OVERVIEW

PLANETARY SCIENCE COURSE

WELCOME TO THE SOLAR SYSTEM

Astronomy is the study of everything we can observe and imagine beyond Earth—the Moon, the Sun, the Solar System with all the planets and lesser objects in it, the Milky Way, and the vastness of the cosmos. Astronomers investigate the kinds and numbers of objects in the cosmos, the composition of the objects, and the motions and interactions of the objects with one another. Because Earth is part of this large system, the science of astronomy includes the study of our own planet.

Astronomers ask fundamental questions: When and where did the universe start? What gave birth to it? What is the destiny of the universe? Space—the seemingly boundless vessel holding billions upon billions of swirling galaxies—is today's final frontier. Astronomers continue to be the pioneers who first ventured into this vast environment, creating the charts that will guide those of us ready to join the adventure.

FOSS AND NATIONAL STANDARDS

The **Planetary Science Course** for grades 7–8 emphasizes the use of knowledge and evidence to construct explanations for the structures and motions of objects in the Solar System. This course supports the following National Science Education Standards.

SCIENCE AS INQUIRY

Develop students' abilities to do and understand scientific inquiry.

- Identify questions that can be answered through scientific investigations.
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the connections between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.
- Use mathematics in scientific inquiry.
- Understand that different kinds of questions suggest different kinds of scientific investigations; current knowledge guides scientific investigations; mathematics and technology are important scientific tools.
- Understand that scientific explanations emphasize evidence.

CONTENT: EARTH SCIENCE

Develop students' understanding of Earth and the Solar System as a set of closely coupled systems.

- Earth is the third planet from the Sun in a system that includes the Moon, the Sun, eight other planets and their moons, and smaller objects, such as asteroids and comets. The Sun, an average star, is the central and largest body in the Solar System.
- Most objects in the Solar System are in regular and predictable motion governed by the force of gravity. Those motions explain such phenomena as the day, the year, seasons, phases of the Moon, and eclipses.

SCIENCE AND TECHNOLOGY

Develop students' understandings of science and technology.

- Science influences society through its knowledge and worldview.
- Scientists and engineers work in many different settings.

HISTORY AND NATURE OF SCIENCE

Develop an understanding of science as a human endeavor that has taken place over time.

- Many individuals from different cultures have contributed to the traditions of science.

FOSS MIDDLE SCHOOL PROGRAM COMPONENTS

FOSS Middle School is a general science curriculum for students and their teachers in grades 6–8. The curriculum is organized into topical courses in three strands: **Earth and Space Science, Life Science,** and **Physical Science and Technology.** Each course is an in-depth unit requiring 9–12 weeks to teach.

This course, designed for students in grades 7–8, includes the following interconnected components.

- A detailed ***Planetary Science Teacher Guide*** in a three-ring binder including overview, materials preparation, goals and objectives, at-a-glance investigation chart, science background, lesson plans, transparency masters, teacher answer sheets, assessments with masters and scoring guides, CD-ROM user guide, and references (books, multimedia, websites). Each chapter of the teacher guide is separated by tabs for easy use. **Planetary Science** has ten investigations, each with two to seven parts.
- **Kit of student laboratory equipment** packaged for multiple classes of 32 students each. The kit also contains class resource materials such as posters, maps, books, and videos. Each course is designed for use with one teacher working with five sections of students per day. The kit also includes **44 transparencies** for use in the investigations.
- ***FOSS Planetary Science Resources*** book containing images, data, and readings for each student.
- ***FOSS Planetary Science Lab Notebook*** containing 41 student sheets and organizers for the investigations. This can be a consumable book for each student or serve as a set of duplication masters for the teacher. Student sheets are printed on one side of the paper so students can remove a page to put it in a binder. The backs of the pages are printed with a grid where students can take notes, make drawings or calculations, or graph results.
- ***FOSS Planetary Science* CD-ROM** for use as a whole-class demonstration tool as well as an individual or small-group interactive instructional tool. The extensive database together with the Student Notebook feature serves as a research and report-preparation tool. The CD-ROM is woven into the instruction and is linked to each investigation through the on-line Teacher Guide.

PLANETARY SCIENCE COURSE MATRIX

SYNOPSIS	*SCIENCE CONCEPTS*	*THINKING PROCESSES*
1. WHERE AM I? (3 sessions)		
Students gain familiarity with maps and images presented in a variety of scales, while developing a sense of planet Earth as a base for inquiry into the vast reaches of the Solar System.	• A map is a representation of a place or area. • Elevation is the distance above Earth's surface, often measured from sea level. • Frame of reference is important in describing locations on Earth.	• Observe the schoolyard and draw a map to represent the area. • Interpret representations of human-made and natural structures in aerial photographs. • Relate information from different frames of reference.
2. ROUND EARTH/FLAT EARTH (2 sessions)		
Students review the several kinds of evidence that led ancient astronomers to conclude that Earth is round. Flat and round Earth models and computer simulations are used to generate evidence.	• Curved surfaces create horizons, which interrupt the line of sight. • The lengths of shadows cast by identical objects vary from place to place on Earth. • Locations on Earth are described in degrees of longitude and latitude.	• Use models and simulations to make observations, gather evidence, and draw conclusions about the shape of Earth. • Make shadow observations, collect and organize information, graph shadow data, and describe and explain the resulting relationship.
3. DAY AND NIGHT (4-5 sessions)		
Students explore the celestial geometry and motions that produce day and night on Earth, using three-dimensional models, printed materials, and multimedia simulations.	• Illuminated opaque objects cast shadows on the side away from the source of light. • The Sun, an average star, is the light source in our system. • Earth rotates (counterclockwise) every 24 hours, causing day and night.	• Use models to relate Earth's motions to the Sun. • Communicate how to determine the direction of Earth's rotation. • Use astronomical data to determine local noon. • Investigate the convention of time zones with maps and globes.
4. DISCOVER THE MOON (4 sessions)		
Students turn their attention away from Earth and discover the Moon. They begin a month-long observation, recording appearance and time of view each day. They study images of the full Moon and generate a list of questions for study.	• The Moon's appearance changes predictably over the course of a 28-day period. • The Moon can be observed during different times of the day and night. • The Moon has a geography very different from that of Earth.	• Observe and record the Moon's appearance for a month. • Observe photos of the Moon, describe major surface features, and communicate a list of questions. • Relate the origin of features of the Moon through a myth.
5. MOON CRATERS (7 sessions)		
Students consider a 1961 scientific controversy: Are the lunar craters products of volcanism or impacts? They simulate lunar impacts and use interactive computer simulations to gather evidence to explain the appearance of the Moon's surface.	• Solid objects traveling at high speeds crashed into the Moon, creating craters. • Different-size objects produce distinctly different kinds of craters. • Impact sequence can be determined by observing superposition.	• Design and conduct experiments to relate impact variables to resulting landforms. • Relate evidence and understanding of processes to construct explanations about the lunar surface.

FOSS CD-ROM	FOSS READINGS	EXTENSIONS
Earth Images • Bret Harte Community		• View *Powers of Ten.* • Apply math to a map. • Compare photos to maps. • Maps in everyday use. • Explore images on the World Wide Web.
Round Earth/Flat Earth Simulation • Movie of ship sailing Earth Shape • Longitude and latitude • Shadow data	• *The Accidental Discovery of America: The First Voyage of Columbus* • *Eratosthenes: The First Person to Measure Earth*	• Prove Earth is round. • Measure a shadow.
Day/Night Simulation	• *Time Zones of the Lower 48 States (Data)* • *World Time-Zone Map (Data)*	• Give time-zone homework. • Look at phone books. • Explore the international date line.
	• *Lunar Myth 1: Father Moon* • *Lunar Myth 2: Rona in the Moon* • *Lunar Myth 3: Moon and His Sister* • *Lunar Myth 4: Tale of the Rabbit* • *Lunar Myth 5: Bahloo, Moon Man*	• Organize a shopping list. • Collect Moon information from the newspaper. • Chart moonrise information. • Research Moon words.
Student Notebook Moon Binder; Earth Binder Crater Formation Mare Formation Moon Crater Locator Map Earth Crater Locator Map Origin of the Moon Simulation	• *The Controversy about Lunar Crater Formation* • *Craters: Real and Simulated* • *The Crater That Ended the Reign of the Dinosaurs* • *How to Get and Hold onto a Moon* • *Gene Shoemaker: The First Man on the Moon?*	• Research crater chains. • Diagram maria as impact basins. • Make model craters. • Who was Gene Shoemaker?

PLANETARY SCIENCE COURSE MATRIX

SYNOPSIS	SCIENCE CONCEPTS	THINKING PROCESSES
6. MAPPING THE MOON (3 sessions)		
Students locate and identify the most prominent craters and maria on the full Moon. Given the diameter of the Moon, they compute the diameters of several craters. They transpose a crater drawn to scale onto a map of their community.	• Scale is the size relationship between a representation of an object and the object and can be expressed as a ratio. • Lunar maria are the result of a sequence of events, starting with an impact creating a huge basin.	• Interpret lunar features on photographs and determine size relationships using mathematics. • Describe a sequence of events that explains the formation of lunar maria. • Draw accurately scaled Moon craters.
7. LANDING ON THE MOON (5-6 sessions)		
Students study the history and technology of Moon exploration. They investigate the interplay of many variables to plan a trip to the Moon, including speed, distance, timing, and more. They model the Earth/Moon system.	• Scale models help people understand size and distance relationships in the Earth/Moon system. • The Moon's rotation produces lunar day and night.	• Construct a scale model of the Earth/Moon system. • Describe the sequence and timing of events that will result in a successful Moon mission. • Compare and describe day and night on Earth and the Moon.
8. MOON ROCKS (4-5 sessions)		
Students collect simulated Moon-rock samples from mare and highland sites, analyze them for kind and abundance, and compare the results. They test the samples for density, and use the results to work on theories of Moon origin and evolution.	• The Moon is composed of rocks and minerals similar to those on Earth. • Density is mass per unit volume of a material. • Denser Moon rocks are in the mare areas; less-dense rocks are in the highlands. Density is a factor in Moon rock distribution.	• Observe, measure, and organize the properties of lunar rocks. • Establish and apply criteria for rock sampling and analysis. • Relate the density of minerals to the formation of the Moon. • Use inferential thinking to compare theories of the origin of the Moon.
9. PHASES OF THE MOON (4 sessions)		
Students come to grips with the processes that produce the observed phases of the Moon.	• The Moon revolves around Earth and rotates on its axis; half of the Moon is lit by the Sun at all times. • The portion of the Moon visible from Earth is predictable. • Motions of Earth and the Moon due to gravity explain the day, year, seasons, eclipses, and Moon phases.	• Use models and simulations to explain the mechanics of Moon phases and eclipses. • Use inferential thinking to predict the positions and motions of the dynamic Sun/Earth/Moon system that account for the day, year, seasons, and phases of the Moon.
10. EXPLORE THE PLANETS (5-6 sessions)		
Students locate possible planets using sequential photographs. They send "probes" to image the planets. They process the digital data to discover a planet, gather information about it, and prepare a travel brochure on it.	• Earth and the Solar System are a set of closely coupled systems. • In the heavens, stars maintain their relationships to one another; planets, comets, and asteroids move with respect to the stars. • Images can be coded into numbers and decoded into visual images.	• Simulate producing a digital image of a distant object. • Review the current knowledge about the planets and propose a planetary tour to apply the knowledge. • Communicate understanding of the Solar System.

FOSS CD-ROM	FOSS READINGS	EXTENSIONS
Moon Crater Locator Maps Mare Formation Simulation	• *Earth/Moon Comparison* (Data)	• Provide basic experiences with scaling. • Research crater names.
Space Exploration • *Moon, Before Apollo* Day/Night Simulation	• *Lunar Probes: Paving the Way for Apollo* • *Sun, Planets, and Satellites by Size* (Data) • *Moon with Landing Sites* (Data)	• Investigate orbiting satellites and spacecraft. • Observe satellites in the night sky. • View a science fiction film. • Create space art.
Moon Rocks and Minerals Earth Rocks and Minerals	• *Moon Rock and Mineral Key* (Data) • *Moon Rock Formation* (Data) • *Top Ten Scientific Discoveries Made During Apollo Exploration of the Moon*	• Research rocks and minerals. • Create science fiction. • Explore websites.
Lunar Calendar Phases of the Moon Day/Night Simulation	• *The Search for New Moons* • *Moonrise/Sunrise Data*	• Use CD-ROM Phases of the Moon Simulation in the computer lab. • Investigate Moon rotation.
Digitizer Planet Images	• *The Solar System in a Nutshell* • *Space Probes* • *Finding Planets Outside the Solar System* • *Naming Comets* • *U.S. Planetary Missions (Data)*	• Make a bulletin board of space-exploration current events. • Read about planets in other planetary systems.

FOSS TEACHER GUIDE

The ***Planetary Science Teacher Guide*** is just that—a guide. It is designed to be an information and planning tool to help you understand and enjoy your visit to the Solar System, much like an interpretive brochure might guide your visit to historic Williamsburg. A good guide will suggest the best path to follow, and will enrich your visit with history, facts, and lore as you proceed. Like any good guide, it will also point out places to rest, where to stop for refreshments. You should feel comfortable and confident that you know what you are doing as you go along.

Like a good guide, it may be pressed into service less as you become more and more familiar with the territory. On your third visit to Williamsburg, you might head straight for the main street, passing by some of the introductory exhibits, and you might visit your favorite spots in a slightly different order than you did before. You might even leave the trail here and there to drink in some of the historical ambiance in a way quite different from that intended by the preparer of the guide brochure.

The first time you visit the **FOSS Planetary Science Course**, we hope you will follow our suggested sequence to get the lay of the land. The guide is filled with information to help you have an excellent first use of the course. It may seem overwhelming at first, but in a short time you will discover how to use it effectively. Here's what we suggest:

Look at the **Table of Contents** to see how the teacher guide is assembled. You'll notice that the guide is subdivided into 19 chapters. Turn each tab to see how much information there is in each section.

Next read the **Overview** section completely. This describes the scope of the course content and discusses issues of instruction, assessment, management, and safety.

Now turn all the pages in the guide, pausing to read the **Goal and Objectives** of each investigation carefully. In this way, you will be able to get a very good sense of the curriculum.

Finally, digest Investigation 1, *Where Am I?* thoroughly. Read the science background carefully and study the **investigation at-a-Glance chart** to see how the investigation is subdivided. The chart also provides a dissected overview of the several days of classroom actions, including the use of media (CD-ROM, video, and readings) and the assessments. Project the actions you read about into your classroom. Visualize students grappling with the issues and working with materials in small groups. If you have the kit at hand, bring out the materials as you read, and do the investigations. Discover where you are on Earth. Then read Investigation 2 carefully, then 3, 4, 5, and so forth. Keep the *Planetary Science Teacher Guide* close at hand (even in hand) during your first trip into the Solar System to ensure a safe and productive adventure.