Activity 6
All About Titan and the Huygens Probe

Overview

During this activity, your youth:

- Are introduced to Saturn's largest moon, Titan, and the history of and science questions for the Huygens Probe from the Cassini–Huygens Mission.
- Listen to a fictional narrative "told" by the Huygens Probe entitled *Memoirs of a Spacecraft*, which includes real science and engineering facts.
- Hear about the findings of the Huygens Probe about Titan, and express those findings through their own drawing.
- Use their imaginations to personalize themselves as robotic spacecraft and write a story, poem, or song about their own journey to Titan.

Time/number of sessions	Activity Type	Space Needed
Two 40-minute sessions	Art and creative writing	Classroom or cafeteria, tables and chairs

Activity Goals

Youth will:

- Increase their knowledge about Saturn's largest moon, Titan.
- Learn some of the science and engineering considerations that go into robotic spacecraft design and flight in space.
- Become familiar with the use of science instruments in space.

Where's the Science and Engineering?

- Engineers took the science questions for the Cassini–Huygens mission and interacted with scientists in different ways to express their concepts — from drawing and building models, to developing sophisticated computer plans. Once they had these plans, the engineers knew how to build the proper spacecraft and instruments for the mission.
- Instruments on the spacecraft function like the senses of our body, sometimes greatly enhanced. Each of the Cassini and Huygens instruments has a specific task to gather a certain kind of information (data).
- The Huygens Probe made several discoveries about the surface of Titan. Titan is like Earth in many ways but as much as it is similar, it is also extremely different. There are rocks, vast deserts with sand dunes, riverbeds and lakes. But the rocks there are made of water ice, the deserts are hydrocarbon grains drifting down from the atmosphere and the rivers and lakes are liquid methane. Humans could not survive on this bizarre alien "Earth."

National Science Education Standards

K–4

Physical Science
- Properties of objects and materials

Personal and social perspectives
- Personal health
- Changes in environments
- Science and technology in local challenges

Technology
- Abilities of technological design
- Understandings about science and technology

5–8

Physical Science
- Properties of objects and materials
- Transfer of energy

Science in Personal and Social Perspectives
- Populations, resources, and environments
- Natural hazards

Technology
- Abilities of technological design
- Understandings about science and technology

Equity/Leveling the Playing Field

- Students have many different kinds of learning styles. Some students learn best when they hear information — others when they see it. In this activity, information is read aloud.
- To support a greater number of students, consider charting the most important information and posting the story for student reference. The more ways a student experiences the information the more likely they are to retain it.

Materials

From Your Supply Closet

Session	For Leader	For Students
1	• Chart paper/whiteboard/chalkboard and markers/chalk	• Tape or glue for attaching drawings to pages of *Saturn Discovery Logs*
1 & 2		• Pencil, drawing paper • *Saturn Discovery Logs*

From a Photocopier/Printer

Session	For Leader
1	• Copy of *Memoirs of a Spacecraft — The Huygens Probe Encounters Titan* Read-Aloud Passage
2	• For optional Leader Reading: copy of the mini-book "Saturn's Moons: Questions, Answers, and Cool Things to Think About" (from Activity 3 — "Discovering Saturn: The Real Lord of the Rings")

Getting Ready

For Session 1
- Gather the *Saturn Discovery Logs* to pass back to students

Leader Tips

Session 1
- Practice reading *Memoirs of A Spacecraft — The Huygens Probe Encounters Titan*

Session 2
- For optional Leader Reading: Practice reading mini-book 4 — "Saturn's Moons."
- Some students may have trouble visualizing themselves as an object, especially one with parts similar to their senses. Walk around as they write their story and help them add what their "spacecraft senses" are learning to their story. Remember that instruments are doing the sensing, not our bodies.

All About Titan and the Huygens Probe

Activity 6

Student Activity

Session 1 • Listening to the Memoirs of a Spacecraft

1. Tell students:
   - As we've discovered already, the Cassini spacecraft dropped a special robotic spacecraft called the Huygens Probe onto the surface of Saturn's moon Titan. This probe has collected information that will help answer many questions about Titan, such as "What is the surface like?"

2. Ask the students what questions they have about Titan or the Huygens Probe. Chart their responses.

3. Tell the students that you will read *Memoirs of a Spacecraft* to them. Encourage them to take notes in their *Saturn Discovery Logs* as you read. Explain to them that they will draw what they think the surface of Titan looks like based on clues they hear in the story.

4. Remind the students that it is a story written from the point of view of the Huygens Probe. The probe is not alive, so this part of the story is fiction. However, they will also be hearing actual scientific information about the Cassini–Huygens mission and about Titan.

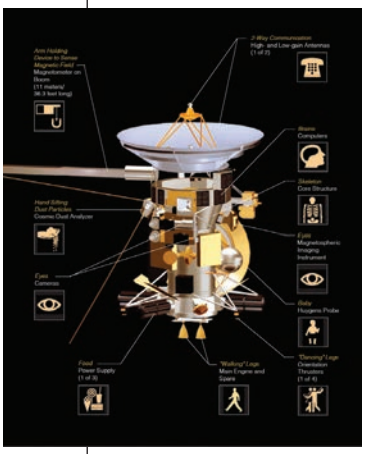
5. Read the *Memoirs of a Spacecraft — The Huygens Probe Encounters Saturn* to students. Remind students to take notes as you read to them.

6. Once the story is finished, have the students begin their drawing/sketch of Titan's surface based on the notes in their *Saturn Discovery Logs.* Tell them to label the parts of their drawing.

7. Tell the students that they will keep their drawings in their *Saturn Discovery Logs*. As they learn new information from the Cassini–Huygens mission, they can make changes to their drawings.

Session 2 • Writing About Our Spacecaft

1. (Optional) Leader Reading: Read aloud all but the last paragraph of page 4 from the mini-book "Saturn's Moons," showing the illustrations.
2. Prepare the students to pretend that they are a spacecraft probe sent to study Titan using the conversation guide below. (They learned some of this information in Activity 5, "My Spacecraft to Saturn.")
   - When the Cassini–Huygens scientists told the engineers what information they wanted to learn about Saturn and its moons, the engineers set to work deciding what kind of spacecraft should be built. In thinking about the data the scientists needed, the engineers had to decide what kind of instruments to build and how those instruments would be used to collect the right information.
   - Most instruments on the spacecraft function like the senses of our body, greatly enhanced. Each of the Cassini–Huygens instruments has a specific task to gather a certain kind of information (data).
   - The cameras are the eyes of the spacecraft because the team needed pictures of Saturn, its rings, and its moons. The computer on the spacecraft is like your brain running all the programs needed to keep the spacecraft safe and functioning. The spacecraft antenna is like your ears and mouth and it can both "hear" instructions from Earth and "speak" reports and data back to the team on earth.
   - Now, imagine that you have a science question you want answered and that your body is a spacecraft specifically built to go to Titan to find the answer. The instruments are like your senses and each has a specific job to do on your mission. The spacecraft looks very different from your body because it is built for space travel, but it performs many of the same jobs. Write about your journey through a story, poem, song, or rap. Be sure to answer the following questions:
     a. What does your spacecraft look like?
     b. In what ways does your body receive information and data like a spacecraft?
     c. How will your spacecraft get to Titan?
     d. What science question do you want to answer when you get to Titan?
     e. Why do you think your science question is important?



Available at:

saturn.jpl.nasa.gov/files/humanspacecraft.pdf

Questions for the Youth (Informal Assessment)

What are some reasons that knowing about Saturn and Titan is important?

Sharing the Findings (Informal Assessment)

- Give students time to share their drawings with partners and/or the whole group. Post their drawings, or direct the students to put them in their *Saturn Discovery Logs*.
- Ask the students to read their stories out loud. When they are finished, their stories should also go into their *Saturn Discovery Logs*.

Leader Reflection/Assessment

Ask yourself:

1. Did the students include information from the *Memoirs of a Spacecraft* in their drawings?
2. Can they clearly explain the different parts of their drawings?
3. Did others in the class comment with interest on each other's spacecraft designs?

Information for Families

Encourage the children to envision the food on their plate as the surface of a planet, and discuss with their family the different ways their body's "instruments" (senses) can detect what the food is like. Encourage them to describe to their families any kinds of food they think the surface of Titan might look like.

Encourage families to visit the Planet Quest website. Take an "alien safari" and find out about "extreme" life forms. Planet Quest has fun facts, animations, and "wild" information for families to share: planetquest.jpl.nasa.gov/system/interactable/3/index.html

NASA Resources

Careers at NASA

Give students an opportunity to learn what the folks at NASA's Jet Propulsion Laboratory experience. Read the staff blog at:
blogs.jpl.nasa.gov/

Meet members of the Cassini team and learn what they do at:
saturn.jpl.nasa.gov/news/cassiniinsider/

Role Model Resource

Jeff Cuzzi, Ph.D., is a research scientist at NASA Ames Research Center in Mountain View, California. One of his first jobs was lead scientist on the first Titan Probe study — an early concept in designing a probe mission to explore Titan — that helped lay the foundation for the Cassini–Huygens probe mission. Today, Jeff is the head scientist of Cassini's Rings Discipline Working Group, charged with leading Cassini's scientific study of Saturn's rings and its interactions with Saturn's environment. Jeff's favorite career moment was arriving at JPL for the Voyager 1 Saturn encounter and seeing the dozens of big media RVs lined up. Saturn was big news! "I was blown away by how well the images we had planned using my brightness models had turned out — beautiful, glowing images of the rings. Everyone was ecstatic, including me." In 2010, Jeff was awarded the Gerard P. Kuiper Prize, the most prestigious individual award in planetary sciences.

Read Jeff's profile at:
solarsystem.nasa.gov/people/profile.cfm?Code=CuzziJ

Read about the contributions of Jeff and his colleagues at NASA Ames Research Center to the Cassini–Huygens mission at:
www.nasa.gov/centers/ames/pdf/80661main_Cassini_Fact_Sheet.pdf

Resources

Hear all about Saturn and its moons in an interview with Bob Mitchell, Cassini mission Project Manager — podcast at
www.jpl.nasa.gov/podcast/cassini20080415.cfm

Watch an animation of the Huygens Probe's descent to the surface of Titan:
saturn.jpl.nasa.gov/multimedia/videos/movies/PIA06434.mov

Note to Leaders: What did Huygens find? Go online with your students to saturn.jpl.nasa.gov/multimedia/flash/Titan for an animated Flash™ video of Huygens on Titan that includes the latest pictures from that world. (Requires free Adobe Flash™ download.) Or download a poster on Titan: saturn.jpl.nasa.gov/education/titanposter/

See pictures of Titan — photojournal.jpl.nasa.gov/target/Titan

Taking Science to the Next Step

Ask the students to make a model of Saturn or Titan. Tell them to label any features they think are important. Have students bring recycled materials from home over the week before this project.

Here's an idea for making a model of Saturn from an old CD and a Styrofoam™ ball: solarsystem.nasa.gov/docs/saturn_model.pdf

Saturn has over 60 known moons! An excellent activity for comparing the moons, "Saturn's Moons,"

can be found in NASA's Saturn Educator Guide (EG-1999-12-008-JPL) at: saturn.jpl.nasa.gov/files/lesson2_saturns_moons.pdf. The lesson was designed for grades 5–8; here are instructions on how to adapt the "moon card" activity for younger students:

- Print and laminate copies of the moon cards for pairs of students. Have the students group the moon cards in at least three different ways. Then ask them to describe the criteria they selected for each of their groupings.
- Have the students observe the cards closely, and write a "show not tell" descriptive paragraph about a moon of their choice. Have students read their paragraphs aloud, and let the whole group/peers guess which moon they have described.

Work with the students to convert the measurements in the *Memoirs of a Spacecraft — The Huygens Probe Encounters Titan* into metric units, which are more commonly used by engineers. Here is an easy way to convert from miles to kilometers:
1 mile = 1.609 kilometers;
from feet to meters: 1 foot = 0.3048 meters;
from Fahrenheit scale temperature (F) to Celsius scale temperature C = (F – 32)*5/9

Literacy

Create a room poster or bulletin board using images of Saturn or its moons. Have students write, "I notice" (observations) and "I wonder?" (questions) on notes and post on the board.

Students can select a moon that they would like to learn more about and write a creative piece. A writing piece might be a short report of information. It could also be a poem. Students could even write fictional autobiographies, and pretend that they are one of the moons.

Consider having your students enter the "Cassini Scientist for a Day" contest — a great way to combine science and literacy. The essay explaining how the best science can be observed from a choice of actual Cassini mission targets wins a teleconference with Cassini scientists!
saturn.jpl.nasa.gov/education/scientistforaday/

Glossary

Data — Facts and statistics collected together for reference or analysis.
Hydrocarbon — A compound of hydrogen and carbon.
Memoirs — An autobiography or a written account of one's memory of certain events or people.
Probe — something that is used to search or discover. It can be a tool, a machine, or a spacecraft.

Leader's Read-Aloud Passage (1 of 4)

Memoirs of a Spacecraft

The Huygens Probe Encounters Titan

December 25, 2004

More than 11 years and two billion miles ago, spacecraft Cassini and I bid farewell to the powerful rocket that carried us from Earth to outer space.

We're pretty big, Cassini and I — about as big as a school bus — and no rocket is big enough to send us straight to Saturn. So we needed to take a roundabout route, one that would allow us to whip around Venus and Earth and Jupiter on our way, so the gravity of those planets could give us the extra speed we needed. It worked really well, and we got to see some amazing sights along the way. Jupiter was awesome!

By the time we passed by Jupiter, we were traveling at an incredible speed — 50,000 miles per hour! If you could go from San Francisco to New York at that speed, it would only take you three minutes!

We might have zipped right past Saturn if it weren't for our rockets. They were aimed in front of us, to slow us down. It was very tricky! If they slowed us down too much, we would be pulled into the giant planet. If they didn't slow us down enough, we would zoom past Saturn and never be able to come back! So the rockets had to be programmed to switch on at precisely the right moment, with exactly the right amount of power, for just the right amount of time.

The rockets burned for 90 minutes straight, before slowing us down enough for Saturn's gravity to pull us into orbit. That initial jolt when the rockets first fired sure surprised me, even though I knew it was coming. Imagine how you might feel running into a brick wall!

But it didn't amaze me nearly as much as what happened next. As we began to orbit Saturn, we flew right through a gap in the rings, then across to the other side of the planet, and then right through the same gap on the other side of the rings. Now that's fancy maneuvering!

I remember talking to Cassini when we first reached Saturn, back in July of 2004 —

"Here we are, Cassini," I said. "We're finally at Saturn! Can you see the bands of color — white and yellow and brown— across the globe? They seem to be storm clouds riding and playing on the wind. Now the rings around the equator are shining brighter than ever. For so long they've looked like silvery bands, or a halo. But at this close distance, I can see that the rings are not solid bands at all! They're a dense ribbon of icy pebbles and sand and gravel and boulders lying in a path around the planet's middle, as if they were racing around Saturn on a gigantic track. Some of the pieces are finer than dust, some are bigger than a house, and others are every size in between! Some of those ice-covered rocks look like chunks of chips and nuts in frozen white cookie dough. I'm thrilled to finally be here, Cassini. But I'm a little sad, too, because in six short months I'll be leaving you. I'll continue on by myself to the mysterious moon called Titan."

Memoirs of a Spacecraft (2 of 4)

January 2005

After three orbits around the beautiful ringed planet, Saturn, my time to say good-bye to Cassini is almost here. I'm the first machine from Earth to land on Titan. I like the fact that I was named after the astronomer who discovered this giant moon. His name was Christiaan Huygens, and he lived in the Netherlands. He spotted Titan in 1655 — more than 300 years ago using a telescope he had built himself.

I can tell you about some of the things I know about Titan. It has gravity, though not nearly as strong as the gravity on Earth. In fact, I weigh just one-seventh of what I weighed back on my home planet.

My elder cousins, the two Voyager spacecraft, took more than 1,000 pictures of Titan when they paid a short visit to Saturn years ago. Their cameras were not able to see through Titan's dense haze and clouds, but they did learn some very interesting things. Scientists already knew that Titan's atmosphere is mostly nitrogen, just like Earth's. But the Voyagers' infrared and ultraviolet cameras revealed that there is also methane and hydrogen in the atmosphere, as well as many other chemicals.

The Voyagers also measured Titan's size — it's 3,200 miles across. That's less than half as wide as Earth, but much bigger than Earth's Moon. In fact, Titan is the second biggest moon in the entire solar system! The Voyagers also measured Titan's temperature, and found that it's about 289 degrees below zero on the Fahrenheit scale. That's much colder than any-place on Earth — even the North and South Poles! And the Voyagers also learned that Titan's atmospheric pressure is 60 percent greater than Earth's. That's about as much pressure as a diver back on Earth would feel under 20 feet of water.

Now I will uncover some of the mysteries that have puzzled people ever since then. What will I find beneath those thick clouds? My partner Cassini has found some astonishing things about Titan's surface. In some amazing ways, it is like my home Earth. There are riverbeds and huge deserts covered in dunes and even lakes. But it is so cold here, so much farther away from the Sun, and it is made so differently, that I expect it will not be like Earth in many ways. I have to get closer and see for myself.

To tell you the truth, I am just a bit nervous about this journey. When Cassini releases me, I will be on my own for the first time, traveling through space and then down through Titan's atmosphere. But it's exciting, too. I'm having a great adventure!

Some things concern me about my mission once I arrive at Titan. My onboard instruments have been carefully programmed, and they were tested numerous times on Earth. But when I send my radio messages to Cassini, and Cassini passes them along to my trusted team of engineers and scientists back on Earth, will they arrive? Earth is so very, very far away — the radio signals will be incredibly faint by the time they get there.

Memoirs of a Spacecraft (3 of 4)

January 14th, 2005

Well, I've been sending pictures and information for a while now!

I'm sure thankful for my special heat shield, which saved me from being burned up when I entered Titan's atmosphere. Then my parachutes opened, and — because there is no great and wild wind in that mysterious atmosphere — I drifted slowly down to the surface.

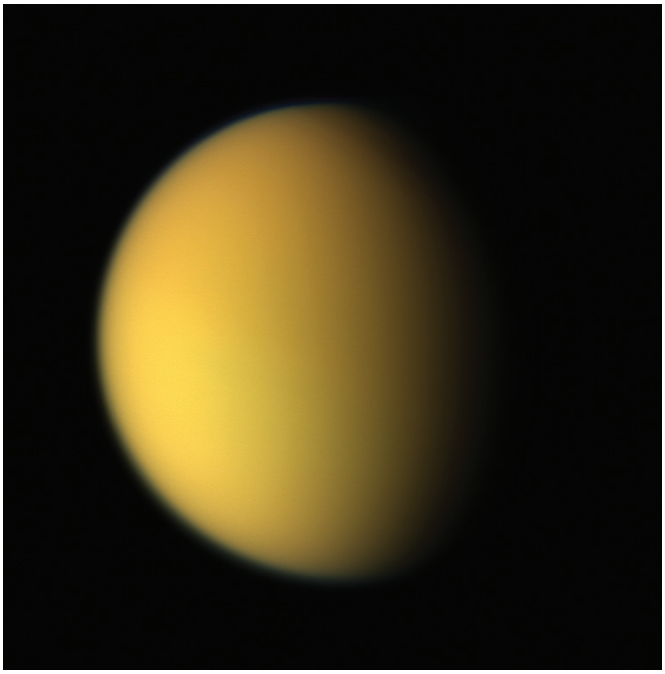
I wondered what Titan's Earth-like surface would look like up close. And now that I'm here, I realize that, as much as Titan is like Earth, it is also extremely different. I am so excited to share what I see with my team on Earth that I am sending back images as fast as I can. My other instruments have sampled the atmosphere and I'm sending back that information too.

It is so cold here that, while I do see rocks, those on Earth are made of silicate, but the ones here are made of water ice. There are lakes and rivers here, and on Earth they are made of liquid water, but here, they are made of liquid methane. On Earth, methane is usually a gas but here in the cold it is liquid. On Earth, desert dunes are made of sand but here; they are formed from the dark hydrocarbon grains that drift down from the atmosphere.

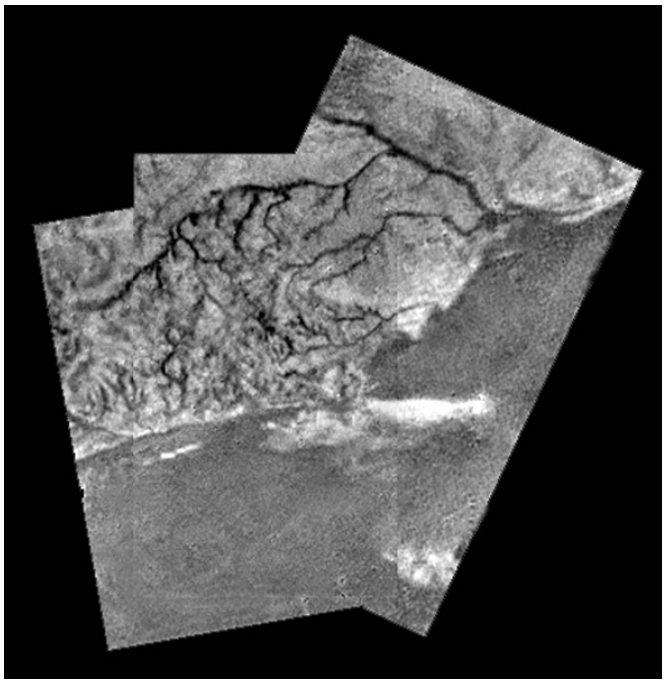
What a remarkable world. My team of scientists and engineers must be so excited by my findings. I wish I could be there to celebrate with them. I wish they could be here to celebrate with me. Will that ever be possible?

My job is now done and my partner Cassini will continue my work by flying close to Titan many times to continue my discoveries. Thanks for bringing me to such an exciting place, my friend.

Memoirs of a Spacecraft (4 of 4)

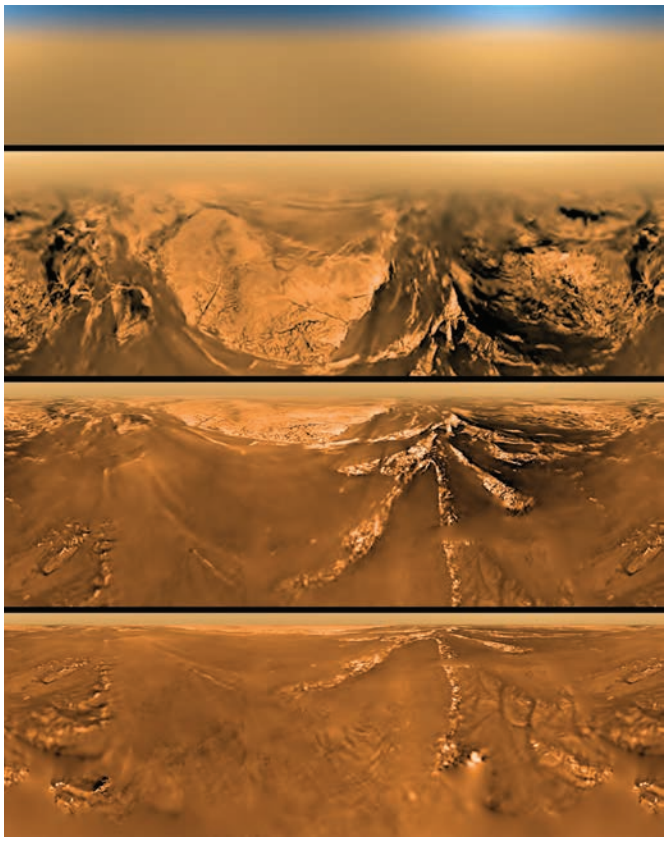


Haze on Titan hides the surface below
(Cassini image)



A flowing river channel on Titan
(Cassini image)

Rounded rocks on Titan (left) and Earth (right)
Credit: NASA/JPL/ESA/University of Arizona and S.M. Matheson



Huygens Probe views of Titan as it descends to surface