Family Space Day Overview

Family Space Day is a three hour event. The activities are set up so that children and parents can select the order in which they undertake activities. Parents and children are encouraged to learn, play, and explore *together*.

Objectives of the Day

Children will:

- learn about the size, distance, and characteristics of the Sun.
- explore the different wavelengths of light emitted by the Sun.
- learn how the Sun's light affects us.

This would be a great time to contact your local astronomy club and ask them to host a solar telescope viewing at your event. You can safely view Sunspots and more through a solar telescope!

Activities

- Station 1: Sun Posters
  Children and their parents examine 9 informational posters to learn about the Sun.

- Station 2: The Size of the Sun
  Children and their parents explore how the size of the Earth compares to the size of the Sun. This activity is integrated into Station 1: Sun Posters.

- Station 3: Paper Plate Sun
  Children and their parents investigate the relative size of our Earth and Sun and their distance apart, and create artistic representations of its layers and features.

- Station 4: The Colors of the Sunshine
  Children and their parents observe that the Sun's "white" light is actually made of many different colors of light.

- Station 5: Solar S'Mores
  Children make a solar oven to make yummy S'Mores!

- Station 6: UV Thing
  Children and their parents experiment to find out what happens when the UV-sensitive beads are exposed to different sources of energy: visible light from flashlight, heat from a hair dryer, ultraviolet light from a UV lamp, and sunlight.

- Station 7: Amazing Rays

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Children explore the Sun's light as energy using photosensitive paper.

- Station 8: Counting Sunspots
  Children and their parents discover the pattern created when plotting the number of Sunspots over a long period of time.

- Station 9: Sun Telescope
  Children and their parents view and then draw Sunspots safely by projecting the Sun onto a white background.

- Station 10: Coloring Sheets and Games
  Children relax and color and play simple games related to the Sun.

- Station 11: Reading Room
  Children and their parents browse and read a selection of books about the Sun (refer to book list for suggested reading).

Other Materials

- *Facilitator Information* – The Sun
- *Explore the Sun* – Book and Website References
- *All About the Sun* – A Sun Fact Sheet

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Facilitator Information

(All you need to know about the Sun to survive the day)

Taken from SkyTellers http://www.lpi.usra.edu/education/skytellers

Our Sun is our nearest star. Its light and heat make life on Earth possible!

When did our Sun form?

Scientists calculate our Sun and solar system formed at the same time — a whopping 4.56 billion years ago. This is based on the ages of the oldest objects that we have sampled from our solar system — meteorites.

How did our Sun form?

Our Sun and the solar system formed from a huge, slowly rotating molecular cloud made of hydrogen and helium molecules and dust. Under its own gravity, the cloud began to compress. As it compressed, it spun faster and faster, like an ice skater who spins faster as he pulls his arms in closer to his body. The spinning flattened the material into a giant disk. Most of the mass was concentrated at the center of the disk, forming a gas sphere. The sphere continued to attract material from the disk. As new material was added, the sphere compressed, increasing the temperatures and pressures until they were sufficient to fuse atoms in the very center of the sphere — and at that point a star — our Sun, was born. The planets and other components of the solar system formed from the remainder of the disk. By exploring our universe with tools such as the Hubble Space Telescope, scientists have discovered stars in various stages of formation. This helps them understand how our Sun may have formed.

How much longer will our Sun shine?

Our Sun will shine as it is for about another 3 to 5 billion years! It will then evolve into a Red Giant over a few thousand years. Scientists arrive at this estimate by calculating how fast the hydrogen in the Sun's core is being converted to helium. Approximately 37% of our Sun's hydrogen has been used since it formed four and a half billion years ago.

How far away is our Sun?

Our Sun's average distance from Earth is 150 million kilometers (93 million miles).

How big is our Sun?

Our Sun's diameter is 1,391,020 kilometers, or about 109 times the diameter of Earth.

Structure of our Sun[1]

Like Earth, our Sun has many different layers. Unlike Earth, our Sun is made of gas!

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The Sun's energy is generated in its core. Gravitational pressures compress and heat the material in the core to over 15 million degrees Celsius or about 27 million degrees Fahrenheit! That's HOT!

Energy passes from the core into the cooler radiative zone (merely 5 million degrees Celsius, or about 9 million degrees Fahrenheit). Here the energy (radiation) moves randomly from atom to atom, with some of the energy moving toward the Sun's surface.
As energy moves out of the radiative zone, it enters the convective zone . Here the atoms do not pass the energy from particle to particle; the atoms themselves move, carrying the heat with them. The hotter material near the radiative zone rises to the cooler surface of the convective zone. As it reaches the top of the convective zone, it cools and sinks.

The photosphere ("sphere of light") is the "surface" of our Sun; because our Sun is made of gas, it does not have a solid surface. The photosphere has temperatures that reach about 5525 degrees Celsius (9975 degrees Fahrenheit) and is the layer that releases most of the light that reaches Earth.

The surface of our Sun has continuously changing dark regions — sunspots. The spots are dark because they are cooler than the surrounding gas (about 3230 degrees Celsius or 5850 degrees Fahrenheit). Sunspots can persist for an hour to several months. The number of sunspots increases and decreases in an 11-year cycle — the solar cycle.
The photosphere and sunspots can be viewed safely with special solar telescopes — but not directly with the human eye!

The chromosphere ("sphere of color") is a 2000-kilometer-thick layer of gas that reaches temperatures between 6000 and 50,000 degrees Celsius (that's about 10,825 to 90,000 Fahrenheit). Most of the energy from the chromosphere is released as red light, which means that the chromosphere can be viewed with special telescopes that filter out the other wavelengths. The chromosphere is dynamic; convection cells swirl the surface, and material shoots off the surface as flame-like features.

The corona is a thin outer layer of our Sun that is seen during a solar eclipse. The corona emits energy at many different wavelengths. Loops and arches of matter are often seen extending out from the corona along lines of the Sun's magnetic field. This material flows away from our Sun as the solar wind. Some of the particles reach Earth's atmosphere and interact with atmospheric particles to create the aurora.

[1]From Lang K. R. (1999) The Sun. In The New Solar System (J. K. Beatty et al., eds.),pp. 23–38. Sky Publishing, Cambridge, Massachusetts.

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What is our Sun made of?

While approximately 60 different elements make up our Sun, hydrogen accounts for about 92% of the atoms (almost three-fourths of the mass) and helium makes up most of the rest (7.8% of the atoms). This is similar to the composition of our universe; hydrogen is the most abundant element, with some helium, and trace amounts of all other heavier elements (like carbon, nitrogen, oxygen, and silicon). Scientists can identify the elements by observing the solar spectrum.

Our Sun, like other stars, emits light, and in some cases more light in one color than another (and some colors are not emitted at all because they are absorbed). Gases of different elements have distinct patterns of emission or absorption that can be determined in the laboratory. Once scientists know which pattern matches which element, they can determine the composition of our Sun — or other stars in the universe — by examining the pattern of the spectrum. The Genesis Mission recently returned samples of the solar wind to Earth; scientists currently are studying these samples to gain a deeper understanding of the composition of our Sun.

Where does the Sun's energy come from?

Stars like our Sun generate their power by turning mass into energy through the process of nuclear fusion. Essentially, hydrogen is converted into helium in the Sun's core, and a little bit of energy is produced every time the reaction occurs.

Gravitational pressure compresses and heats the core material to over 15 million degrees Celsius (about 27 million degrees Fahrenheit). In these extreme conditions atoms cannot exist — hydrogen atoms split apart into protons and electrons. Four hydrogen protons become fused into a single helium nucleus. This helium atom has a smaller mass than the four hydrogen atoms and the mass difference is released as energy; fusion turns mass into energy. While one fusion reaction does not produce much energy, 600 million tons of hydrogen are converted to energy in our Sun every second!

While it feels like we get a lot of energy from our Sun, the amount we actually receive is very small. Because of Earth's distance from our Sun, and because the Sun sends energy in all directions, we only get about one two-billionth of the amount emitted by our Sun. About half of the Sun's energy is in the visible part of the spectrum and much of the rest is infrared radiation. We use special instruments to detect other types of energy like gamma rays and ultraviolet rays.

How does our Sun influence Earth?

The amount of energy reaching Earth is fairly consistent over time, and is called the "solar constant." Our Sun, however, is anything but constant! Sunspots move across the photosphere, growing and diminishing in number in an 11-year cycle. Solar flares, possibly caused by sudden changes in the magnetic field, accompany the sunspots, and spew radiation along with gases and particles into space. Clouds

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of gases occasionally rise and erupt from the chromosphere as coronal mass ejections (what scientists call “CMEs”), also corresponding to the 11-year periods of solar maxima. During a mass ejection event, plumes of material pass into space at speeds in excess of 1000 kilometers per second. All this material contributes to the solar wind, a constant stream of charged particles that flows into space from the outer surface of our Sun. Earth's magnetic field deflects and protects us from the solar wind. During periods of solar activity, the particles interact with Earth's magnetic field to produce the polar auroras. Periods of extreme activity, however, can disrupt communications by damaging the delicate electronics in satellites and interfering with radio waves. Even power grids are not immune; the charged particles alter the magnetic fields around power and phone lines and can induce current surges. While these “storms from space” are disruptive, they do not directly threaten human health on Earth. This is not true in space; astronauts are not protected by Earth's magnetic field and they — and the spacecraft they operate — could be affected by a solar storm.

How are we studying our Sun?

Galileo initiated our investigations of solar activity with his observations of sunspot movement using the newly invented telescope in the early 1600s (1610–1613). Our investigations continue today but take us beyond the visual realm. Space scientists are using all parts of the electromagnetic spectrum, including the ultraviolet, radio, and gamma ranges, to learn more about our Sun. Satellites such as the Solar and Heliospheric Observatory (SOHO) aid their research. Some missions, such as the Genesis sample mission, involve the collection of particles carried by the solar wind. Space scientists will use this information to understand the composition of our Sun, its origin, and the formation of stars and planets. Other missions, like the Ulysses solar polar orbiter, orbit our Sun to monitor the solar wind intensity and magnetic field to understand solar processes. Researchers are also monitoring solar activity through the Geotail mission to understand solar impacts on space exploration, communications, and technology. Moving closer to home, scientists are investigating the interaction of our Sun and Earth systems to learn more about how our Sun influences Earth's weather and climate.

Sun Posters

In this activity, you and your child will read through 9 informational posters to gain an understanding about our Sun.

What You Need:

- 9 sheets of poster board in different colors
- Large print-outs of the questions and answers in the below boxes
- Color images related to the content
- Glue or tape to adhere the information to the posters

What to Do:

Each of the following should be made into a big, bold, colorful poster with related images.

Poster 1:

Our Sun formed 4.5 billion years ago from a cloud of hydrogen and helium gas and dust.

Poster 2:

Our Sun is a giant ball of hydrogen and helium gas. It makes energy by converting hydrogen into helium in its core.

Poster 3:

While special to us, our Sun is a medium sized yellow star of average brightness.

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Poster 4:

How far away is our Sun?

93 million miles!

If Earth were 1 inch across, the Sun would be over 9 feet wide! It would be 985 feet away from the Earth.

What if Earth were the size of a peppercorn? How big would the Sun be? How far away would the Sun be? You will get to make this model soon!

Poster 5:

How big is our Sun?

Station 2: The Size of the Sun goes here.

Poster 6:

Our Sun will shine *as it is* for about another 3 to 5 billion years! (you will be very old when this happens).

Poster 7:

In another 3 to 5 billion years our Sun will use up its interior hydrogen fuel and swell up to become a **red giant** - expanding to engulf Mercury, Venus, and perhaps Earth!

Poster 8:

Eventually the outer layers will be spewed off into space, leaving a cloud of material around a small, hot white dwarf about the size of Earth.

Poster 9:

The material that is spewed off into space will collect into another cloud of hydrogen and helium gas and dust that may form a new star!

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Possible Images for Posters

Solar Images

http://www.noaanews.noaa.gov/stories2005/images/Sun-soho-05-15-2005-1150z.jpg

http://apod.nasa.gov/apod/image/0606/Sun2_trace_big.jpg

http://content.answers.com/main/content/wp/en/f/f6/Sun,_Earth_size_comparison_labeled.jpg

http://library.thinkquest.org/C0121764/what/Sunearth.jpg

http://www.physics.hku.hk/~nature/CD/regular_e/lectures/images/chap15/red_size.jpg

Red Giants

http://library.thinkquest.org/C0126626/fate/redgiant.gif

http://images.iop.org/objects/physicsweb/news/12/2/24/RedGiant.jpg

http://www.astro.washington.edu/endsofworld/postcard%20from%20earth%20pict.jpg

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The Size of the Sun

In this activity, your child will continue their investigation into the size and distance of our Sun.

What You Need:

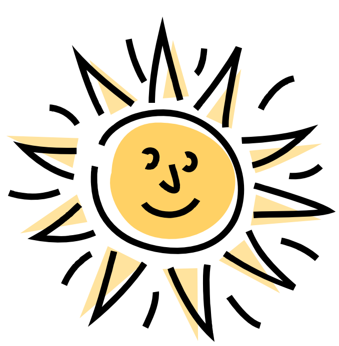
- 110 1” diameter round blue stickers (plus a few extras)
- Masking tape
- One sheet of yellow poster board

What to Do:

- Mark a 9-foot diameter circle on the floor with tape. Put a line of tape across the center of the circle, marking the equator. The circle represents the Sun.
- Label the poster board “Sun” and tape it to the floor in the middle of the circle.
- Invite each child to place one sticker along the line marking the Sun’s middle. Have them place the stickers next to each other without any space in between.
- Have each child number their sticker; the first child marks their sticker with a “1.” The next child labels their sticker “2,” and so on. Be sure not to miss any numbers or get them out of order.
- Each sticker represents the size of the Earth compared to the Sun. How many stickers do you think will fit in a line across the Sun? Check as the day progresses and other children place their stickers to see what the answer is.

Parent Prompts:

How big is the Sun compared to Earth?
(The Sun is huge! About 110 Earths will fit in the line across the Sun, and over a million Earths could fit inside the Sun!



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Paper Plate Sun

You and your child will investigate the size and distance of our Sun and create artistic representations of its features.

What You Need:

- 1 paper plate
- 1 peppercorn
- Glue
- Scissors
- A pencil
- Various craft items (crayons, markers, pipe cleaners, glitter, tissue paper, etc.)

What to Do:

Version 1: No Layers - for Younger Children

- Add different features of the Sun to your plate like Sunspots or solar flares using the craft items
- Glue a peppercorn on the plate to represent the size of the Earth

Version 2: Layers- for Older Children

- Help your child draw the different layers of the Sun on the plate

1. Put a dot in the center of the plate.

2. Core – Draw a circle about two inches in diameter around the dot. Label this circle the 'core'. In the Sun, the core is 27 million degrees F – this is so hot and has such high pressure that hydrogen gas is fused into helium - releasing lots of energy!

3. Radiative Zone – Draw another circle about two inches away from the core. This circle will be about where the smooth part of the plate ends and fluting begins. Label this zone. In the Radiative zone energy from the core is slowly transported outward. It takes 170,000 years to go from the core to the next layer, the Convective Zone!

4. Convective Zone – Draw a third circle about 1 inch away from the exterior of the radiative zone. Label this zone. Within the convective zone churning, turbulent motions carry energy toward the surface.

5. Photosphere – Draw a fourth circle about 1/4 inch away from the convective zone. Label this "photosphere." The photosphere is the 'surface' of the Sun. It is the layer from which the light we see is emitted and where most of the Sun's energy escapes into space. The temperature in the photosphere averages 10,000 degrees F!

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6. Chromosphere – Draw one last circle about 1/8th inch away from the photosphere. Although transparent like the Earth's atmosphere, the chromosphere becomes visible from Earth a few seconds before and after a total solar eclipse as a narrow, pink band around the edge of the Sun.

7. Corona – Color or shade the area that is left on the edge of the plate. This is the Corona, which means 'crown' in Latin. The average temperature in the Corona is about 2 million degrees F.

Parent Prompts:

How big is the Sun compared to Earth?
(At the plate scale, the Earth is the size of a tiny peppercorn!

How far away is the Sun from the Earth?
The Earth is 93 million miles away from the Sun! At our paper plate / peppercorn scale, you would need to hold the plate (Sun) and peppercorn (Earth) about 75 feet (23 meters) apart!)

What can we see on the Sun?
(We can see dark sunspots and solar flares disrupt the surface. Sunspots are as large as or larger than the Earth (peppercorn) and they are violent storms that release heat and particles from the Sun. The Sun also produces big explosions of energy – solar flares - that may reach Earth and disrupt communications and electricity.)

What is our nearest star? (The Sun!)

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The Colors of Sunshine

In this activity, your child will observe that the Sun's "white" light is actually made of many different colors of light.

What You Need:

- Access to the outdoors and a bright Sunny day!
- One sheet of white cardstock

Either

- Scissors
- Tape
- One piece of black construction paper
- One slide of a diffraction grating (*have your child avoid touching the clear filter in the slide by only touching the outside of the slide*)

Or

- A Prism

What to Do:

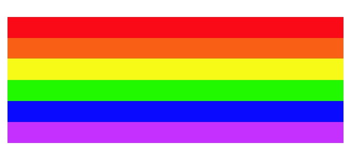
- Fold the black construction paper in half and cut a one-inch square in the center of the paper.
- Tape the slide with the diffraction grating over the hole in the black construction paper.
- Go outside into the bright sunlight.
- Hold the black construction paper with the slide about 5 inches over the white sheet of cardstock paper, so that the sunlight shines through the slide and onto the white paper.
- Look for the rainbow on the paper!

Parent Prompts:

What is happening to the Sun's light? (It is being spread out, so all of the colors that make sunlight "white" can be seen.)

Which colors can your child see in the rainbow? (Most people can see red, orange, yellow, green and blue, and possibly violet. Some children and adults are colorblind and may not be able to see all of these colors.)

What color is your child's shirt? Why is it that color? (Because the "white" sunlight shining on the shirt is being partially absorbed and partially reflected. The colors of the rainbow that are reflected by the shirt are the ones we see.)



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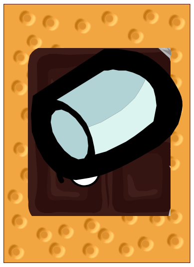
Solar S'Mores

In this activity, you and your child will create a solar oven to take home to make S'Mores. Solar ovens can reach temperatures of 275 degrees F inside. Solar ovens may be the wave of the future – they are economical and environmentally friendly because they don't use gas, electricity or wood!

What You Need:



- One graham cracker broken in half
- One large marshmallow
- Half of a chocolate candy bar
- One small cardboard box
- Black construction paper
- Aluminum foil
- Clear plastic (Heavy plastic laminate works best)
- Non-toxic glue
- Tape
- Scissors
- Ruler
- Markers

What to Do:

- Cut two pieces of aluminum foil to fit the box inside top and bottom.
- Cut and tape a piece of black paper to the foil on the box bottom
- Place two halves of a graham cracker on the bottom of the box
- On one graham cracker, place half a chocolate bar
- On the other graham cracker, place the marshmallow
- Cut a piece of clear plastic to cover the opening on top
- Tape the plastic to seal the box off – Make sure air cannot escape.
- Once you are home, place your oven outside facing the Sun. Open and tilt the top until it reflects the maximum amount of sunlight into your oven. Allow your S'More to cook for several minutes. - *Enjoy!*

Parent Prompts:

What caused the chocolate and marshmallows to melt?
(the Sun's energy – sunlight absorbed and converted to heat)

Would the chocolate and marshmallows have melted as quickly without the clear plastic cover? Why? (No; the plastic helps to trap the heat, similar to the way an oven does!)

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UV Thing

The Sun produces different types of light. Many of the types of light are invisible to us.   One of those is ultraviolet light, or “UV”. We need UV light because our skin uses it to manufacture vitamin D, which is vital to maintaining healthy bones. But we only need about 10 minutes of sunlight each day to allow our skin to make the amount of vitamin D we need. Too much exposure to UV causes sunburn and leads to wrinkles, skin cancer, and cataracts. The good news: we can protect ourselves by covering ourselves by covering up with clothing and using Sun block.

In this activity, you and your child are going to experiment to find out what happens when the UV-sensitive beads are exposed to different sources of energy: visible light from flashlight, heat from a hair dryer, ultraviolet light from a UV lamp, and sunlight.

What You Need:

- Four UV beads
- A few non-UV beads
- Pipe cleaners
- Flashlight
- UV light
- Hair dryer

What to Do:

- Invite your child can make a pipe cleaner animal or person or piece of jewelry; thread 4 UV beads and non-UV beads onto the object, alternating the types of beads
- Make predictions about the reaction of the UV beads to the flashlight, hair dryer and UV light
- Using the flashlight, shine it on the object – Do your UV beads change colors?
- Using the hair dryer, blow the object – Does the heat cause the UV beads to change colors?
- Using the UV light, shine it on the object – Do your UV beads change colors?
- Cover your object with your hand and take it outside to a shady spot
- Predict whether your object will change colors in the shade. What about in the full sunlight?
- Now uncover your object in the shade – Was your prediction right?
- Put your object in the Sun – What happens? Are there any changes?

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Parent Prompts:

If heat and light from the flashlight don't change the color of the UV beads, then what does? (ultraviolet, or UV, light)

Does the Sun give off invisible ultraviolet (UV) light? How can you tell? (the beads turn colors!)

How does ultraviolet light affect us?

Note: The UV-sensitive beads used in this experiment serve as UV radiation detectors. They contain a pigment that changes color when exposed to UV light from the Sun or from "blacklights". The intensity of the color corresponds to the intensity of the UV light. When shielded from UV sources, or when exposed to light that does not contain UV— such as indoor light bulbs — the beads remain white. The beads are designed for multiple use and, according to the manufacturers, will change color up to 50,000 times.

Amazing Rays

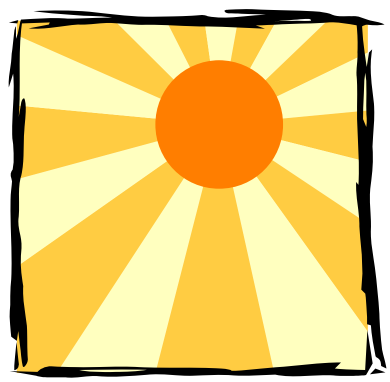
Our Sun is the nearest star. Its light gives us energy—energy to heat up Earth's surface and energy for plants to grow.

Let your child know that the Sun's light is a type of energy, which the special (photosensitive) paper in this activity can use to change color. Plants can use the sunlight as energy to grow, and everything uses the sunlight as energy to warm up.

In this activity, you and your child will explore the Sun's light as energy using photosensitive paper.

What You Need:

- One sheet of 8½" × 11" photosensitive "black and white" paper (from photo supply or science education store)
- Pencils
- Scissors
- Tape
- One sheet of black cardstock
- Access to the outdoors and a bright Sunny day!



What to Do:

- Cut the cardstock in half
- Draw two shapes onto half of the cardstock
- Cut out the shapes
- Place double-sided tape onto the shapes and the half sheet of cardstock to attach them to the photosensitive paper later
- Discuss the questions below before taking your child outside to complete the activity
- Go outside and get a piece of the photosensitive paper – Be prepared to act quickly!
- Very quickly tape the 2 shapes to the photo paper covering up one shape with the half sheet of cardstock
- Wait 2 minutes and observe what happens!

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Parent Prompts:

Will the special paper under the poster board shape get any sunlight? (No)

So will the part of the paper in the dark receive the same energy from the Sun? (No)

What do you think will happen to the paper under the shapes? (The covered areas will not change)

What do they see?
(A clear impression on the side exposed to the Sun's light and heat, where the shape blocked the Sun. The rest of the paper darkened to a color where the Sun's light reached it. There will be little or no impression on the side covered by the black poster board; that side did not receive light, but it was heated.)

Where did the paper get the energy it needed to change colors? (The sunlight)

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Counting Sunspots

Sunspots are magnetic storms on the Sun—these dark areas are a little cooler than the rest of the Sun's atmosphere. They can be easily seen when the Sun's image is projected onto a white surface, using a telescope or binoculars. (Warning—do not look through binoculars or a telescope directly at the Sun!)

Scientists have observed sunspots for centuries, and kept records of the numbers of sunspots seen in a month or a year. They have noticed a distinct pattern in the numbers of sunspots—called the Sunspot Cycle.

What You Need:

- Circular stickers
- Sunspot data
- Slips of paper, each with a year and the number of sunspots for that year
- Bowl for holding the "drawing" slips
- Large graph drawn on brown butcher paper with the:
  - x-axis marked in years from the first observation to the last
  - y-axis marked in 10's of numbers of sunspots

What to Do:

- Have your child draw one slip from the bowl. Help them determine the year and the number of sunspots for that year from the slip.
- Gather enough stickers so that each sticker represents 10 sunspots (for example, if there were 81 sunspots that year, collect 8 stickers)
- Find the year on the bottom of the graph.
- Fill in the graph vertically for that year with the appropriate number of dots.
- Discuss whether you can see a pattern to the graph. Is too much data missing? If so, return to look at it again later in the day.

Parent Prompts:

Are there years with lots of sunspots? Are there years with very few sunspots?

Do you see a pattern to the numbers of sunspots increasing and decreasing? (It takes 11 years to go from low numbers to high numbers and back down again.)

What do you predict will happen in the next year? Five years? Ten years?

This activity was adopted from the activity at
http://www.windows.ucar.edu/tour/link=/teacher_resources/Suncycle_edu.html

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Parents, this may be advanced for your child, but in case inquiring minds want to know:

Sunspots are dark, planet-sized regions that appear on the "surface" of the Sun. Sunspots are "dark" because they are colder than the areas around them. A large sunspot might have a temperature of about 3,700° C or 6,700° F. This is much lower than the 5,500° C or 10,000° F temperature of the rest of the Sun's atmosphere.

Sunspots are only dark in contrast to the bright face of the Sun. If you could cut an average sunspot out of the Sun and place it in the night sky, it would be about as bright as a full moon. Sunspots have a lighter outer section called the penumbra, and a darker middle region named the umbra.

Sunspots are caused by the Sun's magnetic field welling up to the photosphere, the Sun's visible "surface". The powerful magnetic fields around sunspots produce active regions on the Sun, which often lead to solar flares and Coronal Mass Ejections (CMEs). The solar activity of flares and CMEs are called "solar storms".

Sunspots can last for weeks or even months. The average number of spots that can be seen on the face of the Sun is not always the same, but goes up and down in a cycle. Historical records of sunspot counts show that this sunspot cycle has an average period of about eleven years. The 11 year sunspot cycle is related to a 22 year cycle for the reversal of the Sun's magnetic field. While the cycle has been relatively uniform this century, there have been large variations in the past. From about 1645 to 1715, a period known as the Maunder minimum, apparently few sunspots were present on the Sun. Also during that period, the Earth was much cooler than it was before or is now.

Our Sun isn't the only star with spots. Just recently, astronomers have been able to detect "starspots" - "sunspots" on other stars.

Although the number of sunspots is the most easily observed feature, essentially all aspects of the Sun and solar activity are influenced by the solar cycle. Because solar activity (such as coronal mass ejections) is more frequent at solar maximum and less frequent at solar minimum, geomagnetic activity also follows the solar cycle. Why is there a solar cycle? No one knows the answer to this question. A detailed explanation of the solar cycle is a fundamental physics problem still waiting to be solved.

Adapted from "Windows to the Universe" at http://www.windows.ucar.edu/

Sunspot Numbers

Year and Number of Sunspots	1936	80	Year and Number of Sunspots	1969	106
Year and Number of Sunspots	1937	114	Year and Number of Sunspots	1970	105
Year and Number of Sunspots	1938	110	Year and Number of Sunspots	1971	67
Year and Number of Sunspots	1939	89	Year and Number of Sunspots	1972	69
Year and Number of Sunspots	1940	68	Year and Number of Sunspots	1973	38
Year and Number of Sunspots	1941	48	Year and Number of Sunspots	1974	35
Year and Number of Sunspots	1942	31	Year and Number of Sunspots	1975	16
Year and Number of Sunspots	1943	16	Year and Number of Sunspots	1976	13

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Year and Number of Sunspots	1944	10	Year and Number of Sunspots	1977	28
Year and Number of Sunspots	1945	33	Year and Number of Sunspots	1978	93
Year and Number of Sunspots	1946	93	Year and Number of Sunspots	1979	155
Year and Number of Sunspots	1947	152	Year and Number of Sunspots	1980	155
Year and Number of Sunspots	1948	136	Year and Number of Sunspots	1981	140
Year and Number of Sunspots	1949	135	Year and Number of Sunspots	1982	116
Year and Number of Sunspots	1950	84	Year and Number of Sunspots	1983	67
Year and Number of Sunspots	1951	69	Year and Number of Sunspots	1984	46
Year and Number of Sunspots	1952	32	Year and Number of Sunspots	1985	18

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Year and Number of Sunspots	1953	14	Year and Number of Sunspots	1986	13
Year and Number of Sunspots	1954	4	Year and Number of Sunspots	1987	29
Year and Number of Sunspots	1955	38	Year and Number of Sunspots	1988	100
Year and Number of Sunspots	1956	142	Year and Number of Sunspots	1989	158
Year and Number of Sunspots	1957	190	Year and Number of Sunspots	1990	142
Year and Number of Sunspots	1958	185	Year and Number of Sunspots	1991	146
Year and Number of Sunspots	1959	159	Year and Number of Sunspots	1992	95
Year and Number of Sunspots	1960	112	Year and Number of Sunspots	1993	55
Year and Number of Sunspots	1961	54	Year and Number of Sunspots	1994	30

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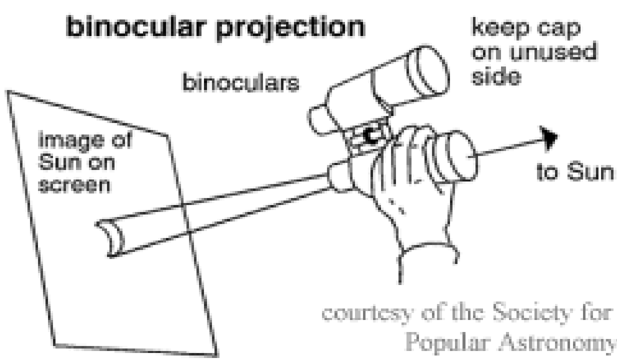
Year and Number of Sunspots	1962	38	Year and Number of Sunspots	1995	18
Year and Number of Sunspots	1963	28	Year and Number of Sunspots	1996	9
Year and Number of Sunspots	1964	10	Year and Number of Sunspots	1997	22
Year and Number of Sunspots	1965	15	Year and Number of Sunspots	1998	64
Year and Number of Sunspots	1966	47	Year and Number of Sunspots	1999	93
Year and Number of Sunspots	1967	94	Year and Number of Sunspots	2000	119
Year and Number of Sunspots	1968	106	Year and Number of Sunspots	2001	111

Viewing the Sun Safely

Caution: Never – ever- ever – look at the Sun directly with your naked eyes or through binoculars or telescopes that do not have solar filters.

One safe way to observe sunspots or eclipses is to project an image of the Sun through a telescope or binoculars onto a white surface. We will be using binoculars for this safe Sun viewing activity. When using binoculars, keep the cover on one of the two tubes. Never look through a telescope or binoculars to point them at the Sun - partial or total blindness could result very quickly. It is safe to study the Sun's surface if you use binoculars to project the Sun's image onto a piece of white poster board.



What You Need:

- Binoculars
- Square piece of white poster board
- Pencil
- Tracing paper

What to Do:

- Lay your piece of white poster board on the ground.
- Holding your binoculars over the poster board and standing aside so that you are not blocking the Sun, focus the image of the Sun onto the poster board, taking care not to put any part of your body in the way of that image (to avoid burns). You may need to alter the distance between the paper and binoculars.
- If the distance and focus are correct, on the poster board you should see a circle of light (the Sun's image) that is brighter at the center and darker around the edges. Inside the circle you should see some small dark spots which are sunspots.
- Trace the Sun and any sunspots that you see on the tracing paper.

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Parent Prompts:

What does your child observe?

Is the Sun the same everywhere in the image or does your child see differences?
Do they see small spots on the image? (Sunspots)

Are all the sunspots the same shape? Are they the same size?

Note that Sunspots increase and decrease depending on where we are during the cycle! Sunspots grow and diminish in number in a cycle that is 11 years long.

A few more words about Sun spots…

- Sunspots are dark because they are colder than the surface of the Sun around them.
- A cold object gives off less light than a hot object.
- You could put two Earths in a large sunspot and still have enough room for the Moon as well!
- Small sunspots can come and go in a few hours.
- Larger sunspots can last for many weeks.

Coloring Sheets and Games

Sun Coloring Page
http://www.enchantedlearning.com/subjects/astronomy/activities/coloring/Sun.shtml

Solar System
http://www.windows.ucar.edu/coloring_book/SS_Beg_new2.pdf

Sun Word Find
http://www.makeitsolar.com/puzzle/word-search-puzzle/04-word-search-sun.htm

Solar Word Find
http://www.windows.ucar.edu/tour/link=/sun/Java/wordsearch/ulysses.html

Sun Maze
http://www.enchantedlearning.com/subjects/astronomy/activities/maze/sunmaze.shtml

Sun Maze
http://library.thinkquest.org/TQ0312847/game_mazes2.htm

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http://www.lpi.usra.edu/education/space_days/Sun

Explore the Sun!

Websites

http://starchild.gsfc.nasa.gov/docs/StarChild/solar_system_level2/Sun.html
NASA's StarChild presents space information for both young and older children, with a special section on our Sun. StarChild includes student activities, graphics, a glossary, and is offered in several languages.

http://www.enchantedlearning.com/subjects/astronomy/Sun
The Enchanted Learning website provides lots of basic information about the Sun in a fun format. There are also coloring pages, puzzles, and quizzes!

http://www.windows.ucar.edu/tour/link=/Sun/Sun.html
Windows to the Universe launches viewers into a variety of Sun topics on all levels. The site is user- friendly and includes a section on Sun myths and stories from around the world.

http://sohowww.nascom.nasa.gov/
NASA's Solar and Heliospheric Observatory (SOHO) orbiting spacecraft investigates our Sun's structure and dynamic nature. This site shares the latest information about Sunspots, space weather, and what is happening inside our nearest star. See the latest pictures of the Sun! Great images!

http://www.nasa.gov/mission_pages/stereo/main/index.html
STEREO mission will map the Sun in 3-D! Check out the images!

http://www.nasa.gov/mission_pages/themis/main/index.html
THEMIS will explore what causes auroras to dramatically change from slowly shimmering waves of light to wildly shifting streaks of color in an effort to better understand the connection between Sun and Earth.

http://science.hq.nasa.gov/Sun/index.html
More NASA Sun Missions!

http://Sunearth.gsfc.nasa.gov/
NASA's Sun-Earth Connection shares discoveries from past and current missions and research, with a focus on the active Sun and its effects on Earth. Abundant resources for educators, children, and the general public.

Explore the Sun!

Books

What's Inside the Sun? Jane Kelly Kosek, 2003, Rosen Publishing Group, ISBN 0823952797.
Kosek describes the positions and characteristics of each layer of our Sun for children ages 4–8.

Why the Sun and Moon Live in the Sky. Niki Daly, 1995, Lothrop, Lee & Shepard Books, ISBN 0688133312.
Daly's retelling of the Nigerian Sun myth complements the Native American version of the Sun's birth for ages 4–8.

Sun (Jump Into Science). Steve M. Tomecek, 2001, National Geographic, ISBN 0792282000.
Children ages 4–8 join a funky purple cat in a learning adventure about the Sun. Facts and practical information about our Sun are presented in a delightfully unique way.

Our Very Own Star: The Sun.
NASA's Central Operation of Resources (NASA CORE) offers this set of booklets to help children ages 5–9 investigate solar flares, Sunspots, and why scientists study our Sun. Available on line with graphics, text, and animation in both English and Spanish.

The Sun. Gregory Vogt, 1996, Millbrook Press, ISBN 1562946005.
In this book for ages 6–11, Vogt provides a considerable volume of information and illustrations about our Sun.

Storms from the Sun: The Emerging Science of Space Weather. Michael Carlowicz and Ramon Lopez, 2002, Joseph Henry Press, ISBN 0309076420.
Older children and adults explore the physics and impact of solar weather on our electronically networked civilization through a series of hypothetical scenarios.

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All About Our Sun!

- Our Sun is our nearest star. Its energy makes life on Earth possible!
- Scientists calculate our Sun and solar system formed at the same time — 4.56 billion years ago! This is based on the ages of the oldest objects that we have sampled from our solar system — meteorites.
- Our Sun will shine as it is for about another 3 to 5 billion years! It will then evolve into a red giant.
- Our Sun's average distance from Earth is 150 million kilometers (93 million miles).
- Our Sun's diameter is 1,391,020 kilometers, or about 109 times the diameter of Earth.
- About a million Earths could fit in the Sun!
- Like Earth, our Sun has many different layers. Unlike Earth, our Sun is made of gas!
- The Sun is over 15 million degrees Celsius or about 27 million degrees Fahrenheit! That's HOT!
- The surface of our Sun often has continuously changing dark regions — sunspots. The spots are dark because they are cooler than the surrounding gas (about 3230 degrees Celsius or 5850 degrees Fahrenheit). Sunspots can persist for an hour to several months. The number of sunspots increases and decreases in an 11-year cycle — the solar cycle.
- The photosphere and sunspots can be viewed safely with special solar telescopes — but not directly with the human eye!
- The chromosphere ("sphere of color") is a 2000-kilometer-thick layer of gas that reaches temperatures between 6000 and 50,000 degrees Celsius (that's about 10,825 to 90,000 Fahrenheit).
- The corona is a thin outer layer of our Sun that is seen during a solar eclipse. Loops and arches of matter are often seen extending out from the corona along lines of the Sun's magnetic field.
- While approximately 60 different elements make up our Sun, hydrogen accounts for about 92% of the atoms (almost three-fourths of the mass) and helium makes up most of the rest. Scientists can identify the elements by observing the solar spectrum.
- While it feels like we get a lot of energy from our Sun, the amount we actually receive is very small. Because of Earth's distance from our Sun, and because the Sun sends energy in all directions, we only get about one two-billionth of the amount emitted by our Sun.

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