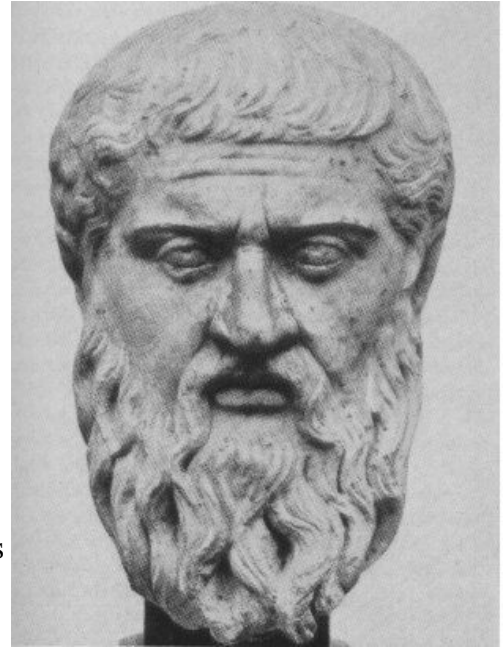


## Plato

Certainly the best known of the great Greek philosophers, **Plato** (427 BCE – 347 BCE) was one of the most creative and influential thinkers in Western history. His philosophical system had a profound influence on Christian theology and Western Philosophy. At the heart of Plato's philosophy is his theory of forms, which are unchangeable and perfect. They are comprehensible only by using intellect or understanding. He was convinced that knowledge is attainable, and that it consists of



two essential characteristics. The first is that it must be certain and infallible and the second is that knowledge must have an object that is genuinely real as contrasted with only an appearance. For Plato, truth is an abstraction and his theory of forms is best illustrated in terms of mathematics. A circle is the locus of all the points in a plane equidistant from a given point called its center. No one has actually seen a true circle, which is perfect. What can be seen are figures drawn to approximate the idea of a circle. The points referred to in the definition of a circle are not physical points, but logical points.

Originally Plato's name was Aristocles, but at school he received the nickname Platon, which means "broad," referring to his wide shoulders. He was the youngest son of a wealthy and aristocratic Athenian family. It is believed that his father, Ariston, was descended from the early kings of Athens. His mother, Perictione, was distantly related to the 6<sup>th</sup> century BCE lawmaker Solon. Little is known of Plato's earlier life, but according to Aristotle, as a young man he studied with Cratylus, a student of Heraclitus, and became a devoted disciple of Socrates in 409 BCE. Plato saw military service in the Peloponnesian War, fought between Athens and Sparta. His early political ambitions disappeared as he

witnessed the decline of imperial Athens and the civil wars that followed the death of Pericles in 428 BCE. Plato was not sympathetic to the restored democracy in 403 BCE, especially after it condemned to death his friend and mentor Socrates. Plato left Athens, expressing the thought that until “kings were philosophers or philosophers were kings” nothing good would occur. He and a few followers took refuge at Megara with the philosopher Euclides. He traveled widely in Greece, Egypt, the Greek cities of Italy, where he studied with Archytas and Timaeus, students of Pythagoras, as well as visiting Sicily, and possibly Asia. At Syracuse in Sicily, at the request of Dion, brother-in-law of Dionysius I, Plato served as a tutor of the new king, Dionysius II. As this king did not have the makings of a philosopher king, things turned out badly, and Plato was cast into prison and sold as a slave until ransomed by Dion. Plato made a hasty return to the safety of Athens.

Plato established his own school, the Academy c. 387 BCE, which became a famous center for philosophical, mathematical, and scientific research. His Academy was named for its location in a grove dedicated to the hero Hecademus. It lasted for nine hundred years, until it was closed down in 529 CE by the order of the Christian Emperor Justinian who objected to it as a “pagan” institution. Plato’s goals for his students, who likely included Euclid before he moved to Alexandria, were to pass on the heritage of a Socratic way of thinking and to guide their progress through mathematical training so they might understand abstract philosophical truths. Plato’s writings, on which his enduring reputation rests, consisted of some 30 philosophical dialogues and a series of *Letters*. These writings addressed both these goals. He conveyed the spirit of the *Socratic Method* by presenting accurate reports of the master’s conversational teachings. Socrates’ method of inquiry was based on discourses with others in which his careful questioning was designed to reveal truth and to expose error. Plato’s later dialogues reflect more of his own ideas, even though Socrates still appears as the main character in the written conversations.

Through his teachings Plato laid the foundations of the science of geometry. His edict that geometric constructions could be made only with straightedge and compasses became mandatory and had a considerable influence on the development of mathematics in the attempts to solve three impossible problems: the trisection of an angle, squaring the circle and the doubling of a cube. Plato also established the practices that subsequent geometers followed, beginning their study with a carefully selected set of accurate definitions and clear assumptions from which theorems were derived by logical proofs. He championed the analytical method of proof, which we might now call backward or goal oriented proof. One begins with the proposition to be proven and works back by steps towards an acknowledged principle from which it can be derived. If the steps are reversible, then by reversing them, one arrives at a synthetic proof, that is, a forward proof in which the argument begins with the axioms and previously proved theorems towards the proposition to be proved. If the steps are not reversible, no conclusion can be drawn. Plato was particularly interested in the mysticism of numbers, but he provided no information in his writings about what part of the science of numbers was taught in his school or how it was taught.

Plato cared only for pure mathematics, dismissing the importance of applications. He indignantly railed against those who would “shamefully turn their backs upon the unembodied objects of pure intelligence.” To Plato, mathematics divorced from crass applications was the loftiest form of pure thought possible. As an illustration, after learning of them from his friend Archytas in 388 BCE, Plato became fascinated with what has come to be called “Platonic Solids.” A *polygon* is a plane figure whose sides are line segments; it is said to be *regular* if all of its sides are equal. A *polyhedron* is a solid whose surface consists of a number of polygonal faces. A polyhedron is *regular* if its faces are congruent regular polygons and the vertices all lay on a sphere. While there are an infinite number of regular polygons, it turns out that there are only five regular polyhedra. They are named for the number of faces they have (Figure 11.10): the tetrahedron (4 triangular faces), the cube (6 square faces), the

octahedron (8 triangular Faces), the dodecahedron (12 pentagonal faces), and the icosahedron (20 triangular faces).

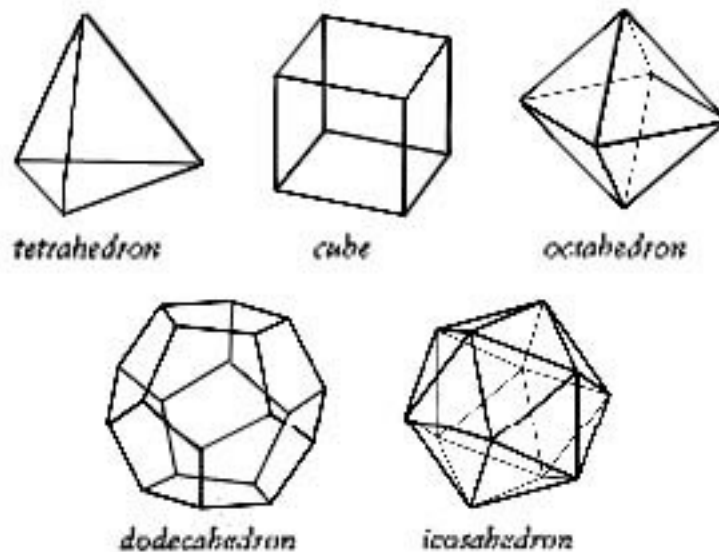


Figure 11.10

Plato believed that the existence of only five perfectly symmetrical arrangements of points in space must be keys to some mystery. He extensively studied these solids and applied them in explaining scientific phenomena. His ideas on these solids, also known as “cosmic bodies,” are found in a dialogue entitled the *Timaeus*. The solids were well known to the Pythagoreans, but the scholiast Suidas credits Plato’s friend Theaetetus with being the first one to write about them. Plato associated the dodecahedron with the universe and the other four with the four “elements,” as follows: fire – tetrahedron, earth – cube, water – icosahedron and air – octahedron. He asserted that mathematics in its ideal form could be used to describe the heavenly bodies, which exhibited perfect geometric form. The five regular solids were used to explain his cosmology. He maintained that the stars, planets, Sun and Moon move round the Earth in crystalline spheres. He taught that the order of the spheres carrying these heavenly bodies were, in their distances from Earth, the Moon (the closest) followed by the Sun,

then Mercury, Venus, Mars, Jupiter, Saturn. Furthest away was the sphere of the stars.

**Quotation of the Day:** “Mathematics is like checkers in being suitable for the young, not too difficult, amusing and without peril to the state.”– Plato