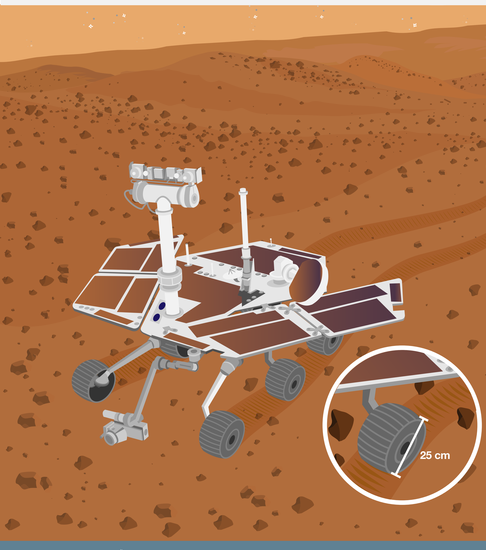
Jet Propulsion Laboratory
California Institute of Technology

π IN THE SKY²

Pi is back in our skies, 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 bad for a mission only planned to last for three months! Opportunity has already beat the off-Earth driving distance record of 39 kilometers and is approaching a marathon distance: 42.195 kilometers.

When Opportunity reaches the marathon mark, how many times will its 25-centimeter diameter wheels have rotated?

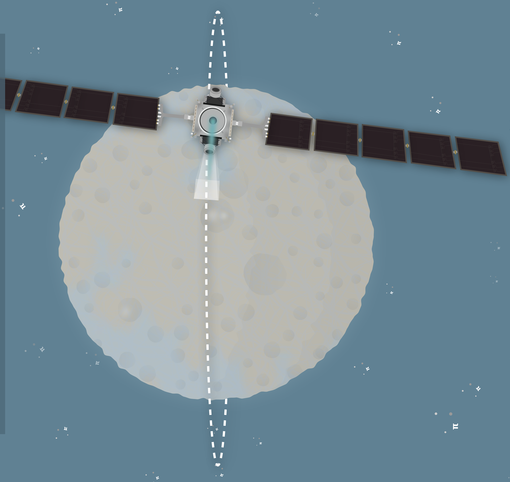
LEARN MORE ABOUT THE MISSION
mars.nasa.gov/mer

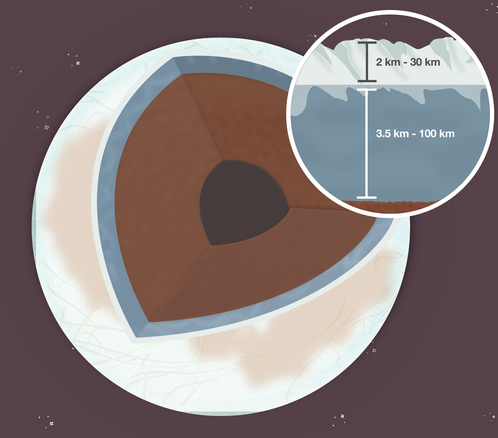
PIXEL PUZZLER

The Dawn spacecraft is orbiting Ceres -- a nearly spherical dwarf planet with an average radius of 475 kilometers -- in a perfectly circular polar orbit. While in orbit, Dawn will snap images of Ceres' surface to piece together a global map. From its lowest altitude orbit of 370 kilometers, Dawn's camera can see a patch of Ceres about 26 kilometers on a side.

Assuming no 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 sea floor. 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 3.5 and 100 kilometers deep, what is the minimum and maximum volume of its ocean?

LEARN MORE ABOUT EUROPA
solarsystem.nasa.gov/europa

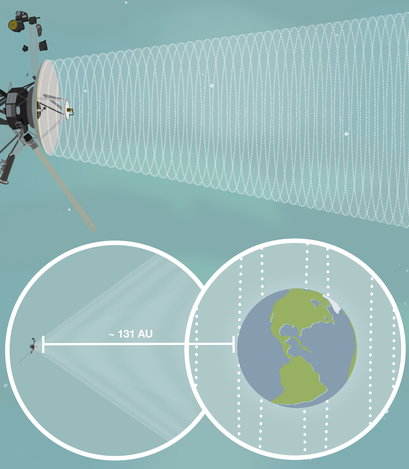
HEAR HERE

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-watt X-band transmitter on Voyager 1 to reach Earth, nearly 131 astronomical units away (one astronomical unit, AU, is equal to about 150,000,000 kilometers). The Voyager high-gain antenna, a circular parabolic reflector, transmits a circular radio signal about 0.5 degrees wide.

At the current 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 watts are received by the DSN antenna?

LEARN MORE ABOUT THE MISSIONS
voyager.jpl.nasa.gov
deepspace.jpl.nasa.gov



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