

Archimedes ^[1]

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Greek Mathematics

Archimedes (287 - 212 BCE) is one of the most famous of all of the Greek mathematicians, contributing to the development of pure math and calculus, but also showing a great gift for using mathematics practically.

With inventions such as the Archimedes Screw and the Archimedes Claw, he showed himself to be a brilliant engineer as much as a theorist.

This was a break away from the traditions of the earlier Greeks, who felt that such pursuits were vulgar and started the process of uniting mathematics and geometry with engineering. This move possibly ties in with the practicalities of politics; Archimedes is renowned for inventing great war machines ^[3] and it may have been the desire to protect his city that forced his hand.

Archimedes and the Theory of Exhaustion

Archimedes' contributions to math were legion, and mostly based around his theory of exhaustion, where he would look for solutions close to the desired answer and give a range. This was the only way that the Greeks could address irrational numbers such as Pi and square roots.

For example, in his development of integration and calculus, he tried to find a value for Pi by using circumscribed and inscribed polygons, eventually using 96 sided polygons inside and outside a circle to generate a value for Pi of between $31\frac{7}{71}$ (approximately 3.1429) and $310\frac{771}{71}$ (approximately 3.1408). This range of values is extremely accurate, as the actual value is 3.1416.

Parabolic Segment and Inscribed Triangle

Parabolic Segment and Inscribed Triangle (Public Domain)

Archimedes wrote a range of treatises, many of which are lost to us, but those that remain show that he truly was a mathematical genius. Modern engineers and applied mathematicians use knowledge and proofs revealed in the work of Archimedes. Some of the remaining books

are

- **On the Sphere and the Cylinder:** Archimedes used this exhaustion technique on solid shapes, calculating the area of the surface of a sphere. He also calculated the volume by calculating that the volume of a sphere is $\frac{2}{3}$ of that of its circumscribed cylinder.
- **Measurement of the Circle:** Here, Archimedes proved that the area of a circle was equal to π multiplied by the square of the radius, and he calculated the square root of 3 to be between $265\sqrt{153}$ (approximately 1.7320261) and $1351\sqrt{780}$ (approximately 1.7320512).
- **On Conoids and Spheroids:** Archimedes examined paraboloids, cones, hyperboloids and spheroids, calculating the volumes and areas of sections of these shapes.
- **On Spirals:** The mathematician studied the properties of the Archimedes spiral, showing how to calculate tangents and areas. His work on the Archimedes screw shows that this was important part of his work and shows his mastery of applied mathematics.

Archimedes Pi

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Archimedes' Pi Approximation ([Creative Commons](#) [4])

- **On Plane Equilibriums:** In this work, he concentrated upon finding the center of gravity for a series of shapes, including parallelograms, triangles, trapeziums and a segment of a parabola.
- **The Quadrature of the Parabola:** In this treatise, Archimedes proved that the area of any given segment of a parabola is $\frac{4}{3}$ of the area of a triangle with the same base length as the segment and equal height.

Page Archimedes Palimpsests

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Page Archimedes
Palimpsests (Creative
Commons)

- **On Floating Bodies:** In this work, Archimedes studies hydrostatics, the properties of floating bodies and the one that gave rise to his 'Eureka' story, although there is little evidence that he actually did that!
- **The Psammites:** Here, Archimedes used the idea of counting the number of grains of sand that could be contained in the universe to devise a numerical notation system. This system was capable of describing numbers as large as 8×10^{63} .

Archimedes: Mathematician and Inventor

Archimedes undoubtedly made many contributions to Greek mathematics, and his works that survive show that he was one of the most influential mathematicians of all time. Strangely, he is not as well known as a mathematician as an inventor and most of the history taught about this remarkable man revolves around his war machines and the Archimedes screw.

Much of the evidence for his inventions, such as complex lever systems, including the Archimedes Claw that he used to snatch attacking Roman ships from the water, and parabolic mirrors designed to burn ships, are largely anecdotal. However, there is little doubt that he certainly had the applied mathematical ability to devise these great machines.

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