

SUGGESTED REFERENCES

- *NASA's Cassini-Huygens mission website offers an extensive formal education program for students in grades K-12.*
<http://saturn.jpl.nasa.gov/home/index.cfm>
- *NASA's Voyager Website contains information and activities for students.* <http://voyager.jpl.nasa.gov/index.html>
- *The Planetary Society website has a good set of activities for students.* <http://www.planetary.org/home/>
- **Uranus and Neptune**
by Ron Miller
21st Century, April 2003
- **Exploring Saturn**
by Dan Bortolotti
Firefly Books, September 2003
- *Nine(8) planets website, gives great detail about each of the planets and their moons. Can be used for data collection activities.* <http://www.nineplanets.org/intro.html>

NATIONAL SCIENCE EDUCATION STANDARDS

Grades 5 - 8
Earth Science
Earth in the Solar System

Grades 5 - 8
Science & Technology
Understanding about Science and Technology

*Source: *National Science Education Standards, 1996, National Academy Press*

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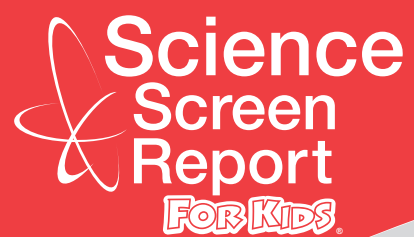


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VOLUME 19 ISSUE 7

SATURN, "Lord of the Rings" & OUTER GAS GIANTS, "Uranus & Neptune"

SYNOPSIS

Saturn, second largest of the gas giants, rules a dazzling domain. The rings of Saturn are billions of moonlets - from grains of dust to rocks the size of trucks. The planet is so light it would float in water. Titan, Saturn's greatest moon, is bigger than the planet Mercury.

Students will see detailed images of the outer gas giants Uranus and Neptune. Imagery from the Voyager spacecraft and the Hubble Space Telescope show students fascinating details about these two mysterious planets. They will also see Neptune's large moon Triton, the coldest place in the Solar System.

CURRICULUM UNITS

- ASTRONOMY
- PHYSICAL SCIENCE
- PHYSICS
- INTEGRATED SCIENCE

RUNNING TIME

20 minutes



Accreditation Board
for Engineering
and
Technology
www.abet.org



Presidential Awards
for Excellence in
Mathematics
and
Science Teaching



Junior Engineering
Technical Society
www.jets.org

BACKGROUND

Saturn is the second largest planet in the Solar System. With a diameter 20% smaller than Jupiter's, Saturn takes 30 years to orbit the Sun. The entire planet is actually less dense than water because it is 94% hydrogen. Saturn has no solid surface, the planet has weather bands instead.

Its cloud layers are similar to Jupiter's. The highest layer is the stratosphere, a diffuse and hazy mixture of gases. Beneath is a layer of ammonia crystals, then ammonium hydrosulfide, ice crystals and then water droplets. Closer to the core, it is denser and hotter. 1,000 kilometers from the stratosphere, hydrogen is liquid. 25,000 kilometers down hydrogen is metallic.

Like Jupiter, Saturn's magnetic field is due to electric currents running through the liquid metallic hydrogen. Auroras result at the poles when the magnetic field traps electrically charged particles from the solar wind. The magnetic force lines draw the particles down to react with the atmosphere.

Saturn's rings are composed of billions of moonlets. These objects range in size from grains of dust to truck-sized rocks. These solid pieces are prevented from aggregating due to Saturn's strong gravitational pull. The rings may have formed from a moon destroyed by the planet or by colliding moons.

Saturn's big moon, Titan, is larger than Mercury. It has a hazy atmosphere composed partly of methane. In 2005, the Cassini spacecraft landed a probe on the moon. It discovered areas of sand, like deserts in Africa, and areas containing a liquid composed of hydrocarbons. Cassini continues to orbit the Saturnian system and send back new discoveries.

Uranus is twice as far away from the Sun as Saturn. It is the third largest gas giant. While the Earth has a tilt of about 23 degrees, Uranus spins backwards and has a tilt of 98 degrees. It is possible that this highly unusual tilt is the result of an impact with a large body the size of Earth early in its history.

Like Saturn, Uranus has rings and scientists predict that the rings are the result of an impact that destroyed the moon Miranda. The debris from the impact formed the rings, but the moon reassembled and has chaotic contours that might be a key to its history.

Uranus has an atmosphere, active weather, cloud layers and a slushy interior similar to Jupiter and Saturn. Unlike the larger gas giants, its core is not very hot. Even more unique is that its magnetic field is off center. Force lines spring not from the core of the planet, but from the slushy layer surrounding it.

Uranus has five large moons: Ariel, Umbriel, Titania, Oberon and Miranda. Miranda looks like a very rough diamond. In its biggest rift, it has cliffs that are 15 kilometers high. If you fell off one of the cliffs, it would take you 14 minutes to fall to the surface due to the moon's weak gravity.

In the 18th century, scientists had trouble predicting the position of Uranus. It was rarely where astronomers predicted it would be in its orbit. Some scientists predicted that its orbit was being disturbed by interaction with another planet farther away. 60 years after the discovery of Uranus, Neptune was discovered after mathematically calculating where it would be to interfere with Uranus.

Slightly smaller than Uranus, Neptune is the farthest gas giant. Images from the Hubble Space Telescope show distinct features including lively storms, high winds and cirrus clouds streaked in bands. It has an atmosphere and interior similar to the other gas giants, but its core radiates more heat than it receives from the sun. Of all the planets, Neptune has the weirdest magnetic field. At a 47 degree tilt, the axis of the field is closer to the surface than to the core.

Neptune has rings that are dark, a dozen tiny moons and a single large moon, Triton. Triton is the coldest body in the solar system. Most of the heat from the sun that is not reflected melts nitrogen beneath the surface that bursts through the surface in little eruptions.

CRITICAL THINKING EXERCISES

1. DESCRIBE how the Voyager spacecrafts were able to travel to the outer planets.
2. EXPLAIN why Titan, which is larger than Mercury, is a moon rather than a planet.
3. EXPLAIN how scientists can determine the composition of the outer layers of gas giants.
4. DESCRIBE what the Huygens probe discovered when it landed on Titan.
5. EXPLAIN how astronomers were able to predict the existence of Neptune based on the orbit of Uranus.
6. CALCULATE how many Earth's would fit into Saturn, Uranus and Neptune.

ADVANCED ORGANIZERS

Prior to viewing this program, students should have some understanding of the following Benchmarks for Science Literacy, Oxford University Press which are excerpted and, in some cases, abbreviated below. Refer to the Benchmarks for more information.

Benchmark 4: The Physical Setting

Section A. The Universe, Know by Grade 8

- Nine planets of very different size, composition, and surface features move around the sun in nearly circular orbits. Some planets have a great variety of moons and even flat rings of rock and ice particles orbiting around them. Some of these planets and moons show evidence of geologic activity.

Section G. Forces of Nature, Know by Grade 8

- The sun's gravitational pull holds the earth and other planets in their orbits, just as the planets' gravitational pull keeps their moons in orbit around them.

**Benchmarks can be found at www.project2061.org/tools/bencho/bolintro.htm*

VOCABULARY

- Aurora** A radiant emission from the upper atmosphere that occurs sporadically over the middle and high latitudes of both hemispheres in the form of luminous bands, streamers, or the like, caused by the bombardment of the atmosphere with charged solar particles that are being guided along the magnetic lines of force.
- Cassini division** A gap in Saturn's rings.
- Gravity assist** The technique of using the energy of a gravitational field and the orbital velocity of a planet to alter the speed and trajectory of a spacecraft.
- Hydrocarbon** Any organic compounds, such as benzene and methane, which contain only carbon and hydrogen.
- Methane** (Symbol: CH₄) An odorless, colorless, flammable gas, that is the major constituent of natural gas, used as a fuel and is an important source of hydrogen and a wide variety of organic compounds.
- Moonlets** A small artificial or natural satellite.
- Nitrogen** (Symbol: N₂) A nonmetallic element that constitutes nearly four-fifths of Earth's air by volume, occurring as a colorless, odorless, almost inert diatomic gas in various minerals and in all proteins and used in a wide variety of important manufactures.
- Stratosphere** The region of the atmosphere above the troposphere and below the mesosphere.
- Alignment** An adjustment to a line; arrangement in a straight line.
- Cirrus** A high-altitude cloud composed of narrow filaments or patches of thin, generally white, fleecy bands.
- Helium** (Symbol: He) an inert, gaseous element present in the sun's atmosphere and in natural gas, and also occurring as a radioactive decomposition product, used as a substitute for flammable gases in dirigible balloons.
- Hubble Space Telescope** The first astronomical observatory above the Earth's atmosphere, designed to provide much more detailed views of the universe than can be obtained from the ground. It has served as one of the major tools used by astronomers to learn about the universe since its launch in 1990.
- Hydrogen** (Symbol: H) A colorless, odorless, flammable gas that combines chemically with oxygen to form water; it is the lightest of the known elements.
- Magnetic field** A region of space near a magnet, electric current, or moving charged particle in which a magnetic force acts on any other magnet, electric current, or moving charged particle.

CAREER POSSIBILITIES

- PHYSICIST
- ENGINEER
- ASTROPHYSICIST
- ASTRONAUT
- ASTRONOMER