Oakland Schools Curriculum Unit Plan

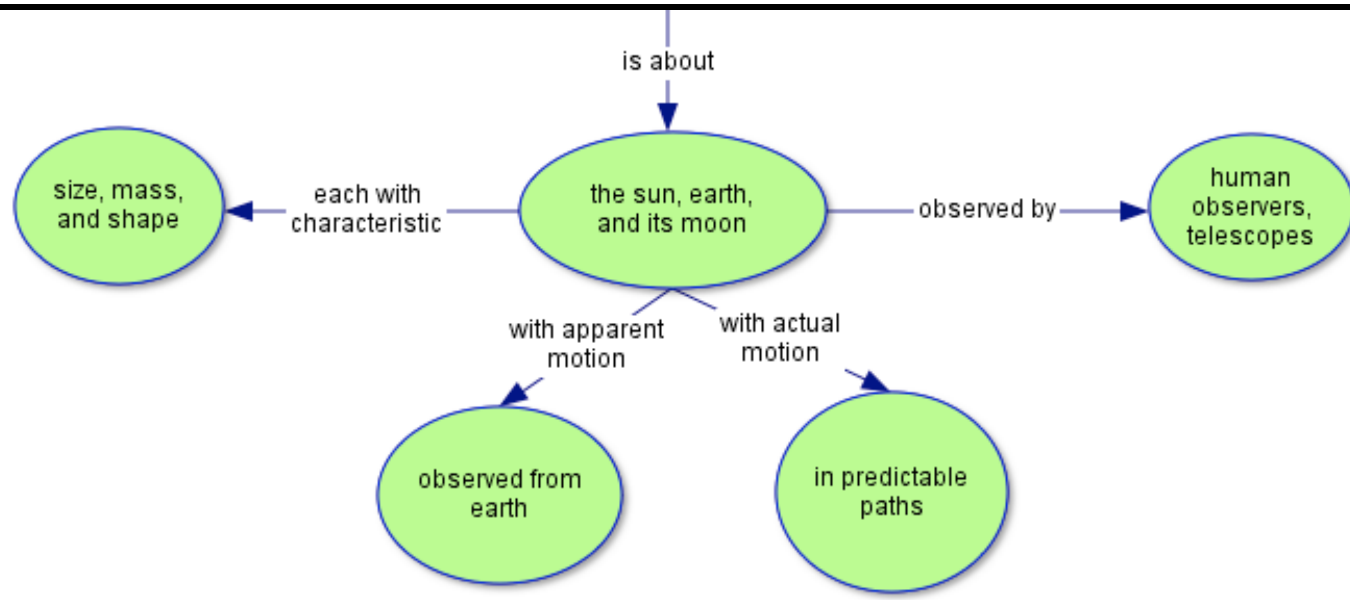
Fourth Grade: Matter and Energy

Motion in the Solar System

Big Picture Graphic   Duration: 4-6 weeks

Overarching Question:

How do forces at a distance affect energy and motion?



Questions to Focus Assessment and Instruction:	*Intellectual Processes:*
1. *What are the characteristics of the sun, earth, and earth's moon?* 2. *How are the apparent movements of the sun, earth, and earth's moon observed on this planet?* 3. *How are the apparent movements of the sun, earth, and earth's moon related to our calendar?* 4. *How can we model the actual movements of the sun, earth, and earth's moon?*	*Cause and Effect* *Comparing/Contrasting* *Describing* *Interpreting* *Measuring* *Organizing*

Unit Abstract

In this Earth science unit students are introduced to the characteristics and motion of common objects in the sky, the sun, Earth and Earth's moon. They contrast the sun and Earth's moon and compare their characteristics to those of the Earth. Students explore similarities and differences in orbits, relative distances and their ability to support life. As they learn and model the rotation and revolution of the Earth, they define a year, and day and night by relating the apparent motion of sun and Earth's moon to calendar events. Students continue to examine the motion of objects in the sky as they study the phases of the moon and its monthly orbit around the Earth. They differentiate the apparent motion of the sun and Earth's moon across the sky through day and night and the seasons. Students conclude the unit by demonstrating their understanding of the sun, Earth and Earth's moon through various activities, illustrations, and models.

Grade Level Content Expectations

Students will:

- make purposeful observations of common objects in the sky, such as the sun and the moon (E.ST.04.11, S.IP.04.11).

- develop research strategies for information gathering to compare and contrast the characteristics of the sun, moon, and earth including relative distances and abilities to support life (E.ST.04.12, S.IA.04.14).

- demonstrate and describe through illustrations and activities the orbit of the earth around the sun as it defines a year (E.ST.04.21, S.RS.04.11).

- demonstrate and explain through activities and models that the spin of the earth creates day and night (E.ST.04.22, S.RS.04.11).

- use data/samples as evidence to separate fact from opinion when describing the motion of the moon around the earth (E.ST.04.23, S.RS.04.14).

- communicate and present findings from nighttime observations to explain how the visible shape of the moon follows a predictable cycle which takes approximately one month (E.ST.04.24, S.IA.04.13).

- conduct a simple and fair investigation and construct charts from data and observations to describe the apparent movement of the sun and the moon across the sky through day/night and the seasons (E.ST.04.25, S.IP.04.13, S.IP.04.16).

Key Concepts

apparent motion
earth
moon
orbit
star
sun

Name ___________________________ Date ___________________________

4th Grade Earth Unit Pre Assessment

Read and answer the following questions. *Remember this is just to "see" what you "already" know and where we need to go from here.

1. Why does the Sun appear larger than other stars?

   A. The Earth is small
   B. The Sun is very bright.
   C. The Sun is the largest star
   D. The Sun is the closest star to Earth.

2. About how long does it take for the Earth to make one orbit around the sun?

   A. 7 days
   B. 28 days
   C. 180 days
   D. 365 days

3. What does "rotation" mean? Give an example.

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4. How long does the Earth take to make one rotation?

   A. One day
   B. One year
   C. One month
   D. One week

5. What does revolve mean? Give an example.

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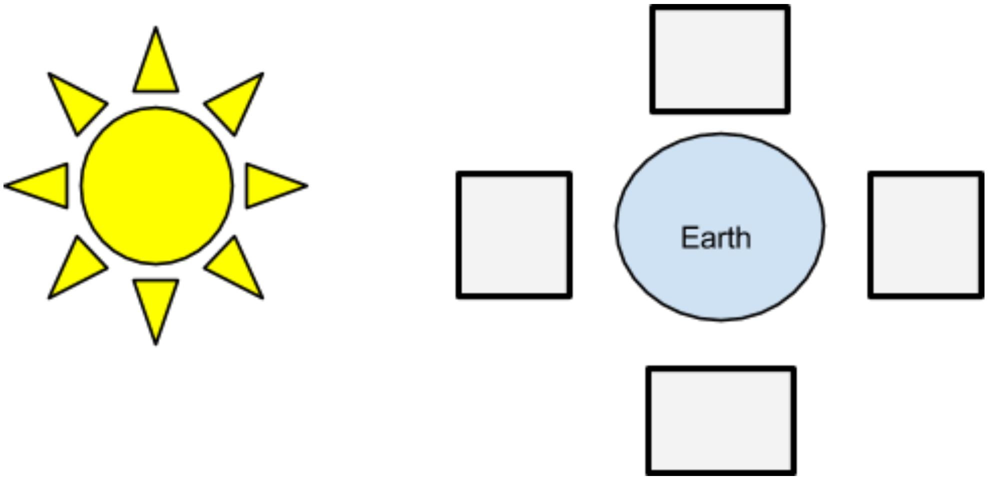
6. The moon changes shape every night. We call these changes, “phases.” Name the phases of the moon.



7. What path does the Sun travel along as it appears to move through the sky?

A. East to West
B. Left to Right
C. North to South
D. Up to Down

8. Is the sun larger or smaller than the moon? Explain how you know.

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9. What scientific tool would you use to observe the stars in the sky?

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10. Compare and contrast the Earth, moon, and the Sun. Give two similarities and two differences between the Earth and moon or the Earth and Sun.

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Unit 4 – Sun, Moon and Earth

<u>About Our Scope Unit/Lesson Template</u>

This template is designed to serve several teaching and learning principles considered as staples of state of the art science instruction. Here are the key principles in summary:

- It's critical to **elicit prior knowledge** as a unit or lesson begins
- **Key questions** should drive student explorations and investigations
- **Activity Before Concept** – Student inquiry-based explorations, which give personal experience with phenomena and ideas, should precede a presentation of science ideas.
- **Evidence is the heart of the scientific enterprise.** Students generate evidence and analyze patterns in data that help to construct scientific explanations around key questions.
- **Concept Before Vocabulary** – attaching science vocabulary to concepts developed by student investigations yields more success than beginning a unit or lesson with a list of science vocabulary.
- **Talk, argument and writing** are central to scientific practice and are among the most important activities that develops understanding.
- **Application** of the ideas provides review, extends understanding and reveals relevance of important ideas.
- **Assessment** of knowledge, skill and reasoning should involve students throughout the learning process and be well aligned to the main objectives and activities of the unit.

The Scope Science template is designed to put these principles into practice through the design of the ***SCOPE LEARNING CYCLE FOR SCIENCE***. Each unit has at least one cycle. The components are listed below:

The Key Question for the Unit	Each unit has one, open ended driving question that relates to all the content and skills of the unit. The Key Question is presented at the opening of the unit and revisited at the unit's conclusion.
Engage and Elicit	Each unit begins with an activity designed to elicit and reveal student understanding and skill prior to instruction. Teachers are to probe students for detailed and specific information while maintaining a non-evaluative stance. They also can record and manage student understanding which may change as instruction proceeds.
Explore and Investigate	A sequence of activities provides opportunities to explore phenomena and relationships related to the Key Question of the unit. They will develop their ideas about the topic of the unit and the Key Question as they proceed through the Explore and Investigate stage of the learning cycle. Each of the activities may have its own Key Question or central task that will be more focused than the unit question. The heart of these activities will be scientific investigations of various sorts. The results, data and patterns will be the topic of classroom discourse and/or student writing. A key goal of the teacher is to reference the Key Question of the unit, the Engage and Elicit of the students and to build a consensus especially on the results of the investigations.
Explain	Each unit has at least one activity in the Explain portion of the unit when students reconcile ideas with the consensus ideas of science. Teachers ensure that students have had ample opportunity to full express their ideas and then to make sure accurate and comprehensible representations of the scientific explanations are presented. A teacher lecture, reading of science text or video would be appropriate ways to convey the consensus ideas of science. Relevant vocabulary, formal definitions and explanations are provided. It's critical that the activity and supporting assessments develop a consensus around the Key Questions and concepts central to the unit.
Elaborate and Extend	Each unit cycle has at least one activity or project where students discover the power of scientific ideas. Knowledge and skill in science are put to use in a variety of types of applications. They can be used to understand other scientific concepts or in societal applications of technology, engineering or problem solving. Some units may have a modest Elaboration and Extension state where students explore the application of ideas by studying a research project over the course of a day or two. Other units may have more robust projects that take a few weeks.
Evaluation.	While assessment of student learning occurs throughout the unit as formative assessment, each unit will have a summative assessment. Summative assessments are posted in a separate document.

Contents

Sun, Moon and Earth

Introduction
This is an astronomy unit that attends to the concepts related to the Earth, Sun and Moon, their motions and cycles, and the characteristics of these objects. It is developed in two cycles; the first cycle explores tools that we can use to observe the sky and the second cycles explores how to interpret the data into a cohesive picture of the motions, relative distances and sizes and the characteristics of the Earth, Sun and Moon.

Topically, the unit addresses concepts within the disciplines of earth and space systems science, which is a very large topic. But the Oakland School Science Scope has established a good deal of coherence by organizing the unit into two cycles:

Cycle 1: Designing Ways to Observe the Sky.
Cycle 2: Making Sense of Observations of the Sky.

The resources and opportunities to address these topics are of such abundance and quality that the unit has the tremendous potential to be a highly relevant, real world and investigation rich experience for students. As teachers look for ways to have students use real world data, apply interactive technology to real world questions and foster meaningful tasks for reading, writing, argumentation and mathematics and framed by the Common Core Curriculum Standards, the issues here provide abundant opportunity. The main limitation is the class time available given other content demands.

On the Common Core State Standards for English Language Arts and Literacy in Science

All science teachers will find the Common Core State Standards of ELA and tremendous asset for reaching learning objectives in science education. Reading, writing, argumentation and discourse are central proficiencies necessary for success in science. All teachers should become fluent with the document and are likely to find it validating.

http://www.corestandards.org/assets/CCSSI_ELA%20Standards.pdf

These standards are best reached with science instruction that connects content to real world problems and experiments, complimented with scientific writing, challenging questions, processes for classroom discussion and debate and use of scientific text.

It is recommended that teachers require students to use an interactive science journal to support learning in this unit. Here are some features and policies to consider:

- A composition book or a drawing book with plain pages
- Drawings could be kept on the right side of the journal and notes/observations about it could be kept on the left, modeling a science journal.

Cycle 1: Designing Ways to Observe the Sky

Introduction

This portion of unit 4 introduces real observations of the sky and tools that can be used to make observations.

Specific objectives in this unit address how to observe, what kinds of instruments can we use to observe, and what is the best way to observe distant objects. Teachers may want to have students keep a portfolio or student scrapbook of their observations and drawings. There are many options for such a portfolio, from a simple folder to an online journal site. The Journal will be a place for students to answer questions and reflect on the activities they accomplish.

Objectives

- Identify the Sun and Moon as common sky objects, and to observe them in order to contrast and compare them.
- Use direct observations, to explain the motions and characteristics of sky objects.
- To understand motions in the sky as regular patterns and from physical forces that can be understood.
- To be able to use various tools, from simple to more complex, to observe the sky and use the observations to understand the objects in the sky.
- Model the motions of the Sun and Moon as they appear in the sky.
- To be able to reproduce images from observations taken, e.g. Moon and Sun drawings.

Key Question: How can we make tools and observations to understand the movement of celestial bodies and how they affect us?

Engage and Elicit

Activity 1 - Observing the Moon During the Day

Purpose
To elicit and begin to record student understanding about the Moon and its characteristics.

Activity Description
Students make guided observations of the daytime moon, making descriptions and drawings in an Astronomy Journal. Being an elicitation activity, there should be a very open, non-judgmental conversation between the teachers and students in regards to their drawings. Observations of the Moon can range from simple drawings to more complex drawings of lunar features.

Focus Question
Can we see the Moon during the day? How can we observe it?

Duration
10-15 minutes a day, for a period of time (week or month).

Materials
- Daytime moon observation activity from Madison School District Planetarium https://planetariumweb.madison.k12.wi.us/mooncal/daymoon.htm
- Drawing sheets, or student astronomy journals
- Orientation materials to Interactive Science Notebooks for teacher use http://www.sciencenotebooks.org/ http://www.youtube.com/watch?v=NVdRfuWe4YM

Teacher Preparation
1. Review the activity for tips on observing the moon in the daytime.
2. Identify the days when the moon will be visible from a location outside the classroom.
3. Students should make an astronomy journal or portfolio, a place to keep their drawings and observations of the sky. Review the resources on Interactive Science Notebooks and determine the approach to be used.

Classroom Procedures
1. Teacher identifies some days when the Moon will be visible, either in the morning or in the afternoon, using the above website or some other source. It would be best to have a group of days, perhaps the week, to set aside 10 minutes a day or less for viewing the moon.
2. Take the students outside to a comfortable viewing area. A southern view of the sky is necessary- from east to west facing south.

3. Start the conversation of Moon observations by eliciting ideas about what you can see in the sky.
4. If it is partially cloudy or the moon is low, it may take a few minutes for the students to locate the moon. When they do, have them draw the moon with as much detail as they can see. They should include features on the earth that are in their field of view.
5. If students are surprised at being able to see the moon during the day, conversation could arise about why we are able to see the moon during the day and night. If no conclusion is reached, the question can be put in a “parking lot” for further exploration.
6. Have student create and begin to use an Astronomy Journal in the Interactive Science Notebook format.

Explore

Activity 2 - Eat an Orange

Purpose
To engage students in the skill of close observation and recording. This activity should come early in the previous moon-observations ongoing activity.

Activity Description
With their drawing journal, students carefully examine an orange in order to draw it. Once they draw the orange, the oranges are lined up for identification.

Focus Question
Are we able to identify an orange by its detailed drawing?

Duration
One class period

Materials
- Astronomy Journals
- Oranges (or some other object that is homogeneous but imperfect, such as an egg. If you feel oranges may be too challenging, potatoes are excellent, since they are all pretty different but also very similar at first glance.)
- Drawing tools such as drawing pencils and real drawing paper, enough for each student.

Classroom Procedures
1. Teacher should have enough oranges for the students to each have one or at least share one with a partner. Any garden variety orange is fine, even Clementines. Though they may all seem the same at first glance, students should quickly begin to examine them for imperfections, marks, bumps and irregularities.
2. Once the students and teacher feel their oranges have been drawn in enough detail, teacher can collect them and students will try to match the drawings to the oranges.
3. Students may have trouble at first really "seeing" and drawing an orange- so teacher may want to model some techniques such as starting from the top and sketching in bumps and marks as you move down the orange.
4. Teacher can set the oranges in a line and distribute drawings randomly to students. Students will inspect the oranges and compare to their drawing. Once all the oranges have been matched up, the students can eat them!
5. If there are oranges that aren't recognizable from the drawings, or the drawings aren't detailed enough, the remaining students without oranges should give at least one detail about a remaining orange that they can recognize that is different from the others, and they too can have an orange.

Explore

Activity 3 - Make an Astrolabe

Purpose
To make an astronomical measuring tool and to learn how it is used.

Activity Description
Students will make a paper astrolabe (also called a clinometer) and use it to measure angles in the sky. It is critical that they understand the risks of looking straight into the sun and are taught to use the astrolabe safely. After the activity they are prompted to determine another use for the astrolabe, such as to measure the angle to the top of their house from different distances.

Focus Question
How can we measure angles in the sky?

Duration
One class period

Materials
- Making a simple astrolabe (printable template) http://cse.ssl.berkeley.edu/AtHomeAstronomy/activity_07.html
- Using a simple astrolabe (with warning about the Sun) http://cse.ssl.berkeley.edu/AtHomeAstronomy/activity_08.html
- Information on astrolabes http://www.astrolabes.org/

Teacher Preparation
1. Use the websites to prepare materials for the students and understand the basic activity.
2. Print instructions for student use, or plan to project on a computer screen.
3. Review background on astrolabes for more on their history and uses.

Classroom Procedures
1. Prompt students to cut out the astrolabe template.
2. Students can assemble the astrolabe as shown in the website using straws and tape.
3. Teacher and students should use precaution at all times. Students should be warned about the dangers of looking at the Sun.
4. Students can begin measuring the altitude of the Sun over time as described in Activity 08 from the website above, or they may use it to track the Moon.
5. After students use the astrolabe in class on the Sun or Moon challenge them to come up with another use. A fruitful option would be to ask student to propose an investigation that they could conduct and report on outside of class.
6. Students should provide a written proposal for teacher approval, and then document their investigation in their Astronomy Journals.

Explore

Activity 4 – Using your Hand to Measure the Sky

Purpose

To provide a way to measure angles in the sky with a fist, something that students always have with them.

Activity Description

Students will calculate the number of degrees in their fist so that they can use it as an astronomical tool. If they are careful, their fists will be fairly accurate astronomical tools.

Focus Question

How can we use our hands to measure objects in the sky?

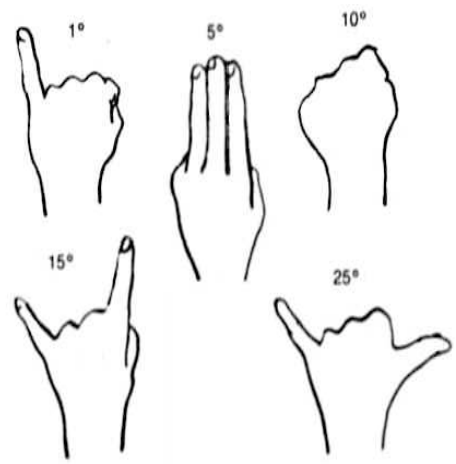


Fig E.
The Common Sky Measurements

Duration

One class period

Materials

- Students' fists
- Calculator

Teacher Preparation

1. Teacher should have the calculations ready on a whiteboard or overhead so the students can follow the relationship you give them to find out the angular size of their closed fist.

Classroom Procedures

1. Have students stand in the classroom if you have enough space, or in a larger room or outside if you do not. They will need to stretch out their arms and make a full circle without bumping into anyone.
2. Students will hold out one arm to their side, not in front of, their body. It is important that they keep their arm to the side and not let it drift to the front as they count fists. Doing so will change the distance from the fist to the eye, and therefore change the angle.
3. Students will use a background object to sight the edges of their fist, moving the back edge of the fist to the place where the front edge was, and begin counting how many fists it takes to go around 360 degrees, a circle.
4. Teacher may want to model this activity. Have students repeat the procedure two or three times for more accuracy. Use the average number of fists to calculate its angular size.
5. Calculation is: 360 degrees divided by the number of fists in a complete circle equals the number of degrees in one fist.
6. Calculate the number of degrees in their fist.

7. Once students have calibrated their fists, have them use their fists to see how high the Sun is in the sky. Or if the Moon is out, have them find the angular separation between the Sun and the Moon.
8. Students can use this in conjunction with their astrolabes. Have them compare data taken with both methods in their Astronomy Journals and have them identify advantages and limitations of each.

Explore

Activity 5 – Shadow Play

Purpose
To understand the nature of shadows and how they tell us about seasons of Earth.

Activity Description
Shadow Play is a set of activities and explanations from NSTA on shadows and how they help us understand motions and phenomenon on the Earth and in the sky. Shadow Play links shadows to seasons. Students will be outside in sunlight noticing characteristics of shadows and how they relate to the Sun. Then they build a simple sundial with a pencil and clay to observe shadows over a longer period of time. They write about their experience in their Astronomy Notebooks. They will also use their fists to make measurements of the height of the sky, from Activity 4 in this cycle. Students use a night sky program to condense time so that they can gather data on the position of the Sun in the sky over a length of time and analyze this data to draw conclusions about the path of the Sun through the sky each season. Then students answer a series of productive questions about the activity and what they have learned.

Focus Question
How do shadows help us understand seasons?

Duration
Variable, depending on the activities you use, and ongoing.

Materials
- The NESTA packet Shadow Play http://learningcenter.nsta.org/files/sc1205_31.pdf
- Atlas Url:
- Other materials needed for the lessons that are listed in the packet (sidewalk chalk, whiteboards, computers, strong light source, action figure, flashlight).
- *Starry Night* (Imaginova) software. http://www.starrynight.com/

Teacher Preparation
1. Download Shadow Play packet and read the background information and procedures.
2. Gather materials from the list above. *The Starry Night* software is optional, or you might choose to use free software like *Stellarium*. http://www.stellarium.org/
3. You will need to choose a sunny day to start where students can be outside.

Classroom Procedures

1. Begin with the first activity on the packet: have students work in pairs and analyze the shadows that they make with their bodies. Then they answer some questions about their experience and observations.
2. The next day, they will construct a simple shadow stick indoors and use a flashlight to simulate the Sun at different times of day. They then analyze their observations and answer more questions about the shadows they observe, listed in the packet.
3. Students will compare their outdoor data with the data they got indoors with the shadow stick and the flashlight. After comparing the data they can draw some conclusions about the position of the Sun making different length shadows. They will also learn some vocabulary terms given in the packet.
4. During any outdoor activity or even indoors near a window, students can practice using their fists or their astrolabes (or both!) to measure the *altitude* of the Sun at different times of day and also at the same time of day in different seasons. However, planetarium software might be easier to use and more efficient than waiting months to collect this data, at least as a supplement to students' data.
5. Students will use a software program to map the altitude of the Sun in the sky over a period of time and answer more questions as listed in the packet.
6. There is an assessment tool given in the packet at the conclusion of the activities.

Activity 5 Extension Activity - 4th Grade Earth Science Explore Question:

How does the tilt of the axis create seasons?

Materials and Equipment

- Sealed-shut cardboard box, stepping stool, brick, or large block of wood
- Flashlight
- Masking tape
- Scotch® tape
- Large, firm book
- Ruler, metric
- Protractor
- Optional: Camera
- Optional: Light meter, such as the Light Meter LX1010B,50,000 Lux Luxmeter with lcd display, available at Amazon.com
- Helper
- Graph paper (3 sheets). Graph paper with lines spaced 5 mm apart should work well. You can use this website to print free graph paper.
- Different-colored pens or pencils (5)
- Lab notebook

Experimental Procedure

Preparing the Light Source

1. Place the sealed-shut cardboard box, stepping stool, brick, or block of wood on a table, or on the flat, firm floor.
2. Lay the flashlight on its side on top of the cardboard box (or other object) and line up the edge of the flashlight so it is close to the edge of the box. Use masking tape to tape the flashlight down so it cannot roll around. Your setup should now look like the one shown in Figure 3, below.

Figure 3. Place the cardboard box, stepping stool, brick, or block of wood on a firm surface and tape the flashlight to the top so that the flashlight's edge is close to the box's edge.

Preparing the Surface

1. Tape a sheet of graph paper to a firm surface, like a cutting board or a large book, as shown in Figure 4, below, so that the paper will be stiff enough to tilt, and so that you can draw on it. Ask your parents if it is okay if you use Scotch tape on the surface you have chosen.

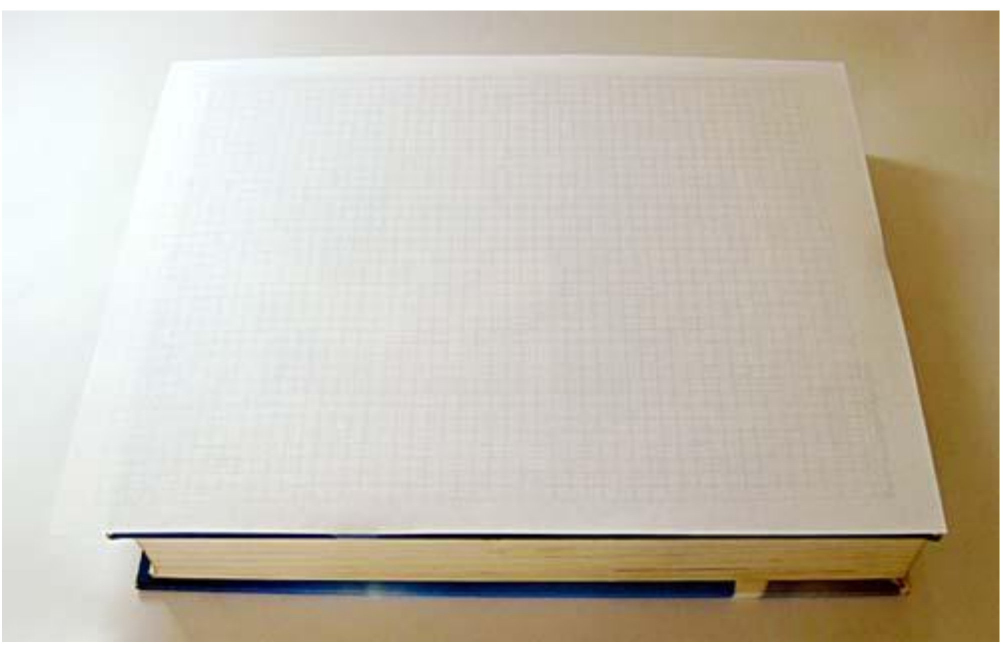


Figure 4. Tape a sheet of graph paper to a firm surface, like a large book.

1. Put the graph paper vertically in front of the flashlight, as shown in Figure 5, below.

Figure 5.. Place the graph paper vertically in front of the flashlight. You may need to hold the surface upright that the paper is taped to (e.g., the book).

1. Turn on the flashlight. Move the graph paper closer or farther away from the flashlight until the light on the paper forms a medium-sized, sharp circle 5 – 6 centimeters (cm) in diameter, as shown in Figure 6, below. Have a helper help you measure the distance from the edge of the graph paper to the cardboard box and write down this starting distance in your lab notebook. You will keep the graph paper at this starting distance for all testing.
    1. *Note:* Make sure you have at least 5 cm of graph paper lines above the top of the circle of light on the graph paper. You will need this space to collect data. If needed, raise the graph paper (by taping it higher up on a large book or cutting board) and/or lower the flashlight (by taping it to a shorter box, stool, brick, or block of wood) so that there is at least 5 cm of graph paper lines above the top of the light's circle.

Figure 6. Move the graph paper further from, or closer to, the flashlight until a crisp, 5 - 6 cm diameter circle of light forms on the graph paper.

Testing the Surface

1. Have a helper hold the graph paper vertically (straight up and down) at the starting distance in front of the flashlight.
2. Use a colored pen or pencil to draw around the outline of the light on the graph paper. Draw a line from the circle and note that the graph paper is at 0 degrees for this outline (no tilt).
    1. An alternative to drawing around the outline is to take a picture of the graph paper with a camera.
3. Observe the brightness of the light inside this outline and record your observation in your lab notebook, or (optionally) measure the brightness with a light meter held at a fixed distance from the graph paper.
4. Place a protractor at the bottom of the graph paper (i.e., at the bottom of the book or cutting board, where it meets the table or floor). This is shown in Figure 7, below. Then tilt the graph paper back, away from the flashlight, by 10 degrees (tip the book or cutting board from the 90-degree mark to the 100-degree mark).

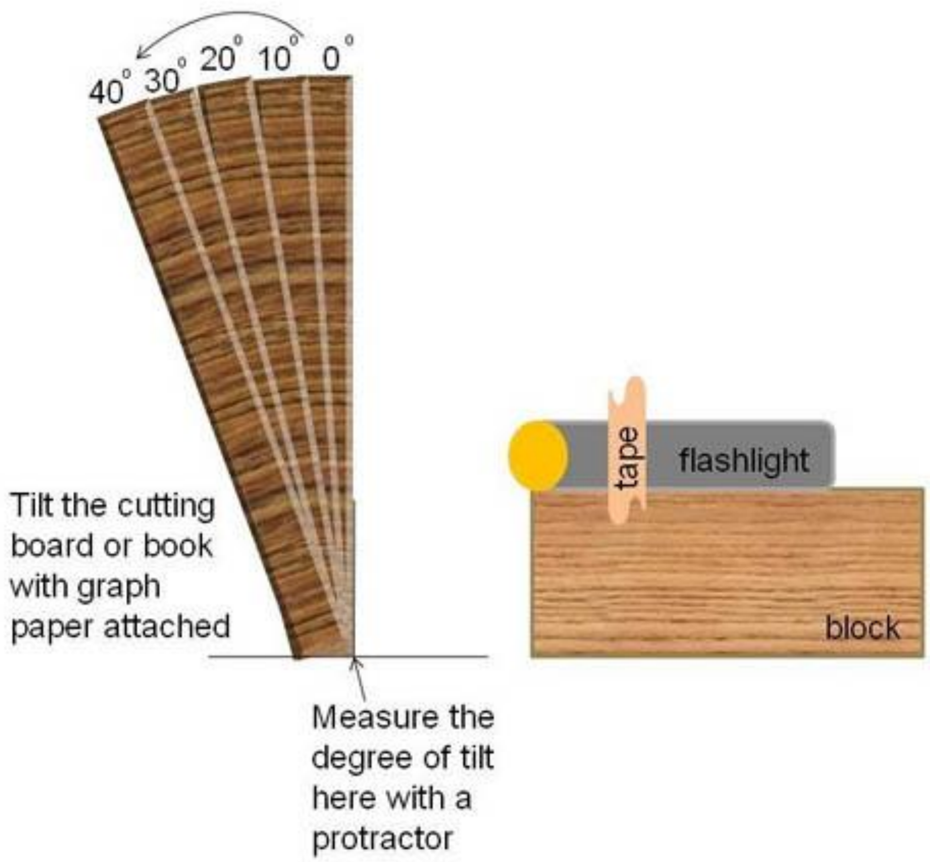


Figure 7. This drawing shows how to measure the angle that the graph paper is tilted using a protractor. (In your setup, you may be using a book instead of a cutting board, or a cardboard box or other object instead of a wood block.)

1. Repeat steps 2–3 using a different colored pen or pencil to draw around the outline of the light on the same piece of graph paper. Compare the brightness of the light inside this outline to the light inside of the previous outline. Be sure to record your observations in your lab notebook.
2. Repeat steps 4–5 for tilt angles of 20, 30, and 40 degrees. Use a different colored pen or pencil each time so each outline is in a different color.
3. Remove the sheet of graph paper and attach a new one.
4. Repeat steps 1–7 two more times.

Analyzing the Graph Paper

1. If you used a camera instead of drawing around the light outlines, print out your photographs so you can analyze them.
2. For each sheet of graph paper, count the approximate number of squares inside each different-colored light outline. For partial squares, estimate how much of the square is lit up; for example, if it looks like one-fourth of the square is lit up, add 0.25; if it looks like half of the square is lit up, add 0.5; if it looks like three-fourths of the square is lit up, add 0.75. Enter your counts in a data table, like Table 1, below.

Number of Lighted Squares

Degree of Tilt	Graph Paper 1	Graph Paper 2	Graph Paper 3	Average Number of Squares
0				
10				
20				
30				
40				

Table 1. In your lab notebook, make a data table like this one to record your results.

1. Calculate the average number of squares inside each outline for each degree of tilt and enter your calculations in the data table.
    1. For example, if for the 10 degree tilt you counted 145.5 squares on graph paper 1, 153.25 squares on graph paper 2, and 138.5 on graph paper 3, the average for the 10 degree tilt would be 145.75 squares (since 145.5 + 153.25 + 138.5 = 437.25, and 437.25 ÷ 3 is 145.75).
2. Make a line graph of your results. Plot the degree of tilt on the x-axis (the horizontal axis) and the average number of squares illuminated on the y-axis (the vertical axis). You can make the line graph by hand or use a website like Create a Graph to make the graph on the computer and print it.
3. Analyze your results. How did the numbers of squares inside the outline change as the degree of tilt increased? How did the brightness change? What degree of tilt produces light similar to what North America experiences in summer? What degree of tilt produces light similar to what North America experiences in winter?

Explore

Activity 6a - Make a Telescope

Purpose
To make and use an optical telescope for observations of the sky.

Activity Description
Students will construct a small telescope using a purchased telescope kit. They will assemble the parts, learning their design uses as they do so. This tool is more sophisticated than the pinhole camera in Activity 6b, Cycle 1, but making one and learning how they are used is an important part of the introduction to scientific observation.

Focus Question
How does a telescope help us observe the sky?

Duration
One class period (45 minutes)

Materials
- Telescope kits can be purchased from these sellers:
  http://www.sciencefirst.com/Refracting-Telescope-Kit.html
  http://starlab.com/shop/Refracting-Telescope-Kit.html
- Another option is a Galileoscope:
  http://galileoscope.org/
- To suppliment observations the Sunspotter telescope is a completely safe solar viewer. Robust wooden varieties are around $350. http://starlab.com/shop/Sunspotter.html
- Website about Telescopes: http://www.nasa.gov/audience/forstudents/9-12/features/telescope_feature_912.html

Teacher Preparation
1. Teacher will order the telescopes ahead of time and become familiar with how they are assembled.
2. For a PowerPoint about the history of Telescopes, this document can be used in parts or as a whole: http://teachingwithtelescopes.org/400%20yerars%20since%20Galileo%20v3.pdf
3. There is also a KWL available about telescopes here: http://teachingwithtelescopes.org/K-W-L.pdf

4. Teacher may want to use the website about telescopes to provide a reading activity for students about telescopes. http://www.nasa.gov/audience/forstudents/9-12/features/telescope_feature_912.html
5. Telescopes can be used for Moon observations, or for Sun observations using the projection method only. Students can also “borrow” them for nighttime planet observation if teacher wishes.
6. If teacher has Galileoscopes, inexpensive tripods will be extremely useful for getting the full benefit from observing with these telescopes.

Classroom Procedures

1. Teacher can begin lesson with a reading assignment on the NASA site: http://www.nasa.gov/audience/forstudents/9-12/features/telescope_feature_912.html
2. This video is a simple and good introduction to telescopes: http://www.watchknowlearn.org/Video.aspx?VideoID=18788&CategoryID=1580
3. Students will assemble the telescope. If using a Galileoscope, the instructions are on the website. Instructions come with the cardboard telescopes and the Sunspotter as well.
4. Students can practice inside with the telescopes, learning to be able to look through one eye and focus on a distant object. This may be more difficult for some students than for others, and a game can be made of it, such as a scavenger hunt for words around the room. One observation the students should make fairly quickly is that objects appear backwards and upside down.

Explore

Activity 6b – Making a Pinhole Camera

Purpose
To make a device enabling students to safely see the sun by projecting it.

Activity Description
Students will use white cardboard and aluminum foil to make a pinhole telescope for safe projection of the sun. They can also use a pair of binoculars or a small telescope. Students will sketch their observations in their astronomy journals. These observations will be used for another activity (Activity 7, Cycle 1).

Focus Question
How can we safely see the Sun?

Duration
One class period

Materials
- Assembly and activity instructions for making sun observations: http://www.csiro.au/Outcomes/Understanding-the-Universe/Tracking-spacecraft/solar-viewer.aspx
- Two sheets of stiff white paper for each pair of students.
- Aluminum foil
- A pin or paper clip to poke holes
  Optional: binoculars: these two websites help with using binoculars for safe solar viewing.
  http://www.exploratorium.edu/sunspots/history4.html
  http://spaceweather.com/sunspots/doityourself.html

Teacher Preparation:
1. Explore the instruction for assembly and the activity.
2. Gather materials and print the student instructions, or create a plan to project them for the class.
3. You will need a sunny day in order to project an image of the Sun, but you don't necessarily have to be outside- a clear window perpendicular to the Sun's rays would work as well.

Classroom Procedures:
1. Gather the materials for students to construct their cardboard camera.
2. Use the websites above as a guide for constructing the cameras and for safety issues associated with their use.

3. Lead students outdoors and have them sketch and describe what they observe on the surface of the sun in their astronomy journals.
4. Back in the classroom, have them compare their sketches with the image of the sun found on the Space Weather website.
5. This activity should be repeated in subsequent days. Their observations can be used in the following activity “Does the Sun ever Change.” The camera is also used in Activity 4 of Cycle 2: ‘How Big are the Sun and Moon?”

Activity 7 – Does the Sun Ever Change?

Purpose
Students will make observations of the sun with their pinhole camera or other observing tool over a period of time.

Activity Description
Student will observe the Sun with their pinhole cameras to see if the Sun changes from day to day. Students rarely notice the sun in the sky, and may be very surprised to find that it has features on its "face" that change from day to day.

Focus Question
Does the Sun ever change? If so, how?

Duration
15-20 minutes, daily for a period of time.

Materials
- NASA's Observe for Yourself Activity
  http://pwg.gsfc.nasa.gov/istp/outreach/sunobserve1.pdf
- Student-built pinhole camera
- Binoculars or Sunspotter telescope, if available
- Astronomy Journals, or drawing paper and pencils
- Space Weather Resources for images of the sun
  http://www.spaceweather.com/

Teacher Preparation
1. Gather materials
2. Explore the Spaceweather resource for daily images of the Sun and its sunspots to use in comparison. This is useful on a cloudy day.

Classroom Procedures
1. Students will use their pinhole cameras to project the Sun, and sketch it. Students don't have to be outside- if you have a clear window and can see the Sun, you can project the Sun indoors as well, but it's better to be outside.
2. If cloudy, students can use the image from Spaceweather.com to sketch the Sun and its spots.
3. Students can make daily drawings for a period of time, perhaps a week or two weeks, and compare the pictures from day to day.
4. Have students individually write down some questions that could be answered using the technologies and tools they have been exploring. Then have small

teams share and select their best two or three questions. Here are some worth considering, but allow students to generate questions first:

- Does the Sun look the same every day?
- What happens to sunspots?
- Do they move?
- Do they grow and shrink?
- If the sunspots move, is the Sun moving or are the spots moving on the Sun?
- How can you decide?
- Can you compare all the spots?
- Are they moving the same way?

Explain

Activity 8 Tools of the Astronomer

Purpose: **To compare and contrast tools of scientist use to study the sky. What do they have in common? How are they different? Of what use are they to us?**

Activity Description: **Students will categorize, compare and evaluate their measurement tools. They will group tools for measuring like the astrolabe and fist, and tools of observation like the telescope and pinhole camera, assessing their uses, pros and cons. Then they will draw some conclusions about the kinds of tools scientists might use.**

Focus Question: **How can we understand the movement of celestial bodies with tools of observation?**

Duration: **1 class period**

Materials:

- **Access to the tools and observations they have made.**
- Student Astronomy Journals
- Website for an overview of Astronomers' Tools from Hands On Universe: http://www.handsonuniverse.org/hs/wise/pdfsWISE/asteroidWISE2.pdf

Teacher Preparation:

1. Make sure students have access to their tools and any observations they've made with it.
2. Teacher may want to make a list of the tools: astrolabe, fist, pinhole camera, telescope, computer, and cameras.

Classroom procedures:

1. Prompt students to make a list of the tools of observation they've made or used.
2. Have them draw a table with four columns: with the tools in the first column, their use on a second column, pros of the tool in the third, and cons in the fourth.

3. Teacher might draw this on a whiteboard or overhead projector to help prompt students.
4. For pros and cons, students might think about how useful the tool is, e.g. how many different measurements can you make with it, or how many things can you observe with it.
5. After they have completed their table, they should draw some conclusions about what is the most useful. They should write a few sentences in their journals about what kind of tools astronomers would use to study the sky.
6. Teacher can show the pdf of Astronomers' Tools or print out the first page to give to students to read aloud in class.

Elaborate

Activity 9 – Making a Human Sundial

Purpose: To develop a human sundial and to understand its use.

Activity Description: Teacher and students will construct a human sundial in an outdoor setting. The sundial is an analemmic sundial that will be calibrated so that it is useful/accurate all year, which most sundials are not. Plus students will be a physical part of the sundial, using their shadows again as they did in Activity 5, Cycle 1.

Focus Question: How can we make a sundial that works throughout the year?

Duration: One or more class periods.

Materials:

- General plans: http://scientificteacher.com/2011/08/30/human-sundial/
- A dialing guide to find your sundial data. Also read the instructions for use. http://www.mysundial.ca/sdu/sdu_dialling_guides_analemmatic_sundial.html
- Here are plans for a garden sundial with live plants: http://www.evergreen.ca/en/lg/lessons/human-sundial.html
- Here is a chalk human sundial from Crayola: http://www.crayola.com/for-educators/lesson-plans/lesson-plan/human-sundial.aspx
- Standard sundial lesson plans
  http://www.eyeonthesky.org/lessonplans/14sun_sundials.html
  http://lasp.colorado.edu/home/wp-content/uploads/2011/08/sundial.pdf

Teacher Preparation:

1. Teacher should read and understand the instructions for making the human sundial. This may take some time and effort, and teacher will want to secure a location where the sundial can be built.
2. It is possible to make a temporary sundial with chalk on a parking lot or playground. Once you have a template, you can recreate it more easily.

Classroom Procedures:

1. In order to understand why an anelemmic sundial is more accurate than a regular one, students should first see how the regular sundial loses accuracy through the year. To illustrate this, teacher can make an analogy of the Earth being a school bus as described here:

Sometimes (when it is closer to the Sun, which happens in the wintertime for the northern hemisphere) the Earth is going slower in orbit, and so it doesn't take as long to spin from noon to noon, so it gets to noon (school) early. Other times, the Earth is going faster in orbit, but it takes a little longer to go from noon to noon, so it shows up to school too late- the Sun isn't at the noon-point in the sky when it is noon. This is a rather abstract idea for 4th grade, so teacher must use their discretion.

2. In order to make up for the different speeds of the Earth, the human sundial will feature different places to stand so the student makes the shadow from different places depending on the date.
3. Teacher can decide how much students will be involved in setting up and building the sundial.
4. Teacher can also start out using a standard sundial at the beginning of the year, and have the students notice how as the months go from September (where a regular sundial is fairly accurate) to December, (where it will be off substantially) and then build the human sundial in the spring. Students will be more familiar with why it works at that point.

Learning Cycle 2: Making Sense of Observations

Introduction to Cycle 2: This portion of Unit 4 centers on using observations and tools to interpret data for understanding. By now students should have a portfolio of observations and an array of tools to use for observing the sky. Students will use this data and their observations to draw inferences and conclusions about the characteristics of the Sun and Moon. They will also use models and research to come to conclusions about the objects in the sky and how they relate to us on Earth.

Learning Objectives

- Explain how the shape of the Moon follows a predictable cycle.
- Describe the motion of the Moon around the Earth.
- Describe the apparent motion of the Sun and Moon through the sky.
- Describe the amount of time for the Moon cycle.
  Identify the causes of Moon phases.
- Use tools and observations to explain the cycles of objects in the sky.
- Show how the movement of the Earth causes time zones and day and night.

Key Question: How can observations from Earth (related to the Moon and the Sun) be described and understood using explanations and physical models?

Activity 1: The Moon Phase Rap

Purpose
To teach students the Moon Phase rap and have them perform it themselves, with their own images for props.

Activity Description
This activity introduces students to a very catchy song about Moon Phases and allows them to learn it along with the phases of the Moon.

Focus Question
What is a fun and easy way to remember the phases of the Moon?

Duration
One or more class periods.

Materials
- Moon phase drawings from the students' observations, or have them draw phases on paper plates to use as props.
- The Phases of the Moon Rap: http://www.youtube.com/watch?v=79M2ISVZiY4

Teacher Preparation
1. Prepare to show the Moon Phase rap
2. Have students collect drawings or make drawings of all the phases of the moon, so they can illustrate them along with the rap.

Classroom Procedures
1. Introduce the rap to the students and let them watch and listen.
2. Teacher may want to stop the rap at different points to talk about the information embedded in the rap.
3. Teacher can prompt the students to hold up their correct moon phase drawings or paper plate phases during the chorus. They will most likely begin to sing along with it- teacher can prompt this, so they begin to memorize the phases in song.
4. This may lead to students wanting to write their own rap or song to illustrate moon phases. If so, teacher and students can make a movie of it and upload it as well.
5. The rap may be repeated often at regular intervals, so that the students through repetition absorb the information in it.

Activity 2 – Moon Flip Book

Purpose
To have students make a flipbook to model the Moon's changing shape cycle.

Activity Description
Students will sequence pictures of the Moon's phases in order from new Moon to full Moon and back to new Moon using a flipbook.

Focus Question
What is the pattern of Moon phases?

Duration
One class period

Materials
- Moon Flip Book template, enough for every student http://www.lpi.usra.edu/education/space_days/activities/moon/documents/Moon_Phases_Flip_Book.pdf
- Staplers, several would be helpful.
- Interactive online tool of the Earth-moon system that depicts phases of the moon. http://www.classzone.com/books/earth_science/terc/content/visualizations/es2503/es2503page01.cfm

Teacher Preparation
1. Create classroom set of pictures of the moon in all phases using the website above, using the print friendly version. Cut off the descriptions.
2. Explore the interactive online tool of the Earth-moon system.

Classroom Procedures
1. Provide the printed sets of small pictures of the moon throughout its cycle to teams of 2 or 3 students.
2. Prompt them to sequence the images in what they think is the correct order.
3. Have students watch the animation of the Moon phases coupled with its motion around the Earth. They should be ordering their phases while watching.
4. Let students compare their order with other groups.
5. Encourage discussion about the order. As this is an elicitation activity, teachers should not immediately correct them when they mis-order the photos. Rather, a good deal of discussion and debate should be instigated. Consensus should be reached, and the students can complete their flip books.

Explore

Activity 3 - Birthday Moons

Purpose
To determine the phase of the Moon on certain dates in order to recognize a pattern of Moon phases over time.

Activity Description
Students will use the computer to determine the phase of the Moon on their birthdays. Then they will make a paper Moon to construct a timeline and a pattern of Moon phases.

Focus Question
How does the Moon change on different dates?

Duration
One class period

Materials
- Large sheet of paper to put timeline on
- Smaller sheets of construction paper for paper Moons
- Tape and scissors
- Marker to mark timeline
- Computer access, or smart phones
- The Moonpage website
  http://www.moonpage.com/

Teacher Preparation
1. Have website ready for students to use
2. Have materials ready, and put the timeline paper up on the wall.

Classroom Procedures
1. Teacher can take a survey of birthday dates, acquiring a range of dates and helping to set the limits on the timeline. Timeline will be about a year, broken into the twelve months with enough room for students to place their moons on their birth date.
2. Students look up the phase of the Moon on their birth date. They can sketch it and name it, and then draw a larger version on a piece of construction paper.
3. Have students put their name and birthday on it, including year, month and day, so they can place it on the timeline on the wall.
4. Once all the Moons are up, ask students if they see a pattern of Moon phases, and if it matches what they've seen in their flip books or any other Moon phase activity they've done.

Explore

Activity 4 – How Big Are the Sun and the Moon?

Purpose

Students will be able to use the pinhole camera to determine how big the Sun and the Moon are.

Activity Description

This activity helps students understand the size of the Sun and Moon, using a tool they have already developed.

Focus Question

Can we determine how big the Sun and Moon are from our homemade tool?

Duration

One class period

Materials

- Pinhole camera from previous activity or a pinhole screen as seen in the website: http://cse.ssl.berkeley.edu/AtHomeAstronomy/activity_03.html
- Video on How to Find the Size of the Sun http://www.youtube.com/watch?v=zioSpV2yq24
- Rulers
- Cardboard or clipboards- with white graphing paper.
- Pencils

Teacher Preparation

1. Practice using the materials and conducting the measurement.
2. Try to plan this for a sunny day to take the students outside for this activity. This can also be done through a window if the temperature is cold outside.
3. Review the video that explains provides instructions and how to build a larger and more accurate pinhole device.

Classroom Procedures

1. Explain to students that they are to use their pinhole camera to project an image of the sun that they will measure.
2. Lead students outside and have them use their pinhole camera to get an image of the sun.
3. Direct them to use a piece of cardboard with white paper taped to it.

4. Students will draw the image in measure it with a ruler, using metric measurements.
5. Students will use the following calculation to estimate the size of the Sun.

$$\frac{\text{Diameter of the image of the Sun}}{\text{Distance from the pinhole to the paper}} \times \text{Distance from Earth to the Sun} = \text{Diameter of the Sun}$$

Note: The distance from the Earth to the Sun is approximately 93,000,000 miles (149,600,000 kilometers).

6. Students will have to take their measurement on a night of a Full Moon. The Full Moon is bright enough to project an image through the pinhole tube.
7. Have them bring their measurement in and do the calculation in class.
8. The distance to the Moon is approximately 239,000 miles (384,000 kilometers).
9. Teacher can bring up the difference of the sizes, which should be about 400 times different. The Sun is 400 times larger than the Moon, yet they look about the same size in the sky. What could account for this? (The Moon is also about 400 times closer than the Sun!)
10. Students and teacher can try to illustrate this using two differently sized balls, the smaller one closer to the eye, and the larger one farther.
11. Try to put them at a distance so the closer one just covers the farther one, and you have made an eclipse. This would be a good time to explain to students why eclipses are so rare- it’s hard to exactly line up the Moon and Sun – much harder to do in space than in your hands. The distances and sizes are much greater.

Explore

Activity 5 – Using an Astrolabe to Measure the Sun-Moon Angle.

Purpose
To connect the angle between the Sun and Moon to the Moon's phase.

Activity Description
Use the tool created in Activity 3, Cycle 1 to measure the angle between the Sun and Moon, and deduce the relationship between this angle and the Moon's phase.

Focus Question
What is the pattern of Moon phases, and how does it relate to the angular distance to the Sun?

Duration
About 10-15 minutes per day, for several days.

Materials
- Student astrolabes from previous activity
- Student Astronomy journals for drawing.
- Madison School District Planetarium activity on the daytime moon https://planetariumweb.madison.k12.wi.us/mooncal/daymoon.htm

Teacher Preparation
1. Pick mornings or afternoons when the moon is visible as well as the sun. It would be best to start with a last quarter Moon if observing in the morning, and each subsequent morning the Moon will be waning into a crescent, a little thinner and a little more toward the east every morning. If observing in the afternoon, pick a waxing crescent and watch it grow larger every day, also moving a little toward the east every day.
2. Have students practice with their clinometers by measuring angles of separation in the classroom. You can draw a Sun and Moon and put them on the ceiling for a model.
3. Make sure you tell students not to look directly into the Sun.

Classroom Procedure
1. Have the students take their astrolabes outside where the Sun and Moon are both visible.
2. Students should use their drawing journals to sketch the Moon and the Sun, taking care not to look directly at the Sun.
3. Position the astrolabe with the protractor numbers face-up.
4. Point one end of the straw to the Moon.

5. Slide the string along the top of the protractor until it is aligned with the direction of the Sun.
6. Use the numbers along the side of the protractor to calculate the angle between the Sun and the Moon.
7. Questions student may answer in their journals:
    - Is the lit or unlit part of the Moon facing the direction of the Sun?
    - Which direction are the "horns" of a crescent facing with respect to the Sun?
    - Does this change as the angle between the Moon and the Sun changes?
    - Do you notice a pattern between the Moon-Sun angle and the phases of the Moon?

Explore

Activity 6 – Time Around the World

Purpose
To investigate time zones in places around the world to draw conclusions about how time changes around the world.

Activity Description
In this activity students will use homemade clocks and computers to compare the time in their classroom to the times in other countries around the world. They will use a model of the Earth and Sun to observe why we have different time zones, and model the differences in clocks that read different times in different places around the world.

Focus Question

Why are there different time zones in the world?

Duration
One class period

Materials
- Tutorial and quiz on time zones, for introduction to time zones: http://www.wisc-online.com/objects/ViewObject.aspx?ID=SOC3702A standard globe
- Strong light source such as an overhead project, flashlight or lamp.
- Little figurines, or plastic or paper "people" that can be taped or stuck to the globe
- Inexpensive clocks to set at different time zones, and labels. Instructions for student made clocks: http://learningideasgradesk-8.blogspot.com/2012/02/paper-plate-clocks-round-up-and-telling.html
- World Sunlight Map http://www.die.net/earth/
- Optional extension: "A Review of Time Zone Mathematics" http://cse.ssl.berkeley.edu/segwayed/lessons/exploring_magnetism/space_weather/guide_activity9.pdf

Teacher Preparation

1. Review the tutorial on time zones and the optional extension on time zone mathematics.
2. Teacher will set up the globe with little "people" on it in different countries. Light source will act as the Sun, coming from one direction.

3. Teacher may want to have several small clocks set to different times, labeled with the country in which the time is accurate.
4. Students need access to a computer or to their smart phones or ipads if they have them. Teacher can also project the data on a big screen.

Classroom procedure

1. Demonstrate the Earth's rotation with the globe using a strong light shining on the globe that represents the Sun. State that this is a simple model of the Sun-Earth system.
2. Ask students to relate the model to the idea of time zones and supplement their explanations in a way so they understand the general idea. At this time the World Sunlight Map would be an excellent way to prompt discussion about this idea.
3. Explain the purpose of the activity is to understand that the Sun is not shining on the entire Earth, and that people in different places experience different times of day.
4. Students will construct their paper plate clocks or be provided some.
5. With the "people" placed on the globe to the west and the east of the "person" standing in your location, teacher will shine the light and rotate the earth so that it is noon for the person in your location.
6. Ask students what time it is on their clocks (should be noon).
7. Then ask what time they think it is for the person to the west.
8. They can move the hour hand of their clock- either before noon or after noon.
9. Repeat with the "person" to the east. Is the time earlier or later than for the person in your location? This might have to be repeated for all students to catch on.
10. Teacher can do a quick check for understanding with their clocks.
11. Supplement their understanding by showing the online tutorial and quiz listed above.

Explain

Activity 7 – Presenting the Sun and Moon

Purpose
To develop strong conceptual mastery of the cycles content, as students use scientific explanations in text and simulation software.

Activity Description
Students read text and use simulations that describe the Moon and the Sun, and they make a presentation based on their research. The presentation is graded with a rubric, and tools and observations can be used as real data in their presentations

Focus Question
What are the Sun and Moon like? How are they different from Earth? How do we know?

Duration
2-3 class periods

Materials

- **Here is an article on the Moon** **http://www.windows2universe.org/earth/moons_and_rings.html&edu=elem**
- And an article on the Sun
  http://www.windows2universe.org/sun/sun.html&edu=elem
- Suntrek website
  http://www.suntrek.org/
- This is a journey through the solar system, but with nice pictures of Earth, Sun and Moon
  http://www.history.com/shows/the-universe/interactives/interactive-universe
- This is an interactive map of the Moon with names of the craters and maria
  http://www.calsky.com/cs.cgi/Moon/2
- This is a great website on everything Moon-related!
  http://home.hiwaay.net/~krcool/Astro/moon/
- Another great site for Moon phases
  http://www.lpi.usra.edu/education/skytellers/moon_phases/about.shtml
- Student instruction sheet and rubric for grading presentations:
  Atlas url:

Teacher Preparation

1. Have articles available to students either printed or on computers, or have a list of websites available.
2. Have whiteboards available or other means of illustration, such as poster board, construction paper, or computers for PowerPoint or some other presentation software.
3. Look over rubric and instruction sheet and make any modifications needed for the class.

Classroom Procedures

1. Students receive instruction on rubric for project presentations, and options for presentations are discussed. Students should work in pairs or alone, but no more than three in a group is workable.
2. Students look through their observations of the Sun and the Moon in their astronomy Journals
3. Teacher passes out article on sky objects or has it available through media.
4. Students read the text and watch the simulations as they take notes on characteristics of the Sun and Moon.
5. Students prepare a report, which can take the form of a poster, a presentation, a song, a children's book, a graphic novel, a sock puppet show, or any other means of communication that is suggested.
6. Students have a class period to research their question, and create their presentations. They may use the guided notes sheet to help guide their inquiry.
7. Teacher sets aside a day for presentations, and students take turns presenting.
8. Good audience manners should be reviewed. Teacher can grade with the rubric as presentations are made.

Elaborate

Activity 8 – We've Been On the Moon!

Purpose

To get a historical perspective of the Moon landings.

Activity Description

Students will watch and discuss footage of the Moon landings and astronauts on the Moon.

Focus Question

How and when did humans go to the Moon?

Duration

One class period

Materials

- Clips of Moon landings, available on the internet http://www.hq.nasa.gov/alsj/a11/a11v_1092338.mpg
- Description of the Apollo Mission http://www.nasa.gov/mission_pages/apollo/40th/index.html
- About Neil Armstrong: http://www.nasa.gov/multimedia/videogallery/index.html?media_id=154021971
- Youtube has a great series of video footage from theMoon landings: http://www.youtube.com/watch?v=RMINSD7MmT4 http://www.youtube.com/watch?v=YrpjwpfixX4
- A wonderfully dramatic National Geographic version of the Moon landing: http://www.youtube.com/watch?v=iSPQTfp5vJE&feature=related
- Another great video on the landing: http://channel.nationalgeographic.com/channel/videos/eagle-has-landed/
- How tricky was the Moon landing?: http://channel.nationalgeographic.com/channel/videos/moon-landings/
- How the moon landings were captured: http://video.nationalgeographic.com/video/news/space-technology-news/1969-moonlanding-vin/

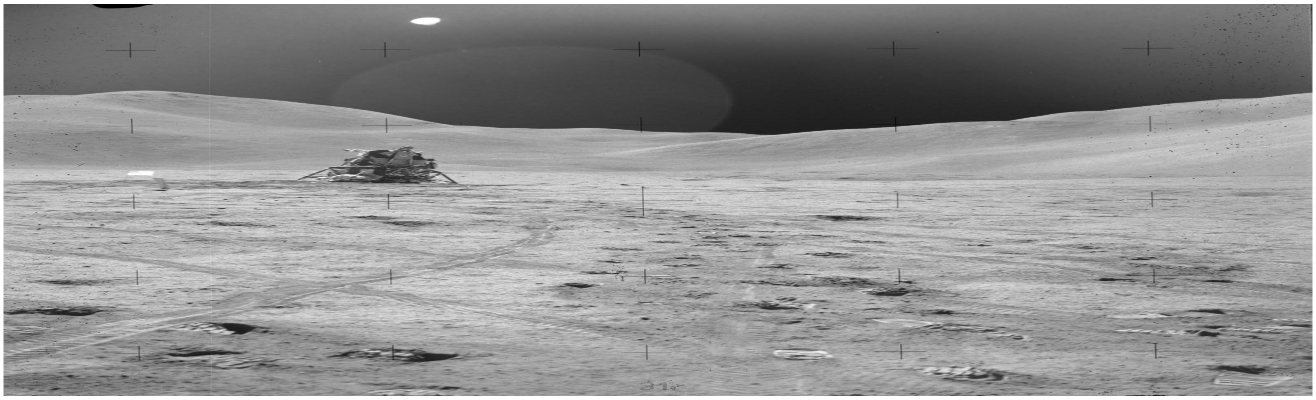
Teacher Preparation

1. Teacher should become familiar with the Apollo missions and the era of Moon exploration.
2. Teacher should gather the clips that are useful in illustrating the successes of the Apollo Missions.

Classroom Procedures

1. Teacher can give any historical background from the late 1960's as appropriate.
2. Show clips and footage of the Moon Landing.
3. As a follow-up, teacher may want to show the Myth busters Moon landing Hoax episdoe if the students are familiar with the Moon hoax "movement."
4. Discussion from students is usually pretty spontaneous and should be encouraged, as questions about this time in history come up.
5. Another option is to show Apollo 13, the movie to the students.

Activity 9- Engineering Challenge



We Challenge You to…

…Design and build a shock-absorbing system that will protect two "Astronauts" when they land.

Landing on the moon is tricky. First, since a spacecraft can go as fast as 18,000 miles per hour (29,000 km/hour) on its way to the moon, it needs to slow way down. Then it needs to land gently. That lander has astronauts inside, not crash-test dummies. Easy does it! Touchdown!

Materials (per lander)

- 1 piece of stiff paper or cardboard (approximately 4 x 5 in/10 x 13 cm)
- 1 small paper or plastic cup
- 3 index cards (3 x 5 in/8 x 13 cm)
- 2 regular marshmallows
- 10 miniature marshmallows
- 3 rubber bands
- 8 plastic straws
- Scissors
- Tape

Brainstorm and Design

Think about how to build a spacecraft that can absorb the shock of a landing.

• What kind of shock absorber can you make from these materials that can help soften a landing?

• How will you make sure the lander doesn't tip over as it falls through the air?

Build:

1. First, design a shock-absorbing system. Think springs and cushions.
2. Then, put your spacecraft together. Attach the shock absorbers to the cardboard platform.
3. Finally, add a cabin for the astronauts. Tape the cup to the platform. Put two astronauts (the large marshmallows) in it.

(NOTE: The cup has to stay open—no lids!)

Test, Evaluate, and Retest

Ready to test? Drop your lander from a height of one foot (30 cm). If the "astronauts" bounce out; figure out ways to improve your design. Study any problems and redesign. For example, if your spacecraft:

- tips over as it falls through the air—Make sure it's level when you release it. Also check that the cup is centered on the cardboard. Finally, check that the weight is evenly distributed.
- bounce the astronauts out of the cup—Add soft pads or change the number or position of the shock absorbers. Also, make the springs less springy so they don't bounce the astronauts out.

Hear Cathy Peddie describe the mission at: moon mission

Buried alive?

The first people who landed on the moon took a big risk. That's because the moon is covered with a thick layer of fine dust. No one knew how deep or soft this layer was. Would a spacecraft sink out of sight when it landed?

Now we know—the layer is firm.

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Name ___________________________ Date ___________________________

Earth and Space Final Assessment

1. Your teacher asked you to look at the moon for a few minutes a day for 5 days. Which sentence is an observation you may make from this lesson?

A. The moon circles the Earth.
B. The moon spins as it travels.
C. The moon has a different shape every day.
D. The moon can be out during the summer or winter.

2. The local weatherman collects data from several different locations in Michigan at 10:00 am. He uses this data to forecast the weather. He also collects data from the weather station at the television studio to give the current weather conditions. Current weather reporting is based on which of the following?

A. Evidence
B. Opinion
C. Prediction
D. Sampling

3. Why does the Sun appear larger than other stars?

A. The Earth is small
B. The Sun is very bright.
C. The Sun is the largest star
D. The Sun is the closest star to Earth.

4. Is the sun larger or smaller than the moon? Explain how you know.

____
____
____
____

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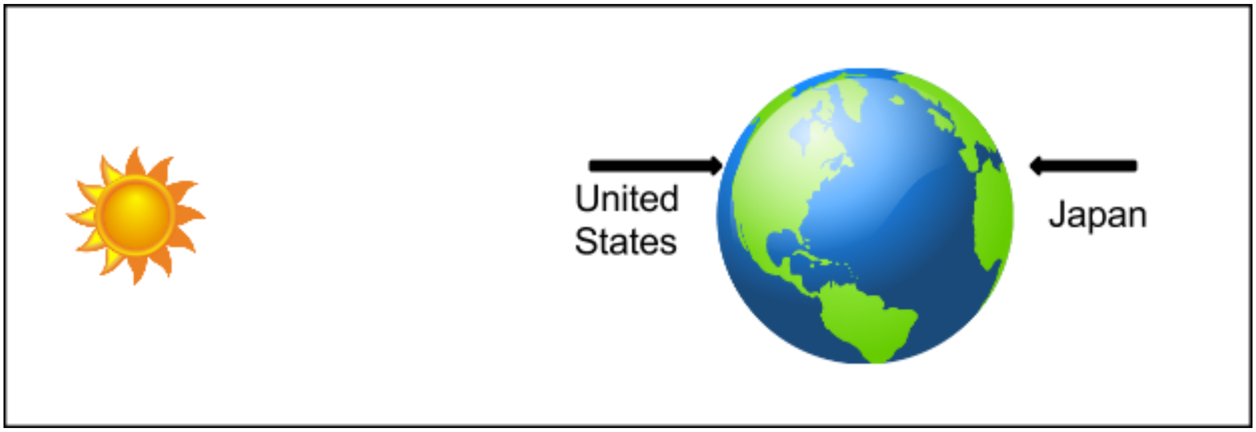
5. Which is a natural satellite of the Earth?

A. Sun
B. Star
C. Moon
D. Planet



6a. Where is it daytime? ____
Explain how you know.____
____
____

b. Where is it nighttime? ____
Explain how you know. ____
____
____

7. Which of the following objects is capable of producing its own light?

   A. Sun
   B. Moon
   C. Earth
   D. Planet

8. About how long does it take for the Earth to make one orbit around the sun?
   A. 7 days
   B. 28 days
   C. 180 days
   D. 365 days

9. What causes the Sun to rise and set every day?

   A. Orbit of the Earth
   B. Rotation of the Earth
   C. Revolution of the Earth
   D. Apparent movement of the Earth

10. Which event causes the Earth to have day and night?

   A. The Earth rotates on its axis.
   B. The moon blocks the sun at night.
   C. The revolution of the Earth around the sun.
   D. The sun orbiting the Earth.

11. How long does the Earth take to make one rotation?

A. One day
B. One year
C. One month
D. One week

12. The Earth spins on its axis. What does the term axis mean?

____

____

____

13. Why does the same side of the moon always face the earth?

A. The moon does not rotate as it revolves around the earth.
B. The moon rotates at the same speed as the earth.
C. The moon rotates slower than the earth rotates.
D. The moon takes the same amount of time to rotate and revolve

14. How often does the moon make one complete orbit around the Earth?

A. Once a day
B. Once a year
C. Once a week
D. Once a month

15. The Sun and stars appear to move in the sky from east to west. What is responsible for that movement?

A. The Earth revolves around the sun.
B. The Earth rotates counter clockwise.
C. The Sun and stars rotate on their axis.
D. The Sun and stars move from east to west.

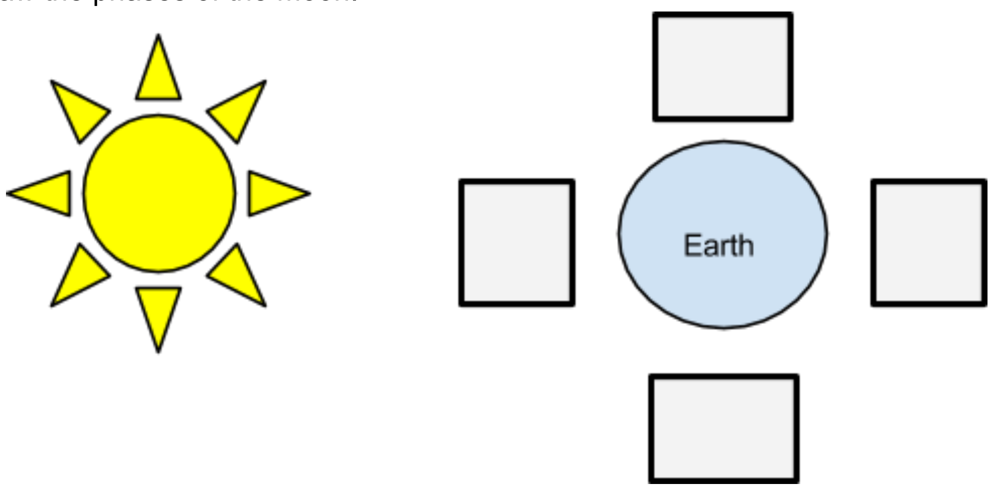
16. Which phase of the moon is missing from this sequence?

A. First quarter
B. Last quarter
C. Waning gibbous
D. Waning crescent

17. You are planning a camping trip. You want as much natural light as possible each night. There will be a new moon on February 5 and a full moon on February 19. Assuming every night during February will have no clouds, which 5 days would be best for your camping trip?

A. February 6 – 10
B. February 15 – 19
C. February 17 – 21
D. February 19 – 23

18. Draw the phases of the moon.



19. A class was keeping a record of where the sun was in the sky at 12:00 noon. They observed the sun getting higher in the sky each day. What event would come next on the school's calendar?

A. Thanksgiving
B. Winter break
C. New school year
D. Summer vacation.

20. What path does the Sun travel along as it appears to move through the sky?

A. East to West
B. Left to Right
C. North to South
D. Up to Down