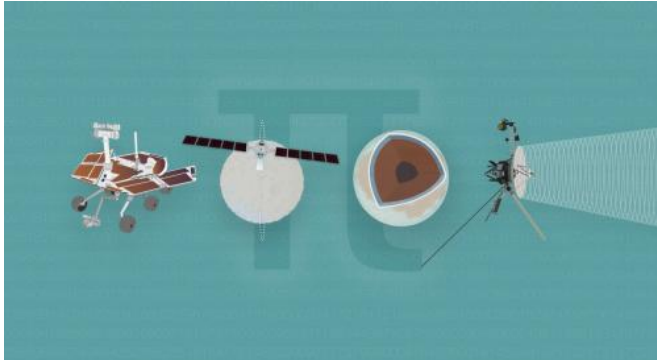


On Pi Day, how scientists use this number

13 March 2015, by Elizabeth Landau



Take JPL Education's Pi Day challenge featuring real-world questions about NASA spacecraft -- then tweet your answers to @NASAJPL_Edu using the hashtag #PiDay. Answers will be revealed on March 16. Image credit: NASA/JPL-Caltech

If you like numbers, you will love March 14, 2015. When written as a numerical date, it's 3/14/15, corresponding to the first six digits of pi (3.1415)—a once-in-a-century coincidence! Pi Day, which would have been the 136th birthday of Albert Einstein, is a great excuse to eat pie, and to appreciate how important the number pi is to math and science.

Pi is the ratio of circumference to diameter of a circle. Any time you want to find out the distance around a circle when you have the distance across it, you will need this formula.

Despite its frequent appearance in math and science, you can't write [pi](#) as a simple fraction or calculate it by dividing two integers (...-3, -2, -1, 0, 1, 2, 3...). For this reason, pi is said to be "irrational." Pi's digits extend infinitely and without any pattern, adding to its intrigue and mystery.

Pi is useful for all kinds of calculations involving the volume and surface area of spheres, as well as for determining the rotations of circular objects such as wheels. That's why pi is important for scientists

who work with planetary bodies and the spacecraft that visit them.

At NASA's Jet Propulsion Laboratory, Pasadena, California, pi makes a frequent appearance. It's a staple for Marc Rayman, chief engineer and mission director for NASA's Dawn spacecraft. Dawn went into orbit around dwarf planet Ceres on March 6. Rayman uses a formula involving pi to calculate the length of time it takes the spacecraft to orbit Ceres at any given altitude. You can also use pi to think about Earth's rotation.

"On Pi Day, I will think about the nature of a day, as Earth's rotation on its axis carries me on a circle 21,000 miles (34,000 kilometers) in circumference, which I calculated using pi and my latitude," Rayman said.

PI IN THE SKY²

Phi back in our skins, helping mathematical sleuths like yourself solve stellar problems. Find the dizzying number of times a Mars rover's wheels have rotated in 11 years. Learn how many images it takes to map a new world. Estimate the volume of an alien ocean. And discover just how powerful -- or faint -- our most distant spacecraft's voice can be. Pi leads the way.

MARS MARATHON
The Mars Exploration Rover Opportunity has been driving on the Red Planet for more than 11 years -- not just for a mission only planned to last for three months! Opportunity has already beat the off-Earth driving distance record of 38 kilometers and is approaching a new one: 40,000 kilometers. When Opportunity reaches the marathon mark, how many times will its 20-wheeled drive train wheels have rotated? LEARN MORE ABOUT THE MISSION: mars.nasa.gov/mer

PIXEL PUZZLER
The Dawn spacecraft is orbiting Ceres -- a rocky spherical dwarf planet with an average radius of 473 kilometers -- in a perfectly circular solar orbit. While in orbit, Dawn will snap images of Ceres' surface to piece together a global map. From its lowest altitude orbit of 275 kilometers, Dawn's cameras can see a patch of Ceres about 28 kilometers on a side. Assuming an overlap in the images, how many photographs would Dawn have to take to fully map the surface of Ceres? LEARN MORE ABOUT THE MISSION: dawn.jpl.nasa.gov

FROZEN FORMULA
Scientists have good reason to believe that Jupiter's moon Europa has a liquid ocean wedged between its ice shell and a rocky core. Though it has a known radius of 1,561 kilometers -- slightly smaller than Earth's moon -- uncertainty exists about the exact thickness of Europa's ice shell and the depth of its ocean. Assuming Europa's ice shell is between 2 and 30 kilometers thick, and its ocean is between 2.2 and 130 kilometers deep, what is the minimum and maximum volume of its ocean? LEARN MORE ABOUT EUROPA: solartydam.nasa.gov/europa

HEAR HERE
The twin Voyager spacecraft, which launched in 1977, are the most distant human-made objects in space. It takes more than 18 hours for a signal from the 12.5-meter Kuiper Telescope on Voyager 1 to reach Earth, nearly 127 astronomical units away from astronomical unit. All is equal to about 150,000,000 kilometers. The Voyager high-gain antenna, a circular parabolic reflector, transmits a narrow radio signal about 0.5-degree wide. At the nearest distance, what fraction of the Voyager 1 radio beam is received on Earth by a 70-meter-diameter antenna at NASA's Deep Space Network (DSN)? How many of the original 12.5 units are received by the DSN antenna? LEARN MORE ABOUT THE MISSIONS: voyager.jpl.nasa.gov deepspacenet.jpl.nasa.gov

Discover more from JPL Education online at: jpl.nasa.gov/edu

Credit: Kim Orr

Steve Vance, a planetary chemist and astrobiologist at JPL, also frequently uses pi. Lately, he has been using pi in his calculations of how much hydrogen might be available for chemical processes, and possibly biology, in the ocean beneath the surface of Jupiter's moon Europa.

"To calculate the hydrogen produced in a given unit area, we divide by Europa's [surface area](#), which is the area of a sphere with a radius of 970 miles (1,561 kilometers)," Vance said.

Luisa Rebull, a research scientist at NASA's Spitzer Science Center at the California Institute of Technology, Pasadena, also considers pi to be important in astronomy. When calculating the distance between stars in a projection of the sky, scientists use a special kind of geometry called spherical trigonometry. That's an extension of the geometry you probably learned in middle school, but it takes place on a sphere rather than a flat plane.

"In order to do these calculations, we need to use formulae, the derivation of which uses pi," she said. "So, this is pi in the sky!"

Make sure to note when the date and time spell out the first 10 digits of pi: 3.141592653. On 3/14/15 at 9:26:53 a.m., it is literally the most perfectly "pi" time of the century—so grab a slice of your favorite pie, and celebrate math!

For more fun with pi, check out JPL Education's second annual Pi Day challenge, featuring real-world NASA math problems. NASA/JPL education specialists, with input from scientists and engineers, have crafted questions involving pi aimed at students in grades 4 through 11, but open to everyone. Take a crack at them at:

www.jpl.nasa.gov/info...ic.view.php?id=11257

Share your answers on Twitter by tweeting to @NASAJPL_Edu with the hashtag #PiDay. Answers will be revealed on March 16 (aka Pi + 2 Day!).

More information: Resources for educators, including printable Pi Day challenge classroom handouts, are available at:
www.jpl.nasa.gov/edu/piday2015

Provided by NASA

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