MATHEMATICS FOR ENGINEERING STUDENTS: PLANE AND SOLID GEOMETRY

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MATHEMATICS

FOR

ENGINEERING STUDENTS

BY

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PLANE AND SOLID GEOMETRY

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PREFACE.

It has been the author's endeavor in writing this book on Geometry to put the student at ease as far as possible by appealing from the start to his common sense.

Technicalities have been avoided wherever possible and the student encouraged to think about the propositions in the same, simple, common sense way that he would consider any practical question arising in his daily experience.

This process is applied even to the construction of figures, his ingenuity being called upon for suggestions as to auxiliary lines, etc. In this way, the solution of original propositions is gradually approached, until confidence is acquired.

In this work, as in all others, the author has adhered to his conviction that the difficulty in mastering mathematical truths is largely due to the student's awe of the subject, and that any legitimate means of securing confidence and of removing apprehension should be employed.

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PLANE GEOMETRY

DEFINITIONS.

1. GEOMETRY is a study of position, form, and dimension.

2. In geometry we consider points, lines, surfaces, solids, and angles.

A geometrical point has only position; no length nor breadth. Can you make a geometrical point?

Geometrical lines have only length; no width nor thickness. Can you draw a geometrical line? Give a definition of a straight line, and of a curved line.

Solids have length, breadth, and height or thickness. Can you draw a solid?

The boundary that separates a solid from its surroundings is called a surface. A surface has extent, but no thickness.

3. A *surface* is called a *plane* when a straight line joining *any* two points in it, lies wholly within the surface. Give an illustration of a surface and of a plane.

4. Plane geometry deals only with figures lying in the same plane.

5. An angle is the amount of divergence of two lines drawn through the same point. The point is called the *vertex* of the angle and the two lines, its *sides*.

6. A segment of a line is any portion of it.

When a line is divided into two equal segments, it is said to be *bisected*. When cut into any two segments it is *intersected*.

7. A segment drawn to greater length is said to be *produced.*

8. A *broken* line is made up of a number of straight lines varying in direction.

9. When two straight lines cut each other they form four angles about the point of intersection. The angles situated on the same side of one line and the opposite sides of the other are called *adjacent* angles thus, (see Fig. 1):

ABC and CBD are adjacent ∠s.

ABC and EBD are vertical ∠s.

10. When one straight line makes *equal* adjacent angles with another it is said to be perpendicular to it, and the equal angles are called *right angles.* *xyw* and *wyv* (Fig. 2) are right angles.

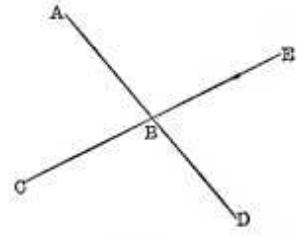

Fig. 1.

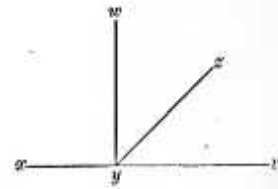

Fig. 2.

11. A *straight* angle is an angle whose sides are in the same straight line on either side of the vertex, thus (Fig. 2): *xyv* is a straight angle.

Angles are read with the letter at the vertex in the middle,

Thus: angle *xyz* has *y* in the middle.

angle *zyv* has *y* in the middle, etc.

12. Angles less than a right angle are called *acute;* those

greater, *obtuse;* and collectively, they are known as *oblique* angles. Hence lines meeting at any angle other than a right angle are said to be *oblique* to each other.

13. If two angles together make a right angle, they are said to be *complementary.* If two angles together make a straight angle, they are said to be *supplementary.* *wyz* and *zyv* are complementary. *xyz* and *zyv* are supplementary (Fig. 2).

AXIOMS.

14. The demonstrations of geometry are based upon certain arbitrary definitions and upon certain truths that are so apparent to average intelligence that they require no proof.

Any argument that arrives at a conclusion must start from some truth or truths accepted by the parties to the argument.

For example, no amount of debate on the phenomena of sound can accomplish any result if one disputant starts from the definition that sound is vibration in the air and the other from the assertion that sound is the effect of vibration on the ear. There must plainly be some common ground of truth from which both must reason. So in geometry certain fundamental assumptions must be agreed upon before reasoning will be effective. Hence the definitions just suggested.

Other definitions would do as well, if they were universely accepted.

Now there happen to be certain truths, in addition to these definitions, that are so evident to everyone that they will be readily adopted. These truths are called axioms and may be stated as follows:

Axiom 1. Things which are equal to the same thing are equal to each other.

Axiom 2. If equals be added to or subtracted from equals, the results will be equal.

Axiom 3. If equals be multiplied or divided by equals, the results are equal.

Axiom 4. If equals be added to or subtracted from unequals, the results are unequal in the same sense.

Axiom 5. If unequals be substracted from equals, the remainders are unequal in the opposite sense.

Axiom 6. The whole is greater than any of its parts.

Axiom 7. The whole is equal to the sum of all its parts.

Axiom 8. Through two points only one straight line can be drawn.

Axiom 9. The shortest distance between two points is the straight line joining them.

Axiom 10. Magnitudes that can be made to coincide are equal, etc.

GEOMETRICAL PROCESSES.

15. Geometrical processes are of two kinds: demonstration and construction.

Demonstration is the establishment of certain relations between the parts of figures already constructed.

Construction is the actual method of building those figures.

A statement requiring demonstration is called a *theorem*. A statement requiring a construction is called a *problem*. *Proposition* includes both.

A truth so obvious that it does not need proof is called an *axiom* or *postulate*, the latter term applying to purely geometrical truths, and relating more to methods.

A *corollary* is a plain inference from an established theorem.

POSTULATES.

The following truths may be assumed without proof.

It is assumed to be true:

(*a*) That a straight line can be drawn from any one point to any other point.

(*b*) That a straight line can be produced to any extent.

PERPENDICULAR AND OBLIQUE LINES.

Proposition I. Theorem.

16. *When one straight line crosses another straight line the vertical angles are equal.*

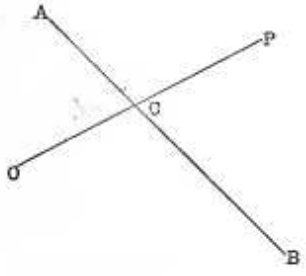

Fig. 3.

Let line OP cross AB at C.

We are to prove $\angle OCB = \angle ACP$.