

Solar System

Instructional Objectives

After viewing the program and participating in accompanying activities, the student will be able to:

1. list the elements of the solar system,
2. describe four major types of motion of the planets within the solar system,
3. describe dynamo effect, and
4. name something that is as of yet unexplained that we can observe about the planets.

Synopsis

This program identifies the following elements of the solar system: sun, planets, moons, asteroids, comets, meteorites, and particles of dust. The notion that the solar system is mostly space is shown, as well as the four primary motions of the planets. Rotation and revolution are described using different planets as examples. Also depicted is the fact that the planets follow the sun through space and are currently moving toward the constellation Hercules. The movement of the solar system as part of the rotating Milky Way Galaxy is described as a process that takes approximately 250 million years.

Electromagnetism as a product of the right combination of density and rotational speed of a planet is explained. The dynamo effect is also depicted for the students. Several planets are used as examples to discuss why they do or do not have magnetic fields, laying groundwork for a process of analytical thinking on the part of the students.

The program opens with a visit with Dr. Eric Chaisson of the Space Telescope Science Institute and closes with a career interview with Bob Brown, Leader of the Center for Special Studies at the Space Telescope Science Institute.

Vocabulary

Asteroid - A synonym for minor planet; one of several tens of thousands of small planets, ranging in size from a few hundred kilometers to less than one kilometer in diameter.

Comet - A small body of icy and dusty matter, which revolves about the sun. When a comet comes close to the sun, some of its material vaporizes. The result is a large coma of tenuous gas and often a tail.

Dynamo effect - The production of electricity by the rotation of a magnet inside a shell of a metallic structure such as a coil of wire or the earth's outer shell of rocks and minerals.



Electrical Conductor - A substance that supports the transfer of electricity. The best electrical conductors are metals.

Element - All atoms of the same kind having identical chemical properties and the same number of protons in each atomic nucleus.

Galaxy - A colossal collection of billions of stars and interstellar matter, held loosely together by their mutual gravity, and often spread over about a hundred thousand light-years.

Helium - A colorless, gaseous element at room temperature having an atomic number of 2 and an atomic weight of 4.0026. Helium has the lowest boiling point of any element, -268.9°C , and becomes a solid with pressure at -269.7°C .

Hydrogen - The first and simplest of all the elements; its atomic number is 1 and its atomic weight is 1.00797. At very low temperatures hydrogen becomes a solid; it melts at -259.2°C and boils at -252.8°C and becomes hydrogen gas.

Moon - A body that revolves around a larger body.

Planet - Any of the nine solid bodies revolving about the sun.

Previewing

With students' help, create a web diagram by placing the term solar system on the board. Have the students describe the solar system. This will serve as a review for the class.

Ask the students to describe the motions of the earth. Ask students to describe (or speculate on) the motions of the other planets.

Ask the students to state questions they have about the planets. List these questions on the board.

Ask students why people haven't visited the planets. What are the obstacles to planetary space travel.

Postviewing

Ask students to recap the significance of Dr. Eric Chaisson's presentation.

Discuss the role of Bob Brown in the support of the Hubble Space Telescope mission.

Ask the students to describe the four major types of motion of the planets within the solar system.

Have students play the roles of planets, sun, other stars, and other galaxies. Have the students move with all four motions. Students playing the role of planets should be especially agile.

Ask a student to spin a globe in the direction the earth rotates. Stop the globe. Have another student come up and spin the globe in the direction that Venus spins. Discuss the directions of spin of the other planets.

Active Involvement

Have students create a map of the solar system (as close to scale as reasonable). Have students add the rotation rates to the map. Ask students to draw a conclusion about the relationship between rotation rate and position in the solar system.

In 1781, William Herschel discovered Uranus. For 60 years after its discovery, astronomers studied its orbital motion. The planet appeared to be defying Newton's Laws of Motion. Have students research the discovery of Neptune and later Pluto. (The article "Where is Planet X?" *Sky and Telescope*. December 1989, pp. 596-99 is a good start.) After the research is complete, discuss the role of prediction in the progress of science. How can the lack of a confirmed prediction be part of scientific progress?

Twenty three spacecraft have been sent to Venus during the past three decades, the latest being the Magellan space

probe. Have the students research why NASA continues to send spacecraft to Venus? Why do we find it so interesting to study?

Bibliography

For high school students:

Beatty, J. Kelly and Andre Chaikin. *The New Solar System* (3rd edition). New York: Cambridge University Press, 1990.

DePuruckes, G. *Galaxies and Solar Systems: Their Genesis, Structure and Destiny*. San Diego: Point Loma Publisher, 1987.

Whipple, Fred L. *Orbiting the Sun*. Cambridge: Harvard University Press, 1981.

Video:

Planet Earth. Episode 4: "Tales from Other Worlds." Pittsburgh: Metropolitan Pittsburgh Public Broadcasting, Inc., 1985.

For middle school students:

Baker, David. *Exploring Venus and Mercury*. Jeco Beach: Rourke Enterprises Inc., 1989.

Branley, Franklyn. *Uranus*. New York: Thomas Y. Crowell, 1988.

Davis, Don and Peter Cattermole. *Mars*. New York: Facts on File, 1989.

Audio:

Stein, Michael. *Ride through the Solar System*. Narrated by Fred Newman. New York: Caedman Publisher.

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See for Yourself Experiments/Projects

Speed and Location

► MATERIALS

- string
- 2 small styrofoam balls or colored tape
- needle with large eye
- glue or tape

► DIRECTIONS

Thread the styrofoam balls on the string. Place one at the middle of the string and attach it with tape or glue. Thread the second ball and place it at the end of the string. Twirl the string over your head. Have your partner describe the motion of the balls. Your partner should record the observations. Switch roles and repeat the experiment.

Now move the ball in the middle to near the end of the string without a ball. Repeat the twirling, observing, and recording.

Compare your two sets of observations.
Draw a conclusion.

Discuss your conclusion with your partner.
Do you agree?

Mysteries of the Planets

► MATERIALS

- newspaper and magazine articles
- poster board
- ingenuity

► DIRECTIONS

Select one of the planets visited by one of the space probes such as Mariner, Pioneer, Viking, Voyager, or a Soviet Space probe or one that has been studied by the Hubble Space Telescope.

Read about the information collected on the planet. What discoveries were made?

Gather images of the planet. If necessary, photocopy the image and add color with colored pencils, markers, pastels or paints. Recreate the original photos as closely as possible.

Create an informational poster about your planet. Be sure to include your artwork.



Distances in the Solar System

► MATERIALS

- calculator
- graph paper
- colored pencils

► DIRECTIONS

The distance between the earth and the sun is often called one astronomical unit (1AU). It is equal to 150 million kilometers. The distance among planets and between the sun and each planet can be expressed in astronomical units.

The figures in the chart below are rounded so we can handle them more easily. Using the distance between the earth and the sun as the denominator of the ratios, you will determine the number of astronomical units each planet is away from the sun and then determine the relationships among the planets.

	Distance in million kilometers (10km)	AU
Mercury	60	
Venus	105	
Earth	150	
Mars	225	
Jupiter	780	
Saturn	1,425	
Uranus	2,880	
Neptune	4,515	
Pluto	5,925	

1. To determine the number of astronomical units each planet is from the sun, divide the distance in million kilometers from the sun for each planet by our standard unit of distance for the earth (150 million kilometers). Add these values to your chart. The top of the column should be labeled AU.
2. Graph the relative locations of the planets to the sun on graph paper using the astronomical unit values.

3. Draw a line from Mercury to Venus. Above that draw a line from Mercury to earth. Above that draw a line from Mercury to Mars. Continue this process until you draw the line from Mercury to Pluto.
4. Using your graph and your column of numbers, calculate the distance each line represents in astronomical units. Add these values to your graph.
5. Choose another planet and draw lines from it to every other planet below the planets on the graph.
6. Repeat step 4 for this new set of lines.
7. Discuss the magnitude of the differences in the distances among planets.

Turn the bicycle upside down so that it is balancing on the handle bars and seat. Slowly move the peddles. What do you observe? Record your observations. Experiment with the movement of the peddles.

If your partner moves the peddles as briskly as possible for 15 seconds, what do you predict will happen during your partner's efforts? After your partner stops the effort? Repeat as necessary.

Explain the value of using a dynamo operated light over a battery operated light. Identify the drawbacks of using a dynamo to power a bicycle light.

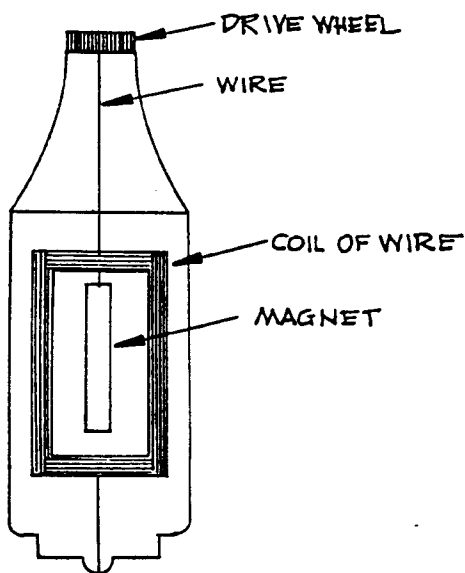
Dynamo

► MATERIALS:

- bicycle equipped with a dynamo
- stopwatch

► DIRECTIONS:

On some bicycles, the lights are powered by a simple dynamo (see diagram). The movement of the wheels causes a magnet to rotate inside a coil of wire. As you remember from Show 22 and the experiments of Faraday and Henry, this causes electricity to flow in the wire. In the case of the bicycle dynamo, the light is powered.



Career Profile

Robert Brown

Leader, Center for Special Studies
Space Telescope Science Institute

Education: B.A. Physics

M.A. Physics

Ph.D. Physics



General Responsibilities

As the Leader of the Center for Special Studies for the Space Telescope Science Institute, Bob Brown has many responsibilities. These revolve around research, studying policy issues, helping to set policy, and developing programs which will affect the Hubble Space Telescope and future missions of NASA.

Bob is a planetary scientist, so it is only natural that one of his primary responsibilities is to do research, especially through planetary observations being made with the Hubble Space Telescope. Some of the more fascinating questions to which Bob and his group are paying special attention concern planetary laboratories, robotics in space, and the possible human explorations and habitation of other planets.

Bob's job is not restricted to questions of planetary exploration. He also spends time investigating the history of public policy relating to astronomy and space exploration. He is interested in how government and private industry have been involved in scientific research. Studying earlier policies allows him to clarify trends for the future.

Based on his knowledge of how science has been approached by government in the past, Bob helps develop new programs that will extend the social returns and benefits of space exploration. Because a great deal of the tax payers' money is invested in the space program, the results of space exploration should benefit the citizens of our country. Developing educational programs that will improve the science literacy of the country is just one example of the solutions Bob is working on.

Bob studies and develops programs that relate the Hubble Space Telescope to the rest of the space program. These problems are not always restricted to science, but may involve launch vehicles, space communications, and other technologies. One recent program Bob has helped to plan is the mission designed to correct the effects of HST's faulty mirror. This is a program that must involve astronomers, engineers, and optical technicians.

Along with his other duties, Bob conducts scientific research. He hopes to be involved in the discovery of planetary systems around other stars. Such planets are difficult to see because they are so faint, giving off no light of their own. In fact, the light that they reflect is one billion times fainter than that given off by a star. Bob feels that because the Hubble Space Telescope can detect very faint objects, it will contribute to the eventual discovery of other planetary systems. Bob is also part of a team that has observing time on the HST to study discs around various stars.

A Typical Day

Arriving at the office between 4:00 and 5:00 am, Bob begins each work day by reading three daily newspapers. He specifically looks for articles and opinion pieces that relate to space and space policy. Because he needs to be aware of science in society and the public's opinion of space exploration, he does not limit his reading to articles written by science experts.

Bob generally writes for two hours a day. Currently he is working on three articles and one report. Often he is preparing for a talk or presentation and must think about how he can most effectively present his ideas. He always likes to stimulate thinking in his audience.

On any day of the week, Bob will need to communicate with ten to twelve scientists and colleagues. His means of communication are varied, and might involve electronic mail, faxes, telephone calls, or written correspondence.

Bob has a very sophisticated computer system, which includes electronic publishing capabilities. He usually spends one to two hours each day working with the soft and hardware packages of his system in order to update and improve his personal skills and knowledge.

By 7:00 or 7:30 pm, Bob is ready to go home. He relaxes by cooking and reading, usually something unrelated to science.

Career Viewpoint

Bob points out that our country's democratic system forces us to rely on the combined wisdom of all the people who live here. This means that not only is it important for our leaders to be among the best thinkers, but that everyone who lives and participates in our country needs to understand scientific and technological issues sufficiently well to form judgments. These issues are often complex and, because of the environmental and energy crisis, will impact the lives of everyone.

Science can not be learned in isolation. Bob suggests that by studying a well rounded set of courses—literature and history, along with the sciences, students will be able to see science within the context of human history. This will help people to develop the knowledge and ability to make informed decisions, as well as prepare them for productive lives in an increasingly technological society.

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