apex will be seen, so that in the plans the points *c* will be the apexes. In Problem 5, therefore, the edge *a'* of the pyramid in the elevation will appear at *ac* in the plan. The edge *b'* of the pyramid will show at *bc* on the plan, and the edge *d'* at *dc*.

The differences in the plans of Problems 1 and 5 will be in showing the edges of the pyramids. Only the edges of the pyramids that can be seen when looking in the direction of the arrow will appear in the elevations.

By drawing these eight problems carefully the student will grasp the principles of projection drawing in its simplest form. This form, which shows the plan and elevation, is used in laying out most architectural drawings.

EXERCISE II, SHEET II

12. Exercise II, Sheet II, presents problems in projection drawing that are based upon those in Sheet I, but which are a little more complicated. Sheet II is to be laid out in eight equal spaces, as was done in Sheet I, and the arrangement of the figures is practically the same. The centers are shown at *c* and the apexes at *c'*.

13. Problems 1 to 4 in Sheet II are concerned with cylinders and cones, hence the plans of these figures are circular. With the dimensions shown on the model sheet, it should not be difficult to draw the circles for the four plans. As Problem 1 is a plain cylinder, its elevation is a rectangle, and Problem 2 being a cone, its elevation is a triangle.

Problem 3 is somewhat more complex, showing two cylinders, the upper one being surmounted by a hemisphere, or dome. As the dome has a circular base corresponding in size with the top of the upper cylinder, no heavy line is used in the elevation to show the division between these two figures. The plan, in this case, consists of two circles, the larger one for the lower cylinder and the smaller one for the upper cylinder. The plan of the hemisphere, or dome, is the same as that for the upper cylinder. Problem 4 is a cone placed on top of a cylinder.

Problems 5 to 8 are combinations of the prisms and pyramids shown in Sheet I, the pyramids being smaller in plan than the prisms. In Problem 8 of Sheet II, two prisms are surmounted by a cylinder and a dome.

In drawing the Problems in Exercise II the T-Square and triangle should be used freely in laying out the polygons and in projecting the lines upwards from the plans to the elevations. These projection lines and all other construction lines are to be made in broken or dotted lines. They should be drawn with uniform dots or with sections of lines with equal spaces between them. Skill in making good broken or dotted lines will come through intelligent practice. The quality of these lines will affect the quality of the drawing.

Complete the drawings of these problems in pencil, being careful, neat, and accurate. Letter the drawings with equal care. When all corrections have been made, clean the drawings and mail them to the Schools for correction. It is not necessary to ink in this Exercise. But if you do ink in the drawings, be especially careful where several lines meet at the apexes of pyramids. Do not ink in a second line in these converging lines until the previous line is quite dry.

EXERCISE III, SHEET I

14. Exercise III, Sheet I, will include the drawing of two problems showing cubes, or square prisms, in different positions.

15. PROBLEM 1. *A cube, or square prism.*

The cube, or square prism, illustrated in Problem 1, rests on a horizontal surface, but its vertical surfaces are shown at angles of 45° to the vertical plane of the paper. In the plan of the cube, the sides *dc* and *dg* are shown at angles with the plane of the paper or the vertical plane *ab*. The sides *ef* and *fg* are likewise at angles with *ab*. The top of the cube, being in a horizontal plane, appears at its actual size.

In the front elevation the cube is viewed in the direction indicated at *c*, or perpendicularly to the vertical plane *ab*. Two sides only will be seen in the elevation, and they will not appear in their actual sizes.

Draw light lines *ks*, *hp*, and *av*, in pencil, as shown. From *d* draw *de* and *dg* $1\frac{1}{8}$ inches in length and complete the square by drawing *ef* and *fg*. This square will represent the top of the cube. Project lines downwards from *e*, *d*, and *g*, and draw the edges of the cube *hk*, *il*, and *jm*. Project points *d*, *g*, and *f* over to the right.

Lay off *or*, which will be one edge of the cube in side elevation. With *jg* as a radius and *o* as a center, lay off the point *u*. With *u* as a center draw three arcs *vn*, *wo*, and *xp*. Draw the vertical line *uvwx* to meet lines from *d*, *g*, and *f*. Draw *nq* and *ps*. The side elevation of the cube will thus be determined. Draw with firm, uniform lines the plan, front elevation, and side elevation. All the figures and letters are to be omitted.

PROBLEM 2. *A cube, or square prism.*

The cube in this problem is shown resting on one edge on a horizontal plane, as shown in the front elevation. The cube, viewed from above, will appear as shown in the plan. Viewed from the side, it will appear as in the side elevation.

Lay off the lines *as*, *cr*, and *ef* according to the dimensions shown. From the point *i*, lay off the lines *ik* and *ij*, $1\frac{1}{8}$ inches in length and at 45° with the horizontal line *ef*. From *k* and *j* lay off the lines *kh* and *jh* at 45° with the horizontal. This will complete the square *ijhk*. Project the points *k*, *i*, and *j* upwards and draw the lines *ca*, *tg*, and *db*. The lines *abdc* will be the plan of the cube. Draw the construction line *ho*. Draw a line *lm* at any convenient place and lay off *lm* equal to *ce*. With *m* as a center, draw the arcs *rl* and *sf*. Draw the lines *fo*, *lf*, *qp*, and *no*, and the side elevation will be determined.

Draw the plan and the front and side elevations neatly, using lines of even thickness. Letter the plan and the elevations, together with the title, problem numbers, student's class letters and number, etc. The dimensions and letters used in drawing the figures may be omitted. After all corrections are made and

the figures completed in pencil, the sheet may be inked in and cleaned. It may then be laid aside until the remainder of the sheets in this exercise are completed.

EXERCISE III, SHEET II

16. Exercise III, Sheet II, consists of two problems, each containing two elevations and a plan. The $8\frac{1}{2}''\times10\frac{3}{8}''$ drawing space on the sheet is to be divided into two equal parts, each $5\frac{3}{16}''\times8\frac{1}{2}''$.

17. PROBLEM 1. *Two elevations and a plan of a hexagonal prism and cylinder.*

This problem is drawn in the same manner as previous problems. The principal lines are to be laid out as shown by the dimensions on the model sheet. The hexagon will be drawn as shown in a previous exercise. The cylinder is 1 inch in diameter.

The drawing should be placed carefully on the sheet, the finished lines made equal in weight, and the projection lines made much finer.

PROBLEM 2. *Elevations and a plan of two intersecting cylinders.*

This problem is drawn in practically the same way as Problem 1. The front elevation and plan will be similar but reversed.

Complete this sheet by lettering, and cleaning it.

EXERCISE III, SHEET III

18. Exercise III, Sheet III is an interesting problem in projection drawing, the intersection of an arched window head on its jamb. A full elevation is shown in the lower right-hand corner of the model sheet. The window jamb is curved and its outline is represented in plan by a quarter circle. The section at the head is represented by straight lines. You will note that, while the jamb is 10 inches wide, the head is 14 inches wide. The relation of the head to the jamb is shown by the dotted line in the plan view. The problem is to draw in elevation and section the intersection of the arched head on the curved jamb. The dimensions shown on the model sheet are to be included on your drawing.

19. PROBLEM. *The intersection of an arch ring and jamb.* The elevation of the intersection, the section at the head, and the plan at the jamb are to be drawn at the scale of $1\frac{1}{2}'' = 1'0''$. The elevation of the window is to be at $\frac{1}{2}''$ scale.

Lay out the border lines of the sheet $8\frac{1}{2}'' \times 12''$. Draw a light horizontal line approximately $8\frac{3}{8}$ inches below the top border line. This will be the face of the jamb in plan. Draw a light vertical line $2\frac{1}{4}$ inches from the left border line. The intersection of these two lines will determine the corner of the jamb. Back from the face of the jamb 10 inches, and 10 inches to the left of the corner, will be the center for the quarter circle forming the outline of the jamb. With this center and a radius of $9\frac{1}{2}$ inches, draw an arc. The dotted line indicating the head can be established by locating a point 14 inches to the left of the corner of the jamb.

Draw a light horizontal line $4\frac{7}{8}$ inches below the top border line. The inside and outside lines of the jamb may be located on this line by projecting up from the plan. The center of the arch will be $11\frac{3}{4}$ inches to the right of the inside line of the jamb. With this point as a center, two arcs may be drawn: one with a radius of $11\frac{3}{4}$ inches, and the other with a radius of $12\frac{1}{4}$ inches. In like manner the outside line of the arch may be drawn.

Draw a vertical line approximately $5\frac{3}{8}$ inches from the left border line. This will establish the front line of the section through the arch. Other lines may be drawn in section from the information available in plan and elevation.

The curved surface forming the head is made up of a series of curved lines or elements, having as their center the center of the arch. The curved surface forming the jamb is made up of a series of vertical lines. Assume typical element in the section and the corresponding element in the jamb located $4\frac{3}{4}''$ from the back line of the jamb. These elements will intersect at the point x in elevation. This point, projected horizontally to the sectional view, will intersect the element determining the point x in section. The point x is only one of a number of points that must be determined. Similarly, other points such as y must be found in order to draw the curved intersection in the elevation and in the section.

With the plan, elevation, and section developed at $1\frac{1}{2}''$ scale, a $\frac{1}{2}''$-scale elevation may be drawn in the approximate location shown on the model sheet.

When the three sheets have been completed in pencil, corrected, and cleaned, they should be sent to the Schools for correction.

APPLICATION OF PROJECTION DRAWING TO ARCHITECTURUAL DRAWING

20. In the preceding exercises, methods of projecting one drawing from another have been shown. These methods are used in obtaining elevations from plans, and plans from elevations. The plan and two elevations are necessary to present most objects completely so that all the dimensions and details may be understood. In the case of buildings it is sometimes necessary to show four elevations, one of each side, in order to show all the features that occur on the four sides of the building. It is also necessary sometimes to draw two, three, or more plans to show the arrangement of the rooms, stairs, and so forth on the different stories. Sections or cuts through the building are also frequently shown. The same is true of parts, or details, of buildings, which are shown by means of elevations, plans, and vertical sections. The methods of projection drawing already taught are somewhat modified when applied to architectural drawing, but the same underlying principles are used. The following exercise will illustrate the application of the principles of projection drawing to architectural drawing.

EXERCISE IV, SHEET I

21. Exercise IV is a representation of a house and consists of one sheet, which shows two elevations and two plans. The lower plan shows, in solid lines, the section through the exterior wall, and is known as a *floor plan*. The *roof plan* is shown above the front elevation. The same methods are employed in making this drawing as were used in previous exercises. Exercise IV, Sheet I, is a very simple application of these methods to an architectural problem.

22. PROBLEM. *To draw the plan and elevations of a house.* Lay out the border lines of the sheet 8½″×12″ and draw the horizontal lines forming the blocks for the title and the other information. Draw a horizontal base line *ab*, 4$\frac{1}{10}$ inches above the bottom block and a vertical line 1⅜ inches from the left-hand border line.

On this vertical line establish the nearest corner of the building about ¾ inch up from the bottom block. Use your 30-60 triangle to lay off the walls of the house. Door and window openings are centered in the front and sides of the house. Use the scale ⅛″ = 1′0″ and make the walls 10″ thick. Complete the floor plan and hatch the walls as shown. This plan shows only an outline of the house, and interior partitions and fireplace are not shown in the plan. The hatching indicates that the walls are in section.

In drawing the front elevation, lay off the lines of the eaves 6 feet and 11 feet above the ground line *ab*. Lay off the ridge line 15 feet above the ground line. Project the wall lines from the floor plan up to the elevation. Locate the chimney midway along the ridge, its dimensions are 18 inches by 28 inches. The door is 7 feet high and the windows 2 feet 9 inches high.

The roof plan is made by projecting lines upward from the front elevation and taking dimensions from the elevation and the floor plan.

In previous Exercises, the projection lines from plan to side elevation were turned with a compass but in this Exercise the same result is accomplished by using a line drawn at 45° to the horizontal. Projection lines should be much lighter than construction lines. Complete the side elevation as shown.

KEY TO CRITICISM

The following symbols are used to indicate criticisms and suggestions on the student's drawings in Elementary Architectural Drawing, Freehand and Ornamental Drawing and Architectural Drawing.

a. Inclination of letters not uniform.
b. Letters not well formed. Study Arts. 2 to 10, 5893B.
c. Letters not uniformly spaced.
d. Practice lettering frequently.
e. Sizes of spaces unequal.
f. Compare your work with model in text.
g. Height of letters irregular. Use guide lines .
h. Letters too large.
i. Letters too small.
j. Use vertical guide lines for your letters. Guide lines should be drawn at random.
k. Numerals should be printed not written.
l. Numerals not well formed.
m. Foot and inch marks not well formed.
n. Line too heavy.
o. Line too light.
p. Line uneven.
q. Line not black enough.
r. Line should be drawn with instruments.
s. Line should be dotted.
t. Line should be broken.
u. Broken or dotted lines uneven.
v. Should be full line not broken.
w. Freehand curved lines not well drawn.
x. Arrow heads not well formed. Use closed type arrow heads.
y. Lines are to be drawn freehand, without the use of inments.
z. Compare your work with attached drawing.

(1) You can do better work.
(2) All sides of figure should be equal.
(3) Not required.
(4) Erase blots.
(5) Practice use of French curve.
(6) Use black drawing ink.
(7) Not enough contrast in weight of line.
(8) You can do better if you take more time.
(9) Facility in freehand drawing comes with practice.
(10) Outline of cut section should be heavy line.
(11) Construction lines omitted.
(12) Section hatching too dark.
(13) Section hatching too close together.
(14) Lettering should be done freehand.
(15) Lettering is too heavy.

A. Dimension lines omitted.
B. Dimensions incorrect.
C. Dimension arrows incorrectly placed.
D. Lines not parallel.
E. Intersections poor.
F. Compass work poor.
G. Line should be dotted as it represents a part not seen.
H. Line should be dotted, as it represents a part cut off.
I. Wrong symbol used.
J. Carelessly drawn.
K. Size too large.
L. Size too small.
M. Not projected properly.
N. Section lines omitted.
O. Section lines not evenly spaced.
P. Lines omitted.
Q. Dimensions omitted.
R. Incomplete.
S. Drawing not to scale.
T. Similar lines should have the same thickness.
U. Symbol omitted.
V. Lettering omitted.
W. Use single line.
X. Avoid flat spots when drawing curves.
Y. Avoid angles when drawing curves.
Z. Quality of line should be clean, crisp and uniform.

DATE	ISSUED TO

IOS