Saturn

Educational Product
Educators Grades 5–8

Teacher Resources
and Student Lessons
in Space Science

(Suggested Grades 5–8)
How to Use the Guide

Overview
The Saturn Educator Guide consists of three major sections — Lessons, Enrichments, and Appendices. There are six standards-based lessons, all grounded in constructivist learning theory. We recommend that you do Lesson 1 — The Saturn System — before any of the others. To prepare for each lesson, review Background for Lesson Discussion at the beginning of each lesson; Appendix 1, Questions & Answers (101 well-organized questions posed as students would ask them); and Appendix 2, Glossary (over 90 technical terms). Use the Enrichments to enliven your teaching with relevant references to art, language, and mythology. To extend your classroom activities, see Appendix 3, Observing Saturn in the Sky; Appendix 4, The Electromagnetic Spectrum; Appendix 5, Resources.

Lesson Design
The first page of each lesson lists the topics, activities, standards, time required, prerequisite student skills, and equipment and materials needed. The second page — Background for Lesson Discussion — provides important information for the teacher. (See Lesson Summaries for a brief description of all the lessons.) While the lessons are focused on science standards for grades 5 though 8, they may be tailored to higher and lower grade levels.

The lessons are designed to reflect the ideals of constructivist learning theory. Students’ prior knowledge, whether or not it is accurate, is the foundation of their learning. Therefore, it is critical for teachers to find out what students already “know” so that misconceptions can be addressed. In the learning process, students construct new meaning through their experiences. Challenging students’ understanding allows them to build knowledge and understanding of the new concepts. Students must be assessed authentically within the context of their learning and have an opportunity to reflect on what they have learned.

Each lesson is divided into four parts:

Part I explores the students’ understanding of the fundamental concept of the lesson. Headings give the teacher a quick reference about the focus of the lesson.

Part II challenges the students to make connections between the concept being explored in Part I and either Saturn or the Cassini–Huygens mission. Students’ preconceptions are challenged through hands-on activities, problem solving, or design projects. As students complete the activity, the teacher guides them to focus on what they learned as a result of their experience.

Part III offers an assessment activity for the lesson. Modeling and demonstration of the activity are built into each lesson prior to the assessment. Criteria for assessing the students’ responses are included. Teachers may want to create rubrics or otherwise quantify the criteria according to their particular students or teaching situation.

Part IV provides questions for reflection, which can be used for closure to the lesson, journal responses, or discussion prompts. They can also be used for individual assessment.

Note — for the sake of simplicity and convenience, in Lessons 1–6 and Enrichments 1–4, the materials a teacher must reproduce have been generically identified as numbered “figures,” which may be conventional figures, illustrations, tables, and so forth. All such figures follow each “Materials” divider page at the end of the lesson or discussion.
### Lesson Overview

#### Content Standards
- **STEM National Science Education Standards:**
  - Unifying Concepts and Processes
    - Systems, order, and organization
    - Earth and Space Science
    - Earth in the Solar System

#### Student Skills
- Working in groups
- Drawing and interpreting system diagrams
- Measuring in millimeters
- Computation (multiplication and division)
- Completing a Venn diagram

#### Common Questions
- Background for Lesson Discussion, page 2
- Questions, page 7
- Answers in Appendix 1, page 225
- 1–21: Saturn
- 22–34: Rings
- 35–50: Moons
- 51–55: Observing Saturn in the Sky

### Equipment, Materials, and Tools

<table>
<thead>
<tr>
<th>For the teacher</th>
<th>Materials to reproduce</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photocopier (for transparencies &amp; copies)</td>
<td>Figures 1–8 are provided at the end of this lesson.</td>
</tr>
<tr>
<td>Overhead projector</td>
<td></td>
</tr>
<tr>
<td>Chalkboard, whiteboard, or easel with paper, chalk or markers</td>
<td></td>
</tr>
<tr>
<td>Color image or video of Saturn (optional)</td>
<td></td>
</tr>
<tr>
<td>Basketball (optional)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>For each group of 3 to 4 students</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Chart paper (18” x 22”); color markers</td>
<td>1 per group</td>
</tr>
<tr>
<td>Notebook paper, pencils; clear adhesive tape; scissors; ruler with millimeter divisions</td>
<td>1 per group</td>
</tr>
<tr>
<td>Meter stick (optional)</td>
<td>1 per group</td>
</tr>
</tbody>
</table>

### Note to the Teacher

According to the National Science Education Standards, a system is an organized group of related objects or components that form a whole. For example, systems can consist of organisms, machines, fundamental particles, galaxies, ideas, numbers, transportation, and education. Systems have boundaries, components, flow (input and output), and interactions.

Have each group share their diagrams with the whole class. Discuss with students their understanding of systems. Guide them to recognize the various aspects of a system and the pervasive nature of “systems” in our world, in the Solar System, and in the Universe.
### Lesson Summaries

<table>
<thead>
<tr>
<th>Estimated Time</th>
<th>Lesson Title</th>
<th>Content Standards</th>
<th>Lesson Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varies by grades</td>
<td><strong>Getting to Know Saturn</strong></td>
<td></td>
<td></td>
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</tbody>
</table>
| **1) The Saturn System** | 3 hrs | Unifying Concepts and Processes  
- Systems, order, and organization  
Earth and Space Science  
- Earth in the Solar System | Students learn the basic concept of a system and work with a scale model of the Saturn system. |
| **2) Saturn’s Moons** | 3 hrs | Unifying Concepts and Processes  
- Systems, order, and organization  
Science as Inquiry  
- Abilities necessary to do scientific inquiry  
Earth and Space Science  
- Earth in the Solar System | Students use data on the 18 moons known to be orbiting in the Saturn system to discover patterns and important relationships between physical quantities in a planet–moon system. |
| **3) Moons, Rings, and Relationships** | 3–4 hrs | Science as Inquiry  
- Abilities necessary to do scientific inquiry  
Physical Science  
- Motion and forces  
Earth and Space Science  
- Earth in the Solar System | Students explore the fundamental force of gravity and how it acts to keep objects like moons and ring particles in orbit. |
| **4) History of Saturn Discoveries** | 3 hrs | History and Nature of Science  
- Science as a human endeavor  
- History of science  
Science and Technology  
- Understandings about science and technology | Students examine how scientists throughout human history have explored Saturn. They learn how scientific knowledge evolves and how technology has improved our ability to solve Saturn’s mysteries. |
| **The Cassini–Huygens Mission** |             |                                                        |                                                                                    |
| **5) The Cassini Robot** | 3–4 hrs | Unifying Concepts and Processes  
- Form and function  
Science and Technology  
- Abilities of technological design | Students explore the capabilities of a robot like the Cassini spacecraft. They compare its robotic functions to human functions. |
| **6) People of the Cassini Team** | 1.5–2 hrs | History and Nature of Science  
- Science as a human endeavor  
Science in Personal and Social Perspectives  
- Science and technology in society | Students use a diverse collection of profiles of people who work on the Cassini mission to learn about science as a human endeavor, and to reflect on their own career goals. |
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## Lessons  

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The Jet Propulsion Laboratory (JPL) of the California Institute of Technology is the nation’s lead center for the robotic exploration of space. The Cassini–Huygens mission to Saturn and Titan is managed by JPL for the National Aeronautics and Space Administration (NASA).

The Saturn Educator Guide was produced in collaboration with the Space Science Institute (SSI), a nonprofit corporation located in Boulder, Colorado, where researchers and educators work together to expand knowledge of the space sciences and communicate that knowledge to the public.

SSI also manages the Western Region Education and Outreach Broker/Facilitator Program for NASA’s Office of Space Science (OSS). This program is responsible for assisting the space science community (including existing and proposed space exploration projects and research programs) in identifying and implementing high-leverage partnerships with education and public outreach (E/PO) organizations.

The Education and Outreach Broker/Facilitator Program is a key element of the Space Science Education and Public Outreach “Ecosystem.” The other main element of the Ecosystem is the set of four NASA/OSS education Forums, which consists of four national centers for space science education and outreach. The Forums provide education and public outreach support for space exploration missions and research programs that are within the four OSS scientific theme areas:

- Astronomical Search for Origins and Planetary Systems
- Solar System Exploration
- Structure and Evolution of the Universe
- Sun–Earth Connection

To learn more about SSI and the NASA/OSS Space Science Education and Public Outreach strategy, visit the following websites:

http://www.spacescience.org/
http://spacescience.nasa.gov/education/ecosystem.htm
The Cassini spacecraft’s 4-year scientific tour of gigantic Saturn and its 18 presently known moons will reveal new beauty, richness, and insights on behalf of all humankind. Cassini was launched in October 1997 and will arrive at the Saturn system in 2004. The Saturn Educator Guide calls upon teachers and students of widely varying interests to come along on this extraordinary journey. You are invited to explore the role Saturn has played in our culture over time and across the diverse oceans of human interest. The Guide is the product of a collaborative venture among scientists, engineers, teachers, and education researchers. We hope we have synthesized the cutting edge of science, the cutting edge of educational research, and practicality of use in the classroom.

The Guide includes opportunities to use the contexts of Saturn and the Cassini–Huygens mission to enrich your curricular units in science. The lessons are grounded in the National Science Education Standards and constructivist learning theory, as well as enhanced by the excitement of real-life space science and engineering. The Guide also offers highlights of the interconnections between Saturn and other areas of human endeavor, such as art, language, history, and mythology. We hope this unique blend will enable a grander diversity of learners to share and benefit from the excitement of Cassini–Huygens mission discoveries.

The international Cassini–Huygens mission is an exciting culmination of centuries of human interest in Saturn. The mission will no doubt resolve some of the most intriguing mysteries of the Saturn system, and perhaps even provide insight into how our own Solar System was formed. The mission team will receive electronic signals from the spacecraft that our computers will interpret to produce artful images for us all to explore and enjoy, of scenes never before observed by human eyes as Cassini extends our earthly senses to worlds that are a billion miles away. Meanwhile, in keeping with the nature of the scientific enterprise, the mission’s investigations will raise many new questions. You may rest assured that there will be many compelling mysteries left for the Saturn explorers of the future!

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