National Aeronautics and Space Administration

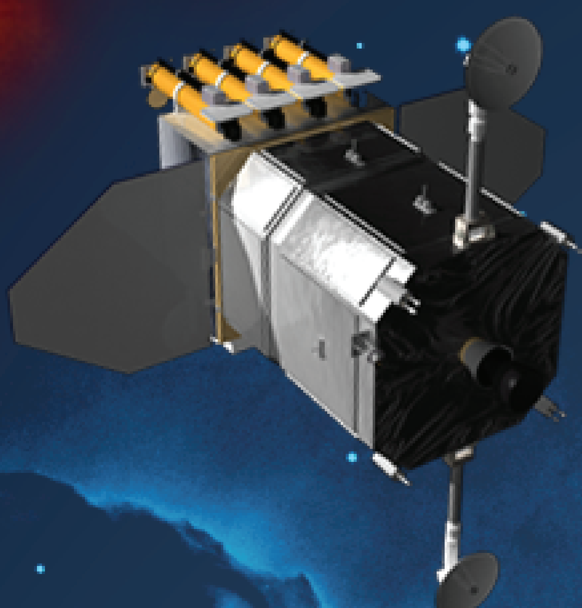
THE SCIENCE OF THE SUN

Elementary Learning Unit

Educational Product	
Educators	Grades K-6

EG-2010-01-031-GSFC

SDO | solar dynamics observatory



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Introduction

Understanding the relationship between Earth and the Sun is a fundamental concept in elementary level science. In this unit, students focus on the Sun as the center of our solar system and as the source for all energy on earth. By beginning with what the Sun is and how Earth relates to it in size and distance students gain a perspective of how powerful the Sun is compared to things we have here on earth, and the small fraction of its energy we receive. Students also gain an understanding of how earth relates to the other planets in the solar system. After dancing around the Sun in a bodies-on lesson on the movements of Earth over one year, students learn the cause of the seasons, and begin to understand that it's the energy we receive from the Sun that most deeply affects us. Transitioning from spatial relationships to energy, students read about and conduct experiments that show them how the Sun's energy is present even in their classroom.

Justification

A clear understanding of the relationship between the Sun and Earth is necessary for preventing and dispelling misconceptions that surface in later grades. This unit seeks to lay a solid foundation of science that teachers can build on through middle and high school earth and physical science. In addition to providing clear scientific concepts, this unit satisfies all elementary national standards addressing Sun/earth relationships and solar energy, as well as earth and life science standards.

How to Use this Guide

This guide was written in the interactive notebook format, one developed to facilitate inquiry learning, constructivist theory, and a brain based model. The following is a discussion about the work behind the model, what you will find in the lessons, and how they apply to the classroom.

Inquiry is:

- **Meaning**
  Science inquiry in education is founded on the principles of brain-based learning. The search for meaning is innate as was explained by Maslow in his hierarchy of needs. Individuals look for meaning in relation to their own experiences, what they value, and how the new information aligns with those factors. The search for meaning in science classrooms can be stimulated by questioning, hypothesizing, and by exploring unexpected results.

- **Connections:**
  The brain is designed to find connections. An effective science inquiry experience is rich in authenticity and purpose, clearly connecting to other

aspects of both science and life. Students will retain and be able to recall facts and information easily when they are linked to multiple sources.

- **Engagement:**
  Students who participate in true science inquiry take ownership of their learning. Introducing challenge and creating a sense of wonder are easy and efficient ways to engage the mind. But remember: Just because something is "Hands on" doesn't mean it's "Minds on." Inquiry doesn't always mean student directed, open-ended research projects. Students learn in a variety of ways, each modality needs to be included to engage as many students as possible.

The ABC's of Inquiry
So how can we apply this in every single lesson/activity/curriculum we create? The answer is you can't. You'd go nuts. But you can structure your resources in a way that lends itself to the creation of such products. Here's how:

- **Activity Before Concept. (ABC)**
  Engage students in the concept to be learned without priming them first. Don't tell them what you are going to teach them, let them figure it out for themselves. Through discussion following the activity the concept can be teased out. What was in their subconscious will emerge and become a solid concept that is not only connected to their prior knowledge, but is now a rewarding "Aha!" moment.

- **Concept Before Vocabulary: (CBV)**
  Explore the concept. As you explore students will realize a need for the words to accurately describe it. Identify the need, then give them the tools. No more rote memorization of vocabulary, the meaning and application of words is now owned by the students.

Why the ABC's? To engage, to wonder, to challenge, and to link. Designing resources with this in mind can't avoid including inquiry.

The Interactive Notebook: "Predict, Method, Live-it"
To further put this into practice, consider this format: The Interactive Notebook. The interactive notebook goes beyond traditional classroom record keeping. It provides a home and structure for the connections being made in an inquiry-based classroom or program.

- The "Predict" portion of the notebook or lesson is to engage your students and to tap into their prior knowledge. This section should be student driven. There is no right answer.

- The "Method" section is the meat of the concept. It could be notes, an investigation, lab results, or drawings. The teacher drives the method to whatever degree is required by the lesson. More structured for “directed inquiry” and more open ended for “true inquiry.”

- The “Live-it” portion is the wrap up, the application and the conclusion. It asks students to prove that they’ve learned by applying the concept. Higher order thinking tasks should be assigned, such as evaluation, application or synthesis. This section should be student driven as well, with products being evaluated by the teacher.

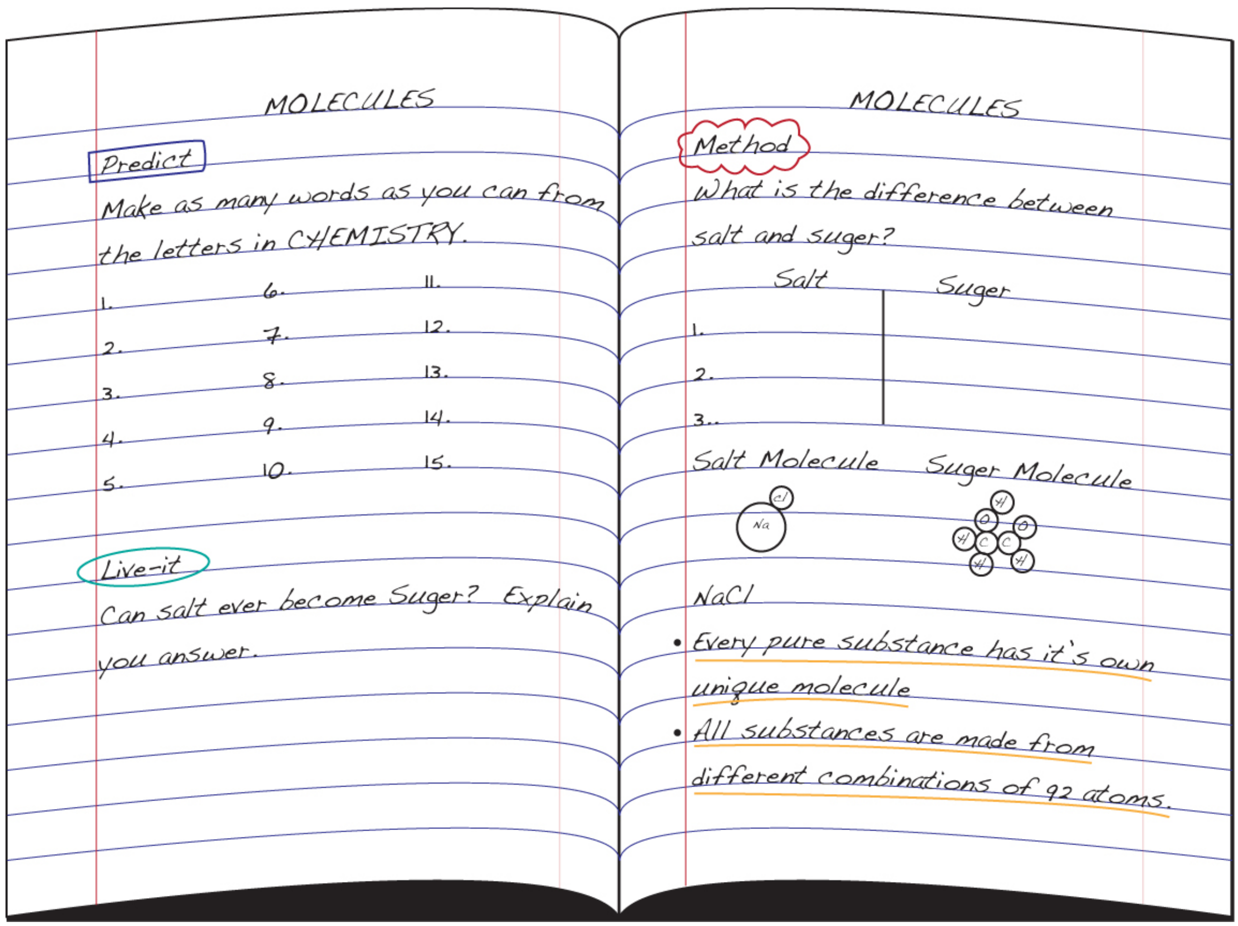


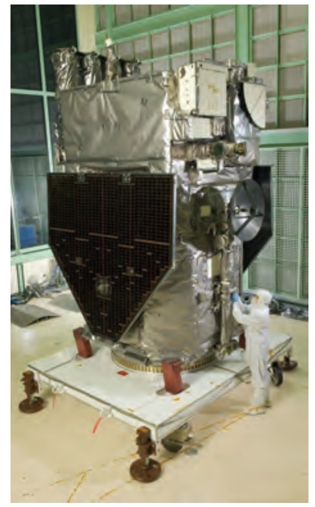
Fig. 1: Example of interactive notebook

So why design lessons using the interactive notebook format? Predict, Method and Live-it are analogous to engagement, connection and meaning.

Science is not a foreign subject – its internal to every student. Exploration is as natural as breathing. The focus needs to stop being on creating the next Einstein, but on showing students that science is a welcomed part of their every day lives.

NOTES:

The SDO Spacecraft


SDO nearing completion in 2009

SDO is one of the largest solar observing spacecraft ever placed into orbit. Its solar panels are 6.5 meters (21.3 ft) wide when extended and will provide SDO all the power it needs from the Sun. The specially-filtered telescopes will take images of the Sun with 10 times greater resolution than high-definition television. Total mass of the spacecraft at launch is 3,100 kg (6,800 lb).

Data for Everyone


SDO's dedicated ground station in Las Cruces, NM

Each day in orbit, SDO will gather as much as 1.4 terabytes of data. Scientists, educators, and members of the general public will be able to browse this huge volume of data giving researchers and others a powerful new way to view the Sun.

SDO is part of the Living With a Star Program within NASA's Heliophysics Division

OUR EYE ON THE SUN
SOLAR DYNAMICS OBSERVATORY
NASA
HMI • AIA • EVE

Visit us on the Web at:
http://sdo.gsfc.nasa.gov

For information on Heliophysics programs and missions, see:
http://nasascience.nasa.gov/heliophysics

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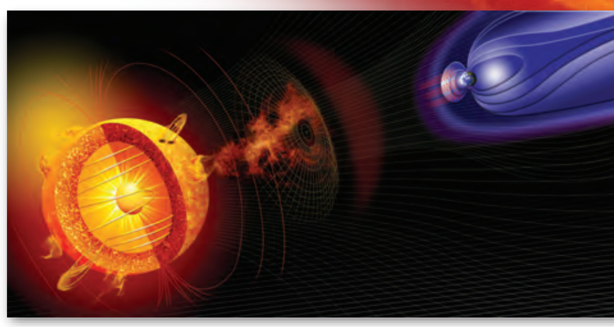
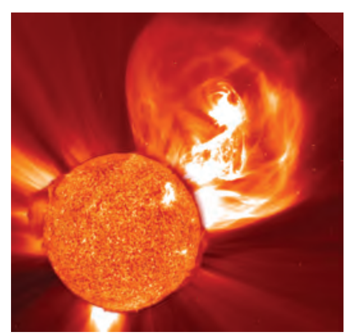
SDO: Our Eye on the Sun

SDO Science



Solar storm impacting Earth and its magnetic shield

Solar activity and variability are key concerns of our modern, increasingly technological society. Solar flares and coronal mass ejections can disable satellites, cause power grid failures, and disrupt GPS communications. Furthermore, because the Sun is so powerful, even small changes in its irradiance could have effects on climate.



Solar storm shooting into space

The Solar Dynamics Observatory (SDO) is designed to probe solar variability in a way that no other mission can match. High-speed cameras on SDO will take rapid-fire snapshots of solar flares and other magnetic activity. This will have the same transformative effect on solar physics that the invention of high-speed photography had on many sciences in the 19th century.

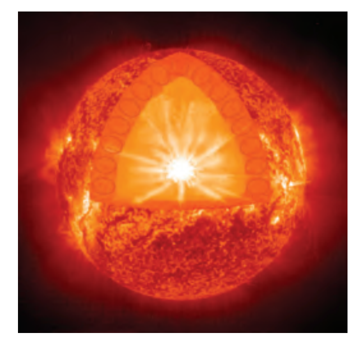
SDO doesn't stop at the stellar surface. A sensor on the observatory can actually look inside the Sun at the very source of solar activity—the solar dynamo itself. There SDO will find vital clues to the mystery of the solar cycle and help scientists predict the future of solar activity.

SDO Instruments

Magnetic activity on the surface of the Sun

The Solar Dynamics Observatory has three main instruments.

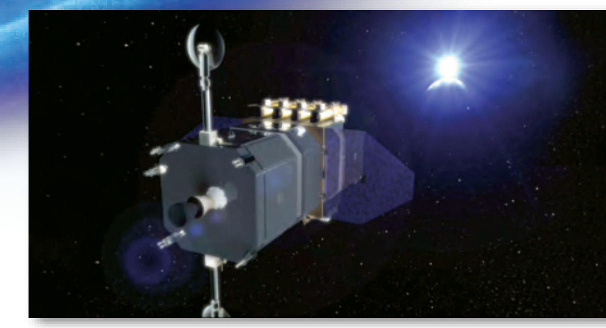
- The ***Extreme Ultraviolet Variability Experiment (EVE)*** will measure fluctuations in the Sun's ultraviolet output. EUV radiation from the Sun has a direct and powerful effect on Earth's upper atmosphere, heating it, puffing it up, and breaking apart atoms and molecules.



SDO will study the solar interior

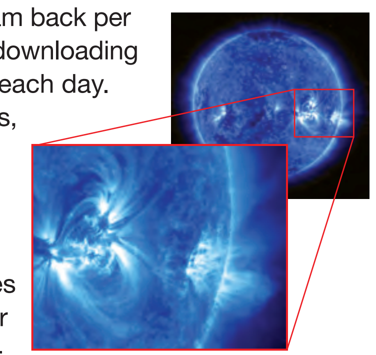
- The ***Helioseismic and Magnetic Imager (HMI)*** will map solar surface magnetic fields and peer beneath the Sun's opaque surface using a technique called helioseismology. A key goal of this experiment is to decipher the physics of the Sun's magnetic dynamo.
- The ***Atmospheric Imaging Assembly (AIA)*** is a battery of four telescopes designed to photograph the Sun's surface and atmosphere. AIA filters cover 10 different wavelength bands, or colors, selected to reveal key aspects of solar activity.

An Avalanche of Data



SDO's orbit will allow continuous observations of the Sun

Imagine watching a high-definition movie that never stops. The enormous screen is filled with the raging Sun, unleashing huge solar flares and billion-ton clouds of hot plasma. The amount of data and images SDO will beam back per day is equivalent to downloading half-a-million songs each day.



SDO's images are super HD

By some estimates, SDO will transmit as much as 50 times more science data than any mission in NASA history. Images with 10 times greater resolution than high-definition television recorded every 0.75 seconds will reveal every nuance of solar activity. Because such fast cadences have never been attempted before by an orbiting observatory, the potential for discovery is great.

The data rate is equally great. To handle the load, NASA has set up a pair of dedicated radio antennas near Las Cruces, New Mexico. SDO's geosynchronous orbit will keep the observatory in constant view of the two 18-meter dishes around the clock for the duration of the observatory's five-year prime mission. Not a single bit should be lost.

Lesson Matrix

Lesson	Objectives	Key Concepts	Vocabulary	Activity	Materials
The Sun as a Star	Students will be able to identify the Sun as a star. Students will be able to compare the Sun to other stars in the sky by explaining why our Sun appears larger and brighter than other stars	The Sun is an average star. Other stars are visible in the sky at night. They are both bigger and smaller than the Sun. The Sun looks different because it is so close to us. If we were closer to another star it would look similar to our Sun.	Sun Star Average Perspective	Students examine pictures of objects up close and far away to try and figure out what they are. Finally students are given an image of a star and the Sun and through discussion about the differences and similarities of seeing objects up close, conclude that the Sun is a star.	Photos Worksheets Two identical objects
The Scale of Things	Students will be able to describe the scale of the solar system, with the Sun at the center. Students will be able to estimate distances.	The scale of the solar system can be represented here on earth using common materials. Both distance and size can be represented. The Sun is 90% of the mass in our solar system. Ten earths can fit side by side across the diameter of Jupiter, and ten (closer to 11) Jupiters can fit side by side across the face of the Sun.	Scale Size Distance	Students begin by estimating the distance between the Sun and Earth, if the Sun is a given size. Then students take a “Solar system walk” through the planets to see the vast distances that separate them. The concept of the Sun as a star is reinforced as students see the picture of the Sun get smaller as they walk away from it.	Solar Pizza Scale of the solar system cheat sheet Meter stick (or wheel) Sidewalk chalk

Lesson	Objectives	Key Concepts	Vocabulary	Activity	Materials
The Size of Things	Students will be able to explain that the Sun is the largest object in the solar system. Students will be able to describe the relative sizes of the 8 planets in the solar system, and Pluto.	The scale of the solar system can be represented here on earth using common materials. Both distance and size can be represented. The Sun is 90% of the mass in our solar system. One million earths could fit inside the Sun. The gas giants are the next largest, followed by the terrestrial planets.	Scale Size	Students begin by estimating the size of each planet and making it with play dough. Then they use their play dough to make a size model of the solar system by following directions and dividing a mass of clay into appropriate sizes.	Size instructions Play-doh, 4-6 tubs per group. 11 x 17 sheet of paper.
What is a Year?	Students will be able to describe the motion of Earth around the Sun over the course of one year.	Earth revolves around the Sun once each year. Earth rotates on its axis, once a day, and 365 days per year. The part that faces the Sun is illuminated. We call it daytime, and the dark side of Earth is in nighttime. The stars we see at night depend on where Earth is in its orbit.	Year Axis Rotate Revolve	Students act out the motions of Earth as it orbits around the Sun over the course of one year, starting with one day, then one year, and finally the months.	An object to act as the Sun and Polaris 12 months signs Globe or ball Flashlight Worksheet
The Reasons for the Seasons	Students will be able to explain what causes Earth to have seasons. Student will be able to explain that when it's summer in the northern hemisphere, it's winter in the southern hemisphere.	Earth is tilted towards Polaris at a 23.5-degree angle. For half of the year the Sun's rays shine directly on the northern hemisphere, and for the other half, on the southern hemisphere. Direct Sunlight heats Earth more than indirect light, causing one hemisphere to be warmer, and one cooler.	Season Northern Hemisphere Southern Hemisphere	Students compare the seasons through identifying activities and drawing scenes in each season. Students learn that Earth heats more when the Sun is in the sky longer by comparing the temperature on thermometers left under a lamp for different lengths of time.	Worksheet for each student Desk or heat lamp Thermometers Watch or clock Flashlight and Globe for demonstration

Lesson	Objectives	Key Concepts	Vocabulary	Activity	Materials
The Source of Energy Lab	Students will be able to explain that plants need Sunlight in order to grow.	Saying that we eat Sunlight wouldn't be far off: The chain of energy transfer around Earth starts at the Sun; Sunlight is used by plants; plants are eaten by animals; and then plants and animals are consumed humans to convert into various forms of energy that we use to survive.	Energy Solar Radiation Source	Students will create a plant box and observe that a plant will grow towards the Sun, its primary source of energy. By periodically collecting data on the growth of the plant, students can come to their own conclusions about why the plant grew towards the Sunlight.	Shoe box Scissors Potting soil Beans to sprout Card board Water Paper towel Small cup
Harnessing the Sun's Energy Lab	Students will be able to explain that energy from the Sun will heat objects on earth.	Solar radiation can be concentrated using reflective material. An object placed at the center point of the reflected light is will be heated through radiation. Items can be cooked this way.	Reflect Radiation Energy	Students will create a solar cooker by lining a box with reflective material and adding a translucent cover. The cooker can be used to make hot dogs or S'mores.	Old shoe or pizza boxes Aluminum foil Plastic wrap Black construction paper Wood dowel Food to cook

Abbreviated Unit

Lesson	Objectives	Key Concepts	Vocabulary	Activity	Materials
The Sun as a Star	Students will be able to identify the Sun as a star. Students will be able to compare the Sun to other stars in the sky by explaining why our Sun appears larger and brighter than other stars	The Sun is an average star. Other stars are visible in the sky at night. They are both bigger and smaller than the Sun. The Sun looks different because it is so close to us. If we were closer to another star it would look similar to our Sun.	Sun Star Average Perspective	Students examine pictures of objects up close and far away to try and figure out what they are. Finally students are given an image of a star and the Sun and through discussion about the differences and similarities of seeing objects up close, conclude that the Sun is a star.	Photos Worksheets
The Scale of Things	Students will be able to describe the scale of the solar system, with the Sun at the center. Students will be able to estimate distances.	The scale of the solar system can be represented here on earth using common materials. Both distance and size can be represented. The Sun is 90% of the mass in our solar system. Ten earths can fit side by side across the diameter of Jupiter, and ten (closer to 11) Jupiters can fit side by side across the face of the Sun.	Scale Size Distance	Students begin by estimating the distance between the Sun and Earth, if the Sun is a given size. Then students take a “Solar system walk” through the planets to see the vast distances that separate them. The concept of the Sun as a star is reinforced as students see the picture of the Sun get smaller as they walk away from it.	Solar Pizza Scale of the solar system cheat sheet Meter stick (or wheel) Sidewalk chalk

Lesson	Objectives	Key Concepts	Vocabulary	Activity	Materials
What is a Year?	Students will be able to describe the motion of Earth around the Sun over the course of one year.	Earth revolves around the Sun once each year. Earth rotates on its axis, once a day, and 365 days per year. The part that faces the Sun is illuminated. We call it daytime, and the dark side of Earth is in nighttime. The stars we see at night depend on where Earth is in its orbit.	Year Axis Rotate Revolve	Students act out the motions of Earth as it orbits around the Sun over the course of one year, starting with one day, then one year, and finally the months.	An object to act as the Sun and Polaris 12 months printed on individual sheets of paper. Globe or ball Flashlight Worksheet
The Source of Energy Lab	Students will be able to explain that plants need Sunlight in order to grow.	Saying that we eat Sunlight wouldn't be far off: The chain of energy transfer around Earth starts at the Sun; Sunlight is used by plants; plants are eaten by animals; and then plants and animals are consumed humans to convert into various forms of energy that we use to survive.	Energy Solar Radiation Source	Students will create a plant box and observe that a plant will grow towards the Sun, its primary source of energy. By periodically collecting data on the growth of the plant, students can come to their own conclusions about why the plant grew towards the Sunlight.	Shoe box Scissors Potting soil Beans to sprout Card board Water Paper towel Small cup

Pre and Post Assessment

Name: ______________________________ Date:____________

1. What is the Sun?

2. Draw a picture of Earth and the Sun in space:

3. What does Earth do in space in one year?

4. When it is summer in the United States, in the Northern Hemisphere, what season is it in Australia, in the Southern Hemisphere?

5. Why is the Sun important to Earth?

Acceptable Responses to Post Unit Assessment

1. The sun is a star.
2. Various drawings, emphasis on showing the earth with half facing the sun, illuminated by it's light, and half facing away, darkened in shadow.
3. It goes around the sun once *or* it makes one year *or* it goes through all the seasons once.
4. Winter.
5. The sun give us life, light, heat, energy, food.

NOTES:

The Sun as a Star

Grades:
3 – 5

Objectives:
- Students will be able to identify the Sun as a star.
- Students will be able to compare the Sun to other stars in the sky by explaining why our Sun appears larger and brighter than other stars

Description:
Students examine pictures of objects up close and far away to try and figure out what they are. Finally students are given an image of a star and the Sun and through discussion about the differences and similarities of seeing objects up close, conclude that the Sun is a star.

Suggested Timing:
25 – 30 minutes.

National Standards
Content Standard D: As a result of their activities in grades K-4, all students should develop an understanding of objects in the sky: The Sun, moon, stars, clouds and airplanes all have properties… that can be described.

Content Standard D: As a result of their activities in grades 5-8, all students should develop an understanding of Earth in the solar system: The sun, an average star, is the central and largest body in the solar system.

Vocabulary:
- Sun
- Star
- Average
- Perspective

Materials: (One per group)
- Photo sets
- Worksheet
- Two identical objects

Background Information:

The Sun is the most prominent object in the daytime sky. It gives us light and heat. Despite it's seemingly huge size, the Sun is really just an average star. Other stars are visible in the night sky that are both bigger and smaller than the Sun. The Sun looks different because it is so close to us. If we were closer to another star it would look similar to our Sun. The next closest star to earth is Proxima Centauri; a dim star in a group of three stars all orbiting each other. It is 4.22 light years away. A light year is the distance light can travel in a single year. Light travels 670,616,629.2 miles per hour. Multiplying that out to how far it can go in a year you get 5,754,696,000,000 miles in one light year! Compare that to the time it takes light to get to earth from the Sun, which is only 8 minutes, the Sun is much closer. That's a huge distance, which is why all the other stars in the sky appear to look so much smaller than our Sun.

Content:

Predict: (Engagement and assessing prior knowledge)

Tell students that perspective, or, how we see things can change depending on where we are. Show the class Photo 1, a large color photo of a window, and give them time to guess what it is. Take some suggestions and write them on the board. Ask questions like, "What makes you think that?" and "What clues do you see in this picture that can help you figure out what it is?"

After taking several guesses reveal that it is a building but photographed from very close up. Show them Photo 2, a picture of the whole building. Explain that objects can look very different when you see them up close, and they can also look very different when you see them from far away.

Method: (Body of the lesson)

Explain to students that in this activity they will be given sets of photos of objects close up. They need to guess what each of the photos is of.

Divide the class into groups of two or three. Give students the worksheet, give instructions to cut the set of mystery photos out and have them guess identity of the object in each photo. Record their answers on the worksheet (Mystery Photos).

Note: Instead of having each student record guesses on individual sheets, a larger version of the worksheet can be made as a poster or on the board. The teacher or selected students can record class answers.

Introduce the vocabulary word *perspective*. Define it as "how you see things." Place an object at the front of the room. Have students change seats or sit on or under their desks. Have students move from one side of the room to the other, front to back. At each new location have students describe how the object appears to them. Look for words like, *smaller, bigger, darker, and shorter.* Have students return to their seats.

Take two identical objects. Have a student hold an object while you take the other. Ask the students if they are the same. Confirm with them that they are the two of the same item. Have the volunteer student stay in one place holding the item. Take the second item and move back a few steps. Question students about their similarities. Move away a few more steps. Ask students how their perspective has changed. Are the objects still the same? Ask students why they look different.

After every group is done review the answers and discuss how they came to each conclusion. Show students Picture 3 (Photo of star field). Explain that this picture is taken from very far away. Show them Picture 4 (of the Sun) and ask students what it is. Explain that the Sun photo is taken up close. Ask students to explain why the Sun looks so different than the stars they see at night. Tell them to think about the photo activity for a clue to the answer. Students should mention that it is because we see the Sun more closely than the other stars.

Tell students that the Sun is an *average* star compared to the other stars in the night sky. Ask students what the word average means. Explain that it means it's not the biggest, or the smallest, but right in the middle. There are bigger and smaller stars than the Sun.

> **Note:** Mention to students that the image of the Sun was taken through a special solar telescope, and that they should NEVER look directly at the Sun with their naked eyes.

Live-It: (Assessment/application assignment)
Have students draw themselves or other objects from the perspective of an ant. Look for a change in perspective, size, and detail of the chosen object.

<u>Extension:</u>
Have students draw a comparison between how they would see an object, and how an ant would see the same object.

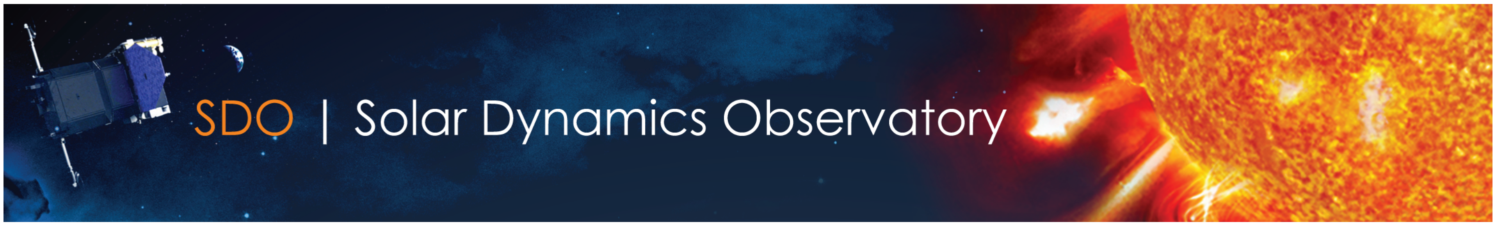
Have students create a poster teaching their family that the Sun is a star.

Bring students outside and give them eclipse viewing glasses (available at http://www.rainbowsymphony.com/) Spend time viewing the sun and looking for features such as sunspots.

Resources:

ESA Kids in our Universe:
http://www.esa.int/esaKIDSen/TheSun.html

NASA's The Solar System:
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Sun&Display=Kids



MYSTERY PHOTOS

Name: ____________________

Date: ____________________

Can you guess what is in each of the photos?

Photo 1: ______________________________

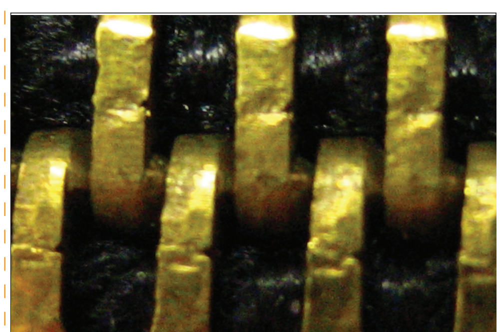
Photo 2: ______________________________

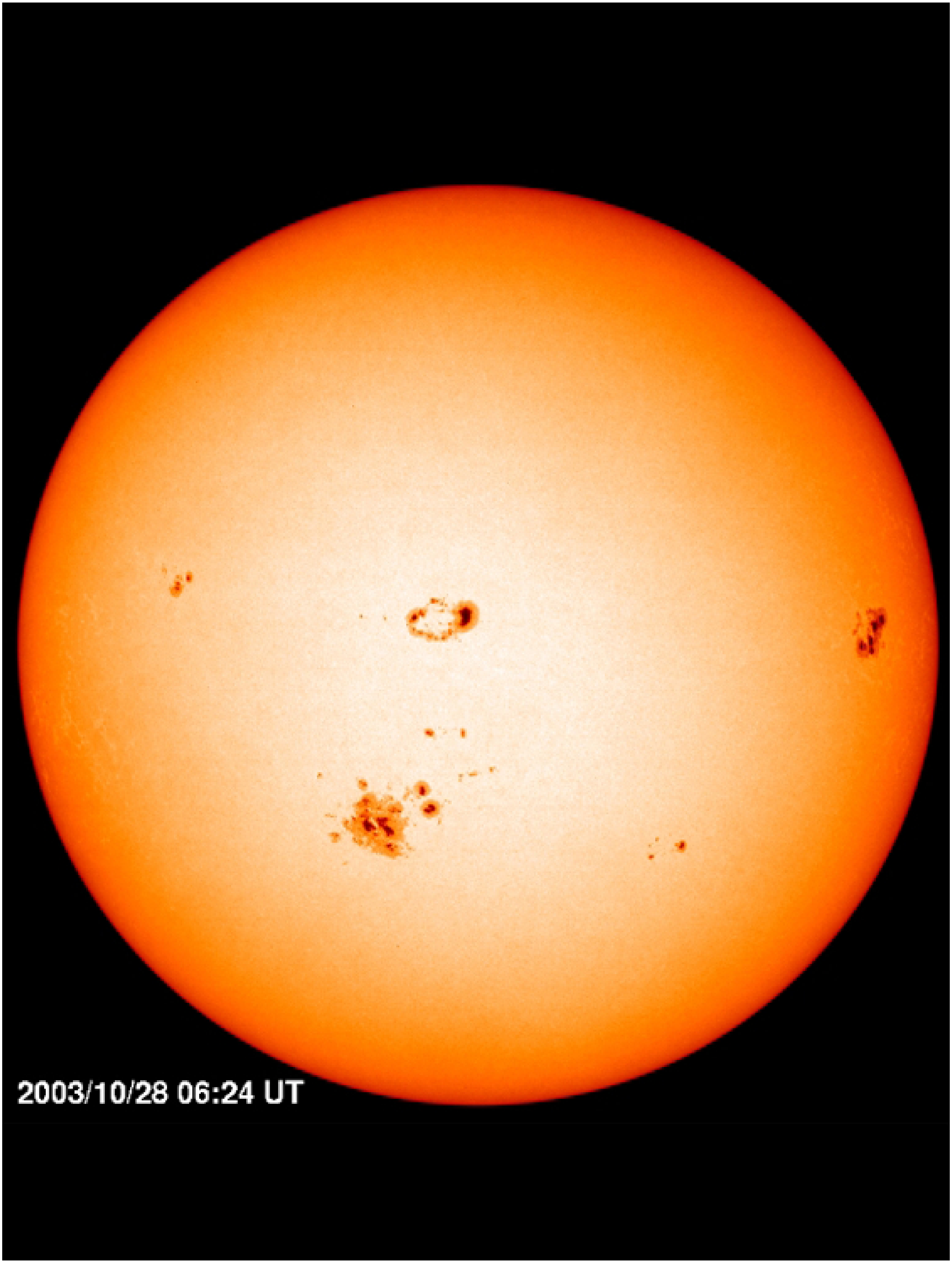
Photo 3: ______________________________

Photo 4: ______________________________

Photo 5: ______________________________

Photo 6: ______________________________

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NOTES:

The Scale of Things

Grades:
3 – 5

Objectives:
- Students will be able to describe the scale of the solar system, with the Sun at the center.
- Students will be able to estimate distances.

Description:
Students begin by estimating the distance between the Sun and Earth, if the Sun is a given size. Then students take a "solar system walk" through the planets to see the vast distances that separate them. The concept of the Sun as a star is reinforced as students see the picture of the Sun get smaller as they walk away from it.

Suggested Timing:
45 – 60 minutes.

National Standards
Content Standard D: As a result of their activities in grades K-4, all students should develop an understanding of objects in the sky: The Sun, moon, stars, clouds and airplanes all have properties… that can be described.

Content Standard D: As a result of their activities in grades 5-8, all students should develop an understanding of Earth in the solar system: The earth is the third planet from the sun in a system that includes the moon, the sun, eight other planets and their moons, and smaller objects, such as asteroids and comets. The sun, an average star, is the central and largest body in the solar system.

Vocabulary:
- Scale
- Size
- Distance

Materials:
- Solar Pizza
- Scale of the solar system cheat sheet
- Meter stick (or wheel)
- Sidewalk chalk

Background Information:
The scale of the solar system can be represented here on earth using common materials. Both distance and size can be represented, for example, ten earths can fit side by side across the diameter of Jupiter, and ten (closer to 11) Jupiters can fit side by side across the face of the Sun, while 112 Earth's can span the same diameter. While the exact distance between planets changes constantly as they orbit the Sun, if we line them up we can create a model showing their approximate distances from each other. The inner or *terrestrial* (rocky) planets; Mercury, Venus, Earth and Mars are separated from the *jovian* (gas) planets; Jupiter, Saturn, Uranus and Neptune, by the asteroid belt. The asteroid belt is thought to be the remains of small planet-like bodies torn apart by the gravitational forces of Jupiter. The vast distances between planets affect our ability to travel to them. It would take us eight months to get to Mars when it is closest to us in its orbit. The physical and psychological stresses of such a long journey, as well as the large quantities of fuel and supplies, and the possibility of complications along the way are all prohibitive factors. Future technologies may allow us to overcome these obstacles and the students of today may be the first astronauts to set foot on another planet.

Content:

Predict: (Engagement and assessing prior knowledge)
Tell students that they are going to learn about the size of the solar system. Ask them if they think that they could fit the solar system inside their classroom. Tell them that they can if they *scale* it down. To help us understand relative measurement, we create models (scale models) where the size and distance relationships are the same in the model as they are in the real world. Tell them that to *scale* something means to make it bigger or smaller but keep the measurements the same relative to each other. Give some examples, possibly including maps and how they use a scale to show how far away something is. Maps show distance in miles or kilometers yet it all fits on one page.

Tell students that they are going to take a guess at how far away Earth would be if the Sun were 6 inches in diameter. Tape up the Solar Pizza (provided at the end of this lesson) at one end of the hallway or classroom and tell them to stand where they think Earth would be. Give them a few moments to make their predictions then pace off 65 feet to where Earth is located. Call all students to stand with you. Hold up the image of Earth to show them its size. This is a good opportunity to reinforce that Earth is a very special planet, in the perfect place to support life, and that everything they know, their home school and friends are all on that small dot, and we should do our best to take care of it. This is also a good point to have students look back at the Sun and remember that it is a star like any other in the night sky. It just looks different because we are so close to it.

Method: (Body of the lesson)
Explain that they will be creating a scale model of the solar system in their schoolyard. This will show them how far apart the planets are compared to each other.

Use the table below as a reference if 1 meter = 20,000,000 miles:

The Scale of the Solar System Cheat-Sheet:

Distance Table	Distance to the Sun	Total METERS to the Sun	Measure the solar system starting at the Sun:
Sun	0 km	0	Start Here
Mercury	57 million km	2.85	2.85 more meters to Mercury
Venus	107 million km	5.3	2.45 more meters to Venus
Earth	150 million km	7.5	2.2 more meters to Earth
Mars	229 million km	11.45	3.95 more meters to Mars
Jupiter	777 million km	38.85	27.4 more meters to Jupiter
Saturn	1.4 billion km	70	31.15 more meters to Saturn
Uranus	2.9 billion km	145	75 more meters to Uranus
Neptune	4.5 billion km	225	80 more meters to Neptune
Pluto (Planetoid)	5.9 billion km	295	70 more meters to Pluto

This activity can be completed in several ways:

- For younger students guide them through measuring out the distances, do it your self ahead of time, or be the primary one to use the meter stick or wheel. Students can take turns marking planets with chalk.
- For older students, have them complete the calculations using the blank table and then measure out the solar system themselves.

Live-It: (Assessment/application assignment)
Have older students make a list of other scaled representations that they have seen in their life.

Have younger students make a scaled drawing of their house, room, or classroom.

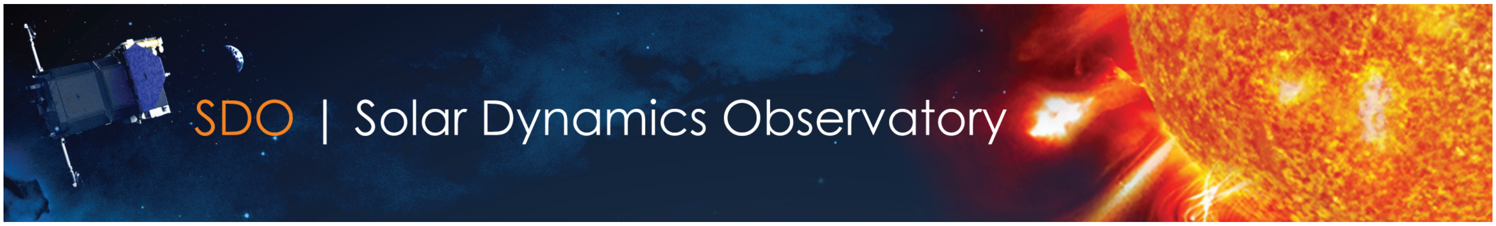
Have students answer the following questions: “Think about the activity we just did where we learned about how far away the other planets are. Why do you think humans have never been to another planet? Which planet do you think we should try and visit first? Why did you choose that planet? Which planet would it take the longest time to get to?”

Extension:

Have students learn about NASA's New Horizons mission to Pluto. New Horizons was launched in 2006 and will reach Pluto in 2015.

Resources:

New Horizons Mission Web Sites:
http://www.nasa.gov/mission_pages/newhorizons/main/index.html
http://pluto.jhuapl.edu/



School Yard Solar System Scale Model

scale: 1 meter = 20,000 km

Celestial Body	Distance to the Sun	Total METERS to the Sun	Measure the Solar System
Sun	0 km	0	________ Start here
Mercury	57 million km		________ more meters to Mercury
Venus	107 million km		________ more meters to Venus
Earth	150 million km		________ more meters to Earth
Mars	229 million km		________ more meters to Mars
Jupiter	777 million km		________ more meters to Jupiter
Saturn	1.4 billion km		________ more meters to Saturn
Uranus	2.9 billion km		________ more meters to Uranus
Neptune	4.5 billion km		________ more meters to Neptune
Pluto (Planetoid)	5.9 billion km		________ more meters to Pluto

NOTES:

The Size of Things

Grades:
3 – 5

Objectives:

- Students will be able to explain that the Sun is the largest object in the solar system.
- Students will be able to describe the relative sizes of the 8 planets in the solar system, and Pluto.

Description:
Students begin by estimating the size of each planet and making it with Play-doh. Then they use their play dough to make a size model of the solar system by following directions and dividing a mass of clay into appropriate sizes.

Suggested Timing:
25 – 30 minutes.

National Standards
Content Standard D: As a result of their activities in grades K-4, all students should develop an understanding of objects in the sky: The Sun, moon, stars, clouds and airplanes all have properties… that can be described.

Content Standard D: As a result of their activities in grades 5-8, all students should develop an understanding of Earth in the solar system: The earth is the third planet from the sun in a system that includes the moon, the sun, eight other planets and their moons, and smaller objects, such as asteroids and comets. The sun, an average star, is the central and largest body in the solar system.

Vocabulary:

- Scale
- Size

Materials: (One per group)

- Size instructions
- Play-doh, 4-6 tubs. (3lbs: minimum quantity required for this activity)
- 11 X 17 in sheet of paper.

Background Information:

The scale of the solar system can be represented here on earth using common materials. By selecting a small ratio a scale model can be created to shoe both relative size and distance. The Sun is 90% of the mass in our solar system. One million earths could fit inside the Sun. The gas giants are the next largest, followed by the terrestrial planets, accounting for only 10% of the mass of the solar system. The inner or *terrestrial* (rocky) planets; Mercury, Venus, Earth and Mars are smaller than the *jovian* (gas) planets; Jupiter, Saturn, Uranus and Neptune. It should also be noted that this figure does not account for the smaller objects in the solar system, asteroids and moons. Jupiter for example, has over 50 moons, one of which is larger than the planet mercury.

Content:

Predict: (Engagement and assessing prior knowledge)
Give students their tubs of Play-doh and tell them to divide it up into the 8 planets and Pluto, making each one the size they think it ought to be compared to the rest of the planets. Have them place the planets on a large sheet of paper. Give students time to make their predictions. Students must use ALL the Play-doh. After making each of the planets and Pluto have students trace the circumference of each planet and label it.

Method: (Body of the lesson)
This activity is best done when the instructions are given out loud and also posted on a white board, projector, or hand out. Explain to students that they will be learning about the size of the planets compared to each other.

1. Make 10 equal balls from all 4 or 6 tubs of Play-doh combined. Squash 6 of them together...this will be JUPITER. Place the ball on the paper labeled JUPITER.

2. Take another 3 and squash them together...this is only part of SATURN (you will add to SATURN two more times before the activity is over). Place the ball on the paper labeled SATURN.

3. Divide the ball of Play-doh that is left into 10. Squash 5 of them together and add them to SATURN. Take 2 and squash them together...this is NEPTUNE. Place the ball on the paper labeled NEPTUNE.
4. Take another 2 and squash them together...this is URANUS. Place the ball on the paper labeled URANUS.

5. With the ball that is left, make 10 equal sized balls. Squash 9 of them together...add them to SATURN. SATURN is now complete!
6. Divide the remaining ball into 2. 1 is EARTH. Place the ball on the paper labeled EARTH.

7. Now is when things get tricky! Divide the ball that is left into 10. 9 of them make up VENUS. Place the ball on the paper labeled VENUS.

8. Make 10 balls out of the 1 that is left. Use 9 to make create MARS. Place the ball on the paper labeled MARS.

9. Divide the ball of Play-doh that is left into 10. 9 of them make up MERCURY (Place them on the paper labeled MERCURY)

10. And the one left is PLUTO! Place the ball on the paper labeled PLUTO.

Why isn't the Sun included in this activity? The Sun is so much larger than all of the planets that if you use a 3lb tub of Play-doh to make the 8 planets and Pluto, it would take 980 tubs to make the Sun!

Live-It: (Assessment/application assignment)
Have students rearrange the planets in order of largest to smallest, then make a poster with each planet labeled and in the order of largest to smallest.

Answer this question: “Were your planet size predictions right? Explain.”

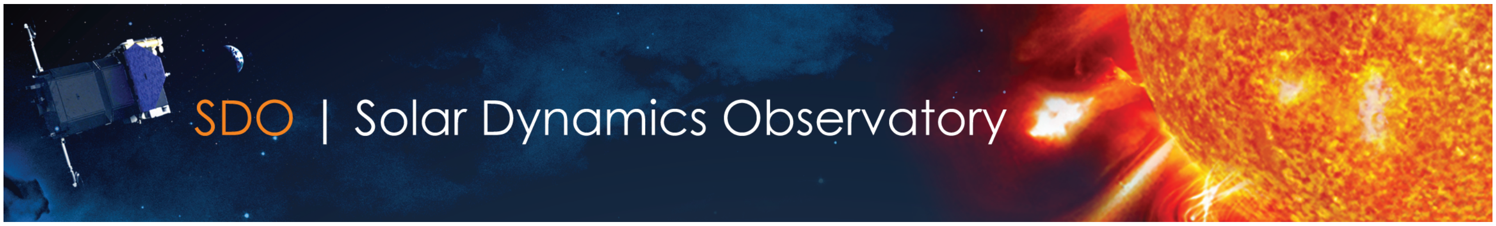
Extension:

Students can make their poster out of magazine photos, or trace the circumference of the accurate clay planets onto their poster to make it more accurate.

Resources:

NASA’s Solar System Website:
http://solarsystem.nasa.gov/planets/index.cfm

The Nine Planets:
http://nineplanets.org/



LAB SHEET: PLAY-DOH SOLAR SYSTEM

STEP 1:

- ☐ Mash play-doh from all cans into one big ball
- ☐ Now make 10 equal balls.
- ☐ Squash 6 of them together...this will be JUPITER. Place the ball on the paper where you labeled JUPITER.
- ☐ Take another 3 and squash them together...this is only part of SATURN (you will add to SATURN two more times during this activity). Place the ball on the paper labeled SATURN.

STEP 2:

- ☐ Divide the ball of Play-doh that is left into 10 equal balls.
- ☐ Squash 5 of them together and add them to SATURN.
- ☐ Take 2 and squash them together...this is NEPTUNE. Place the ball on the paper labeled NEPTUNE.
- ☐ Take another 2 and squash them together...this is URANUS. Place the ball on the paper labeled URANUS.

STEP 3:

- ☐ With the ball that is left, make 10 equal sized balls.

  Squash 9 of them together...add them to SATURN. SATURN is now complete!

STEP 4:

- ☐ Divide the remaining ball into 2. 1 is EARTH. Place the ball on the paper labeled EARTH.

STEP 5:

- ☐ Now is when things get tricky! Divide the ball that is left into 10. 9 of them make up VENUS. Place the ball on the paper labeled VENUS.

STEP 6:

- ☐ Make 10 balls out of the 1 that is left. Use 9 to make create MARS. Place the ball on the paper labeled MARS.

STEP 7:

- ☐ Divide the ball of Play-doh that is left into 10.
- ☐ 9 of them make up MERCURY (Place them on the paper labeled MERCURY).
- ☐ The one left is PLUTO! Place the ball on the paper labeled PLUTO.

CONGRATULATIONS!!! You have completed a scale model of the Solar-system planets out of Play-Doh!!

What is a Year?

Grades:
3 – 5

Objectives:
- Students will be able to describe the motion of Earth as it travels (revolves) around the Sun over the course of one year.

Description:
Students act out the motions of Earth as it orbits around the Sun over the course of one year, starting with modeling one day, then one year, and finally the months.

Suggested Timing:
25 – 30 minutes.

National Standards
Content Standard D: As a result of their activities in grades K-4, all students should develop an understanding of changes in Earth and sky: Objects in the sky have patterns of movement.

Vocabulary:
- Year
- Axis
- Rotate
- Revolve

Materials:
- An object to act as the Sun (light bulb or balloon)
- All 12 months printed on individual sheets of paper.
- Globe or ball
- Flashlight
- Worksheet for each student

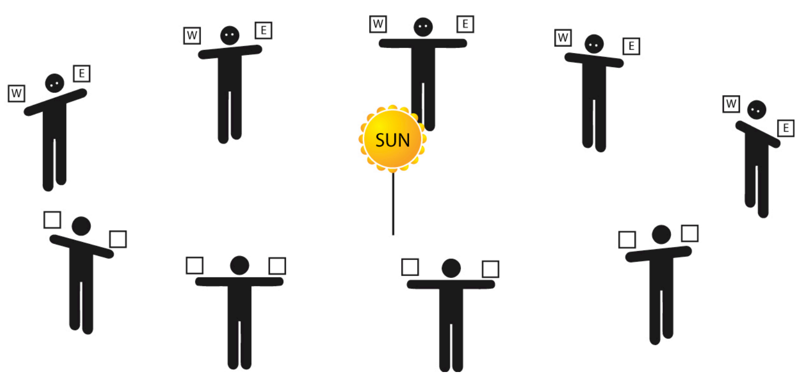
Background Information:

Earth revolves around the Sun once each year, moving counterclockwise in its orbit as seen looking down on the North Pole. Earth rotates on its axis counterclockwise as well, once a day, and 365 days per year. The half of Earth that faces the Sun is in daytime, and the half that faces away is in nighttime. We can associate Earth's location in its orbit around the Sun with the months of the year. This connection shows students that the calendar is a measure of time, and the pattern we see in seasons and stars as Earth moves around the Sun repeats as the year begins again.

Content:

Predict: (Engagement and assessing prior knowledge)
Tell students to draw what they think Earth looks like from space, using the worksheet provided (Draw Earth from space). This worksheet includes an image of the Sun on the right side of the paper. Student drawings may or may not take into account that the side of Earth facing away from the Sun would be dark, and the side of Earth facing the Sun would be illuminated.

Method: (Body of the lesson)
Have students stand in a circle with an object or light bulb in the center of the room to represent the Sun.



1. Explain that earth rotates on its axis *counterclockwise*. Explain what counterclockwise means, and have students rotate once counterclockwise.

2. Ask students to imagine there is a man standing on Mt. Nose (your nose). How would you have to stand so that it is noon on Mt. Nose?

3. Instruct students to stand so that its Sunrise (with their Sun on their left), noon (facing the Sun), Sunset (with the Sun on their right), and midnight (facing away from the Sun) on Mt. Nose. Have them do this several times.

4. Explain that earth revolves around the Sun in the same direction as it rotates on its axis: Counterclockwise.

5. Instruct students to walk in a circle counterclockwise, making one trip around the Sun and ending back where they started.

6. Instruct students to walk in a circle counterclockwise, spinning on their axis counterclockwise. Explain that there are 365 days in a year, so that means to make their model accurate, the would have to spin on their axis 365 times as they revolve around the Sun just once.

7. Ask: What do we use to measure time over a year? (Months). Add the month labels to the wall of the room, starting with January at one end and moving counterclockwise. Make sure to evenly space them so that January is opposite of July, and March is opposite of September.

8. Instruct students to look around the room and find their birth month, then stand at that spot. Note: Teachers can also have students line up by birth date.

9. Show students the globe and the flashlight. Turn the flashlight on and shine it on the globe.

10. Ask students to show you which side is in daytime and which is in nighttime. Ask them to explain their reasoning. Probe students until they can explain that when it is daytime we are facing the Sun, and when it is nighttime we are facing away from the Sun. When it is daytime and we are facing the sun, the Sun is so bright that we cannot see the other objects that are in the distant sky with our naked eye. At nighttime, when we are facing away from the Sun, we can see the objects (like other stars and the planets in our solar system) in the distant sky.

Live-It: (Assessment/application assignment)
Tell students to re-draw what they think Earth looks like from space, using the worksheet provided (Draw Earth from space). This will be the second time they've done this exercise (Once in a pre-assessment). Look for student drawings that show the half of Earth that faces Earth illuminated, and the other half darkened.

Extension:
Have students create a model of the Sun and Earth out of Styrofoam balls, painting the Sun and Earth, showing daytime and nighttime.

Resources:

Daylight Map
http://www.daylightmap.com/index.php

Animations of Earth Orbiting the Sun:
http://www.mathsisfun.com/earth-orbit.html
http://www.ncsu.edu/scivis/lessons/earthinspace3d/eSpace.avi

Draw the Earth in Space!

Name: ____________________
Date: ____________________

NOTES:

The Reasons for the Seasons

Grades:
3 – 5

Objectives:

- Students will be able to explain what causes Earth to have seasons.
- Student will be able to explain that when it's summer in the northern hemisphere, it's winter in the southern hemisphere.

Description:
Students compare the seasons through identifying activities and drawing scenes in each season. Students learn that Earth heats more when the Sun is in the sky longer by comparing the temperature on thermometers left under a lamp for different lengths of time. As an extension students learn that the spherical shape of Earth causes the seasons to be opposite in each hemisphere.

Suggested Timing:
60 – 90 minutes.

National Standards
Content Standard D: As a result of their activities in grades K-4, all students should develop an understanding of objects in the sky: The Sun provides light and heat necessary to maintain the temperature of Earth. Changes in Earth and sky: Objects in the sky have patterns of movement

Content Standard D: As a result of their activities in grades 5-8, all students should develop an understanding of Earth in the solar system: Seasons result from variations in the amount of the sun's energy hitting the surface, due to the tilt of the earth's rotation on its axis and the length of the day.

Vocabulary:

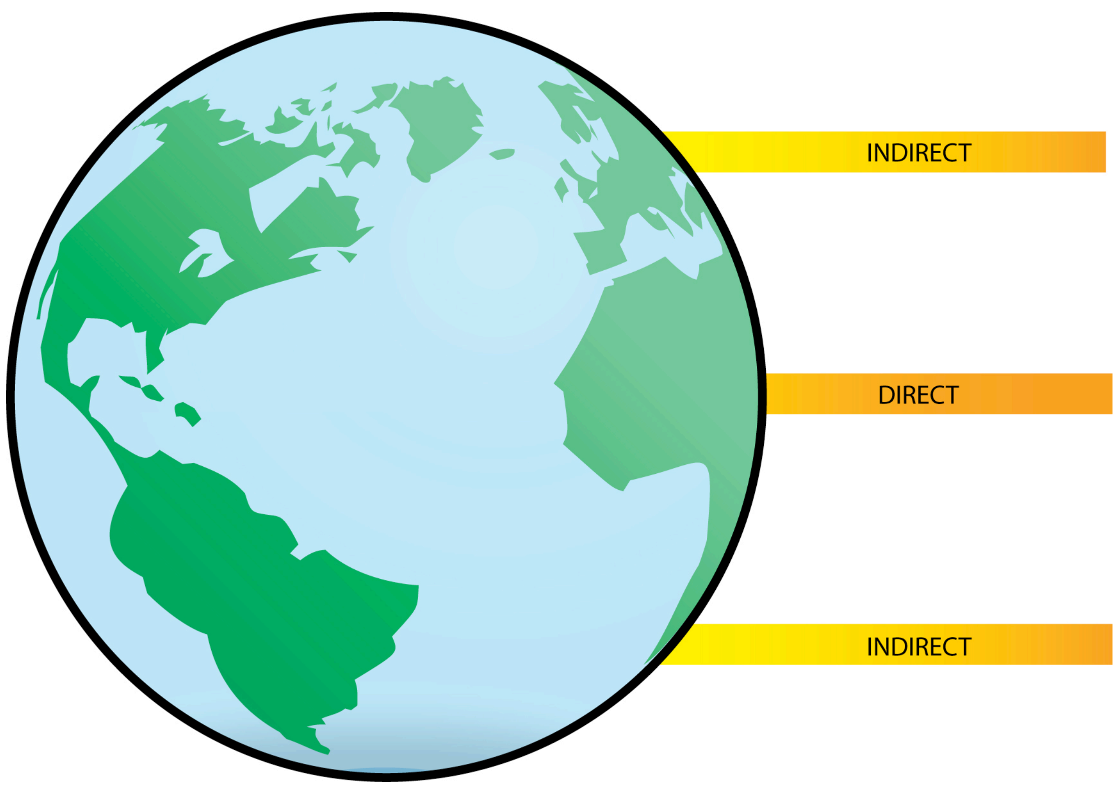
- Season
- Northern Hemisphere
- Southern Hemisphere

Materials: (One per group)

- Worksheet for each student
- Desk or heat lamp
- Thermometers
- Watch or clock
- Flashlight and Globe for demonstration

Background Information:

The seasons on Earth are caused by the tilt of Earth on its axis, which is approximately 23.5 degrees. Earth's axis is tilted towards the North Star and remains in that inclination throughout the year. As Earth revolves around the Sun its axis is continually tilted in the same direction. If you extended the line of the axis into space it would touch Polaris, or the North Star. As Earth rotates around its axis Polaris appears to remain in the same place while all the stars rotate around it. For half of the year the Sun's rays shine directly on the northern hemisphere, and for the other half, on the southern hemisphere. Because of Earth's spherical shape, the hemisphere tilted towards the Sun receives more hours of daylight. Direct Sunlight heats Earth more than indirect light, causing one hemisphere to be warmer, and one cooler. These differences cause the seasons on earth.



Content:

Predict: (Engagement and assessing prior knowledge)
Begin by having students brainstorm activities and events that occur in each season. This can be done in groups on a sheet of paper divided into four sections, or as a class where the teacher or students write on a whiteboard or poster paper.

Ideas may include: Swimming in summer, school beginning in the fall, leaves turning in the fall, snow or cooler temperatures in the winter, rain in the spring, or other local activities and events.

Ask students to write down their answer to the following question: "Why do we have different activities in different times of year? How are the seasons different?" When they are done writing their prediction, have a few students read their answers out loud.

Ask students if they notice anything about their bedtime in the summer and in the winter. Bedtime can be substituted with ride to school in the morning, or how long they can play outside, etc… After taking some answers, guide students to the observation that the Sun rises and sets later in the winter and the days are shorter. The opposite is true in the summer. Students may notice that it's light out on their way to school in the morning when school first starts, but towards December it is dark out on their way in.

Method: (Body of the lesson)
Tell students they are about to do an experiment to see if daylight has anything to do with the difference between summer and winter. Ask students what kind of experiment they think would help them to tell if more hours of *daylight* affects *temperature*.

After brainstorming ideas, hand out the worksheet (Daylight and Temperature) and have students look over the procedure for the experiment. Explain that they will be recording a change in temperature with a thermometer under a lamp left on for four different amounts of time.

1. Guide students through filling out the prediction section of the worksheet, completing the statement: "The longer we leave the thermometer under the lamp, the ______________ the temperature will be."

2. Continue the experiment by setting up a lamp over a thermometer. Be sure to measure the distance between the lamp and the thermometer, making sure that both tests occur at the same distance. Also, if the lamp is too far away it will take too long to heat up. Place it around six inches from the thermometer, depending on the intensity of the lamp.

3. Have students work as a class or in groups, keeping time and recording the data. Record the thermometer reading once every thirty seconds. Data can be plot on a graph in front of the class as well as on student worksheets.
4. Conclude the experiment by analyzing the data students collected. Discuss what the data tells them, and how it relates to the length of day on earth. Ask to write down if their prediction was correct.

Next, get out a globe and a flashlight. Shine the flashlight on the globe and ask students to identify the side that is night and the side that is day. Tell students that Earth is tilted at a 23-degree angle. Tilt the globe, keeping the flashlight in the same orientation. Ask them if they can see a difference between the top – Northern Hemisphere, and the bottom – Southern Hemisphere. The hemisphere tilted towards the Sun will have the most light shining on it. Have students guess which season it is in that hemisphere (summer). Ask them what season it would be in the opposite hemisphere (winter). Conclude by restating that the tilt of Earth gives different amounts of light to different hemispheres, the more light, the warmer it is, the less light, the cooler it is.

Live-It: (Assessment/application assignment)
Have students draw a picture of Earth with people in the northern and southern hemisphere wearing clothing appropriate for the season. Look for images of people in the northern hemisphere wearing summer clothes, and in the southern hemisphere wearing winter clothes, or vice versa.

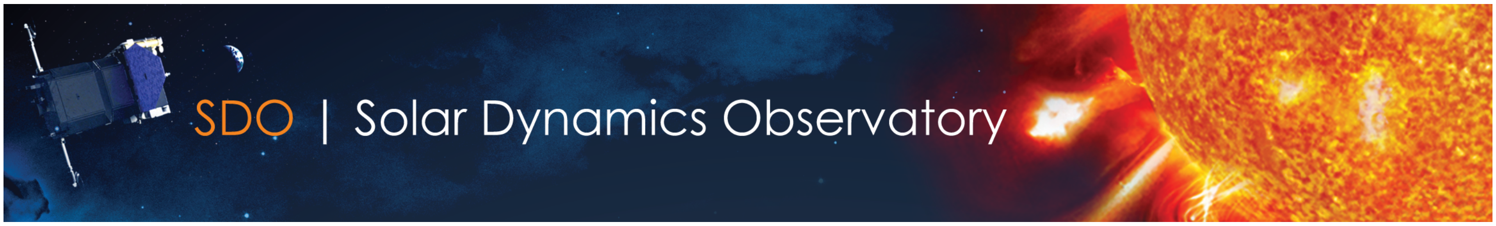
Ask students if there are places on Earth that do not experience changing seasons and why this could be possible.

Extension:
Have students write a letter to a pen pal in Australia (or the US if you are in a southern hemisphere country), talking about the current season and asking them about the weather where they are now.

Resources:

More activities and videos on the reason for the seasons:
http://ksnn.larc.nasa.gov/k2/s_seasons_a.html

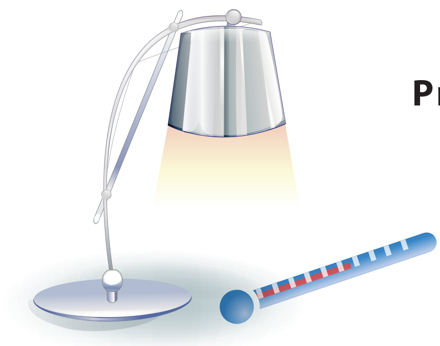
Seasons Animation:
http://esminfo.prenhall.com/science/geoanimations/animations/01_EarthSun_E2.html



Daylight and Temperature

Name: ______________________

Date: ______________________



Predict: What will happen if we leave the thermometer under the lamp?

"The longer we leave the thermometer under the lamp, the ____________ the temperature will be."

Measure the distance from the thermometer to the lamp: ______________________

TIME	TEMPERATURE
30 seconds	
1 minute	
1 minute 30 seconds	
2 minutes	
2 minutes 30 seconds	
3 minutes	
3 minutes 30 seconds	
4 minutes	
4 minutes 30 seconds	
5 minutes	

NOTES:

The Source of Energy Lab

Grades:
K – 5

Objectives:
- Students will be able to explain that plants need Sunlight in order to grow.

Description:
Students will create a plant box and observe that a plant will grow towards the Sun, its primary source of energy. By periodically collecting data on the growth of the plant, students can come to their own conclusions about why the plant grew towards the Sunlight.

Suggested Timing:
25 – 30 minutes.
1 – 2 weeks for plant growth.

National Standards
Content Standard A: As a result of their activities in grades K-4, all students should develop an understanding of organisms and their environment, 1: All animals depend on plants. Some animals eat plants for food. Other animals eat animals that eat the plants.

Content Standard D: As a result of their activities in grades K-4, all students should develop an understanding of objects in the sky: The Sun provides light and heat necessary to maintain the temperature of Earth.

Vocabulary:
- Energy
- Solar
- Radiation
- Source

Materials: (One per group)
- Shoe box
- Scissors
- Potting soil
- Beans to sprout
- Card board
- Water
- Paper towel
- Small disposable cup

Background Information:

Energy is defined as the ability to do work on an object. Examples of work being done include a person carrying a box upstairs, a plant growing, a cake heating up in the oven, and electricity lighting up a light bulb. All work done on earth requires energy, and the ultimate source of our energy is the Sun.

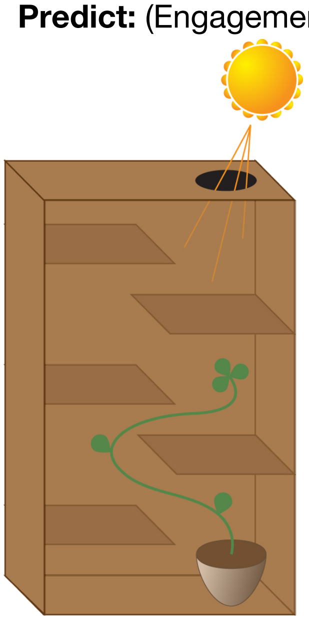
Energy travels from the Sun to earth by radiation, which is energy in the form of waves and particles. We see the waves of visible light, but waves that are smaller or bigger are invisible to the human eye. Infrared radiation passes through the atmosphere and heats the surface of Earth. Visible light interacts with plants that use it to photosynthesize water and carbon into sugar, chemical energy they can use to grow. Humans, in turn, consume energy from plants in the form of food and fossil fuels like gas and coal.

Saying that we eat Sunlight wouldn't be far off: The chain of energy transfer around Earth starts at the Sun; Sunlight is used by plants; plants are eaten by animals; and then plants and animals are consumed humans to convert into various forms of energy that we use to survive.

We also gather energy directly from the Sun using solar panels and wind turbines. Solar panels work by using photons of light from the Sun to knock loose electrons and then force them to move in one direction around a circuit, producing electricity. Wind turbines spin when the Sun unevenly heats Earth, causing cool, dense air to rush into areas of warm, less dense air. This wind pushes the turbines, which spin a magnet through a coil, which pushes the electrons around a circuit, producing electricity.

Content:

Predict: (Engagement and assessing prior knowledge)



Ask students what plants need to grow. Have them list this on a piece of paper or write it on the white board for the class to see. Remind students that Sunlight is essential for plant growth.

Method: (Body of the lesson)

The Plant Box:

1. Sprout a bean seed in a cup with a paper towel and water first, then plant it in a small cup filled with potting soil.
2. Stand a shoebox on its side so that it is as tall as it can be. Using cardboard, create a maze from the bottom to the top of the shoebox, leaving space at the bottom for the cup with the sprout. See figure below.
3. Cut a 2 inch diameter hole in the top of the shoebox.

4. Place the cup with the seedling that has already sprouted in the bottom of the shoebox. Place the lid over the box.
5. Remove the lid to water the sprout as needed.
6. Place in a spot where the box will get Sunlight, but not overheat.

Over time the sprout will begin to grow along the maze created in the box, toward the Sunlight coming through the hole at the top.

Lab Activities:

1. Students can use the worksheet provided to regularly collect data on the plant growth in their box. This is a good opportunity to learn about observational data and quantitative data – recording what you can see versus what you can measure.

2. The size of the plant can be measured more exactly by following its curved growth around the maze with a string, and then measuring the length of the string.

3. Plant growth can then be tracked on a bar graph. Seeing the trend of growth over time can lead to conclusions about the rate of plant growth to the amount of Sunlight it gets.

4. Have students decorate the shoebox with images of the Sun and the things on earth that use it, illustrations from the story, or vocabulary words.

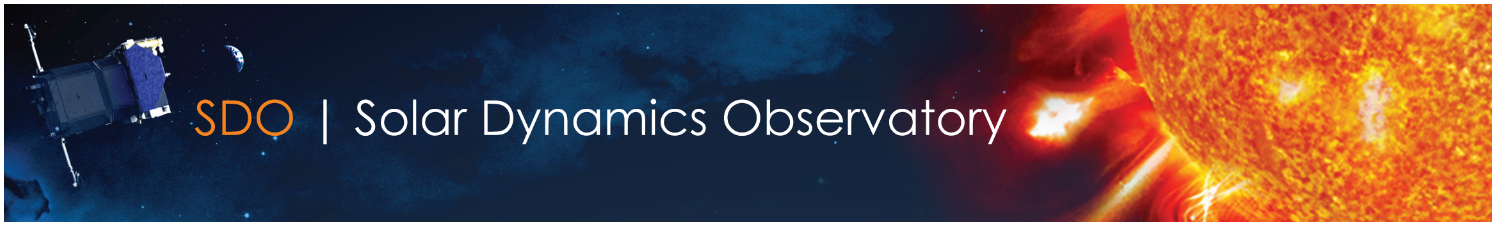
Live-It: (Assessment/application assignment)
After collecting data for a few weeks, have students make a booklet about the growth of their plant. The booklet should include:

- A drawing of their plant
- Data they recorded.
- An explanation of why they think the plant grew like it did.

Extension:
One sprout can be kept in the dark while another is exposed to full Sunlight. One sprout can be rotated daily in a planter while another is left with one side always facing the Sun. For more advanced students try putting one plant in a box with red LED lights, and another plant in a box with blue LED lights and observing the differences in their growth.

Resources:

Photosynthesis Animations:
http://woodchurchscience.edublogs.org/files/2008/03/photosynthesis-flash.swf
http://www.indiana.edu/~oso/animations/ginkgogrowth.html



Searching for the Sun!

Name: ______________________
Date: ______________________

Data Sheet:

DAY 1: Date:	**What I see...**	**Plant Size:**
DAY 2: Date:	**What I see...**	**Plant Size:**
DAY 3: Date:	**What I see...**	**Plant Size:**
DAY 4: Date:	**What I see...**	**Plant Size:**
DAY 5: Date:	**What I see...**	**Plant Size:**

Conclusion: What's Happening?

____

____

____

____

NOTES:

Harnessing the Sun's Energy Lab

Grades:
K – 5

Objectives:
- Students will be able to explain that energy from the Sun heats objects on earth.

Description:
Students will create a solar cooker by lining a box with reflective material and adding a translucent cover. The cooker can be used to make hot dogs or s'mores.

Suggested Timing:
30 – 60 minutes.

National Standards
Content Standard D: As a result of their activities in grades K-4, all students should develop an understanding of objects in the sky: The Sun provides light and heat necessary to maintain the temperature of Earth.

Vocabulary:
- Reflect
- Radiation
- Energy

Materials: (One per group)
- Old shoe or pizza boxes
- Aluminum foil
- Plastic wrap
- Miscellaneous construction materials
- Tape
- Scissors
- Black construction paper, cut to be smaller than the top of the shoe or pizza box.
- Small wood dowel or straw
- s'more, hotdog, or nachos to cook.

Background Information:
The Sun is the most influential body in our solar system, accounting for 90% of its mass. Because of the great distance between Earth and the Sun only one billionth of the Sun's energy, or 1.7 x 10^14 kilowatts, actually reaches earth. The measure of power per area is called solar flux. Outside of its atmosphere Earth receives a flux of about 1353 watts per meter squared. We call this number the solar constant, although the number varies slightly over the year due to small changes in distance between Earth and Sun.

The surface of Earth does not receive the same flux due to absorption and scattering from the atmosphere, latitude, time of day and year, and weather. Radiation that does make it through the atmosphere can be concentrated using reflective material. An object placed at the center point of the reflected light is will be heated. Solar cookers work this way.

There are several designs of solar cooker, the most popular being the box oven, the parabolic oven, and the panel oven. The box oven works by reflecting light through a translucent cover into a lined box. The cover prevents most heat from escaping, allowing temperatures inside to rise. The food to be cooked is then placed inside the box. The parabolic oven works by reflecting light off of mirrors. The food is placed at the focus of the light. These ovens heat up very quickly. Panel ovens use the same principal, reflecting light back down onto an absorbing surface. These cookers are relatively inexpensive and simple to construct, making them ideal for mass production.

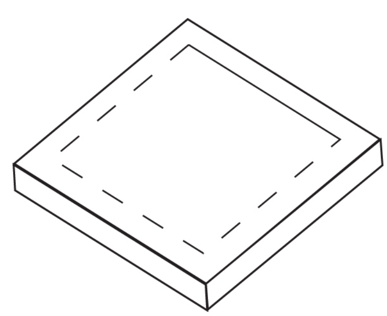
Content:

Predict: (Engagement and assessing prior knowledge)
Ask students if they have ever gotten hot in the summer. Give them time to talk about what they did to get cool again, then ask them if they have ever heard the expression "Hot enough to fry an egg." Explain that this means someone thinks it's very hot outside. Ask students if they think that they could actually use the *energy* from the Sun to do work, like give us electricity, or cook food. Take several answers.

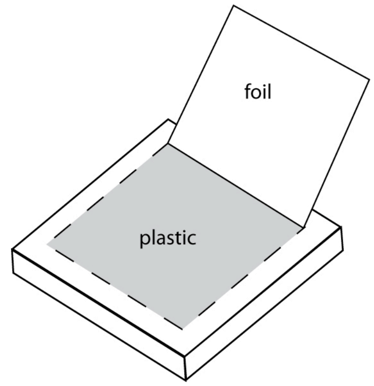
Explain that they are going to attempt to build their own solar cooker to test their theory.

Method: (Body of the lesson)
Constructing the Solar Cooker:

1. Have the student trace a square 1in from the edge of the pizza box. Cut along three edges, leaving the edge closest to the box opening. Form a flap by gently folding back along the uncut line to form a crease.

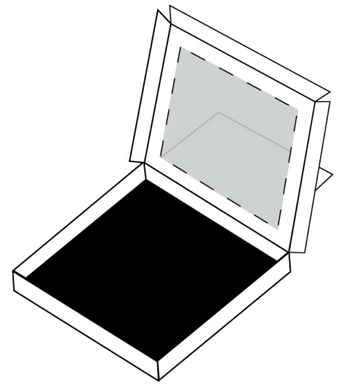


2. Cut a piece of aluminum foil to fit on the inside of the flap. Smooth out any wrinkles.



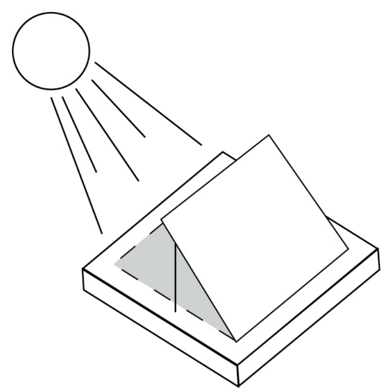
3. Measure a piece of plastic to fit over the opening you created by forming the flap in your pizza box. The plastic should be cut larger than the opening so that it can be taped to the underside of the flap.

4. Measure a 2nd piece of plastic wrap. Tape this piece to the top side of the box. (This will make a total of two layers of saran wrap with a small layer or air in between). It is important to get these seals tight!



5. Cut another piece of aluminum foil to line the bottom of the pizza box and carefully glue into place. Cover the aluminum foil with a piece of black construction paper and tape into place. Note: the layer of aluminum foil underneath the black is optional.

6. Line the sides of the pizza box with rolled newspaper or other materials for added insulation.



7. Close the pizza box top (window), and prop open the flap of the box with a wooden dowel, straw, or other device (if needed) and face towards the Sun. Adjust until the aluminum reflects the maximum Sunlight through the window into the oven interior.

8. Cook some s'mores!

Live-It: (Assessment/application assignment)
Have students draw a picture showing how the solar cooker works. Elements to look for: The Sun, the oven, cooking food, people, depiction of heat/energy transfer.

Ask students to explain in their own words how the oven works.

Extension:
Try this same activity on a cloudy day and compare results.
Place different foods in the oven and time how long each of them takes to cook.
Place a thermometer inside the oven and measure the temperature every 2 minutes. Record results on a graph.
Discuss the Sun as an alternative energy source. Show the class pictures of solar cells, solar energy plants, and windmills – where the Sun causes the wind that moves the turbines.

Resources:
http://sdo.gsfc.nasa.gov - The Solar Dynamics Observatory

More information on solar cooking:
http://www.solarcooking.org/
http://www.re-energy.ca/pdf/Solar%20Heat%20LP%20formatted.pdf

SDO - Solar Dynamics Observatory

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http://sdo.gsfc.nasa.gov/epo/educators/