Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
1998 Volume VI: Selected Topics in Contemporary Astronomy and Space Science

Fly Me to the Moon

Curriculum Unit 98.06.05
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This is a unit on the moon. It is intended for students in the third and fourth grades. I would encourage teachers to use this unit in conjunction with the study of the solar system. The time frame for the unit is one month, so as to coincide with one revolution of the moon around the earth.

The unit will provide teachers and their students with an in-depth study of the moon and will include other subject areas such as math, science, writing and art. What I have written will provide teachers with sufficient knowledge on the subject of the moon so as to enable them to be comfortable teaching the unit. Teachers should also encourage their students to use their library media center as another resource for information.

I chose to write my curriculum unit on the moon because it is so close and everyone has actually seen it, in contrast with other celestial bodies in our universe. I felt that if I studied the moon, it would be easier for me to relate this to my students because I had learned so much about it. My participation in the Yale New Haven Teachers Institute Astronomy Seminar and my research on the moon has made me realize how little I knew. I have learned a lot in the past few months and I now look at scientists, astronomers, astronauts and others who study the universe in a new way. The moon still has many mysteries left for us to discover. It is important for educators to encourage and spark the interest of our students in this fascinating area of science.

The New Haven Public School System has recently rewritten its curriculum. The science curriculum standards for astronomy state that students in the fourth grade should be able to identify objects in the sky, such as the sun, moon, planets and stars and they should be able to observe and describe their features and characteristics. Secondly, students will explain the characteristics and patterns of the movement of the moon.

The moon curriculum unit will address these content standards in a way that will encourage and motivate students to be life-long learners. The unit will attempt to answer the questions "What would life be like on earth if there were no moon?" and "What is it like on the moon?"

Man has been intrigued with the moon throughout the ages. In many cultures the moon has been the source of myths and legends. Rites, rituals and ceremonies have been held in honor of the moon. In ancient times the main importance of astronomy was its signaling of seasonal change. Harvesting and planting cycles were set by the sun, the moon and the stars. It was even believed that rays of the full moon caused insanity, hence our word "lunatic" which is derived from "luna" the Latin name for our nearest celestial neighbor.

The many stories and myths from around the world based on the moon, and which can be found in the library

provide an excellent way to begin the curriculum unit on the moon. They will allow students to realize how far man and science have come throughout the ages and how in many cases our popular notions of the moon may not be very different from what people thought hundreds of years ago.

In 1609 Italian astronomer Galileo Galilei (1564-1642) used the first refracting telescope. He was the first person to use a telescope for sky observation. Although Galileo used a very small telescope he not only was able to see craters on the moon but also four other moons orbiting the planet Jupiter. Galileo found that the moon was not a smooth, shiny, perfect sphere. The edges appeared jagged and uneven against the dark night sky.

The moon is the earth's only known natural satellite. A satellite is a body that orbits around another larger body. Therefore the moon is our satellite. The earth is a satellite of the sun. Seven of the nine planets have satellites. The giant planets have stronger gravity than the terrestrial planets and therefore have more moons .

Lesson 1

Research the Satellites of the Solar System

Objective: To have the students be able to use the media center to locate and access information on the satellites in the solar system.

Materials: Reference materials and internet access if available.

Procedure: Have the students locate resources the will provide information on the planets that have satellites. Find the names of the satellites, their distance from the planet and their diameters. Also their periods of revolution and who discovered them and when they were discovered should be found. Have the students work in small groups and research one planet. Have the students present their information in graph format.

Evaluation: Have the students share their information orally and display the graphs.

The moon makes no light of its own. The moon shines by reflecting sunlight. Most of the sunlight that shines onto the moons surface is absorbed. Only 11% of the sunlight that the moon absorbs is reflected back into space. The moon is the brightest light in the night sky because it is closer to earth than any other sky object

The moon rises in the East and sets in the West every day because of the fact that the earth rotates on its axis once every 24 hours. The earth's gravity has locked the moon into what is known as synchronous rotation. The moon, like the earth, rotates on its axis. The rotation of the moon on its axis takes approximately 27.3 days. It also takes the moon 27.3 days to complete one trip around the earth. This rotation is called a sidereal month. The sidereal revolution period is measured relative to the stars. Because the earth and the moon have traveled together around the sun during sidereal month, two more days must pass before the syzygy occurs. The moon, earth and sun must be in a line before the moon is new or full again. The mean time for the moon to repeat is phases is called a synodic month, which occurs every 29.5 days. The synodic period is measured from the earth. The moon needs two more days to catch up with the earth in order to reach its position relative to the sun as viewed from the earth. The orbit of the moon is elliptical, therefore the moon appears to look larger at perigee, when its orbit is closest to the earth and smaller at apogee, when its orbit is farthest

from the earth. v Because the moon's rotation period is equal to it's period of revolution, the same side of the moon always faces the earth. Due to variations in the moon's motions known as librations, we actually see 59% of the moon's surface over time. Librations were first observed by Galileo.

Lesson 2

The Moon's Rotation

Objective: To have the students understand why we only see one side of the moon as it rotates on its axis.

Materials: Students, one small (tennis size) ball with a marked spot on it.

Procedure: Have each student try this exercise and observe others as they do the exercise. Have the student imagine that he is the earth. Have the student hold out one hand and hold the ball , (the moon) with the marked side visible to him. Have the student turn around slowly. Have the student notice that the mark on the ball has been visible to the student (earth) at all times as it made a complete rotation. This is what the moon does during a month's time period. Have the students try this again but this time keeping the marked spot on the ball facing the in the same direction at all times. If this were what actually occurred, then we would see the other side of the moon.

The moon changes its appearance regularly each month. The bright shape that we see from earth lit by the sun is called the moon's phase. The phases change as the moon orbits around the earth. Depending on where the moon is in its orbit around the earth, sunlight will be coming from the right , the left, different angles, and from behind the moon itself. The reflected light that the moon gives off allows us to view the various phases of the moon with an unaided eye.

Phases of the Moon

The first phase of the moon during its orbit around the earth is known as the new moon. (To get a better picture of where the moon is located during the phases draw a clock. The earth will be in the center and the new moon is a three o'clock. The sun should be further to the right in line with three o'clock. Have your students do this as you teach them about the phases of the moon). The new moon continues its orbit counterclockwise around the earth, moving away from the sun (taking a position between two and one o'clock). It takes about two days for the moon to reach this position known as waxing crescent. Waxing means the moon is getting larger. In about one week's time the moon will have traveled one quarter of its orbit. (it will now be at the 12 o'clock position on our clock). This moon rises at noon and is the first quarter moon. Several days later the moon will travel (between the ten and eleven o'clock position) to the waxing gibbous phase. More than half of the moon's surface will be shining on earth. After two weeks into its cycle the full moon will illuminate the night sky. The full moon occurs 12.37 times a year. During the full moon, the moon is on the opposite side of the earth from the sun. The full moon is highest in the sky at midnight. (the full moon should be at the nine o'clock position). As the moon continues on its eastward orbit the light reflected from it begins to wane. This phase, (located between eight o'clock and seven o'clock) is known a waning gibbous. There is less sunlight used for illumination. The last quarter phase, (located at six o'clock) is when the left half

of the moon is illuminated. In the last week of the monthly orbit the moons appearance is becoming thinner and thinner. This phase (located between five and four o'clock) is called waning crescent. After a few days the moon will be back where it started (at the three o'clock position). One month's time will have passed and another is about to begin. On several occasions it is possible to have two full moons in a month. When this happens the second full moon is referred to as a 'Blue Moon'.

Lesson 3

Phases of the Moon

Objective: To teach the students the phases of the moon.

Materials: A small styrofoam ball attached to the end of a pencil. A light source with a bright bulb (400 watts).

Procedure: In this demonstration the student will be the earth and hold out the pencil with the styrofoam ball with one arm. This will be the moon and the light will be the sun. Have the student stand in the same position as we did earlier with the clock. The student at the center represents the earth and the outstretched hand with the ball at three o'clock represents the moon. The light is the sun and will be further past three o'clock. Have the student slowly turn in a counter-clockwise direction and observe the various phases on the moon.

Lesson 4

Moon Journal

Objectives: To have the students learn through observation and record data.

Materials: Journal, pencil, newspaper, poster board and markers.

Procedure: Have your students keep a journal on the moon for a months time. Have the students observe the moon daily for a months time period, sketch and write about what they observe. Have them write any questions down about what they are observing. Newspapers provide us with exact local times of moonrise and moonset and what phase you can expect to see on a particular date. Have students record the information that they get from the newspapers and their actual observations of the moon by making charts or graphs. Have the students predict each day what time they think the moon will rise and set. Make a graph to show the actual times and compare the differences for each day. Does the time of moonrise have any correlation to the phase it may be in?

The moon in comparison to the earth is large for a satellite. The moon is located at an average of 384,400 kilometers (239,000 miles) away from the earth. At perigee distance from the earth it is 356,410 kilometers (222,756 miles) away and a apogee distance from earth it is about 406,697 kilometers (254,186 miles) away. The earth's moon is fifth in size of all the moons in the solar system. The diameter of the moon is about 1/4 of the earth's diameter. The equatorial diameter of the earth is 12,756 kilometers (8,000 miles). The moon's equatorial diameters 3,476 kilometers (2,160 miles). The moon's mass is 1/80 that of the earth's. This

provides the surface gravity we are used to. Gravity depends on mass and radius. Gravity is a force that causes everything to be pulled towards its center. Through experiments Galileo learned that gravity pulls all objects down at the same speed and affects balance. The moon's surface gravity is only 1/6 the of the earth's. If an astronaut weighed 120 pounds on the earth, he would weigh 20 pounds on the moon.

Lesson 5

Gravity

Objective: To show the students that all objects are pulled down at the same speed. This "pulling down" force is called gravity.

Materials : A softball and a ping-pong ball.

Procedure: Have each student hold a softball and a ping-pong ball at equal distance from the floor. Release the two balls at the same time. Have the students observe this procedure several times and record their observations. Discuss why the balls landed at the same time.

Lesson 6

The Center of Gravity

Objective: To have the students to a simple experiment to locate the center of gravity. To have the students understand that gravity affects balance.

Materials: Students and rulers.

Procedure: Have the students balance a ruler on their index fingers, each finger at either end of the ruler. Have the students slowly move their fingers together towards the center. The students should see how they can only move one finger at a time. The finger that is not moving is were the center of gravity is. Eventually both fingers will meet. Try finding the center of gravity with other objects and balancing.

Lesson 7

How Much Would You Weigh If You Were on the Moon?

Objective: To learn and use division to determine weight on the moon. To teach measurement.

Materials: A variety of objects. A scale.

Procedure: Have the students weigh themselves on a scale. Have the students use division to determine what

they would weight on the moon. Have the students weigh a variety of objects using a scale, then determine how much these objects would weigh on the moon. Have the students create their own math word problems. Find out how much the whole class weighs on the earth and how much they would weigh on the moon.

The moon's surface is much different from the earth's. There are no continents or oceans on the moon. The moon is made of rocky material that has been melted, crushed by meteorite impacts and erupted through volcanoes. The moon has a thick crust (60 km) , a lithosphere 960-1000 km) and a partly liquid asthenosphere (100-1740 km). It is possible that there is a small iron core at the bottom of the asthenosphere but this has not been confirmed.

The moon is covered with craters. The word crater comes from the Greek word "cup" or "bowl". The craters are circular holes on the surface. The craters were formed by high-speed impacts from meteors or other interplanetary debris. Craters that are larger than 10 kilometers usually have central peaks, which are hills that have been pushed up by pressure within the moon when the weight of the rocks that were impacted was removed. There are about two or three dozen of these impact basins and the largest is about the size of Connecticut. The craters have been named after famous scientist such as Ptolemaeus and Copernicus. Astronomers believe that the great basins were formed about four billion years ago during a short period of time, afterwards only smaller impacts occurred. The earth, too, would have many craters if it were not for our atmosphere which burns up small pieces of rocks, comets, asteroids and debris by friction. The larger ones can come through, and we do have several meteor craters. The ÿ most famous and first to be discovered is the Barringer meteorite crater, near Winslow, Arizona. The crater is 4,200 ft. across and 60 ft. deep. It is estimated to be between 5,000 and 75,000 years old. Most craters have been filled with water and have become lakes and others have fallen into the ocean. The moon has no atmosphere, even the tiniest bit of dust can cause a crater to form. The earth's craters were erased by erosion due to water and wind. The moon has no air or water to erode a crater away.

Dark patches on the moon are called lowlands or maria from the Latin word mare (meaning seas). Galileo gave them this name when he viewed the moon through his telescope. We know today that they contain no water but the name stuck. Dark lava rocks fill the low basins known as maria. Solidified lava flowed across the lower-lying areas of the moon after the large impact basins were formed. These basins were formed early in lunar history, about 3.2 - 3.9 billion years ago. Maria are concentrated on the near side of the moon and cover about 16 % of the moon's surface. Anorthosires are light rocks that form the light, rugged highlands known as terrae. The lunar highlands were formed about 4.4 - 4.6 billion years ago and cover about 80% if the moon's surface. Since then there has been little activity on the moon's surface with the exception of a few small , sporadic crater-forming impacts. Most of the moons surface is covered with regolith. Regolith is a mixture of rocky debris and fine dust produced by meteor impact. Regolith is lunar soil and is found over the entire moon. Regolith can be up to 26 feet thick on the maria and up to 49 feet on the terrae. About 382 kilograms of rock samples were brought back to earth by the Apollo and Luna programs. These samples have provided scientist with answers to many of the questions they had about the moon. From the samples they learned that the moons rocks are between 4.6 and 3 billion years old. The youngest moon rocks are as old as the oldest earth rocks. Early events that probably affected both planetary bodies can now only be found by studying these moon rocks. The rocks have led us to believe that the moon was formed by the impact theory. This states that the earth collided with a very large object and the moon was formed from the ejected material. This theory also helps to explain why the moon and the earth are locked in synchronous orbit.

The astronauts also discovered that the moon is a very silent and airless place. Without air there is no sound. The sky on the moon is always dark. With no atmosphere and no magnetic field, the moon's surface is directly

exposed to solar wind. There is some evidence that hydrogen ions from solar wind have become embedded in the moon's regolith. This lunar hydrogen may be of use someday to man. Though the moon has no atmosphere, there is evidence that what are the characteristics of ice has been detected in the deep craters near the moon's south pole. The stars shine all the time. There is no weather on the moon. No rain, water, clouds, or snow. Days and nights are equal to fourteen earth days long. There is no air to spread the hot temperatures, therefore it is very warm during the day and very cold during the evening. Temperatures above boiling and below freezing can be felt on the moon.

Throughout our history the rise and fall of the tides have been studied by man. The tides are a periodic motion of bays, gulfs and seas. At most shores there are two high and low tides during a twenty-four hour period. This is the same amount of time that it takes the earth to rotate, therefore we experience a high or low tide every 12 hours and 25.5 minutes. Tides are caused by the gravitational pull on the earth and its oceans from the moon and the sun and the rotation of the earth. The moon is the principal cause of the tides because it is much closer. The sun's tidal effect is about half as strong as the moons. The gravitational pull is stronger on the side of the earth that is facing the moon causing a high tide, while simultaneously on opposite side of the earth the gravitational pull is fainter also causing high tides. The phases of the moon also affect the tides. During a full moon and a new moon when the earth, moon and sun all lie in a straight line, the gravitational pull increases causing extremely high and low tides. These tides are known as spring tides. If the moon is at perigee during a spring tide, the tidal ranges will be extremely large. When the moon is in its first and third quarters the sun is at a right angle to the moon. The height of the waves are subject to the opposing forces of the sun and the moon during these times resulting in a minimal range between high and low tides. These tides are known as neap tides. If the moon is at apogee during a neap tide, the tidal range will be extremely small. The gravitational pull that the moon has on the earth is seen more clearly with the oceans but it is also being felt on the land. Most ponds and lakes do not experience tides because the water and the land move or rise simultaneously.

Lesson 8

Tides

Objective: To have the students locate the times of the local area tides.

Materials: Newspapers, internet, tide charts.

Procedure: Have the students make a graph showing the various times of high and low tides for a week at one location. Have the students make a few graphs for several neighboring locations. Compare and contrast the times. Discuss the differences and similarities of times.

Field Trip: Plan a visit to the beach at high and low tides. Have the students make observations to the conditions of the land at both times. Discuss the differences and similarities.

Lunar eclipses are another interesting phenomena. Long ago eclipses were a source of mystery and were viewed with great fear. An eclipse is named for the object that is being eclipsed, or obscured. Eclipses occurs when the sun, earth and full moon are in relative alignment along the same plane. In a solar eclipse the moon passes between the earth and the sun. This can only happen when the moon is in the "new" phase. the far

side of the moon is illuminated and the side facing the earth is in darkness. During this time the moon cast a shadow on the earth. This shadow sweeping across the earth is called the umbra. The shadow acts like an umbrella. In a lunar eclipse the moon moves into the earth's shadow. They can only occur when the moon is in its "full" phase. During a lunar eclipse the moon darkens when it enter the earth's shadow or umbra. There is a much greater chance of seeing a to ¹tal lunar eclipse than a total solar eclipse. The reason for this is that a lunar eclipse can be seen any place on earth where the moon is shining. Lunar eclipses last longer, the maximum time being one hour and forty-seven minutes. It still receives sunlight that is refracted around earth by our atmosphere. Pollution and clouds affect the color of the moon, causing it to appear dull red. The next total lunar eclipse visible from North America will occur on January, 21 in the year 2000. It will last a total of seventy-six minutes. No special precautions are needed to safely view a lunar eclipse.

Perhaps the most exciting event relative to the moon is that man has seen the other side and has walked on its surface. The Soviets launched the first man, Yuri Gagarin, into earth orbit on April 12, 1961. On May 5, 1961, the U.S. launched Alan Sheperd into a brief suborbital flight. Six weeks later in May, in a speech to the U.S. Congress, President John F. Kennedy stated that our nation should commit itself to reaching the goal of landing a man on the moon before the decade was out. The National Aeronautics and Space Administration of the United States (NASA), now turned its efforts into achieving this goal. The race was on and the finish line was the moon.

Project Mercury, which was already underway at the time, furnished the U.S. with the experience of humans in space. A total of 10 manned flights were in the Gemini Program between March 1965 and November of 1966. They provided us with experience in long-duration space flights, rendezvous and docking techniques. Moreover they provided us with images of the moon's surface and helped on locating landing sites for the Apollo program.

Apollo was the Greek god of prophecy, sunlight, poetry and music. He rode a chariot pulled by three golden horses Facross the sky. Project Apollo was the first American space mission. It carried out eleven missions, sending nine of them to circumnavigate the moon and six of them landing men on the moon. In January of 1967 the first mission , Apollo 1 was launched. The mission was tragic. There was a fire on the launch pad killing the three astronauts aboard. It understandably delayed future Apollo missions. Between October , 1968, and May,1969, Apollos 7 through 10 were successfully launched preparing Apollo 11 for it's historical flight. On July 20, 1969, the Lunar Module landed in the moon's Sea of Tranquility at 4:18 p.m. EST. At 10:56 p.m., Commander Neil Armstrong stepped onto the moons surface and was followed by pilot Edwin E. Aldrin Jr.. The famous words "That's one small step for man, and one giant step for mankind." were said by Armstrong as he stepped off the ladder on to the surface of the moon. The Command Module pilot, Michael Collins orbited above, taking photographs and conducting scientific experiments. This Apollo mission was viewed live around the world by the largest television audience in history. The Apollo 11 mission returned to earth on July 24, 1969. The national goal of landing men on the moon and returning them safely to earth within the decade of the 1960's was achieved. Six more Apollo mission were flown to the moon prior to the end of Apollo in 1972. The success of these missions have provided us with most of the data and scientific knowledge we have of the moon. Thirty-two Americans participated in the Apollo Lunar missions. Twelve of them have walked on the moon and only four of them are still living. While writing this unit, Alan Shepard the first American to fly in space and fifth human to walk on the moon, died. He was 74 years old. Alan Shepard spent 33 hours on the moon and was the only lunar golfer. Alan Shepard's earlier flight in 1961 marked the beginning of the U.S. manned space program. It has been 36 years since Shepards first space flight and 26 years since the last Apollo astronauts returned to earth from the moon in 1972. NASA has since experienced budget cuts and ambitious plans have been halted. Space exploration and space projects have become internationalized since

the Apollo days and the feasibility of a lunar base would probably come about through international funding. As we prepare for future space and lunar explorations it remains clear that we are still learning from the Apollo missions and the experiences of their crews.

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