# The Magic of Pi (π)

## π -- The Most Magical Number

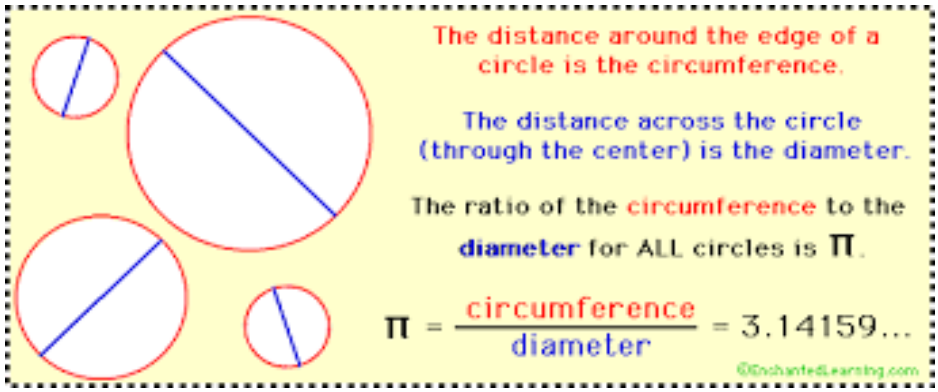
"Mathematics reveals its secrets only to those who approach it with pure love." — Archimedes

Magicians thrive on mystery, patterns, and the unexpected. Few mathematical ideas capture these qualities better than π. Like magic, π is both mysterious and endlessly surprising.

Infinite, unpredictable, and filled with surprising coincidences, π has fascinated mathematicians, scientists, and performers alike for thousands of years. From ancient civilizations to modern computers calculating trillions of digits, π continues to reveal new wonders — much like magic itself.

Before exploring its long history and surprising properties, it helps to begin with the simple idea at the heart of it all: what π actually is.

## What Is π?




As shown in the illustration above, π is the ratio of a circle's circumference to its diameter — the circumference divided by the diameter ($\pi = \frac{c}{d}$). The lowercase form of the 16th letter of the Greek alphabet, "π", is used to designate this ratio [1]. In the Greek alphabet, π falls between omicron (o) and rho (ρ). This ratio remains constant regardless of the size of the circle. A circle can be as small as the eraser on a pencil or as large as the Earth's equator, yet the ratio is always the same [2]. This constant, π, is commonly approximated as 3.14, though it can also be expressed as the fractions $\frac{22}{7}$ or $\frac{355}{113}$, the latter yielding the first six decimal places of π with remarkable accuracy [3]. Once people understood this constant ratio, civilizations across the world began trying to measure it with increasing precision. Their efforts form one of the most fascinating threads in the history of mathematics.

# Historical Approximations

**Babylonian Clay Tablet**
**1900-1680 BC**
**3.125**

**Egyptian Rhind Mathematical Papyrus**
**1650 BC**
**3.1605**

**Greek**
**Archimedes of Syracuse (c. 287-212 BC);**
**Hero of Alexandria (c. 10 AD–70 AD)**
**Ptolemy (c. 150 AD);**
$\frac{223}{71} < \pi < \frac{22}{7}$
**3.142;**
**3.1416**

**Chinese**
**Liu Hui (c. 220-295 AD);**
**Zu Chongzhi (c. 429-500AD);**
**3.14159;**
**3.1415926**

**Indian**
**Madhava of Sangamagrama (c. 1340–1425);**
**Kerala School (1300-1600)**
**Infinite Series:**
$\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \cdots;$
**17 correct decimal places**

**European**
**Gottfried Leibniz (1646–1716)**
**Alternating Arctangent Series:**
$\pi = 4\left(1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} - \cdots\right)$

Babylonian, Egyptian, Greek, Chinese, and Indian mathematicians all sought increasingly accurate values of π. Ancient Babylonian tablets and Egyptian papyrus evidence that π was discovered about 4,000 years ago. The Babylonians estimated π at about 3.125. The Egyptians used 3.1605 for π.

The first geometrically rigorous calculation of π was carried out by the Greek mathematician Archimedes of Syracuse (287-212 B.C.). He was the first to prove boundaries for π by inscribing polygons inside a circle and circumscribing polygons around it. He showed that $\frac{223}{71} < \pi < \frac{22}{7}$. This was the most accurate and mathematically justified estimate of π in the ancient world. Hence, π is sometimes referred to as "Archimedes' constant".

In the 5th century AD, Chinese mathematicians approximated π to seven digits; Zu Chongzhi (429–500 AD) computed π to lie between 3.1415926 and 3.1415927. Chongzhi's famous Milü fraction $\frac{355}{113}$ remained the world's most accurate rational approximation for nearly 1,000 years. This precision was unmatched anywhere in the world until the 15th century. Indian mathematicians continued to refine its value in subsequent centuries.

The first analytic expression of π is based on an infinite series discovered in the 14th century by the Indian mathematician Madhava of Sangamagrama. He calculated π to 11 correct decimal places, and his successors—including Parameshvara, Nilakantha, and Jyeshtadeva—extended his methods to reach 17 decimal places and preserved his derivations in the *Yuktibhāṣā*. These achievements represent the earliest known use of power series, error analysis, and proto-calculus techniques in world mathematics, centuries before similar ideas appeared in Europe. The same series was later discovered independently and first published in Europe by the German mathematician Gottfried Wilhelm Leibniz around 1676. As mathematicians refined π's value, they also needed a clear and universal way to represent it. That search for a symbol has its own story.

## Symbol and Notation

As mathematicians refined the value of π, they also sought a clear and consistent way to represent it. The number pi began being symbolized by the lowercase Greek letter "π" in 1706 by Welsh mathematician William Jones who was a close friend of Sir Isaac Newton and English astronomer, mathematician, physicist, and cartographer Sir Edmund Halley (Halley's Comet). Halley lived from 1656 to 1742; it was Halley who encouraged Newton to publish the *Principia* and financed its printing.

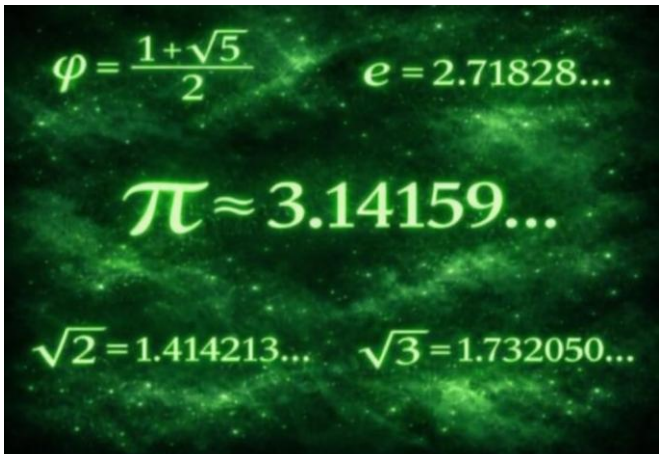
Earlier mathematicians often used the Latin letter "p" to stand for *perimeter* or *periphery* (i.e., circumference). Jones wanted a symbol that still evoked that idea but looked cleaner and avoided confusion with other uses of *p*.

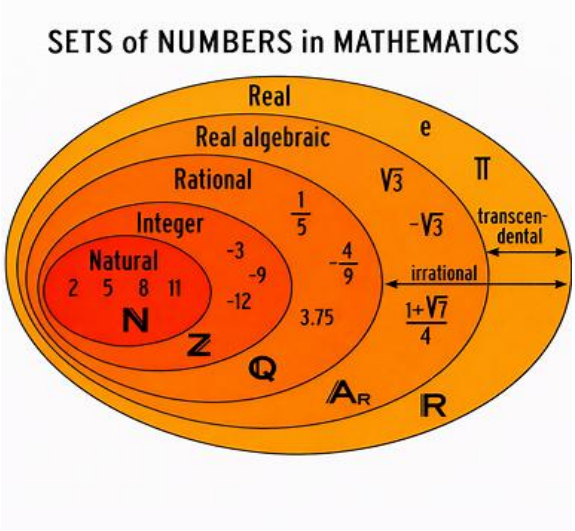
By Jones' time, Greek letters like α, β, and θ were widely used in geometry and trigonometry, so choosing a Greek "π" fit the emerging stylistic norm and made the notation feel more formal and universal. Jones is believed to have preferred the aesthetic of the Greek "π" over the plain Latin "p", feeling it simply sat better on the page. Although Jones introduced the symbol, it did not become standard until Swiss mathematician and physicist Leonhard Euler (pronounced oiler) adopted π in the 1730s and used it consistently.

## Mathematical Properties

With the symbol π firmly established, attention shifted from approximating its value to understanding its deeper nature — a journey that revealed some of the most remarkable facts in mathematics. In 1761, Johann Heinrich Lambert, an influential Swiss-German polymath, proved that π is an irrational number. In plain English, this means that π cannot be expressed as a simple fraction, and it has an infinite decimal expansion: after the decimal point, the digits continue indefinitely without repeating. The digits of π never end. Though π's digits appear random, mathematicians have not yet proven that they are "statistically" random.

In 1882, German mathematician Ferdinand von Lindemann showed that π is transcendental. That is a technical way of saying that π cannot be created from any combination of ordinary algebraic operations—no matter how you add, multiply, or take roots, you will never produce π exactly. It belongs to a rare category of numbers that lie beyond the reach of standard algebra.




## π in Popular Culture

Beyond the world of mathematics, π has captured the imagination of writers, scientists, and storytellers, finding its way into books, films, and popular science. Starting in 1962, Pulitzer Prize–winning astrophysicist Dr. Carl Edward Sagan became widely known for his world-famous thirteen-part documentary television series *Cosmos: A Personal Voyage* (1980–81), viewed by 500 million people in sixty countries. He co-created the series with his wife, Ann Druyan, and Steven Soter, and served as its presenter.


In his 1985 book *Contact*, Carl Sagan speculated that there are hidden messages contained within the digits of π; one such message implies a "Creator" who intentionally designed the universe and its mathematical constants. The 1997 movie *Contact* adaptation of Sagan's book dropped the concept of a grand creator. The movie starred Jodie Foster, James Woods, Matthew McConaughey, Jena Malone, and Tom Skerritt.

During a video published on the YouTube channel *Numberphile* on March 14, 2012, mathematician Dr. James Grime of Cambridge, England popularized the theory that by carrying out π to just 38 decimal places, one could measure the circumference of our known universe [4]. Remarkably, this is accurate to within the width of a hydrogen atom—0.000001 (one-millionth) the thickness of a human hair. That is remarkably precise when we consider that our universe has a diameter of 93 billion light years! Measured in miles that is 541 sextillion miles or 541,000,000,000,000,000,000,000 miles.


While Dr. Grime popularized the "universe-to-atom" analogy in 2012, the idea that roughly 39–40 digits provide near-perfect cosmic precision has been a known mathematical fact for decades.

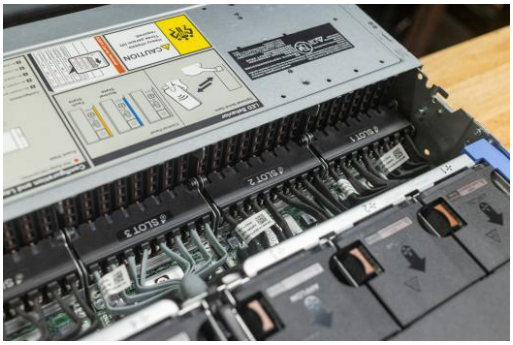
For example, Austrian Jesuit astronomer Christoph Grienberger (also spelled Gruemberger), after whom the lunar crater Gruemberger is named, manually computed π to between 36 and 38 digits, publishing this value in his *Elementa Trigonometrica* of 1630. Father Grienberger was among the Collegio Romano mathematicians who evaluated and ultimately confirmed Galileo's telescopic discoveries. A modern numerological curiosity notes that his birthday, 7/2/1561, occurs at the 182,220$^{th}$ decimal digit of π.

There are other math communicators who have mentioned or explained the 38 decimal places concept including Australian recreational mathematician/stand-up comedian Matt Parker who also appears on *Numberphile*.

Dr. Simon Singh, MBE is a British popular science author and theoretical and particle physicist. Singh explores π and has helped spread pi-related curiosities through his talks and various mathematical works, including his 2013 book *The Simpsons and Their Mathematical Secrets* in which he discusses the numerous mathematical references, puzzles, and theorems hidden throughout the animated series and how the show incorporates π into its stories. He has also presented a BBC Radio 4 series, *Simon Singh's Numbers*, dedicated to explaining the historical and conceptual significance of important numbers like π.

## Modern Calculations

Even as π appears in culture and storytelling, it remains a subject of intense scientific and computational effort. Modern technology has pushed its calculation to staggering new heights.



- On January 29, 2020, cybersecurity analyst Timothy Mullican of Huntsville, Alabama set a new world record by calculating π to 50 trillion decimal places. It took his computer about ten months (303 days) to complete the computation.

- On May 19, 2025, Kioxia Corporation announced that it had collaborated with Linus Media Group to set a new GUINNESS WORLD RECORDS® title for the "Most Accurate Value of Pi". A groundbreaking 300 trillion digits were calculated; this record was officially verified and confirmed by Guinness World Records as of April 2, 2025.

- On December 11, 2025, StorageReview pushed π to 314 trillion digits. It took their computer 110 days to complete the calculation.

Despite these mind-boggling iterations of π made possible by our modern computers, it is interesting to note that NASA's Jet Propulsion Laboratory uses only 15 decimal places of π for its highest-accuracy interplanetary navigation calculations. The most distant human-made object from Earth is the spacecraft Voyager 1 (launched September 5, 1977). Using π rounded to just 15 decimal places, the resulting navigational error in figuring the location of Voyager 1, which is now 16 billion miles away, would be the width of your fingernail!

## Fun Facts

Alongside these monumental achievements, π is full of delightful quirks and coincidences that continue to fascinate enthusiasts. A sequence of six consecutive nines occurs in the decimal representation of the number $\pi$, starting at the 762nd decimal place. It has become famous because of the mathematical coincidence, and because of the idea that one could memorize the digits of $\pi$ up to that point, and then suggest that $\pi$ is rational. The earliest known mention of this idea occurs in Douglas Hofstadter's 1985 book *Metamagical Themas*, where Hofstadter states, "I myself once learned 380 digits of $\pi$, when I was a crazy high-school kid. My never-attained ambition was to reach the spot, 762 digits out in the decimal expansion, where it goes '**999999**', so that I could recite it out loud, come to those six 9s, and then impishly say, 'and so on!'"

3.14159265358979323846264338327950288419716939937510
82097494**592307816**406286208998628034825342117067982
14808651328230664709384460955058223172535940812848111
74502841027019385211055596446229489549303819644288 10
97566593344612847564823378678316527120190914564856 69
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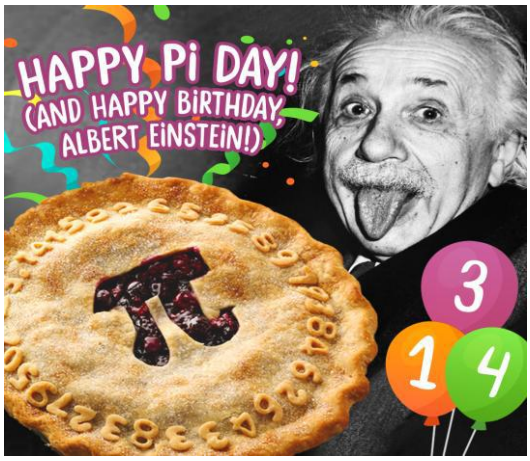


- The number 186,000, the approximate speed of light in miles per second, occurs at the 2,352,935th decimal digit of π [5].

- Pi is a mathematical idea that has its own day. March 14, that is, three-fourteen (3-14) is celebrated worldwide as "Pi Day".

- Pi Day, March 14, is Albert Einstein's birthday.

## A Personal Comment

After exploring π from so many angles — historical, mathematical, cultural, and computational — I would like to end with a personal comment. This discussion is not meant be a formal academic paper; it is intended to be an enjoyable exploration of π—shaped by books, articles, and the bits of knowledge I have gathered over the years through family, teachers, and simple curiosity. Some of the material comes from a handful of books and online sources, but much of it reflects what I absorbed from the people who first sparked my interest: my parents, Dan and Marion; Sister Yolanda – my 5th and 6th grade teacher; Sister Mary Magdalene, who taught me in 7th and 8th grade; and Sister Marie Bonaventure, my sophomore-year geometry teacher and one of my favorites in high school. Like magic itself, π reminds us that the universe is full of patterns, mysteries, and wonders still waiting to be discovered.

*Lazarus*

## Notes

[1] In mathematics, upper case (capital) pi Π connotes a different concept – the product of a sequence of terms.

[2] The Earth's equator is slightly irregular but close enough for illustration.

[3] Here is a memory trick to help you easily remember this last fraction. Start counting from the number "1" using only the first three odd numbers, which are 1; 3; 5. Now repeat each of these numbers once and arrange them in pairs like this: 1,1; 3, 3; and 5, 5. Then place the last three of these numbers (as the numerator) over the first three numbers (as the denominator), that is, put 355 over 113, i.e. $\frac{355}{113}$. And there you have the fraction needed to yield a very accurate representation of pi: 3.141592…. Round the "2" to a "3", and you have 3.141593. Do this because the number following the "2" in the actual expression of pi is a "6"; and when converting the fraction $\frac{355}{113}$ to a decimal, the number following the "2" is a "9". So, in either of these expressions of pi, the "2" should be rounded up to a "3".

[4] *Numberphile* was developed by Brady John Haran OAM who is an Australian-British independent filmmaker who previously worked as a video journalist for the BBC. He produces educational videos and documentary films for his YouTube channels, the most notable of which are *Computerphile* and *Numberphile*.

[5] The exact speed of light in a vacuum is 186,282 miles per second.