Euclid

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Euclid (pron.: /ˈjuːklɪd/ *ɛwk-lid*; Ancient Greek: Εὐκλείδης *Eukleidēs*), fl. 300 BC, also known as **Euclid of Alexandria**, was a Greek mathematician, often referred to as the "Father of Geometry". He was active in Alexandria during the reign of Ptolemy I (323–283 BC). His *Elements* is one of the most influential works in the history of mathematics, serving as the main textbook for teaching mathematics (especially geometry) from the time of its publication until the late 19th or early 20th century.[1][2][3] In the *Elements*, Euclid deduced the principles of what is now called Euclidean geometry from a small set of axioms. Euclid also wrote works on perspective, conic sections, spherical geometry, number theory and rigor.

"Euclid" is the anglicized version of the Greek name Εὐκλείδης, meaning "Good Glory".[4]

Euclid

Euclid in Raphael's *School of Athens*

Born	Unknown
Died	Unknown
Residence	Alexandria, Egypt
Fields	Mathematics
Known for	Euclidean geometry Euclid's *Elements*

Contents

Life

Little is known about Euclid's life, as there are only a handful of references to him. The date and place of Euclid's birth and the date and circumstances of his death are unknown, and only roughly estimated in proximity to contemporary figures mentioned in references. No likeness or description of Euclid's physical appearance made during his lifetime survived antiquity. Therefore, Euclid's depiction in works of art is the product of the artist's imagination.

The few historical references to Euclid were written centuries after he lived, by Proclus and Pappus of Alexandria.[5] Proclus introduces Euclid only briefly in his fifth-century *Commentary on the Elements*, as the author of *Elements*, that he was mentioned by Archimedes, and that when King Ptolemy asked if there was a shorter path to learning geometry than Euclid's *Elements*, "Euclid replied there is no royal road to geometry."[6] Although the purported citation of Euclid by Archimedes has been judged to be an interpolation by later editors of his works, it is still believed that Euclid wrote his works before those of Archimedes.[7][8][9] In addition, the

"royal road" anecdote is questionable since it is similar to a story told about Menaechmus and Alexander the Great.[10] In the only other key reference to Euclid, Pappus briefly mentioned in the fourth century that Apollonius "spent a very long time with the pupils of Euclid at Alexandria, and it was thus that he acquired such a scientific habit of thought."[11] It is further believed that Euclid may have studied at Plato's Academy in Athens.

Elements

Main article: Euclid's Elements

Although many of the results in *Elements* originated with earlier mathematicians, one of Euclid's accomplishments was to present them in a single, logically coherent framework, making it easy to use and easy to reference, including a system of rigorous mathematical proofs that remains the basis of mathematics 23 centuries later.[13]

One of the oldest surviving fragments of Euclid's *Elements*, found at Oxyrhynchus and dated to circa AD 100 (P. Oxy. 29). The diagram accompanies Book II, Proposition 5.[12]

There is no mention of Euclid in the earliest remaining copies of the *Elements*, and most of the copies say they are "from the edition of Theon" or the "lectures of Theon",[14] while the text considered to be primary, held by the Vatican, mentions no author. The only reference that historians rely on of Euclid having written the *Elements* was from Proclus, who briefly in his *Commentary on the Elements* ascribes Euclid as its author.

Although best known for its geometric results, the *Elements* also includes number theory. It considers the connection between perfect numbers and Mersenne primes, the infinitude of prime numbers, Euclid's lemma on factorization (which leads to the fundamental theorem of arithmetic on uniqueness of prime factorizations), and the Euclidean algorithm for finding the greatest common divisor of two numbers.

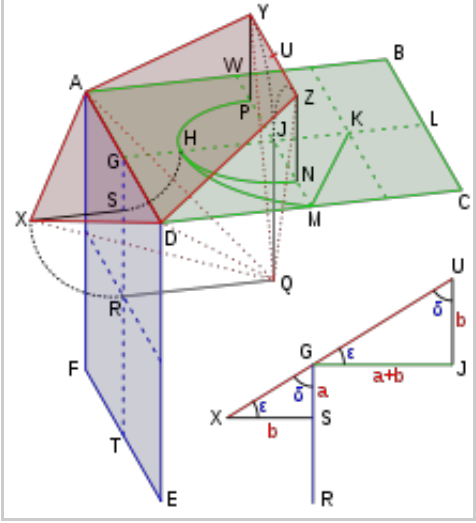
The geometrical system described in the *Elements* was long known simply as *geometry*, and was considered to be the only geometry possible. Today, however, that system is often referred to as *Euclidean geometry* to distinguish it from other so-called *non-Euclidean geometries* that mathematicians discovered in the 19th century.

Other works

In addition to the *Elements*, at least five works of Euclid have survived to the present day. They follow the same logical structure as *Elements*, with definitions and proved propositions.

- *Data* deals with the nature and implications of "given" information in geometrical problems; the subject matter is closely related to the first four books of the *Elements*.
- *On Divisions of Figures*, which survives only partially in Arabic translation, concerns the division of geometrical figures into two or more equal parts or into parts in given ratios. It is similar to a third century AD work by Heron of Alexandria.
- *Catoptrics*, which concerns the mathematical theory of mirrors, particularly the images formed in plane and spherical concave mirrors. The attribution is held to be anachronistic however by J J O'Connor and E F Robertson who name Theon of Alexandria as a more likely author.[15]
- *Phaenomena*, a treatise on spherical astronomy, survives in Greek; it is quite similar to *On the Moving Sphere* by Autolycus of Pitane, who flourished around 310 BC.

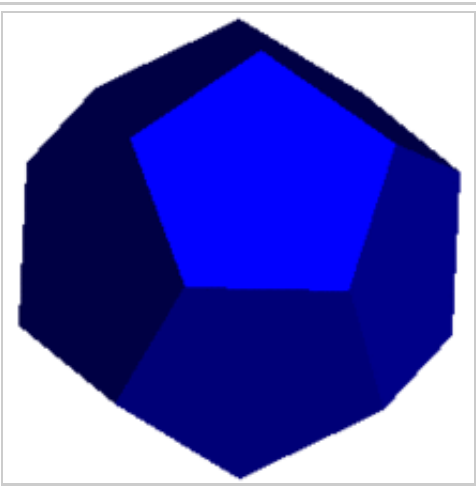
- *Optics* is the earliest surviving Greek treatise on perspective. In its definitions Euclid follows the Platonic tradition that vision is caused by discrete rays which emanate from the eye. One important definition is the fourth: "Things seen under a greater angle appear greater, and those under a lesser angle less, while those under equal angles appear equal." In the 36 propositions that follow, Euclid relates the apparent size of an object to its distance from the eye and investigates the apparent shapes of cylinders and cones when viewed from different angles. Proposition 45 is interesting, proving that for any two unequal magnitudes, there is a point from which the two appear equal. Pappus believed these results to be important in astronomy and included Euclid's *Optics*, along with his *Phaenomena*, in the *Little Astronomy*, a compendium of smaller works to be studied before the *Syntaxis* (*Almagest*) of Claudius Ptolemy.



Euclid's construction of a regular dodecahedron

Other works are credibly attributed to Euclid, but have been lost.

- *Conics* was a work on conic sections that was later extended by Apollonius of Perga into his famous work on the subject. It is likely that the first four books of Apollonius's work come directly from Euclid. According to Pappus, "Apollonius, having completed Euclid's four books of conics and added four others, handed down eight volumes of conics." The Conics of Apollonius quickly supplanted the former work, and by the time of Pappus, Euclid's work was already lost.
- *Porisms* might have been an outgrowth of Euclid's work with conic sections, but the exact meaning of the title is controversial.
- *Pseudaria*, or *Book of Fallacies*, was an elementary text about errors in reasoning.
- *Surface Loci* concerned either loci (sets of points) on surfaces or loci which were themselves surfaces; under the latter interpretation, it has been hypothesized that the work might have dealt with quadric surfaces.
- Several works on mechanics are attributed to Euclid by Arabic sources. *On the Heavy and the Light* contains, in nine definitions and five propositions, Aristotelian notions of moving bodies and the concept of specific gravity. *On the Balance* treats the theory of the lever in a similarly Euclidean manner, containing one definition, two axioms, and four propositions. A third fragment, on the circles described by the ends of a moving lever, contains four propositions. These three works complement each other in such a way that it has been suggested that they are remnants of a single treatise on mechanics written by Euclid.


Construction of a dodecahedron basing on a cube

See also

- Axiomatic method
- Euclid's orchard
- Euclidean algorithm
- Euclidean geometry
- Euclidean relation