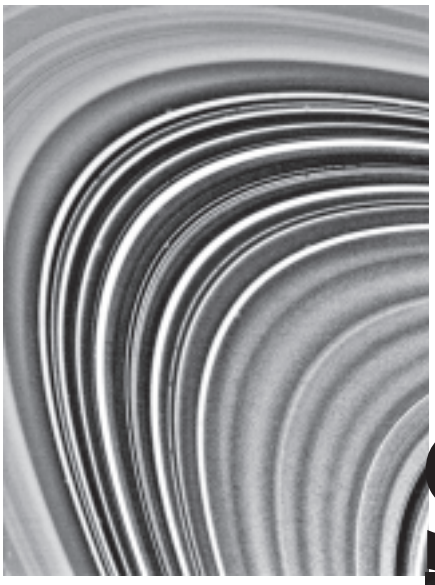

Educational Product	
Educators	Grades 5–8

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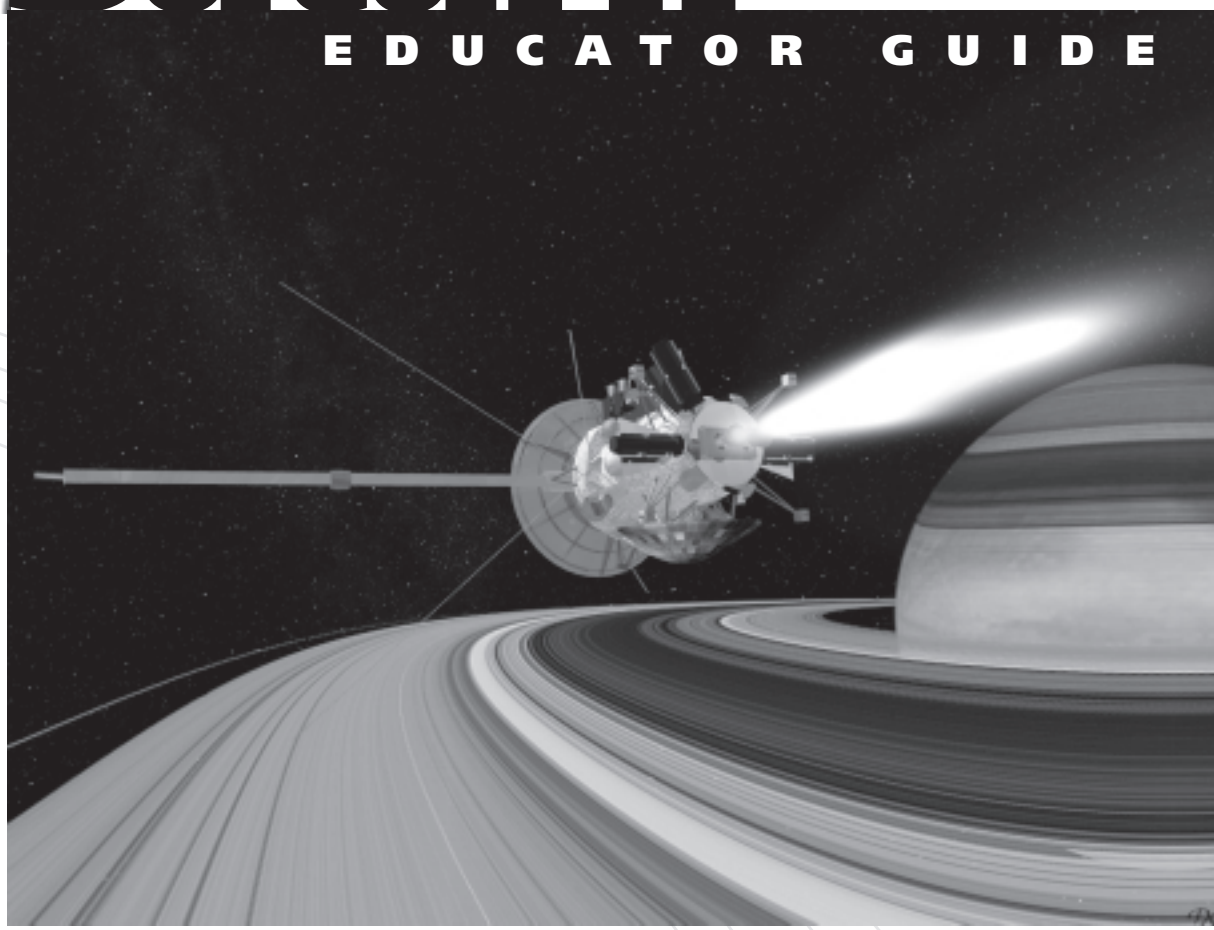
Saturn

EDUCATOR GUIDE



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 Theme, Number, & Name

Time Required
(Varies with grade level)

Lesson Overview

Content Standards

Student Skills

Common Questions

Items Needed for the Lesson

Note to the Teacher

GETTING TO KNOW SATURN

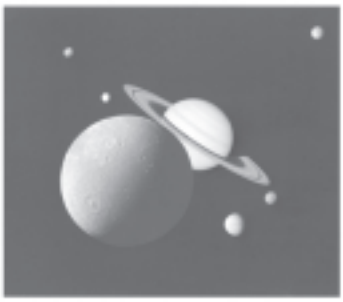
LESSON 1

The Saturn System

3 hrs

Students learn the concept of a system and apply it to learning about the Saturn system. They work with a ready-made scale diagram of the Saturn system, including the planet, rings, and moons.

The lesson prepares students to complete a Venn diagram that compares and contrasts the Saturn and Earth–Moon systems in terms of the systems' components and interactions.



Composite of Voyager images of Saturn and some of the moons.

MEETS NATIONAL SCIENCE EDUCATION STANDARDS:

Unifying Concepts and Processes
- *Systems, order, and organization*

Earth and Space Science
- *Earth in the Solar System*

PREREQUISITE SKILLS

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

BACKGROUND INFORMATION

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

For the teacher
Photocopier (for transparencies & copies)
Overhead projector
Chalkboard, whiteboard, or easel with paper; chalk or markers
Color image or video of Saturn (optional)
Basketball (optional)

For each group of 3 to 4 students
Chart paper (18" x 22"); color markers
Notebook paper; pencils; clear adhesive tape; scissors; ruler with millimeter divisions
Meter stick (optional)

Materials to reproduce		
Figures 1–8 are provided at the end of this lesson.		
FIGURE	TRANSPARENCY	COPIES
1	1	1 per group
2	1	
3		1 per group
4		1 per group
5		1 per group
6		1 per group
7		optional
8		1 per student

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.

inputs, outputs, organizing principles, or forces.)

6 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

ESTIMATED TIME	LESSON TITLE	CONTENT STANDARDS	LESSON DESCRIPTION
Varies by grades	**GETTING TO KNOW SATURN**		
3 hrs	**1) The Saturn System**	**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.
3 hrs	**2) Saturn's Moons**	**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.
3–4 hrs	**3) Moons, Rings, and Relationships**	**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.
3 hrs	**4) History of Saturn Discoveries**	**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		
3–4 hrs	**5) The Cassini Robot**	**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.
1.5–2 hrs	**6) People of the Cassini Team**	**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.

Contents

Preface vii
Acknowledgments ix

Lessons

GETTING TO KNOW SATURN

1 The Saturn System 1
2 Saturn's Moons 31
3 Moons, Rings, and Relationships 65
4 History of Saturn Discoveries 95

THE CASSINI-HUYGENS MISSION

5 The Cassini Robot 121
6 People of the Cassini Team 143

Enrichments

CULTURAL CONNECTIONS — ART, LANGUAGE, MYTHOLOGY

1 Searching for Saturn 189
2 Saturn Puzzles 199
3 Saturn Poetry 207
4 Mythology of Saturn 219

Appendices

1 Questions & Answers 225
2 Glossary 265
3 Observing Saturn in the Sky 273
4 The Electromagnetic Spectrum 277
5 Resources 279

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Space Administration

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Pasadena, California

JPL 400-864 12/99

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

Dear Fellow Educators:

One of the most remarkable gifts of being human is the ability to experience the beauty, the richness, and the insights that accompany the fields of literature, art, music, architecture, and the sciences. Indeed, these areas of human endeavor are like vast oceans that meet and mingle in many places. Several streams of interconnection between mathematics and music, or between art and architecture, are well known, but there are yet new voyages that lead us from the currents in one ocean to those in another. NASA's Cassini–Huygens mission to the magnificent ringed planet Saturn is such a voyage.

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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