The Cassini program is an international cooperative effort involving NASA, the European Space Agency (ESA) and the Italian Space Agency, Agenzia Spaziale Italiana (ASI), as well as several separate European academic and industrial contributors. About 260 scientists from 17 countries were hoping to gain a better understanding of Saturn, its rings, moons and magnetosphere.

The unmanned robotic spacecraft was comprised of both NASA's Cassini probe and ESA's Huygens lander, which landed on Saturn's largest moon, Titan. Cassini was the fourth space probe to visit Saturn and the first to enter its orbit.

Cassini was launched in 1997 and arrived at Saturn in 2004. There it began its mission by photographing Titan, and launched the Huygens Probe down to the surface of Saturn's moon, Titan. It continued to photograph the moon until late 2016 when it began some more extreme orbits around Saturn. Since that time it has sent back amazingly detailed pictures of Saturn's rings. After 20 years in space, its mission has come to an end. In April 2017, Cassini was placed on an impact course that unfolded over five months of daring dives - a series of 22 orbits that each passed between the planet and its rings. The Grand Finale was September 15, 2017 when it made its final approach to the giant planet Saturn. Cassini burned up and disintegrated like a meteor.

What interesting things do you think Cassini discovered?
Cassini–Huygens was a three-axis stabilized spacecraft equipped for 27 diverse science investigations. The Cassini orbiter had 12 instruments and the Huygens probe had six. Equipped to thoroughly investigate all the important elements that the Saturn system may uncover, many of the instruments had multiple functions. The spacecraft communicated through one high-power and two low-power antennas. It was only in the event of a power failure or other such emergency situation, that the spacecraft communicated through one of its low-power antennas. Three Radioisotope Thermoelectric generators – known as RTGs – provided power for the spacecraft, including the instruments, computers, radio transmitters, altitude thrusters, and reaction wheels.

**Cassini Facts by the Numbers:**
- 2.5 Million Commands executed
- 635 GB of science data collected
- 6 named moons discovered
- 162 targeted flybys of Saturn's moons
- 27 nations participated
- 4.9 billion miles traveled since launch
- 3,948 science papers published
- 294 orbits completed
- 453,048 images taken
- 360 engine burns

**Cassini's Grand Finale by the Numbers:**
- 22 orbits in total
- 76,806 MPH top speed relative to Saturn
- 4 passes through Saturn's innermost rings
- 1200 mile gap between Saturn and its rings
- 1 minute from atmosphere to loss of contact.
Why go to Saturn?
Scientists want to learn much more about Saturn's atmosphere, its inner composition, its radiation environment and its history. How did the giant planet develop? What causes its lightning bolts, massive storms and whistlers (electromagnetic waves that are produced by lightning)? How does its magnetosphere interact with the rings and the moons? What is the secret of its perfectly aligned magnetic field? Saturn's magnetic field and the planet appear to rotate about the same axis. This alignment is unique among all known planets and, depending on what scientists find on Saturn, scientists may have to rethink their theories of how planetary magnetic fields form.

Questions scientists want answered:

- What is the source of heat inside Saturn that produces 87% more energy than the planet absorbs from sunlight?
- What is the origin of Saturn's rings?
- Where do the subtle colors in the rings come from?
- Are there any more moons?
- Why does the moon Enceladus have such an abnormally smooth surface? (Has recent melting erased the craters?)
- Which chemical reactions are occurring in Titan's atmosphere?
- What is the source of the methane, a compound associated to biological activity on Earth, which is so abundant in Titan's atmosphere?
- Are there any oceans on Titan?
- Do more complex organic compounds and 'pre-biotic' molecules exist on Titan?

How long does it take to get to Saturn?
The journey took seven years! Cassini–Huygens has traveled at an average speed of about 37,000 miles per hour. It covered a distance of about 746 million miles.
Why are scientists interested in Saturn's moons?

Why go to Titan?

Titan is one of the most mysterious objects in our Solar System. It is the second largest moon (only Jupiter's moon, Ganymede is bigger), and it is the only moon with a thick atmosphere. It is this atmosphere that excites scientist's interest, since it is thought to resemble that of a very young Earth. Preserved in the deep freeze of Titan's atmosphere are chemical, carbon-rich compounds thought to be similar to those of Earth's primeval soup. Primeval soup is the chemical environment in which the first biological molecules were formed under natural forces. The results from Huygens, combined with Cassini's global observations from repeated flybys of Titan, will provide vital information towards the great mystery of how life began on Earth.

Discovery on Titan!
This image was returned January 14, 2005, by the European Space Agency's probe after it's successful descent to land on Titan. The Titan probe took 20-hours and 27-minutes to descend to Titan's surface. The image is remarkably like Earth before life evolved, with methane rain, erosion and drainage channels and dry lake beds. A soup of complex chemicals of hydrocarbons, including benzene, were found in Titan's atmosphere. Scientists believe Titan possesses many parallels to Earth, including lakes, rivers, channels, dunes, rain, clouds, mountains and possibly volcanoes.

Why do you think scientists are excited finding familiar chemicals on the moon Titan?
On December 25, 2004, the four foot-wide probe named Huygens began its 22 day journey to the surface. Titan, is the largest of Saturn's moons. It is the only celestial body in space besides Earth that features stable bodies of surface liquid! The major difference of the surface liquid is Earth has water but Titan’s liquid is composed of methane and ethane. Not to mention a frigid surface temperature of −290.83 degrees Fahrenheit. In addition to its surface liquid, later flybys of Cassini have also detected the presence of a subsurface ocean likely as salty as Earth's own Dead Sea.

Cassini was able to perform flybys close to the planet. The spacecraft produced spectacular and very detailed true color images of the gas planet. Everything visible on the planet is a cloud. The parallel reddish-brown and white bands, the white ovals, and the large Great Red Spot persist over many years despite the intense turbulence visible in the atmosphere. These clouds grow and disappear over a few days and generate lightning. Streaks form as clouds are sheared apart by Jupiter's intense jet streams that run parallel to the colored bands.

During Cassini's orbit around Saturn, it managed to pick out seven previously unknown moons in orbit within the planet's rings. These include Methone, Pallene, Polydeuces, Daphnis, Anthe and Aegaeon. The seventh moon, discovered in 2009 is presently named S/2009 S 1 and is only 984 feet in diameter. The moon Daphnis is called the 'wavebreaker moon'. Daphnis's gravity creates waves in the rings around it. Daphnis has a couple of narrow ridges and relatively smooth surface.

Do you think there are more moons to be discovered on Saturn?
Top Discoveries!

Saturn has an icy moon named Enceladus which may be hiding a subterranean ocean filled with extraterrestrial life. Frequent Cassini flybys of the moon, which measures roughly 310 miles in diameter, have found conditions favorable for microbes. It has liquid water, organic carbon, nitrogen (in the form of ammonia) and an energy source. Besides Earth, there is no other environment in the solar system where we can make all those claims. Up close, you can see massive geysers, akin to ice volcanoes, spewing liquid water to create a smooth, frozen white surface. It is an active moon with a global ocean of warm liquid salty water beneath the crust.

What would you think if they discovered extraterrestrial organisms on Saturn's moon?

In 2006, scientists studying Cassini's image were baffled to discover what appeared to be a massive hurricane churning away at its north pole. This weather phenomenon has never been observed on another planet. This hurricane is 50 times the size of an average hurricane on Earth. Its eye alone is 1,250 miles wide with winds four times faster, but it is also completely stationary. The other mystifying feature is how it formed in the first place without access to large quantities of water vapor. This storm has a unique six-sided jet stream known as the "hexagon."
Top Discoveries!

Cassini's mission made it possible to watch the changes in Saturn's dynamic ring system. The spacecraft discovered propeller-like formations, witnessed the possible new moon formation and observed what may be one of the most active, chaotic rings in our solar system.

The Great Northern Storm!
The red, orange and green clouds (false colors) in Saturn's northern hemisphere, indicate the tail end of a massive storm that started in December 2010. Even after visible signs of the storm started to fade, infrared measurements continued to reveal powerful effects at work in Saturn's atmosphere. Typically a 30-year storm, this one arrived 10 years early. Within months, this storm grew to encircle the planet with a swirling band. The largest temperature increases ever recorded for any planet were measured. Molecules never before seen in Saturn's upper atmosphere were detected. The storm diminished shortly after its head collided with its tail, a little less than a year after it had begun.

Why do you think the storm is so big? Why do you think Saturn has so many storms on its planet?

The total cost of the Cassini–Huygens mission is about $3.26 billion, including $1.4 billion for pre-launch development, $704 million for mission operations, $54 million for tracking and $42 million for the launch vehicle.
Why End the Mission?
By 2017, Cassini had spend 13 years in orbit around Saturn, following a seven-year journey from Earth. The spacecraft was low on the rocket fuel used for adjusting its course. If left unchecked, this situation would have eventually prevent mission operators from controlling the course of the spacecraft. In order to avoid the unlikely possibility of Cassini someday colliding with one of the moons, NASA chose to safely dispose of the spacecraft in the atmosphere of Saturn. This ensured that Cassini could not contaminate any future studies of habitability and potential life on those moons.

The Final Mission
In April 2017, NASA's Cassini spacecraft began writing the final, thrilling chapter in its remarkable 20-year long story of exploration. Every week, Cassini dived through the approximately 1,200-mile-wide gap between Saturn and its rings. No other spacecraft had ever explored this unique region. A final close flyby of the moon Titan on April 22 used the moon's gravity to reshape Cassini's trajectory so that the spacecraft leapt over the planet's ice rings to pass between the rings and Saturn. During 22 passes over about five months, the spacecraft's altitude above Saturn's clouds varied from about 1,000 to 2,500 miles. At times, Cassini skirted the very inner edge of the rings; at other times, it skimmed the outer edges of the atmosphere. During the final five orbits, its orbit passed through Saturn's uppermost atmosphere, before finally plunging directly into the planet on September 15, 2017.
1. Why do scientists want to study other planets and their moons?
2. Would you travel to another planet? If it was a one way trip? Or if it was a round trip?
3. Why do you think they wanted to control the end of Cassini's mission and its destruction?
4. Do you think we will find life on other planets?
5. Do you think scientists should continue to explore other planets? Why or why not?
6. What other questions/answers do you think scientists should be searching for as they study outer space?