Why Pi Matters

By Steven Strogatz

March 13, 2015

Every March 14th, mathematicians like me are prodded out of our burrows like Punxsutawney Phil on Groundhog Day, blinking and bewildered by all the fuss. Yes, it's Pi Day again. And not just any Pi Day. They're calling this the Pi Day of the century: 3.14.15. Pi to five digits. A once-in-a-lifetime thing.

I'm dreading it. No hope of solving any equations that day, what with the pie-eating contests, the bickering over the merits of pi versus tau (pi times two), and the throwdowns over who can recite more digits of pi. Just stay off the streets at 9:26:53, when the time will approximate pi to ten places: 3.141592653.

Pi does deserve a celebration, but for reasons that are rarely mentioned. In high school, we all learned that pi is about circles. Pi is the ratio of a circle's circumference (the distance around the circle, represented by the letter C) to its diameter (the distance across the circle at its widest point, represented by the letter d). That ratio, which is about 3.14, also appears in the formula for the area inside the circle, $A = \pi r2$, where π is the Greek letter "pi" and r is the circle's radius (the distance from center to rim). We memorized these and similar formulas for the S.A.T.s and then never again used them, unless we happened to go into a technical field, or until our own kids took geometry.

So it's fair to ask: Why do mathematicians care so much about pi? Is it some kind of weird circle fixation? Hardly. The beauty of pi, in part, is that it puts infinity within reach. Even young children get this. The digits of pi never end and never show a pattern. They go on forever, seemingly at random—except that they can't possibly be random, because they embody the order inherent in a perfect circle. This tension between order and randomness is one of the most tantalizing aspects of pi.

Pi touches infinity in other ways. For example, there are astonishing formulas in which an endless procession of smaller and smaller numbers adds up to pi.
One of the earliest such infinite series to be discovered says that pi equals four times the sum $1 - 1/3 + 1/5 - 1/7 + 1/9 - 1/11 + \cdots$. The appearance of this formula alone is cause for celebration. It connects all odd numbers to pi, thereby also linking number theory to circles and geometry. In this way, pi joins two seemingly separate mathematical universes, like a cosmic wormhole.

But there's still more to pi. After all, other famous irrational numbers, like e (the base of natural logarithms) and the square root of two, bridge different areas of mathematics, and they, too, have never-ending, seemingly random sequences of digits.

What distinguishes pi from all other numbers is its connection to cycles. For those of us interested in the applications of mathematics to the real world, this makes pi indispensable. Whenever we think about rhythms—processes that repeat periodically, with a fixed tempo, like a pulsing heart or a planet orbiting the sun—we inevitably encounter pi. There it is in the formula for a Fourier series:

$$x(t) = \sum_{k=0}^{\infty} a_k \cos(2\pi kt / T) + b_k \sin(2\pi kt / T)$$

That series is an all-encompassing representation of any process, $x(t)$, that repeats every T units of time. The building blocks of the formula are pi and the sine and cosine functions from trigonometry. Through the Fourier series, pi appears in the math that describes the gentle breathing of a baby and the circadian rhythms of sleep and wakefulness that govern our bodies. When structural engineers need to design buildings to withstand earthquakes, pi always shows up in their calculations. Pi is inescapable because cycles are the temporal cousins of circles; they are to time as circles are to space. Pi is at the heart of both.

For this reason, pi is intimately associated with waves, from the ebb and flow of the ocean's tides to the electromagnetic waves that let us communicate wirelessly. At a deeper level, pi appears in both the statement of Heisenberg's uncertainty principle and the Schrödinger wave equation, which capture the fundamental behavior of atoms and subatomic particles. In short, pi is woven into our descriptions of the innermost workings of the universe.

So that's what I'll be celebrating when the clock strikes 3.14.15 9:26:53—safe in my burrow, waiting out the mayhem. See you next year.

- *Steven Strogatz is a professor of mathematics at Cornell. He is the author, most recently, of "The Joy of x."*

Source: https://www.newyorker.com/tech/annals-of-technology/pi-day-why-pi-matters

Read these questions below BEFORE reading the two articles to help guide your reading.

<u>Article Title:</u> ***"Learn About Pi"***

What book of the Bible that mentions the ratio of diameter to circumference?

Who used polygons with many sides to approximate circles and determined Pi was approximately 22/7?

Who was the first to use the symbol π in 1706?

Which Swiss mathematician made the Pi symbol famous?

How many digits past the decimal are needed to accurately calculate the spherical volume of our entire universe?

<u>Article Title:</u> ***"Why Pi Matters" by Steven Strogatz***

What do you call the number of square units needed to cover a region?

What do you call a line segment drawn from the center of a circle to a point on the circle?

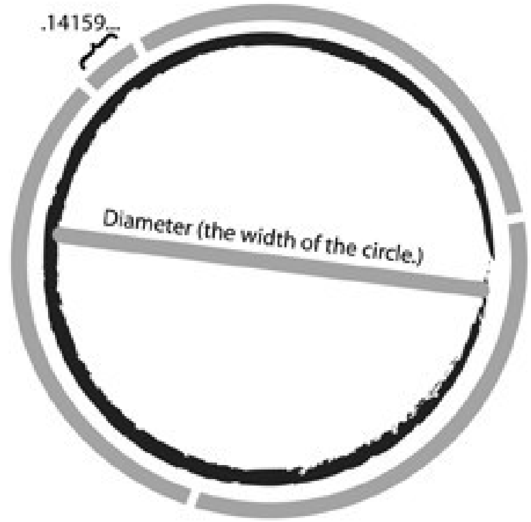
What type of number cannot be expressed as a fraction, (they are never-ending and random sequences)?

What series is an all-encompassing representation of processes that repeat periodically?

Who wrote the uncertainty principle?

Who wrote a wave equation?

LEARN ABOUT PI



Pi (π) is the ratio of a circle's circumference to its diameter. Pi is a constant number, meaning that for all circles of any size, Pi will be the same.

The diameter of a circle is the distance from edge to edge, measuring straight through the center. The circumference of a circle is the distance around.

HISTORY OF PI

By measuring circular objects, it has always turned out that a circle is a little more than 3 times its width around. In the Old Testament of the Bible (1 Kings 7:23), a circular pool is referred to as being 30 cubits around, and 10 cubits across. The mathematician Archimedes used polygons with many sides to approximate circles and determined that Pi was approximately 22/7. The symbol (Greek letter "π") was first used in 1706 by William Jones. A 'p' was chosen for 'perimeter' of circles, and the use of π became popular after it was adopted by the Swiss mathematician Leonhard Euler in 1737. In recent years, Pi has been calculated to over one trillion digits past its decimal. Only 39 digits past the decimal are needed to accurately calculate the spherical volume of our entire universe, but because of Pi's infinite & patternless nature, it's a fun challenge to memorize, and to computationally calculate more and more digits.

GEOMETRY

The number pi is extremely useful when solving geometry problems involving circles. Here are some examples:

The area of a circle. A = πr2

Where 'r' is the radius (distance from the center to the edge of the circle). Also, this formula is the origin of the joke "Pies aren't square, they're round!"

The volume of a cylinder. V = πr2h

To find the volume of a rectangular prism, you calculate length × width × height. In that case, length × width is the area of one side (the base), which is then multiplied by the height of the prism. Similarly, to find the volume of a cylinder, you calculate the area of the base (the area of the circle), then multiply that by the height (h) of the cylinder.

Source: https://www.piday.org/learn-about-pi/