Topic Page: Geometry, Analytic

Definition: **analytic geometry** from *Merriam-Webster's Collegiate(R) Dictionary*

(1835) **:** the study of geometric properties by means of algebraic operations upon symbols defined in terms of a coordinate system —called also *coordinate geometry*

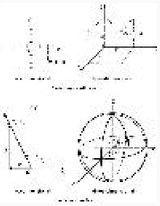

Image from: **coordinate systems** in *The Macmillan Encyclopedia*

Summary Article: **analytic geometry**
From *The Columbia Encyclopedia*

branch of geometry in which points are represented with respect to a coordinate system, such as Cartesian coordinates, and in which the approach to geometric problems is primarily algebraic. Its most common application is in the representation of equations involving two or three variables as curves in two or three dimensions or surfaces in three dimensions. For example, the linear equation $ax+by+c=0$ represents a straight line in the xy-plane, and the linear equation $ax+by+cz+d=0$ represents a plane in space, where a, b, c, and d are constant numbers (coefficients). In this way a geometric problem can be translated into an algebraic problem and the methods of algebra brought to bear on its solution. Conversely, the solution of a problem in algebra, such as finding the roots of an equation or system of equations, can be estimated or sometimes given exactly by geometric means, e.g., plotting curves and surfaces and determining points of intersection.

In plane analytic geometry a line is frequently described in terms of its slope, which expresses its inclination to the coordinate axes; technically, the slope m of a straight line is the (trigonometric) tangent of the angle it makes with the x-axis. If the line is parallel to the x-axis, its slope is zero. Two or more lines with equal slopes are parallel to one another. In general, the slope of the line through the points (x_1, y_1) and (x_2, y_2) is given by $m= (y_2-y_1) / (x_2-x_1)$. The conic sections are treated in analytic geometry as the curves corresponding to the general quadratic equation $ax^2+bxy+cy^2+dx+ey+f=0$, where $a, b, \ldots, f$ are constants and a, b, and c are not all zero.

In solid analytic geometry the orientation of a straight line is given not by one slope but by its direction cosines, λ, μ, and ν, the cosines of the angles the line makes with the x-, y-, and z-axes, respectively; these satisfy the relationship $\lambda^2+\mu^2+\nu^2= 1$. In the same way that the conic sections are studied in two dimensions, the 17 quadric surfaces, e.g., the ellipsoid, paraboloid, and elliptic paraboloid, are studied in solid analytic geometry in terms of the general equation $ax^2+by^2+cz^2+dxy+exz+fyz+px+qy+rz+s=0$.

The methods of analytic geometry have been generalized to four or more dimensions and have been combined with other branches of geometry. Analytic geometry was introduced by René Descartes in 1637 and was of fundamental importance in the development of the calculus by Sir Isaac Newton and G. W. Leibniz in the late 17th cent. More recently it has served as the basis for the modern development and exploitation of algebraic geometry.

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