

# 1 History of Calculus

## 1.1 Integral calculus

Greek geometers are credited with a significant use of infinitesimals. Democritus is the first person recorded to consider seriously the division of objects into an infinite number of cross-sections, but his inability to rationalize discrete cross-sections with a cone's smooth slope prevented him from accepting the idea. At approximately the same time, Zeno of Elea discredited infinitesimals further by his articulation of the paradoxes which they create.

Antiphon and later Eudoxus are generally credited with implementing the method of exhaustion, which made it possible to compute the area and volume of regions and solids by breaking them up into an infinite number of recognizable shapes. Archimedes developed this method further, while also inventing heuristic methods which resemble modern day concepts somewhat. It was not until the time of Newton that these methods were made obsolete. It should not be thought that infinitesimals were put on rigorous footing during this time, however. Only when it was supplemented by a proper geometric proof would Greek mathematicians accept a proposition as true.

In the third century Liu Hui wrote his Nine Chapters and also Haidao suanjing, which dealt with using the Pythagorean theorem (already stated in the Nine Chapters), known in China as the Gougu theorem, to measure the size of things. He discovered the usage of Cavalieri's principle to find an accurate formula for the volume of a cylinder, showing a grasp of elementary concepts associated with the differential and integral calculus.

Indian mathematicians produced a number of works with some ideas of calculus. The formula for the sum of the cubes was first written by Aryabhata circa 500 AD, which was an important step in the development of integral calculus.

Around 1000 AD, Ibn al-Haytham (known as Alhazen in the West), an Iraqi mathematician working in Egypt, was the first mathematician to derive the formula for the sum of the fourth powers. In turn, he developed a method for determining the general formula for the sum of any integral powers, which was fundamental to the development of integral calculus.

In the 17th century, Pierre de Fermat, among other things, is credited with an ingenious trick for evaluating the integral of any power function directly, thus providing a valuable clue to Newton and Leibniz in their development of the fundamental theorems of calculus.

At around the same time, there was also a great deal of work being done by Japanese mathematicians, particularly Kowa Seki. He made a number of contributions, namely in methods of determining areas of figures using integrals, extending the method of exhaustion. While these methods of finding areas were made largely obsolete by the development of the fundamental theorems by Newton and Leibniz, they still show that a sophisticated knowledge of mathematics existed in 17th century Japan.