Exercises in Plane Geometry.

Before beginning to draw any of these exercises the pupil should, without referring to the first page, have a clear idea of the stages of construction required for the correct solution of that exercise.

Assistance in this respect is often obtained by making small freehand sketches of the stages it is proposed to adopt—often working backwards from the result.

All working lines are to be shown.

1.—Points **A** and **B**, the extremities of an arc 7.5 c.m. radius, are 11 c.m. apart. Describe the arc and divide it into 4 equal parts.

2.—Show the largest square that can be cut out of a circle 5¼" diameter.

3.—A straight line **AB** is 11 c.m. long. Find **C**, a point 3.5 c.m. distant from this line, and equidistant from its extremities. Join **C** with **A** and **B** and give the name of the figure so formed.

4.—Points **A** and **B** are 1¾" apart. **C** is 2⅞" distant from **A** and **B**. Join **CA** and **CB**, and make an angle 3¼ times greater than the angle **ACB**.

5.—The base **AB** of a triangle is 7 c.m. long; the angle at **A** is 30 degrees, that at **B** is 105 degrees. Construct the triangle; give its name: show its altitude and write the size of the angle at the apex.

6.—Draw a line **AB**, 3¼" long and find point **C** on it so that **AC** shall be two-sevenths of **AB**.

7.—Make drawings of your set-squares when the longest side of each is 13 c.m.

8.—Divide a circle 3½" diameter into 3 equal parts by lines drawn from its centre. Give the size of the angles formed by the radii.

9.—Describe an arc **AB** with a radius of 9 c.m., so that the steel point of the compass will not make a mark on the paper (put the steel point on a set-square when describing the arc). Find a point on the paper so that an arc described from it shall be parallel with and 5 m.m. distant from **AB**.

10.—At points **A** and **B** the extremities of a line 1¾" long construct angles of 90 and 45 degrees forming a triangle **ABC**. Complete the square of which this triangle is one-eighth.

11.—A ladder 10 feet long leaning against a vertical wall makes an angle of 75 degrees with the ground which is horizontal. Draw three lines for the ladder, wall and ground, when a foot is represented by a quarter of an inch. Give the angle the ladder makes with the wall.

12.—On a straight line **AB**, 9 c.m. long find point **X** so that **AX** shall be three fifths of **XB**.

13.—Points **A** and **B** are 2" apart. Find a point **C** so that lines from **A** and **B** will form four equal angles at that point.

14.—Draw **AB** a straight line 9.5 c.m. long. **C** is 4.5 c.m. from **A** and 6.5 c.m. from **B**. Through **A** draw a line parallel with **CB**, and through **B** a line parallel with **AC** producing them to meet at **X**. What is the name of the figure **ACBX**?

15.—Draw any scalene triangle and describe a circle to pass through the three angular points.

16.—Take any three points **A**, **B** and **C** not in a straight line. Join **AB** and draw a line from **C** to meet **AB** in an angle of 45 degrees.

17.—The centre lines of four straight roads meet at point **X**. Two of these **AX** and **BX** are at right angles. **CX** makes 120 degrees with **BX**, and **DX** lies half way between **CX** and **AX**. The roads **DX** and **BX** are each 2 chains wide, the other two are half that width. Show these to a scale of 1 inch to a chain.

18.—Points **A** and **B** are 5 c.m. apart. **C** is 3·5 c.m. from **B** and 5·5 c.m. from **A**. Find a point **D** equidistant from **A**, **B** and **C**.

19.—Construct a quadrant when the extremities of the arc are 3¾" apart. Divide the quadrant into six equal parts.

20.—How would you prove by a simple experiment that the three angles of any triangle contain 180 degrees or two right angles, and that the four angles of any quadrangular figure contain 360 degrees or four right angles?

Exercises in Solid Geometry.

For each of the 26 problems in this book a drawing of the solid is given on one plane of projection, and the pupil is required to represent it on the other plane.

For the following 20 exercises no drawings are shown. Descriptions or specifications of the surfaces or solids and their relations to both planes of projection are given from which plans and elevations are to be made.

Exercises 1 to 10 are on lines and surfaces in simple positions such as are found in the plans and elevations on page 24.

Exercises 11 to 20 are on solids, different in size and position from those on page 24.

Before beginning to draw an exercise the pupil should have a clear idea, not only of the surface or solid to be represented, but its position with reference to both the planes of projection. Small models will be of great assistance in this respect, but if with these there is still any difficulty, reference may be made to the problem on which the exercise is based. These problems should, however, be referred to after and not before the required exercises are done.

1.—A point **A** is 2" above the H.P. and 1" from the V.P. (such as the apex of cone, Prob. 6).

2.—A line 2½" long stands vertically on the H.P.; it is 1½" from the V.P. (such as the axis of cylinder, Prob. 4).

3.—The same line projects from, and is at right angles with the V.P. It is 1" above the H.P. (axis of prism, Prob. 7).

4.—A line 5 c.m. long is parallel with both the V.P. and the H.P. It is 3.5 c.m. from the V.P. and 6 c.m. above the H.P. (an edge of the cube, Prob. 3).

5.—Draw a line 3.5 c.m. long on the H.P. It is 1.5 c.m. from, and parallel with the V.P. This line is the plan of a square surface, one edge of which is on the H.P. (as the near face of the solid, Probs. 3 and 13).

6.—Draw in elevation a 1½" line 2½" above and parallel with the H.P. This line represents a square surface when its edge nearest the V.P. is 1½" from and parallel with it (the upper face of cube, Prob. 8 or 12).

7.—The same square surface rests on the H.P. on an edge at right angles with the V.P. There is ½" between the V.P. and the square (the side faces of cube, Prob. 3).

8.—An equilateral triangular surface of 5.5 c.m. edge is parallel with and 1.5 c.m. from the V.P. An edge of the triangle is on the H.P. (the ends of prism, Prob. 14).

9.—A plan of the last surface is represented on the H.P. by a line at an angle of 45 degrees with the V.P. An edge of the triangle is on the H.P. (the ends of prism, Prob. 16).

10.—The same surface is parallel with the H.P. and 1.8 c.m. above it. A corner of the triangle is on the V.P. and an edge of the surface is at 75 degrees with that plane. (From any point on the I.L. draw a line 3.5 c.m. long and at 75 degrees with it. This is one side of the triangle in plan).

11.—A cone, axis 3", base 2" rests on its apex on the H.P. The axis is vertical and 2½" from the V.P. (Prob. 6).

12.—The centre of a sphere 3 c.m. diameter is 5.7 c.m. above the H.P. and 4.3 c.m. from the V.P. (Prob. 5).

13.—A 5 c.m. square prism 7.2 c.m. long projects from the V.P. The axis is 6·4 c.m. above the H.P. and its rectangular faces are parallel and perpendicular with the H.P. (Prob. 7).

14.—A 2" cube rests on the H.P. on a face. A vertical edge is on the V.P., and the vertical faces of the solid are at 45 degrees with that plane. (Prob. 9 is here transposed. Draw the plan first).

15.—A prism 3.8 c.m. square by 6.5 c.m. axis, rests on the H.P. on a rectangular face. The axis is at 45 degrees with the V.P. (Prob. 15).

16.—A slab 1½" square by ½" thick rests on the H.P. on a square face. The solid is ½" distant from and parallel with the V.P. A pyramid—base 1" square, axis 2"—rests on the slab; the edges of the base of the former being parallel and equidistant from the edges of the slab. (Prob. 12).

17.—An equilateral triangular prism, 3.7 c.m. edge of end by 7.3 c.m. axis, has one long edge on the H.P. and one of its rectangular faces vertical. The end of the solid is parallel with and 1.5 c.m. from the V.P. In this exercise the elevation, which is drawn first, has a side (rectangular face) at 90 degrees with the I.L. instead of horizontal as in Prob. 14.

18.—An inch square prism 3" long stands on the H.P. The axis is vertical and 2" from the V.P.; the rectangular faces of the solid are at 60 and 30 degrees with the V.P. (a position somewhat similar in Prob. 23).

19.—An equilateral triangular prism, 4.2 c.m. edge of end by 7.5 c.m. axis, has one long edge on the H.P. The axis is at 45 degrees with the V.P. and one of its rectangular faces is parallel with the H.P. (The prism of Prob. 16 is here turned upside down).

20.—A cone—base 5 c.m. axis 8 c.m.—rests on the H.P. on one point of the base. The axis is horizontal and inclined at 45 degrees with the V.P. First draw the plan—an isosceles triangle, base 5 c.m., altitude 8 c.m., the base being at 45 degrees with the I.L. Project the base as in Prob. 21.