Maynard F. Jordan Planetarium

It's About Time

Edited by Leisa Preble

Mission Statement:
The mission of the Maynard F. Jordan Planetarium of the University of Maine is to provide the University and the public with educational multi-media programs and observational activities in astronomy and related subjects.

Cosmic Classroom

Looking for fun and interesting space activities? The planetarium staff has prepared a collection of materials we call the Cosmic Classroom for you to use before and/or after your visit. These materials are entirely for use at your own discretion and are not intended to be required curricula or a prerequisite to any planetarium visit. The Cosmic Classroom is one more way that the Jordan Planetarium extends its resources to help the front line teacher and support the teaching of astronomy and space science in Maine schools.

The lessons in this Cosmic Classroom have been edited and selected for the range of ages/grades that might attend a showing of this program at the Jordan Planetarium. Those activities that are not focused at your students may be adapted up or down in level. Our staff has invested the time to key these materials to the State of Maine Learning Results in order to save you time.

The State of Maine Learning Results performance indicators have been identified and listed for the program, the Cosmic Classroom as a package, and each individual activity within the package. The guide also includes related vocabulary and a list of other available resources including links to the virtual universe. We intend to support educators, so if there are additions or changes that you think would improve, PLEASE let us know.

Thank you, and may the stars light your way.

The Maynard F. Jordan Planetarium Staff

The Program – It's About Time

A second, a minute, an hour, a day, a week, a month, a year, a decade, a century, all measure time. It's About Time takes you up from the top of Mt. Kilimanjaro to an orbiting geosynchronous space station. As the Earth gets smaller below you, your clocks stay the same, and we view the changes that days and seasons cause on earth. This show talks about the cycles that rule our planet and our lives, and ends with the entire time since the Big Bang compressed into a single day.

We are very glad that you have chosen to visit our planetarium with your group. We hope that this guide will help you prepare your group, or help you review their experience at the University of Maine's sky theater.

State of Maine Learning Results Guiding Principles

The lessons in this guide, in combination with The Magical Millennium Tour, will help students to work towards some of the Guiding Principles set forth by the State of Maine Learning Results. By the simple act of visiting the planetarium, students of all ages open an avenue for self-directed lifelong learning. A field trip encourages students to think about learning from all environments including those beyond the schoolyard. A Jordan Planetarium visit also introduces visitors to the campus of the largest post-secondary school in Maine and encourages them to think of this as a place which holds opportunities for their future education, enjoyment and success.

Other sites on the University campus, including three museums, explore a variety of subjects, and the Visitors Center is always willing to arrange tours of the campus. A field trip can contribute to many different disciplines of the school curriculum and demonstrate that science is not separate from art, from mathematics, from history, etc. The world is not segregated into neat little boxes with labels such as social studies and science. A field trip is an opportunity for learning in an interdisciplinary setting, to bring it all together and to start the process of thinking. For a more complete discussion of field trips, please visit the Jordan Planetarium web site.

If used in its entirety and accompanied by the Planetarium visit this guide will help students to:

Become **a clear and effective communicator** through

A. oral expression such as class discussions, and written presentations
B. listening to classmates while doing group work, cooperation, and record keeping.

Become **a self-directed and life long learner** by

A. introducing students to career and educational opportunities at the University of Maine and the Maynard F. Jordan Planetarium.
B. encouraging students to go further into the study of the subject at hand, and explore the question of "what if?"
C. giving students a chance to use a variety of resources for gathering information

Become **a creative and practical problem solver** by
A. asking students to observe phenomena and problems, and present solutions
B. urging students to ask extending questions and find answers to those questions
C. developing and applying problem solving techniques
D. encouraging alternative outcomes and solutions to presented problems

Become **a collaborative and quality worker** through
A. an understanding of the teamwork necessary to complete tasks
B. applying that understanding and working effectively in assigned groups
C. demonstrating a concern for the quality and accuracy needed to complete an activity

Become **an integrative and informed thinker** by
A. applying concepts learned in one subject area to solve problems and answer questions in another
B. participating in class discussion

State of Maine Learning Results Performance Indicators

In conjunction with the Maynard F. Jordan Planetarium show The Magical Millennium Tour this guide will help you meet the following State of Maine Learning Results Performance Indicators in your classroom.

Grades 3-4

Science and Technology –

G. Universe

#1. Illustrate the relative positions of the Sun, moon, and planets.

#2. Trace the source of the Earth's heat and light energy to the Sun.

#3. Describe the Earth's rotation on its axis and its revolution around the Sun.

#4. Explore the relationship between Earth and its moon.

J. Inquiry and Problem Solving

#1. Make accurate observations using appropriate tools and units of measure.

#3. Use results in a purposeful way.

L. Communication

#3. Reflect on work in science and technology using such activities as discussions, journals, and self-assessment.

Mathematics

F. Measurement

#1. Solve and justify solutions to real life problems involving the measurement of time, length, area, perimeter, weight, temperature, mass, capacity, and volume.

English Language Arts –

B. Literature and Culture

#3. Respond to speakers in a variety of ways.

Grades 5-8

Science and Technology -

G. Universe

#1. Compare past and present knowledge about characteristics of stars and explain how people have learned about them.

#3. Compare and contrast distances and the time required to travel those distances on Earth, in the solar system, in the galaxy, and between galaxies.

5. Describe the motions of moons, planets, stars, solar systems, and galaxies.

Secondary

Science and Technology -

G. Universe

#3. Explain how astronomers measure interstellar distances.

Performance Indicators Snapshot

The Show

G. Grades 3-4

Science and Technology
G. #1, #2, #3, #4

Mathematics
F. #1

English Language Arts
B. #3

Grades 5-8

Science and Technology
G. #3

The Guide

Grades 3-4

Science and Technology
G. #1, #3, #4, J. #3, L. #3

Grades 5-8

Science and Technology
G. #1, #3, #5

Secondary

Science and Technology
G. #3

Reasons for the Season

This lesson is part of the Sixth Grade Science Teacher Resource Book (TRB3) http://www.usoe.org/curr/science/core/6th/TRB6/.
Author: Utah LessonPlans
Additional Resources: Alan Gould, Carolyn Willard and Stephen Pompea. The Real Reasons for Seasons Sun-Earth Connections. GEMS Lawrence Hall of Science, University of Berkeley, CA, 2002.

<u>Objectives and State of Maine Learning Results Performance Indicators</u>:

1. Learners will be able to identify basic informal fallacies in arguments. (5-8. Science and Technology. K. #3)
2. Learners will be able to communicate effectively using scientific language and reasoning. (3-4. Science and Technology. L. #1)
3. Learners will demonstrate awareness of social and historical aspects of science. (5-8. Science and Technology. M. #1.)
4. Learners will be able to examine the ways people form generalizations. (5-8. Science and Technology. K. #1.)

<u>The General Idea</u>:

In this activity students will learn how Earth's axis of rotation affects the angle of sunlight and the length of day. Students will first learn the relationship between the height of a light source and the length of the shadow cast by an object in the path of the light source. They will record shadow lengths to infer changes in the sun's angle over at least a 3-month period. They will also record the high temperatures on the days where shadow lengths are recorded. Finally, students will compare day length with the high temperatures.

<u>Getting Ready</u>:

Describe the relationship between the tilt of Earth's axis and its yearly orbit around the sun.

<u>What You Need</u>:

- " Season Survey ", 2-3 copies per student
- meter sticks or measuring tapes
- lamp or flashlight
- dark room
- outdoor thermometer (a minimum/maximum thermometer would be ideal)
- graphing paper
- sunrise/sunset and temperature dates for the State of Maine (http://www.erh.noaa.gov/er/gyx/index.php)

<u>What to Do</u>:

1. Give each student 2 or more copies of the "Season Survey." Have each student complete a copy of the survey. Have them ask a family member or friend (not a member of the class) to complete the other(s). When all the surveys have been completed, together as a class, tally the number of responses for each answer choice for each survey question. Discuss with the class to determine which answers are correct. If a particular answer had the highest number of responses, does that mean that it is the correct answer? Explain that historically the majority of people have believed incorrect ideas. Ask if they can think of any examples? (Earth is flat; Earth is center of the universe) Explain that the best way to find out the correct answers is to research the problem. This will be done by making observations and by learning what other scientists have discovered.
2. In a darkened room have a student hold a meter stick upright where everyone will be able to see the shadow. Move the lamp or flashlight up and down to show that when the light source is high, the shadow cast by the meter stick is short. When the light source is low, the shadow is long. Have another student sit near the meter stick and have them point to the light source with their extended arm. The angle of the student 's arm is large when the light source is high and smaller

when the light source is low.

[Sun Shadow Observations - WARNING! - Never look directly at the sun!]

3. Begin shadow measurements on a sunny day. Select a straight up and down object on the school grounds such as a flagpole, tetherball pole, or basketball standard. Choose a time of day when students will be able to consistently make measurements (perhaps a recess break). It is very important that the shadow be measured at the same time of day each time it is measured. With the whole class watching, demonstrate how to measure the shadow cast by the object. It is also important that it is measured consistently each time. Before going outside to measure, decide on a format for keeping track of the records in student science journals. Have students record the date, time and length of the shadow in their science journals.
4. Arrange for an outdoor thermometer to be placed outside your classroom (not in direct sunlight). Have students record the high temperature for the days they observe the sun's shadow. You will need to work out a system for finding the high reading. Thermometers are available with a remote sensor so they could be read inside. Or, if you use a minimum/maximum thermometer it will automatically register the high (and low) temperature each day. An alternative to tracking and recording the actual temperatures is to find and record the official weather temperatures in the newspaper or on the Internet.
5. Continue to make observations with the whole class for about a week. Little change will be noticed, but it will set the pattern for further observations.
6. Organize the class in teams of two or three to continue making observations. Arrange a schedule for the class observations and a method for sharing information with other class members. Continue to make records for a period of at least 3 months. Ideally it would be best to keep records through the school year so students could see the seasonal changes.
7. Periodically discuss with your class what is happening to the length of the shadow. Have them note what is happening to the amount of daylight. This is a good time to discuss sunrise and sunset times. Discuss why this is happening. Be sure students know that Earth's axis of rotation is the reason for the sun's changing position in the sky.
8. Have students calculate the length of daylight for two days each month. Or you may have students gather information from newspaper or Internet sources or from class observations.
9. After sufficient data is collected, organize students in small groups to make the following series of graphs: a graph showing the shadow changes, a graph showing temperature highs, and a graph showing length of daylight. Compare the similarities and differences of the three graphs. Students may notice that the coldest days are not the days with the shortest shadow or the least amount of daylight. Help them understand that one reason for this discrepancy is because the materials Earth is made of take time to cool and warm.

<u>Extra Activities</u>:

- Students locate and use Internet sources to keep track of sunrises and sunsets and daily temperatures.
- Have students make two or three graphs on the same graph paper to show comparisons.
- Use this demonstration to show students how water heats and cools relatively slowly. Fill a pan with water and place it on a hot plate, turned on high. Help students notice that the pan heats up quickly, but the water does not. Monitor the temperature of the water throughout the experiment. Turn the hot plate down slightly to medium-high. Observe whether the water becomes immediately cooler. It does not. Actually the water temperature may go up. The water temperature does not respond quickly to temperature changes. Relate this to how the earth's surface (3/4 water) does not heat up or cool down immediately.

Assessment Plan:

- Refer to the original survey students took at the beginning of the unit. Have them take the survey again. Discuss the correct answers.
- Have students choose one misconception about the way people erroneously think about the seasons and write why the misconception is false and what the correct answer is.

The Four Seasons

http://www.sciencenetlinks.com/lessons.cfm?BenchmarkID=4&DocID=256

Objectives and State of Maine Learning Results Performance Indicators:

1. Learners will be able to demonstrate how the earth's tilt on its axis results in the seasons.(5-8. Science and Technology. F. #1)
2. Learners will be able to trace the sources of earth's heat and light energy to the sun. (3-4. Science and Technology. G. #2)
3. Learners will be able to describe the earth's rotation on its axis and its revolution around the sun. (3-4. Science and Technology. G. #3)

Purpose:

To understand that it is the tilt of earth's axis that causes the seasons.

The General Idea:

From their earth studies in grades 3 through 5, students have learned about earth itself and earth in relation to the sun. Students should understand that earth is on an axis and rotates (resulting in night and day) and that earth takes about a year to orbit the sun. More specifically, students should "reasonably understand the relative size, motion, and distance of the sun, moon and the earth," or they will face a great challenge in understanding the phenomena of seasons.(*Benchmarks for Science Literacy*, p. 335-336 (http://www.project2061.org/tools/benchol/ch15/findings.htm.)

There is a common misconception of people of all ages regarding the seasons, and that is the notion that earth heats up because it is nearer to the sun. Though earth does make an elliptical orbit around the sun, it is not the distance that causes the seasons, it is the tilt of earth's axis that results in the seasons: sunlight hits different latitudes at different angles at different times of year

What You Need:

- Misconceptions About the Seasons worksheet
- Four Seasons Mission sheet
- Cosmic Map (unmarked section)
- Materials to demonstrate earth orbiting the sun. We recommend that you use an apple for the earth and poke a pencil through it to show the axis. A large ball is needed for the sun, and the bigger it is, the better. You can also use other materials. For example, clay works to make an earth and you can use a basketball for the sun (just remind students that the sun in proportion is much, much bigger than the earth).
- Chart Paper
- Magic Markers

What to Do:

The following questions will help you ascertain what your students think about how the seasons occur. Ask students the following questions and write their answers on chart paper. Save the chart paper so that you can review these answers later and allow students an opportunity to revise them.

1. What are our seasons like? (These answers will of course depend on where you live. Be sure students explore weather changes and the difference in length of day when answering this question.)
2. What are seasons like in other parts of the world? (Students may know that some parts of the world are warmer or colder. They may also know that some places are in darkness for most of the winter.)
3. What do you think causes the seasons? (Students may come up with all sorts of suggestions, some of which may be wrong. Do not confirm or criticize their ideas, but ask them to elaborate, or reason out their ideas.

Activity One:

Begin the lesson with a brief reading of the “Four Season Mission”. After they finish reading, ask the following question:

- If you are earth, as you orbited the sun, were you always in the same relation to the sun? (Clearly, the answer is no, but if students did not recognize this, have one pair do the exercise again. Have the "earth" student stop at various places and ask if she is facing the sun the same way.)

This exercise should help students visualize that the axis is always pointed in the same direction. It is not exactly analogous to earth orbiting the sun, however, because it doesn’t directly demonstrate how earth’s axis, in conjunction with the annual orbit, changes earth’s relation to the sun.

For instance, it is important for students to understand that the Northern Hemisphere "leans" toward the sun during part of the year resulting in more intense sunlight in that area of earth. During another part of the year it leans away, resulting in less intense sunlight and cooler weather.

Activity Two:

The next exercise will demonstrate visually the "tilt" of earth and how different areas receive more intense sunlight throughout the year.

Put a large ball on a desk. Hold up an apple, stem facing up, and draw the equator with a marker explaining as you go along. Now poke a pencil all the way through the apple from top to bottom and explain that the top (where the stem comes out) is in the area of the Northern Hemisphere.

Ask students:

- If the earth is tilted on its axis how should I tilt the earth (apple)?

Now, with your earth (apple) tilted properly, be sure to keep the pencil pointed in the same direction as you start to walk it (orbit) around the bigger ball (sun). It is easiest to keep the pencil facing toward the same wall. Do one full orbit, then do another orbit and stop at when the Northern Hemisphere is leaning toward the sun.

Ask the following questions:

- Where is the Northern Hemisphere pointed? (It is pointed toward the sun.)
- Do you think the Northern Hemisphere is warmer during this time of the year? (Yes, because sunlight is hitting it directly. Be sure that students don’t think it is because that part of earth is closer to the sun.)

Now, keep orbiting until the Northern Hemisphere is pointed away from the sun and ask the following:

- When the Northern Hemisphere points away from the sun, then what? (Now, the Northern Hemisphere gets cooler.)
- Why does the Northern Hemisphere get cooler? (Again it is important for them to realize that it is the sunlight falling less intensely that causes it to be cooler.)
- What about the Southern Hemisphere? (The Southern Hemisphere receives direct rays and is now warmer than it usually is.)

Students at this point should understand that sunlight falls more intensely on different parts of the earth throughout the year. Now, give them a sense of time. They probably know that it takes earth a year to orbit the sun, but may not have thought about it in the context of seasonal changes.

Asking this question will help students realize a complete picture of the seasons:

- How many months do you think go by between when the Northern Hemisphere receives direct rays from the sun as opposed the Southern Hemisphere? (About six months. This should bring home the idea that as the earth orbits, the seasons on different parts of the planet change. You may need to demonstrate the orbit one more time, stopping at each quarter to show that earth is in a different position in relation to the sun throughout the year.)
- Now have students do the Cosmic Map activity.   This activity is a fun way to reinforce what they've just learned.

Assessment

Review students' original ideas about what causes the seasons (discussed in the Motivation). You may want to use different color markers to amend certain ideas on the chart paper, or to add new ideas. Discuss how their thoughts might have changed:

- Do you have the same ideas about why we have seasons?
- If not, what is different? (Students should recognize that they might have had misconceptions.)
- Does this make you wonder if you have ideas about other things that might not be exactly right? (Invite students to feel comfortable with the fact that they may have wrong ideas about some things, and that they should never assume they are right.)

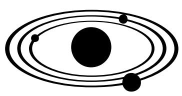
To assess student understandings of the seasons, ask them to demonstrate with either a drawing, poster, or model how and why the seasons change. Regardless of how they demonstrate this concept, students should show that:

- the earth is tilted on an axis
- different parts of earth receive direct rays from the sun at different times of the year
- the relation of earth's hemispheres in relation to the sun are what result in different seasons

A Planetary Day, A Planetary Year

Based on A planetary day is caused by one rotation. A planetary year is caused by a revolution. by Susan Reynolds and Onondaga-Cortland-Madison Board of Cooperative Educational Services math, Science and Technology.

Objectives and State of Maine Learning Results Performance Indicators:



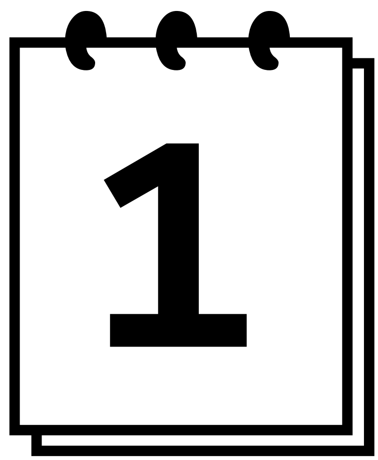
1. Learners will be able to describe the cycle of day/night and attribute it to the turning of Earth. (3-4. Science and Technology. G. #1.) (5-8. Science and Technology. G. #5.)
2. Learners will be able to define rotation and explain how it causes a planetary day (3-4. Science and Technology. G. #3.)
3. Learners will be able to define revolution and identify a planetary year as one revolution. (3-4. Science and Technology. G. #3.)

The General Idea:

How do we measure a day? A year? Students often take for granted that a day has 24 hours in it and that there are 365 days in a year. But how do we determine what a day really is? Or how many days there are in a year? This activity will help students to understand that a planetary day is the amount of time that it takes for a planet to rotate once around its axis and a year is the amount of time it takes for a planet to revolve once around the Sun.

Getting Ready:

- Set up the globe and light



What You Need:

Globe
Small piece of clay
Light

What To Do:

1. Using the globe, place a piece of clay on your state
2. Shine the light on the globe
3. Slowly rotate the globe from west to east

What To Discuss:

1. What does it represent when our state faces the light?
2. What does it represent when our state faces away from the light?
3. How long does this combination of daytime and nighttime take on Earth?
4. What do we call a 24-hour period on the planet Earth?
5. If this 24-hour period is called an Earth day, what would a day on Jupiter be called? On Mars? (Jupiter day, Mars day)
6. How might we name a day so that we could talk about a day on any planet? (a planetary day, one rotation around a planets axis causes one planetary day no matter which planet you are on.)

What To Do:

1. Using the light to represent the Sun, walk around the light carrying the globe to represent revolution.
2. You can also spin the globe as you walk so that students can see the difference between the rotation and the revolution of the Earth.

What To Discuss:

1. How long does it take for the Earth to revolve once around the Sun?
2. How many days are there in a year?
3. One revolution of the Earth around the Sun equals one Earth Year. If we were talking about any planet what would you call one revolution? (a planetary year).

Light Years

Based on <u>Large distances in space are measured in light years.</u> by Susan Reynolds and Onondaga-Cortland-Madison Board of Cooperative Educational Services math, Science and Technology.

<u>Objectives and State of Maine Learning Results Performance Indicators:</u>

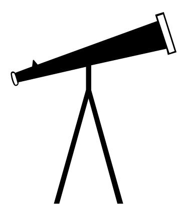
1. Learners will be able to define the term light year (5-8. Science and Technology. G. #3.) (Secondary. Science and Technology. G. #3)
2. Learners will be able to explain the distances of some stars close to our solar system (5-8. Science and Technology. G. #1.)

<u>The General Idea:</u>

Ever wonder why scientists felt the need to develop a new measure for distance? Last night, if it was clear, you might have seen the group of stars known as the Big Dipper. The closest of those stars is approximately 432 trillion miles away. Because of these vast distances, scientists created a new unit of measure called the light year.

<u>Getting Ready:</u>

- Have students review place value into the trillions



<u>What You Need:</u>

Copies of light years work sheet

<u>What To Do:</u>

1. Define the speed of light (180,000 miles per second)
2. Using multiplication, show how far light travels in one year
3. Given the mileage from the Earth to the Sun (93 million miles, also known as an Astronomical Unit or AU) have student compute the time light would need to travel from the Sun to Earth

<u>What To Discuss:</u>

1. If the Sun were to suddenly change color, how long until we would know?
2. If we look at objects deep in space tonight, what are we really observing? (the objects as they appeared in the past).
3. If a star is located 10 light years away from Earth, what is its distance from Earth in miles?

<u>What To Do:</u>

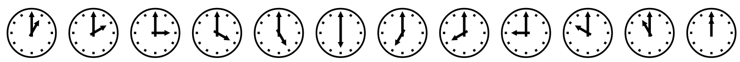
1. Hand out the Light Years worksheet for students to complete on their own, in groups, or as homework.

The Maynard F. Jordan Planetarium - Cosmic Classroom Activity

Making a Star Clock

Objectives and State of Maine Learning Result Performance Indicators:

1. Learners will be able to tell time by the stars using a Star Clock
2. Learners will be able to observe the motion of the stars as the Earth rotates (3-4. Science and Technology. G. #3.)



The General Idea:

The shimmering stars high in the sky is a beautiful and familiar sight. But did you know that you can tell time by observing their trip around the Earth? By using a Star Clock you can determine the time of night by comparing the stars to the position of the horizon. This activity, and subsequent uses of the Star Clock, will help student to recognize the constellations and their changing locations in the night sky.

Getting Ready:

- Photocopy both Star Clock worksheets

What You Need:

A photocopy of both Star Clock worksheets for each student
A brass paper fastener for each student

What To Do:

4. Hand out copies of the Star Clock worksheet to each student.
5. For a sturdy clock, either print on heavy paper or glue Circle A and Circle B to cardboard before cutting.
6. Using sharp scissors, cut out Circle A and the small window inside it labeled "CUT", and Circle B.
7. Push a paper fastener through the North Star on Circle A and the dot in the center of Circle B.
8. To use your Star Clock, choose a clear and starry night to test it.
9. Allow time for your eyes to adapt to the darkness.
10. Face North and locate the Big Dipper.
11. Hold the Star Clock in front of you so that the present month in on the top of the clock.
12. Rotate the STAR WHEEL so that the Big Dipper is in the same position as it is in the sky.
13. Read the time in the window of the star wheel.

What To Discuss:

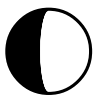
1. How does the star clock work?
2. Why are the stars in different places at different times of the year?
3. How is it possible that we can see some constellations every night (circumpolar constellations) and other constellations seem to come and go with the seasons?

Telling Time by the Phases of the Moon

<u>Objectives and State of Maine Learning Results Performance Indicators:</u>

3. Learners will be able to tell time by the phase and position of the moon using a Moon Phaser (3-4. Science and Technology. G. #4.) (5-8. Science and Technology. G. #5.)

<u>The General Idea:</u>



The silvery moon high in the sky is a beautiful and familiar sight. But did you know that the moon actually follows a very ridged pattern in its trip around the Earth? By using a Moon Phaser you can determine the time of day by comparing the sun and the moon positions. This activity, and subsequent uses of the Moon Phaser, will help student to recognize the moon's repetitive path around the Earth.

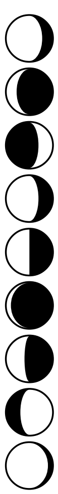
<u>Getting Ready:</u>

- Make photocopies of the attached Moon Phaser pattern
- It's good to do this activity on a day when the moon is visible during the school day

<u>What You Need:</u>

A copy of the Moon Phaser Pattern for each student
Scissors for each student
A hole punch
A paper fastener for each student

<u>What To Do:</u>



1. Hand out a copy of the Moon Phaser Pattern to each student
2. Have the students cut out both parts of the Moon Phaser and punch a hole in the appropriate place on each piece.
3. Connect the two pieces with a brass paper fastener (with the Horizon Card on top).
4. When the students are finished making their Moon Phasers, take the class outside to a place where the moon is viable.
5. Hold the moon Phaser so that the half circle Horizon Card has the word HORIZON right side up.
6. To find the time that a phase of the moon rises, rotate the horizon card until the desired phase is at the "E" (East). The "To the Meridian" arrow will point to the time of rising.
7. To determine when the moon phase crosses the meridian (when it is at its highest point in the sky as it travels from East to West), rotate the Horizon Card until the desired phase is lined up with the "To the Meridian" arrow. Read the time pointed to by the "To the Meridian" arrow.
8. To find the time that a phase of the moon sets, rotate the Horizon Card until the desired phase is at the "W" (West). The "To the Meridian" arrow points to the time of setting for that phase.
9. To tell time by the moon's phase and sky position, locate the moon in the sky. Rotate the Horizon Card until the Moon Phaser matches the sky. Read the time that the "To the Meridian" arrow points to.

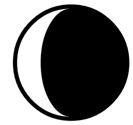
<u>What To Discuss:</u>

1. How is it possible to tell time by the phase and position of the moon?
2. What causes the phases of the moon change?
3. How accurate are the Moon Phasers that the class made?
4. Is that as accurate as they can get?

5. How might the be made more accurate?

Continuations/Extensions:

1. The moon rises about an hour later each day as a result of the moon's orbit around the Earth and the Earth's orbit around the Sun. This means that more of the moon's surface becomes visible to us as each day passes. About seven days after the new moon the first quarter moon rises. Have students determine when the first quarter moon rises, when it sets, when it crosses the meridian, etc. You might also want to have students find out information such as where the moon will be when the sun sets, etc. You can also repeat these steps with other moon phases. Then have students look for the moon at that time on that day to see if their predictions where correct.



Vocabulary List

Astronomer	A person who studies and contributes to the science of astronomy.
Atmosphere	A layer of gases that surround a body such as a planet.
Axis	An imaginary straight line around which an object rotates.
Black Hole	A cosmic body of extremely intense gravity from which nothing, not even light, can escape.
Comet	Frozen masses of gas and dust which have a orbit through the solar system.
Constellation	A grouping of stars, considered by humans to form a picture in the sky. Often related to mythology.
Day	The time it take for a planet to make one full rotation (on Earth, 24 hours).
Electromagnetic Radiation	A series of electromagnetic waves.
Galaxy	A cluster of stars, dust, and gas held together by gravity.
Gravity	The force of attraction between two objects which is influenced by the mass of two objects and the distance between the two objects.
Light Year	The distance that light travels in one year, approximately 6 trillion miles.
Milky Way galaxy	large spiral galaxy consisting of several billion stars, one of which is the Sun.
Moon	A natural satellite orbiting a planet.
Orbit	A specific path followed by a planet, satellite, etc.
Planet	A massive object orbiting a star.
Revolution	The circling of a smaller object around a larger object.
Rotation	The spinning of an object on its axis.
Solar System	The system of planets, moons, and other objects revolving around a star (in our case, the Sun).
Star	a massive, self-luminous celestial body of gas that shines by radiation derived from its internal energy sources.
Sun	Sol, the star that is closest to Earth and from which we get heat and light energy.
Time	The measured or measurable period during which an action, event, process, or condition exists, occurs or continues.
Time Dilation	In the theory of special relativity, the "slowing down" of a clock as determined by an observer who is in relative motion with respect to that clock.
Universe	The vast expanse of space which contains all of the matter and energy in existence.
Wormhole	A hypothetical structure of space-time envisioned as a long thin tunnel connecting

	points that are separated in space and time.
Year	The time it take for a planet to make one full revolution around a star, in our case, the Sun (on Earth, 365.25 days).

Some good books to use with It's About Time

Clocks!: How Time Flies

Aust, Siegfried. 1991, Lerner Publications.

Discusses time and the invention of clocks to keep track of daily activities.

Keeping Time

Branley, Franklyn Mansfield. 1993, Houghton Mifflin.

Describes the different ways in which we measure time.

Time

Walpole, Brenda. 1995, Gareth Stevens Pub.

Discusses the elements of time and various ways to measure it.

The Millennium

Cohen, Daniel. 1998, Pocket Books.

A compendium of information and trivia about the coming of the new millennium.

Some good web sites to use with It's About Time

greenwich2000.com/time

Information about Greenwich Mean Time from the official Greenwich 2000 web site.

physics.nist.gov/time

A National Institute of Standards and Technology (NIST) Physics Laboratory presentation on the history of time.

aa.usno.navy.mil/AA/faq/docs/millennium.html

The 21st Century and the 3rd Millennium - When Will They Begin? From the U. S. Naval Observatory

www.calendarzone.com

Examples of and essays about a wide variety of calendars

www.time-travel.com

Home page of the Time Travel Research Center

Lessons From The World Wide Web

Also, a wide variety of lesson plans and activities can be found on the World Wide Web. These sites are dedicated to lesson planning in a variety of subjects.

cse.ssl.berkeley.edu

The Center for Science Education at U. C. Berkeley Space Science Laboratory home page with a link to the Science Education Gateway, Lesson Plans

www.outerorbit.com

Space News' Outer Orbit home page offers links to lesson plans and other space related links.

btc.montana.edu/ceres

Maintained by the Burns Telecommunications Center, this page links to educational activities and classroom resources.

www.bbc.co.uk/worldservice/science

The British Broadcasting Company's web site for science related material.

spaceplace.jpl.nasa.gov/spacepl.htm
This California Institute of Technology and NASA Jet Propulsion Laboratory site for kids offers information and activities .

discoveryschool.com
This Discovery Channel education site allows teachers to search for lesson plans by grade and subjects.

ericir.syr.edu/Projects/Newton
Lesson plans based of the popular PBS series, Newton's Apple

www.thegateway.org
Sponsored by The U.S. Department of Education's National Library of Education and ERIC Clearinghouse on Information & Technology, this site offers lesson plans for all subjects and all grades.

www.thursdaysclassroom.com
Lesson plans, activities, and teacher resources presented from Science@NASA

Astronomy Web Sites Worth a Visit

www.ume.maine.edu/~lookup
The Maynard F. Jordan Planetarium and Observatory home page.

www.ume.maine.edu/~lookup/tgreso.htm
The teacher resources and bibliography page on the Maynard F. Jordan Planetarium web site

space.jpl.nasa.gov
NASA's Jet Propulsion Laboratory web site

emma.la.asu.edu/dsn_solarsyst.html
An astronomy information page compiled by Ken Edgett, Arizona State University

ssd.jpl.nasa.gov
A site about our solar system maintained by the Solar System Dynamics Group of the Jet Propulsion Laboratory.

seds.lpl.arizona.edu/nineplanets/nineplanets/nineplanets.html
A Multimedia Tour of the Solar System from the Students for the Exploration and Development of Space

www.teelfamily.com/links/space.html
Space and astronomy links for kids

www.clearsail.com/astronomy.htm
Astronomy links from the ClearSail student fun and research site

www.dustbunny.com/afk
A web site about astronomy, designed for kids, with tons of information

www.tcsn.net/afiner/intro.htm

A "just for kids" site about the solar system

hawastsoc.org
The Hawaiian Astronomical Society's home page

spaceplace.jpl.nasa.gov/spacepl.htm
The Jet Propulsion Laboratory's web site for kids

www.calacademy.org/planetarium
Alexander F. Morrison Planetarium home page

www.nss.org/askastro
The "Ask an Astronaut" web site

stardate.utexas.edu
Learn what's going on TODAY in astronomy on the "Star Date" web page, maintained by the University of Texas' McDonald Observatory

einstein.stcloudstate.edu/Dome/constellns/constlist.html
Find out the names of each constellation and the stories behind those names

Activities/Worksheets