NSTA SOLAR ECLIPSE GUIDE FOR EDUCATORS

A Solar Eclipse Double-Header

October 14, 2023 and April 8, 2024

By Dennis Schatz and Andrew Fraknoi

Many people in the U.S. experienced the celestial beauty and sense of wonder of the 2017 total eclipse of the Sun. As the Moon crossed in front of the Sun, the Sun went dark, and the day suddenly turned into night. Whether you saw it or not, we have good news. Two solar eclipses are coming to North America soon—a "Double-Header"—on Saturday, October 14, 2023 (an annular—or ring-of-fire—eclipse) and Monday, April 8, 2024 (a total eclipse). Everyone not on the narrow eclipse path in North America will see a partial eclipse on both dates, where the Moon covers part of the Sun's surface.

To see the ring-of-fire during the annular eclipse, you will need to be in a 100 mile-wide path that stretches from the coast of Oregon to the southeast coast of Texas.

To see the solar corona (the Sun's faint atmosphere) during the total eclipse, you need to be in a 150 mile across path that starts in Mexico, enters the U.S in Texas and moves northeast through a number of states until leaving the U.S from New York. From there it moves on to the eastern part of Canada.

Rarely does nature offer us such wonderful teachable moments, when our students can *experience* key science concepts while observing a spectacular sky event first hand. This Guide gives you the key information and links to other resources you need, so that you, your students, and your community can make the most of these two eclipses.

The following clickable Table of Contents allows you to go directly to each topic.

May you have clear skies and enthusiastic learners during the two eclipses.

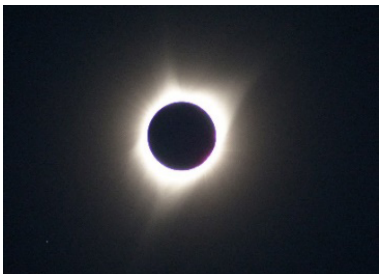
Dennis Schatz
Andrew Fraknoi

FIGURE 1

Annular Eclipse Showing Ring of Solar Surface (Ring-of-Fire) Still Visible as Moon Passes in Front of the Sun

Photo by Kevin Baird

FIGURE 2



Total Eclipse Showing Solar Corona as the Moon Passes in Front of the Sun and Completely Covers the Sun's Surface

Photo by Cary Sneider during August 2017 Eclipse

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1. The Eclipse Double-Header

The Basic Facts about Each Eclipse

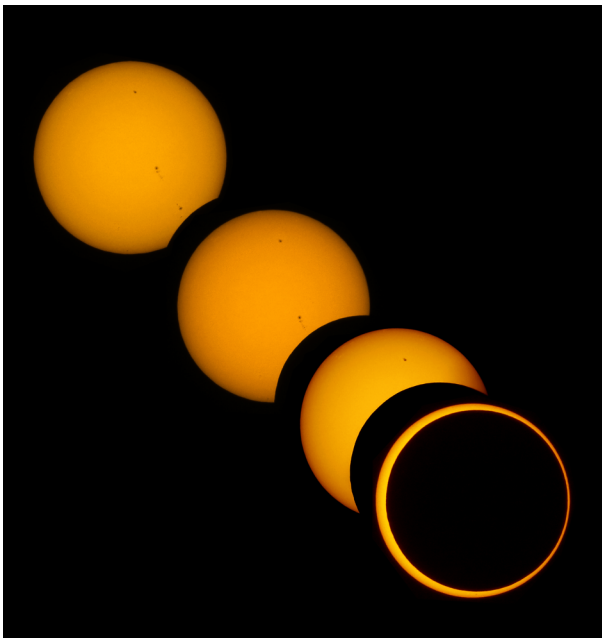
The October 14, 2023 eclipse is an annular eclipse, which you can think of it as the "warm-up" event for the total eclipse in the following April. The annular eclipse happens on a Saturday, when school is not in session. This may actually make it more important that you prepare your students, so they can observe it safely from home.

In an annular eclipse, the Moon's disk is too small to cover the Sun completely, and the Sun never goes completely dark. But at maximum eclipse, you can see a dramatic "ring of fire" around the dark sphere of the Moon (see figure 3). You need to be in a narrow path on the Earth's surface to see the ring (see figure 4). If you are off that path, you see a partial eclipse, where the dark Moon appears to take a "bite" out of the Sun. Since the full Sun never goes dark during an annular eclipse, you will need to use special protective glasses or indirect viewing methods throughout the eclipse (see section 3). For the U.S., the annular eclipse path begins in western Oregon at 9:13 am PDT and ends on Texas Gulf Coast at 12:03 pm CDT. The rest of North America (except for NW Alaska) will experience a nice partial eclipse.

The map in Figure 4 shows you the path where annularity is visible. Outside the path, everyone will see a partial eclipse. More detailed information is in the sections that follow. To find out exactly what will happen at your location or anywhere else, go to: www.timeanddate.com/eclipse/solar/2023-october-14

The April 8, 2024 eclipse is a total eclipse (see figure 5), and it falls on a Monday, when students are likely to be in school (unless it is spring break.) The path of totality (where the Sun is blocked completely by the Moon getting in front of it) is over 150 miles wide, and passes over more cities than the 2017 eclipse (see figure 6). If you are on the path, when only a sliver

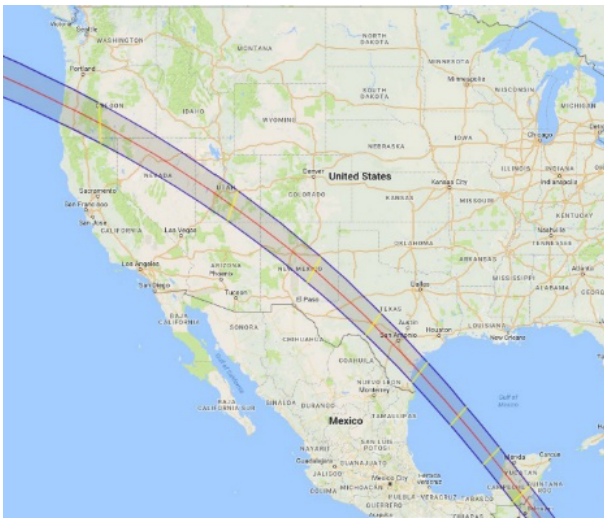
FIGURE 3



Annular Eclipse Showing Ring of Solar Surface (Ring-of-Fire) Still Visible as Moon Passes in Front of the Sun

Photo by Brocken Inaglory

FIGURE 4



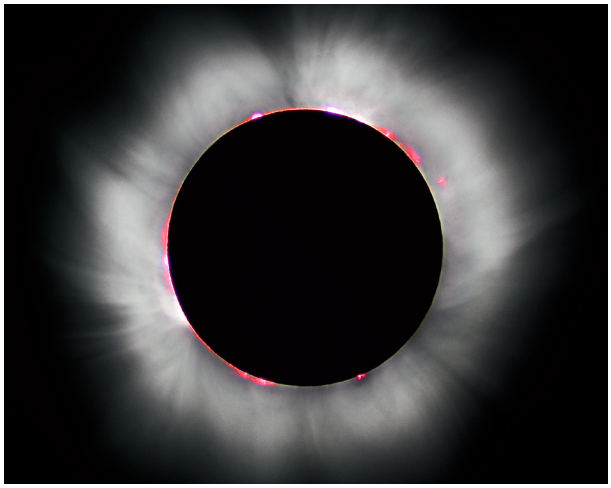
Credit: Fred Espenak, Eclipsewise.com

of sunlight is visible, your surroundings will begin to darken, as if the Sun were setting in the middle of the day. Temperatures will drop and birds will go to roost, thinking that night is coming. Finally, the Sun will be totally covered and the beautiful solar atmosphere (the *corona*) will become visible. Totality will last four minutes or less and then the Sun will slowly be uncovered.

Totality will be visible first in Mexico, coming to Texas just after noon local time. The eclipse then moves northeast through Oklahoma, Missouri, Ohio, New York, and Maine (to name just a few of the states) and into eastern Canada. As the eclipse moves further north and east, the times involved might come right around school dismissal in some districts, so planning ahead will be essential. Some 32 million people live in the path, and many others will be going there on the weekend before. Outside the narrow path of totality, all of North America will see a partial eclipse.

If teachers, students, and families want to enjoy beauty of the solar eclipses, whether they are in the path for them, or not, they will need to be prepared to observe the event safely. Remember, whenever any part of the Sun's surface is showing, one will need to wear special protective glasses or view the eclipse indirectly (see section 3). We expect science teachers to play a key role in getting science and safety information out to their communities.

FIGURE 5

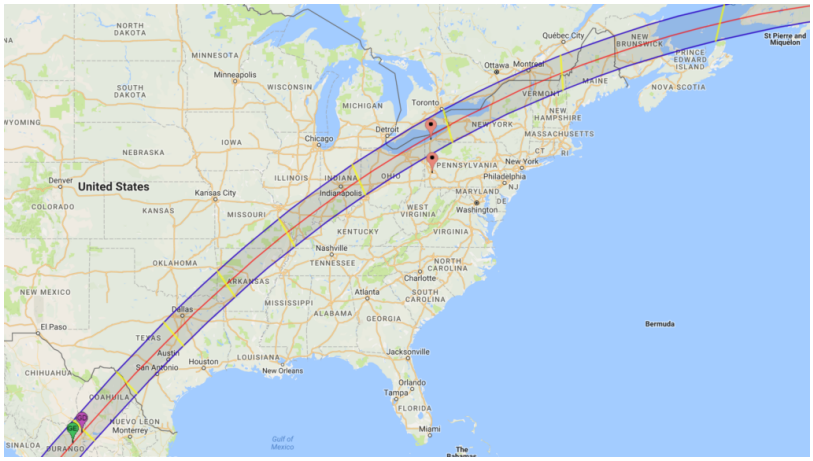


The Sun's Atmosphere (the Corona) only Visible During the Total Eclipse

Photo by Luc Viatour

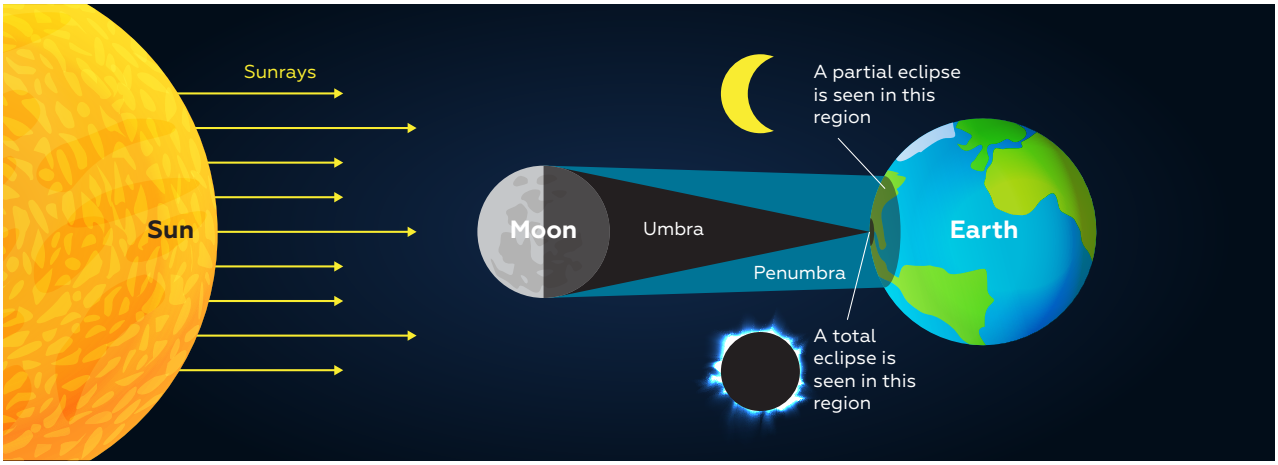
The map in Figure 6 shows you the path where totality is visible. More detailed information is in the sections that follow. To find out exactly what will happen at your location or anywhere else, go to: www.timeanddate.com/eclipse/solar/2024-april-8

FIGURE 6



Credit: Fred Espenak, Eclipsewise.com

FIGURE 7



From *Solar Science* insert for 2017 solar eclipse

What Causes a Partial, Annular, and Total Eclipse?

An eclipse of the Sun occurs when the Moon moves between the Sun and Earth, blocking some or all of the Sun (see image above). While the Sun is much bigger than the Moon, it is also much farther away. It just happens that these two things combine to make the Sun and Moon appear roughly the same size in the sky when seen from Earth. When the two are exactly lined up, the Moon can hide the Sun from our sight—causing a "total" eclipse. If the line-up is not exact, you experience a "partial" eclipse.

As you can see in Figure 7, total eclipses of the Sun—such as the one that will occur in April 2024—are only visible on a small part of Earth's surface where the Moon's shadow is darkest. This zone of dark shadow is called the umbra. If you are outside the zone of totality—but not too far outside—you are in the outer part of the shadow called the penumbra and will see a partial eclipse.

However, the Moon doesn't orbit Earth in a perfect circle: it moves in an ellipse that brings it sometimes a bit closer, sometimes a bit farther, from Earth. If the Moon and Sun are lined up, but the Moon is farther away from us in its orbit, the Moon will not be able to cover the Sun completely. In that case, we will see the Moon covering most of the Sun but leaving a bright "ring-of-fire" around the Moon's dark disk. This line-up is called an "annular" eclipse and it's what we will see in October 2023.

Historical records and mathematical calculations tell us that there is a total eclipse of the Sun visible from somewhere on Earth every year and a half on average. But, the path of totality is just a narrow strip, so any given spot on the surface of our planet only witnesses a total eclipse roughly once every 350 years—and most of the time this is over an ocean, which covers 2/3 of Earth. There are groups of eclipse enthusiasts who find total eclipses so enchanting that they travel regularly to places where such eclipses are visible, even if they have to rent a boat or a plane!

Partial eclipses are visible in a much larger region than the narrow zone where totality or annularity are visible. In 2023 and 2024, many, many more people (500 million) will see a partial eclipse than will witness the total or annular eclipses. It will be important to make everyone, no matter where they will be on the eclipse days, feel that they are lucky to see one of nature's most memorable sky shows.

How Long Will Each Eclipse Last?

The exact cosmic lineup that forms a total eclipse lasts only a short time in any given location. The annular phase in 2023 will last a maximum of 3 minutes 39 seconds in the center of the Moon's shadow. The total phase in 2024 will last a maximum of 4 minutes 26 seconds. This is relatively long for totality. In 2017, the maximum length of time for totality was 2 minutes 40 seconds, but the longest total eclipse can last up to 7 minutes. The exact time it lasts depends on your location in the shadow band. The closer you are to the central line of the eclipse shadow, the longer you will have to enjoy the spectacle.

These times do not include how long the partial eclipse phase last in each location. Typically, the Sun is partially eclipsed for about 2 ½ hours, from the time the Moon just starts covering the Sun until the Sun is totally uncovered. This means there is plenty of time to hold educational solar eclipse activities for a class, school, or family.

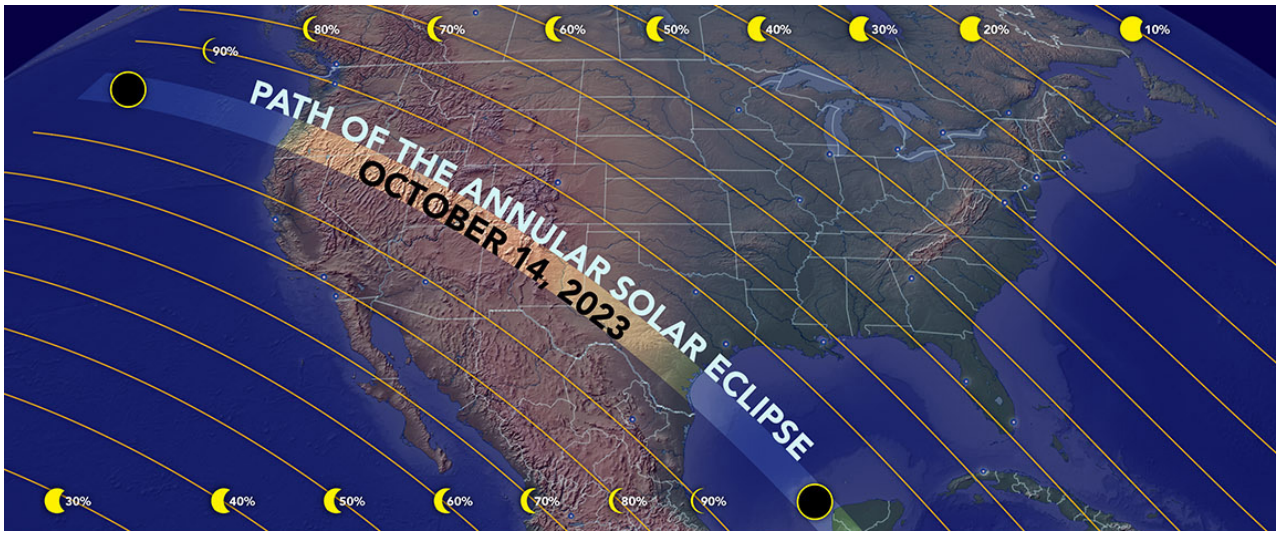
Of course, the sky must be clear to see the eclipse. If clouds hide the Sun, you will not see the eclipse at all—you'll miss all the fun. That means that for serious eclipse fans, selecting the spot to watch the eclipse also means researching the history of the weather in each location.

Where and When Can I See the Each Eclipse?

Figures 8 and 9 show not only the paths where people will see each eclipse, but also the percentage of Sun covered by the Moon for different locations across most of North America.

The following tables provide eclipse information for key locations in North America.

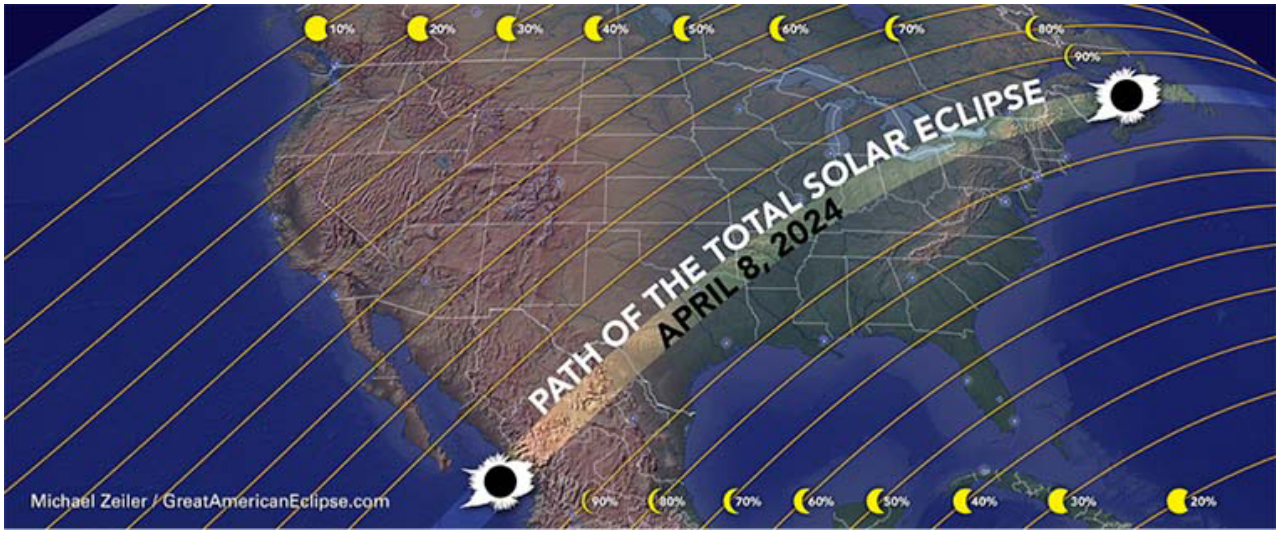
FIGURE 8



For the Saturday, October 14, 2023 annular eclipse, the map below shows not only the path where people will see an annular eclipse, but also the percentage of Sun covered by the Moon for different locations across most of North America.

Michael Zeiler, GreatAmericanEclipse.com

FIGURE 9



For the Monday, April 8, 2024 total eclipse, the map below shows not only the path where people will see a total eclipse, but also the percentage of Sun covered by the Moon for different locations across most of North America.

Credit: Michael Zeiler, GreatAmericanEclipse.com

TABLE 1: Annular Eclipse, Oct. 14, 2023

Some Places Where the Eclipse Will be Annular

Location	Partial Beg	Ann Beg	Ann End	Partial End	Alt	Duration
Eugene, OR	8:05 am	9:17	9:21	10:40 am	18°	3:55 min
Crater Lakes Nat Park OR	8:05 am	9:17	9:22	10:41 am	20°	4:33
Winnemucca NV	8:06 am	9:21	9:25	10:47 am	24°	4:27
Ticaboo UT	9:10 am	10:28	10:33	12 n	32°	4:45
Albuquerque NM	9:13 am	10:35	10:39	12:10 pm	36°	4:48
Roswell NM	9:16 am	10:39	10:43	12:15 pm	40°	4:41
Odessa TX	10:18 am	11:43	11:48	1:22 pm	43°	4:49
San Antonio TX*	10:24 am	11:52	11:56	1:33 pm	48°	4:21
Corpus Christy TX	10:26 am	11:56	12:01	1:38 pm	50°	4:53
Uxmal (near Merida), MEX	10:46 am	12:23	12:27	2:10 pm	62°	4:07
Belize City, BEL+	9:53 am +	11:32	11:37	1:20 pm	65°	5:11
La Ceiba, HON+	9:58 am	11:39	11:44	1:27 pm	67°	5:12
Santa Fe Nat'l Park, PAN	11:24 am	1:08	1:13	2:55 pm	68°	5:02

* In a larger town, the exact eclipse duration depends on where in the town you are.
+ Belize/Honduras don't observe daylight savings time; so time is off from the rest
In this table, alt means altitude—how high the eclipsed Sun will be in the sky, where 0° would mean being at the horizon and 90° would mean being directly above your head.

TABLE 2: Annular Eclipse, Oct. 14, 2023

Eclipse Information for the Biggest US Cities

This table shows what the 2023 eclipse will look like in some of the biggest American cities. Note that most places see a partial eclipse. (In the chart, "Diam Cov" gives the % of the Sun's diameter that will be dark.)

Location	Begins	Max	Ends	Diam Cov	Alt at Max
New York City	12:08 pm	1:22	2:36 pm	35%	41°
Los Angeles	8:08 am	9:25	10:50 am	78%	28°
Chicago	10:37 am	11:58	1:22 pm	54%	40°
Houston	10:27 am	11:59	1:38 pm	90%	49°
Philadelphia	12:05 pm	1:21	2:37 pm	38%	42°
Phoenix	8:11 am	9:32	11:02 am	85%	34°
San Antonio *	10:24 am	11:54	1:33 pm	96%	48°
San Diego	8:09 am	9:26	10:53 am	76%	30°
Dallas	10:24 am	11:53	1:30 pm	86%	46°
San Francisco	8:05 am	9:20	10:42 am	83%	23°
Indianapolis	11:40 am	1:02	2:29 pm	55%	42°
Washington DC	12:00 pm	1:19	2:39 pm	42%	43°
Miami	11:57 am	1:34	3:12 pm	67%	56°
Austin	10:24 am	11:54	1:33 pm	93%	47°
San Jose	8:06 am	9:20	10:43 am	82%	23°
Fort Worth	10:23 am	11:52	1:29 pm	87%	45°
Jacksonville	11:51 am	1:23	2:57 pm	63%	52°
Charlotte	11:51 am	1:17	2:45 pm	53%	47°
Columbus	11:46 am	1:07	2:31 pm	50%	42°
Seattle	8:08 am	9:20	10:40 am	86%	17°
Denver	9:14 am	10:36	12:06 pm	85%	34°
Boston	12:18 pm	1:26	2:33 pm	29%	39°

* Will see the annular eclipse

Don't forget, you can find out what the 2023 annular eclipse will be like in your area by going to: **www.timeanddate.com/eclipse/solar/2023-october-14**

TABLE 3: Total Eclipse, Apr. 8, 2024

Some Places Where the Eclipse Will be Total and Will Last a Longer Time

Location	Partial Beg	Tot Beg	Tot End	Part End	Alt	Duration
Torreon MEX	12 noon	1:17	1:21	2:43	71°	4:09 min
Kerrville (near San Antonio) TX	12:15 pm	1:32	1:36	2:56	68°	4:25
Arlington (near Dallas) TX	12:23 pm	1:40	1:44	3:02	65°	3:22
Morrilton (near Little Rock) AR	12:34 pm	1:51	1:55	3:11	62°	4:14
Cape Girardeau MO	12:42 pm	1:58	2:02	3:17	58°	4:07
Carbondale, IL	12:43 pm	1:59	2:03	3:18	57°	4:10
Indianapolis IN*	1:51 pm	3:06	3:10	4:23	54°	3:46
Cleveland OH*	1:59 pm	3:14	3:18	4:29	49°	3:49
Erie PA	2:02 pm	3:16	3:20	4:31	48°	3:43
Niagara Falls NY	2:05 pm	3:18	3:22	4:32	46°	3:31
Buffalo NY*	2:05 pm	3:18	3:22	4:32	46°	3:45
Rochester NY*	2:07 pm	3:20	3:24	4:33	45°	3:39
Sherbrooke (near Montreal) CAN	2:17 pm	3:28	3:31	4:38	40°	3:26
Oakfield ME	2:22 pm	3:32	3:35	4:41	36°	3:22

* = In larger cities, the duration can be different in different parts of the city

The column labeled "Alt" shows how high the eclipsed Sun will be in the sky, where 0° would mean being at the horizon and 90° would mean being directly above your head. Duration means the length of time that the eclipse will be total (the Moon will fully cover the Sun.)

TABLE 4: Total Eclipse, Apr. 8, 2024

Total Eclipse Information for the Biggest US Cities

(Note that in most places the eclipse will be partial)

Location	Begins	Max	Ends	Diam Cov	Alt at Max
New York City	2:11 pm	3:26	4:36 pm	91%	43°
Los Angeles	10:06 am	11:12	12:22 pm	58%	55°
Chicago	12:51 pm	2:08	3:22 pm	94%	53°
Houston	12:20 pm	1:40	3:01 pm	94%	68°
Philadelphia	2:08 pm	3:24	4:35 pm	90%	46°
Phoenix	10:08 am	11:20	12:35 pm	71%	60°
San Antonio	12:15 pm	1:34	2:56 pm	99%	69°
San Diego	10:03 am	11:11	12:23 pm	62%	57°
Dallas *	12:23 pm	1:43	3:03 pm	100%	65°
San Francisco	10:14 am	11:13	12:16 pm	45%	50°
Indianapolis *	1:51 pm	3:08	4:23 pm	100%	54°
Washington DC	2:04 pm	3:21	4:33 pm	89%	47°
Miami	1:48 pm	3:02	4:13 pm	56%	61°
Austin*	12:17 pm	1:37	2:58 pm	100%	68°
San Jose	10:13 am	11:13	12:17 pm	46%	51°
Fort Worth	12:22 pm	1:42	3:02 pm	100%	65°
Jacksonville	1:48 pm	3:05	4:20 pm	71%	58°
Charlotte	1:54 pm	3:12	4:26 pm	83%	54°
Columbus	1:56 pm	3:13	4:27 pm	99.6%	51°
Seattle	10:39 am	11:29	12:21 pm	31%	45°
Denver	11:28 am	12:40	1:54 pm	71%	58°
Boston	2:16 pm	3:30	4:39 pm	93%	41°

* = will see total eclipse.

"Diam Cov" gives the % of the Sun's diameter that will be dark.

Don't forget, you can find out what the 2024 solar eclipse will be like in your area by going to: **https://www.timeanddate.com/eclipse/solar/2024-april-8**

What Should I Expect to Happen During Each Eclipse?

Most people will be in a location to see a partial eclipse in both 2023 and 2024. As the Moon starts to come in front of the Sun, a small bite will be taken out of the Sun's disk. The size of the bite will increase for a little over an hour and then will slowly decrease for approximately the next hour. Whenever the Sun is not covered completely, the only way to look directly at the Sun is by using approved solar-viewing glasses, or by viewing an indirect image of the Sun (see section 3).

But, what will happen if you are in the path of annularity or totality? Being in the path of annularity is less spectacular than being in the path of totality. In October of 2023, those in the path will get to see the "ring-of-fire" around the dark disk of the Moon. But, even with only a few percent of the Sun's surface showing, the surrounding landscape does not get that dark, the Sun cannot be viewed directly without protection, and the Sun's atmosphere is not visible.

Things are quite different for the total eclipse in April of 2024. As more and more of the Sun is covered by the Moon near the time of totality, shadows become sharper, temperatures (slowly) lower, and the sky grows darker. If you are viewing from high ground, you may be able to see the Moon's shadow on the land racing toward you (but that's not always easy to see).

Just before the Moon completely covers the Sun, it will get significantly darker, and you may see "the diamond ring effect" (Figure 10). For a second, you see the faint ring of the Sun's last crescent of light and then the bright (diamond) flash of the last glimpse of the Sun. That flash is the light of the Sun glimpsed through a valley on the edge of the Moon.

Then, when the Sun is completely covered, its outer atmosphere (called the corona) becomes visible as a faint flickering glow around the dark disk of the Moon. Sometimes, you can also see red or pink *prominences*, small tongues of hot material jutting outwards from the Sun's surface. Also, take a moment to tear your eyes away from the Sun and glance around. The world is dark, but it's a darkness that is not quite like night and nothing like a cloudy day. (The sky near the Sun may look darker than the sky near the horizon.) You can frequently notice the absence of sound as wind dies down and living things seem to hold their breath.

This short period of totality is when you can (and need to) look directly at the Sun. It is even OK to view the fully eclipsed Sun with binoculars to get a better view of the corona and prominences. But don't forget to go back to viewing the Sun indirectly, or with safe-viewing glasses, as soon as any part the Sun's surface reappears.

You may see another diamond ring as the Sun emerges from behind the Moon, which tells you it's time to get protection in front of your eyes.

FIGURE 10

The "diamond ring" effect during the total solar eclipse on July 22, 2009

Source: Lutfar Rahman Nirjhar, Wikimedia Common, CC BY-SA 3.0.

2. About the Handouts for Students to Share with Family and Friends

The last four pages of this Guide (the Appendix) are handouts that you can copy and give your students to share with their family members and friends. Please note that that there is a box for you to provide the time the eclipse occurs in your location. You can find the information for the 2023 annular eclipse at: www.timeanddate.com/eclipse/solar/2023-october-14. You can find the information for the 2024 total eclipse at: www.timeanddate.com/eclipse/solar/2024-april-8. Electronic copies of these handouts are available at: https://static.nsta.org/pdfs/SolarEclipses2023_Handouts.pdf

3. Safe Ways to View the Eclipses

Are Eclipses of the Sun Dangerous to Watch?

The sheer quantity of the Sun's light can cause serious damage to the sensitive tissues of the eyes, often without one being immediately aware of it! Normally, our common sense protects us from looking directly at the Sun for more than a second. But during an eclipse, astronomical enthusiasm can overwhelm common sense, and people can wind up staring at the Sun for too long. Make sure you have something with you to protect your eyes or to view the Sun indirectly before the eclipse becomes total—or if you are only seeing a partial eclipse. See suggestions for safe viewing strategies in the following sections).

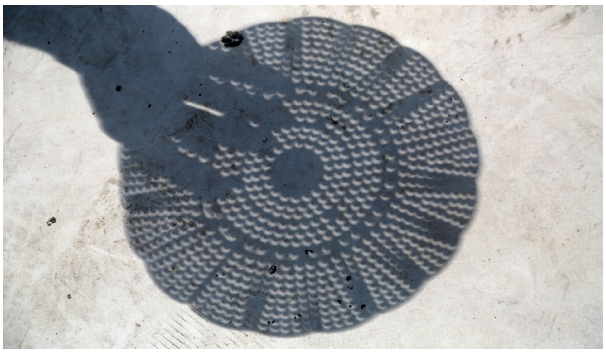
As we discussed in section 1, the few minutes of total eclipse (when the Sun is completely covered) are safe, but any time that even a small piece of the bright Sun shows, your eyes are in danger. Astronomers will be working with many organizations and companies to help everyone observe the eclipse safely. Paper glasses with special filters made of protective material will be sold in a variety of places—see more information on later pages.

What Are Some Ways to Watch the Eclipse Safely When Part of the Sun's Surface is Visible?

Creating multiple images of the Sun

We'll discuss a number of ways to make a pinhole projector of the Sun, but most homes already have the perfect pinhole projector to produce multiple images of the partially eclipsed Sun—a pasta colander. To use it during the eclipse, stand with your back to the Sun and hold up a colander so that the Sun's light shines through on the ground or a wall where, inside the colander's shadow, there will be many tiny images of the eclipsed Sun.

FIGURE 11



NASA Image by Joy Ng

Safety note: You should definitely NOT directly look at the Sun through binoculars or a telescope, except during totality, because they concentrate the rays and make looking at the Sun *more* dangerous, not less. Only use such instruments to look directly at the Sun if you have a reliable solar filter specifically designed to fit them and know how to use it!

Something similar can be seen when you let the Sun shine through the fingers of both hands, crossed over each other, or in the shadow of a tree that has many leaves and branches that cross.

FIGURE 12

Photo by Kelly Beatty

DIY Pinhole Projectors to Indirectly View the Sun

There are many ways to make pinhole projectors for observing the eclipse. They make a great class project and involve some interesting science concepts. One easy method is to take two pieces of cardboard or thick paper. Put a pinhole in one (taking care to make a small, neat hole). Then, stand with your back to the Sun and let the Sun's light fall through the hole and onto the other sheet (see figure 13). You'll get a small but distinct image of the Sun.

FIGURE 14

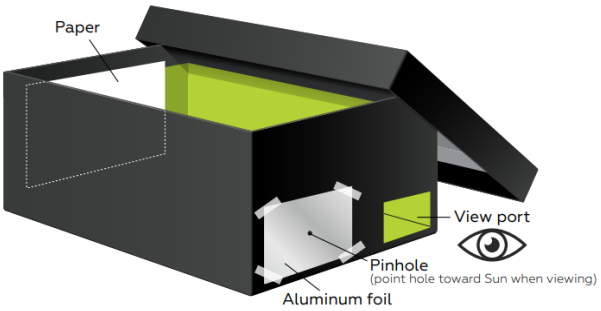


Image source: *Solar Science*, page 354

A way to get a sharper pinhole is to cut a square out of the middle of one piece of cardboard, tape a sheet of aluminum foil over the hole, and put the pinhole in the foil instead of the cardboard. The farther apart the two pieces of cardboard or paper, the larger the image of the Sun will be (but it will be a small image in any case).

You can also make such a pinhole projector inside a box, such as a shoe box (see figure 14), a cereal box, or a poster shipping box. Again, the image of the eclipsed sun on the box will be quite small, but it will be distinct.

You can find instructions for

- a cereal box viewer at: hilaroad.com/camp/projects/eclipse_viewer/eclipse_viewer.html
- a UPS triangular shipping box viewer at: www.exploratorium.edu/eclipse/how.html

FIGURE 13

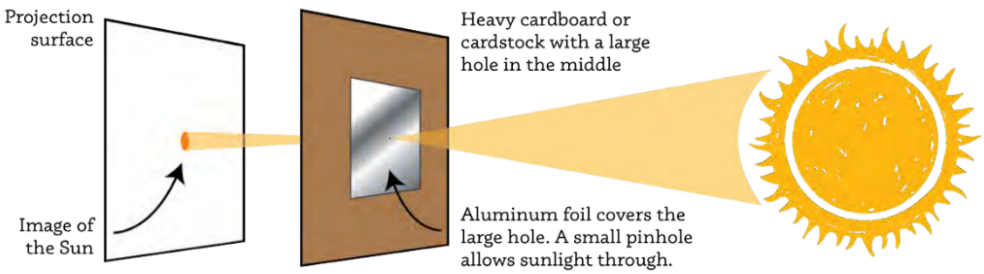


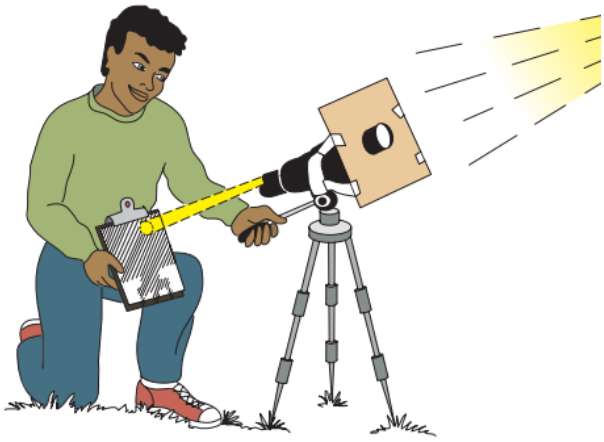
Image source: Solar Eclipse Activities for Libraries (SEAL) Guide

Projecting an Image of the Sun Through Binoculars

You can use one side of a pair of binoculars mounted on a tripod to project a larger image of the eclipsed Sun. Outside, extend the tripod to its full length and attach the binoculars securely to the tripod head. Then, cut a hole in the center of a large piece of cardboard the same size as on of the binocular openings. Slip the cardboard over the opening and tape it in place. See Figure 15 for what the setup should look like when complete. Now point the large end of the binoculars toward the Sun and have someone else hold a white sheet or cardboard some distance away from the smaller end. Move things around until you see an image of the Sun on the paper or cardboard. Use the focus knob of the binoculars to make the image of the Sun sharper.

Under no circumstances should you look at the Sun *through* the binoculars!

FIGURE 15



Source: Schatz, D., and P. Allen. 2003. *Astro adventures II: An activity-based astronomy curriculum.* Seattle, WA: Pacific Science Center, p. 52.

Safe-Solar-Viewing Glasses to Look Directly at the Sun

Because the Sun's light is so intense, you need to protect your eyes with some sort of safe filter if you want to look at it directly. Sunglasses, exposed film (does anybody still remember what that is?), and smoked glass do NOT filter out enough of the light to be safe! If you have access to welder's supplies (and not many people do), #14 arc-welder's glass is an excellent filter (but it has to be #14 and not a lower number). The cheapest and easiest solution is a pair of special solar-viewing glasses—which consist of special black polymer material that reduces the Sun's light to safe levels.

These safe-solar-viewing glasses are available to purchase at many science museums and planetariums, at telescope and camera stories, and university and college bookstores. If you obtain some for your family or class, be sure you get them from a reliable source. Somewhere on the paper or plastic frame, it should say that the glasses are compliant with the ISO 12312-2 international safety standard.

The glasses can be ordered in bulk at a significant discount (as little as 50 cents each). However, the few companies that make the glasses are warning that they expect to run out months before the eclipses happen, so you should order them early. Reliable companies making and selling them include the following:

- Rainbow Symphony: **www.rainbowsymphony.com/products/eclipseglasses?variant=40209088643119**
- American Paper Optics: **www.eclipseglasses.com/collections/eclipse-glasses-stock**
- Thousand Oaks Optical: **thousandoaksoptical.com/shop/eclipse/solar-viewer-cards-glasses/**

FIGURE 16

Photo by Mark Margolis

You may want to get the school PTA or a local foundation involved in making a bulk purchase. Many school organizations sold the glasses at a modest profit to underwrite student activities, or so that students could receive them for free. The American Astronomical Society keeps an updated webpage with all the reliable producers and retailers they are aware of at: eclipse.aas.org/resources/solar-filters

Astronomer Doug Duncan has created a *Solar Snap* filter to put over your cell phone camera for safe viewing and photography of the partial phases of an eclipse (and the Sun in general.) It comes with a Velcro dot for attachment and a free app for Apple and Google phones. See: www.eclipseglasses.com/collections/solar-snap-eclipse-app/products/solar-snap-the-eclipse-app

Discounts are available for educational institutions (with discounts on safe-viewing glasses too) at: www.eclipseglasses.com/products/special-school-discount-program

4. Using the Eclipses as a Teachable Moment to Engage with Science Phenomena

Activities/Experiences Leading up to the Eclipses

For those who follow the Next Generation Science Standards (NGSS), the learning expectations associated with eclipses is found at the middle school level:

> **Performance Expectation MS-ESS1.A**
> *Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.*

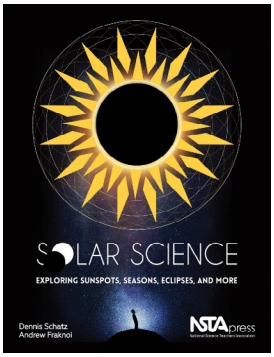
Even if your state does not use the NGSS, your state standards likely include learning about lunar phases (critical for understanding what causes eclipses) at either the upper elementary or middle school level.

In 2017, NSTA published solar eclipse-related articles in its three K-12 journals. The teaching strategies listed in the three articles are still appropriate today. You can find them at:

- Science & Children (PreK-Elementary) bit.ly/3LvT5ge
- Science Scope (Middle School) bit.ly/3JFhNtx
- The Science Teacher (High School) bit.ly/3FnbdoS

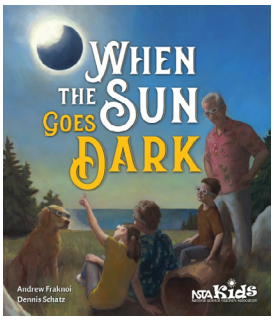
Updated versions of these articles will appear in the 2023 summer or fall issues of the journals.

NSTA has developed several resources that provide learning experiences to use in your classroom:



i) ***Solar Science: Exploring Sunspots, Seasons, Eclipses, and More,*** written by the same team whose work you are reading right now, provides a series of activities in Chapter 4 that introduces and explains lunar phases (important for understanding what causes eclipses) and both solar and lunar eclipses. Together, the activities provide the three-dimensional learning approach emphasized in the K-12 Framework for Science Education and the NGSS.

Available at: my.nsta.org/resource/102100/solar-science-exploring-sunspots-seasons-eclipses-and-more



ii) ***When the Sun Goes Dark*** is a children's book for grades 3-6 that provides a great way to reinforce the science concepts connected with eclipses, using a fun interaction between "eclipse chasing" grandparents and their grandchildren.

Available at: my.nsta.org/resource/108257

iii) ***Next Time You See the Moon*** is a children's book for younger children (k—4). Children learn about many of the Moon's mysteries through vivid pictures and engaging explanations.

Available at: my.nsta.org/resource/95308/next-time-you-see-the-moon

The author of this book, Emily Morgan, has made a short video demonstrating the use of simple models to explain the appearance of the Moon: www.youtube.com/watch?v=wz01pTvuMa0

iv) A video of an NSTA webinar, by the two authors of this booklet, introducing the eclipses of 2023 and 24 and some of the activities you can do to prepare for them is available at NSTA at: my.nsta.org/resource/125329

For a list of other classroom activities—not necessarily from NSTA—about eclipses, the Moon, and the Sun (available free on the Web) see: bit.ly/teacheclipse. Also, see the list of references in section 7.

Making the Eclipses a School or Community-wide Event

As interest grows in the eclipse "double-header," you may get requests from others at your school for eclipse-related information, activities, and programs. Alternatively, you and your students may want to offer your help explaining, preparing for, and observing the eclipses. Students' families may also look to science teachers and schools for reliable suggestions. Planning in advance, you might be able to convert the eclipses into school-wide programs and community learning experiences.

With the first eclipse happening in mid-October, the beginning of the 2023-24 school year still provides adequate time to prepare students for understanding and observing the eclipses. Once your students feel they understand both eclipse science and solar observing safety, you might encourage them to become "eclipse outreach agents" to others in the school and the community. Perhaps they can even disseminate useful information via their social media, although it might be useful to provide some sample text that they can use or adapt.

It is best to first give them time to practice by explaining the upcoming eclipses to their families. Then, perhaps for extra credit, the most enthusiastic can go into other classes (with handouts) to spread the news to other students. You might work with other science teachers, the school library, and principal's office to organize a schoolwide assembly, and/or set up exhibits or bulletin boards to provide eclipse information for everyone in the school.

Finding Solar Eclipse Resource Partners

If there is an amateur astronomy club in your community, their members may be willing to come out to your location to work with the science teachers and students and their families in the weeks or days leading up to each eclipse. A list of astronomy clubs in the U.S. that are especially interested in doing public outreach can be found through NASA and the Astronomical Society of the Pacific's Night Sky Network, at: nightsky.jpl.nasa.gov/club-map.cfm

Other directories of amateur clubs in the US are made available by:

- The Astronomical League: www.astroleague.org/astronomy-clubs-usa-state
- *Sky & Telescope* magazine (they also list other astronomy organizations by location): skyandtelescope.org/astronomy-clubs-organizations
- Astronomy magazine (their list includes more types of organizations): astronomy.com/groups.aspx (once you get a state listing, click on the name of each organization (even though it doesn't look like a link) to get more info.

NASA's Solar System Ambassadors are specially trained individual to provide presentation and resources to schools and other organizations. They will be eager to work with schools in their communities to be sure you are ready for the eclipses. Find a Solar System Ambassador near you at: solarsystem.nasa.gov/solar-system-ambassadors/directory

As news about the upcoming eclipses gets out to people through teachers like you and later the media, there will be growing public interest in finding information, eclipse glasses, and other safe viewing methods. As they were in 2017, public libraries are likely to be key centers for community eclipse information, particularly in towns that do not have easy access to college astronomy departments or science museums.

The SEAL Project at the Space Science Institute in Boulder, CO (part of their STARNet network of libraries) (www.starnetlibraries.org/about/our-projects/solar-eclipse-activities-libraries-seal)

has funding from the Moore Foundation, to provide 10,000 public libraries with 5 million solar viewing glasses and information (similar to this booklet) regarding the upcoming eclipses.

Libraries that join the network are encouraged to find partners - including local science teachers - to help do community eclipse events. If you, and perhaps your students might like to help, you can find a list of libraries involved, at www.starnetlibraries.org/about/our-projects/solar-eclipse-activities-libraries-seal. If your local public library is not part of STAR Net, encourage the library join the network and tell them ways you might be available to help when they are ready to provide eclipse programs for the community.

If your community has a college or university with an astronomy department or a science museum that does astronomy programs, they may already be making plans for public or community events, and may be delighted if you and some student volunteers want to help them.

TV, radio, and newspapers are often the last to "tune in" to the eclipses, so most reporters are likely to find out about the eclipse pretty late from their national sources. If you feel comfortable with the media, you might want to approach a local media outlet and give them an early heads-up about the eclipse. Just be sure you include enough background information so that a non-science person can understand what will be happening during the coming year. They might even decide to come out to your school or the local library when eclipse events are happening and make it a special occasion for everyone.

Alternatively, you and other teachers might want to work with students on getting accurate and accessible eclipse information out through the many social media (like Facebook, Instagram, TikTok, Reddit, etc.) that young people now use as their primary information contacts. You can include some of the free eclipse images available at eclipse.aas.org/resources/images-videos.

STAR net

Science-Technology Activities & Resources For Libraries

Please bear in mind that the day of the eclipse will likely be too late for providing information, training, or sun-viewing glasses to families scattered around your community. It is in the months and weeks leading up to the eclipse that outreach activities are most needed.

We know that people learn the most about something they teach to others, so this is the perfect time to practice this strategy. We hope you and your students find plenty of opportunities to educate and inform others in your school and community.

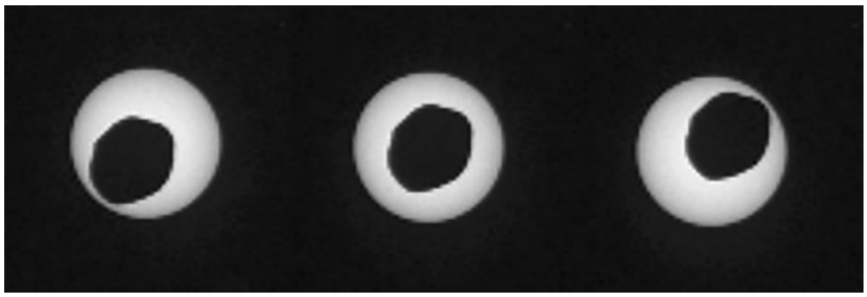
What to Do During the Hour that the Moon Slowly Moves in Front of the Sun

Whether you are in the total or annular path or not, there will be a long period when the Moon is slowly eclipsing part the Sun. Once you reviewed safe-viewing procedures and walked around to make sure everyone is observing them, you could lead a discussion about eclipse basics with students, family and friends. Bring some balls with you and show how the Sun, Moon, and Earth are lined up. Talk about the coincidence that, as seen from Earth, the Moon and the Sun happen to be exactly the same size in the sky. Bringing the right size balls with you can help you demonstrate this. This is not true for any other combination of planet and moon in our neighborhood. For example, Mars's moon, Phobos, is not large enough in the sky to cover the Sun (Figure 17).

Another good topic to discuss might be that some worlds have atmospheres and some do not. Talk first about the atmosphere of the Earth, with its thin

FIGURE 17

Mars's moon, Phobos, does not cover the Sun.



Mars's little moon, Phobos, almost eclipses the Sun in August 2013 in this sequence of images taken by NASA's Curiosity rover. This moon looks smaller than the Sun from the surface of Mars and thus cannot provide a total eclipse.

Source: NASA/JPL

Source: Solar Science, page 13 of insert

layer of air that surrounds our planet, giving us the oxygen we need to breathe and providing the air pressure we need for water to be a liquid (in space it would be a gas). A good activity to help kids imagine the extent of our atmosphere is "How High Up Is Space?" from the Astronomical Society of the Pacific, available at: **astrosociety.org/file_download/inline/74e02a72-a5c6-48d3-a498-d87732a44388**. Discuss what other worlds also have atmospheres. Not all planets have them, but many do, such as Venus, Mars, Jupiter, Saturn, Uranus, and Neptune.

Now ask them what they think about the Sun having an atmosphere. Can a star like the Sun, made entirely of superheated gas, still have some kind of lighter layer of gas around it? If you are in the path of totality, tell them that you will soon find out together. If the Sun has an atmosphere around it, it would usually be hard to see because the Sun is so bright. During a total eclipse, however, the Moon completely covers the Sun, so any faint atmosphere becomes visible. If you are seeing an annular or partial eclipse, you won't be able to see it, but students can be given the challenge of finding the best image of a total eclipse on the Web that shows the Sun's atmosphere in detail.

If you bring an outdoor thermometer with you, you can measure the effect of the eclipse on the Sun's ability to heat our planet by taking readings with the thermometer every 15 minutes or so. If you are in the path of totality, you should increase the frequency of your measurements as it gets darker just before the total eclipse.

If your school has the resources to purchase some the Solar Snap filters and app for cell-phone cameras that we discussed in **section 3**, this can also be a time for taking and sharing cell-phone images of the Sun.

If possible, set up a computer and monitor to show in real time what other people are doing and seeing across North America. One excellent source for livestreaming of the eclipses will be **www.exploratorium.edu/eclipse**

What to Do If It Is Cloudy on the Day of the Eclipse

Whether it is cloudy or not, it is always good to have a number of hands-on activities as part of your plans for eclipse observing—see suggestions in previous section. These engage your students in

case of poor weather conditions, and even if the Sun is visible, they keep everyone busy for the duration of the event.

Other activities about the Sun, Moon, and eclipses are listed in the guide at: **bit.ly/teacheclipse**

If it's partly cloudy, remember that the partial eclipse lasts over two hours, so glimpses of the Sun may be possible as the cloud cover changes.

If the Sun seems to have no chance of peeking through, don't despair! Access to cable TV or the internet will provide many ways to see live views of the eclipse as it's happening elsewhere. Students can also see images and video later in the news. Whether it is cloudy or not, access to images on cable TV or the internet will allow your audience to get a sense of what others are seeing across the country, especially along the path of annularity or totality.

5. Engaging with your Administrators Early

We can't emphasize enough how important it is to engage with your school administrators early and often as you prepare to make the most to the two solar eclipses. In 2017, many school administrators, who did not fully appreciate the learning value of the eclipse and how it can easily be observed safely, decided to cancel teachers' plan to view the eclipse at the last minute.

Educators who started working early with their administrators, on the other hand, reported about the wonderful experience their student had:

> *I began talking to my administration about the eclipse about 6 months ahead of time, and then about how students could safely view, since they would be at school during the actual eclipse. I am fortunate that my principal is very supportive of science and we worked together to make it a fantastic, once in a lifetime experience for our students and families. We planned an entire day of STEM events for our students centered around the sun, moon, shadows, UV light, etc. I also invited a meteorologist to the school to speak to the kids ahead of time about what to expect, how to view safely, etc. We had an eye doctor come to the school and talk to all our students about eyesight and how and why we protect them from the sun the morning of the eclipse.*

But the story was different at another school, where a teacher report that "All came to a crashing end when our district leadership (superintendent) determined that the risk [of going outside] would be too great for our students." She went on to recommend that "superintendents need to be coached on the value of students observing phenomena in the natural world."

Based on many recommendations like this, NSTA has prepared a School Administrators Guide for the 2023/2024 Solar Eclipses for you to share at your school; it is available at **https://static.nsta.org/pdfs/SolarEclipses2023_Admin.pdf**.

The three key takeaways in the Administrator's Guide are:

1. Eclipses are a wonderful learning experience, and understanding what causes them is something almost all state science standards require.
2. With proper preparation, eclipses are safe to view. A research study a few years ago during a total solar eclipse in the UK showed "There were no recorded cases of permanent visual loss."
3. Safe eclipse-viewing techniques are easy to find and use. In the Administrator's Guide, links are provided to a list of safe-viewing strategies, so the administrators can see for themselves.)

We hope you find the Administrator's Guide useful and that you meet early with your principal, district coordinators, superintendent, school board members, and anyone else who needs to be informed about the great teaching value and the various safe viewing options for watching this never-to-be-forgotten experience.

6. Frequently Asked Questions Beyond the Basics

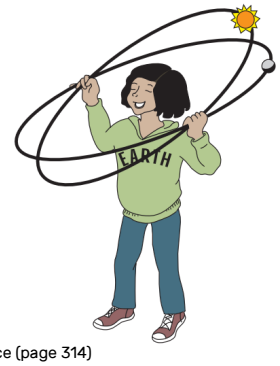
What do Experienced Eclipse Chasers Recommend for Those Who Are Seeing their First Eclipse?

Some of their helpful hints include:

1. Expect a big crowd and prepare for it.
2. Everyone in your group should go to the bathroom just before leaving to view the eclipse.
3. Bring drinks and snacks with you if you are viewing all the parts of the eclipse.
4. Don't neglect the sunscreen, hats, and sunglasses if you are in an open area.
5. For young kids, bring something to keep them occupied while waiting.
6. For older people, bring a folding chair and a sun umbrella.
7. If you have a limited supply of safe sun-viewing glasses, tell the group that they can share them, and to only look at indirect images of the eclipse when it isn't their turn to use the glasses.
8. Remember sunglasses are for reducing glare. They don't have the protection to let you look directly at the Sun, so remind people not to rely on them!

Why is There Not an Eclipse Every Month, When the Moon in Its Orbit is in the Direction of the Sun?

Since each month there is a full Moon (with the Moon opposite the Sun in our sky) and a new Moon (with the Moon in the same direction as the Sun in our sky), students often wonder why we don't have a lunar and solar eclipse every month. The key to why eclipses don't happen every month is that the plane of the Moon's orbit is not exactly aligned with the plane of the Earth's orbit around the Sun. The Sun appears to travel along what is called the ecliptic, and the Moon's orbit is inclined about 5° relative to this. Two hula hoops are an easy way to demonstrate the tilted orbits.



Source: Solar Science (page 314)

Because of this tilt, in most months we see the Moon a little bit above or below the position where we see the Sun in the sky. Only twice a year, when the two orbits intersect, do the Sun, Moon, and Earth line up to produce an eclipse. During these roughly twice yearly "eclipse seasons," we typically have a pair of eclipses, one lunar eclipse during the full Moon and a solar eclipse during the new Moon, followed by another pair of solar and lunar eclipses about six months later. The solar eclipses, however, are total or annular over only a narrow path, so hundreds of years can pass before a given place on Earth sees another total or annular solar eclipse.

If I Miss This Total Eclipse, When Is the Next One Visible From the Continental United States?

The next total solar eclipse to go through the continental United States will be on August 12, 2045. It will mostly go through a different set of states than the one in 2024, but similar to the path of totality in 2017. To see total eclipses between 2024 and 2045, you will need to travel to another part of our planet.

Will We be Able to Sunspots During the Two Eclipses?

The Sun goes through an 11-year cycle, becoming more and then less active during that period. When the Sun is more active, it displays more sunspots (darker, cooler spots on the Sun's surface), energetic flares, great arches of hot gas called *prominences*, and ejections of great masses of gas from the Sun's atmosphere (the corona). The last activity minimum was in 2019, so October 2023 and April 2024 will be during the next maximum period. This means that students observing the disk of the partially eclipsed Sun could see sunspots. Anyone with a view of the total eclipse is also likely to see reddish prominences right above the dark disk of the Moon.

7. Resources for Further Information

1. NSTA Web Seminar on the Eclipse (featuring the authors of this article): **my.nsta.org/resource/125329**
2. Times and circumstances of any eclipse in your community: **www.timeanddate.com/eclipse**
3. American Astronomical Society authoritative website on safe eclipse viewing and reliable information: **eclipse.aas.org**
4. NASA Eclipse Website: **solarsystem.nasa.gov/eclipses/home**
5. The Great American Eclipse website (with good maps): **www.greatamericaneclipse.com**
6. Eclipse 2024 Site with an eclipse simulator for any location: **https://eclipse2024.org/eclipse-simulator/**
7. Space Science Institute Solar Eclipse Activities for Libraries (SEAL) Project: **www.starnetlibraries.org/about/our-projects/solar-eclipse-activities-libraries-seal**
8. The Exploratorium Science Museum links to live telecast of the eclipses (plus nice videos and activities for understanding and viewing eclipses): **www.exploratorium.edu/eclipse**
9. Best weather predictions for eclipse days: **eclipsophile.com**
10. Resources Connecting Eclipses and Fiction/Films/Music, etc.: **bit.ly/eclipsesand**

8. About the Authors

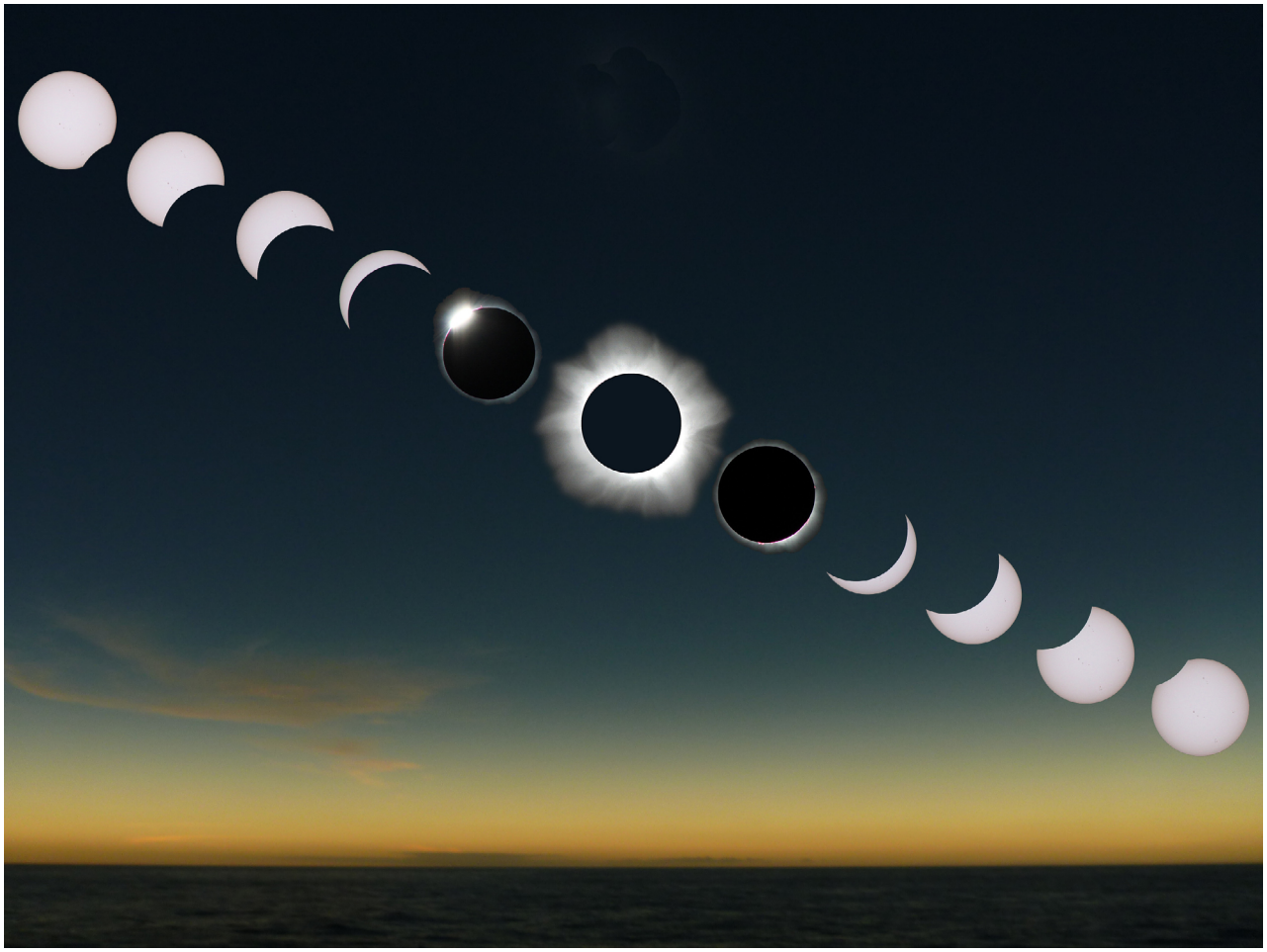
Dennis Schatz retired as the Senior Vice President for Strategic Programs at the Pacific Science Center in Seattle, and now works on science education projects at the Institute for Learning Innovation. For four years, he served as a Program Director for in the Education and Human Resources Directorate at the National Science Foundation. He was the first astronomer to be elected President of the National Science Teaching Association. Schatz is the author of 23 science books for children that have sold almost 2 million copies worldwide and have been translated into 23 languages. In 2021, he received NSTA's highest honor, the Robert H. Carlton award for his outstanding contribution and leadership in science education at the national level. You can learn more about him on his website at www.dennisschatz.org

Andrew Fraknoi retired in 2017 as Chair of the Astronomy Department at Foothill College, near San Francisco, and now teaches in programs for retired people at the University of San Francisco and San Francisco State University. He is the lead author of a free, electronic, introductory college textbook, *Astronomy*, published by the nonprofit OpenStax project, which has become the leading astronomy textbook in the U.S. Over the years, he has appeared on many local and national radio programs, explaining astronomical developments in everyday language. These days, he also writes science fiction stories based on astronomy; seven of them have been published so far. You can see them at his website Fraknoi.com

Both authors serve on the Eclipse Task Force of the American Astronomical Society, working to make the 2023-24 eclipse a safe and educational experience for everyone, and they each have asteroids named after them by their colleagues in recognition of their work in improving the public understanding of science. They are co-authors of a children's book about eclipses, *When the Sun Goes Dark*, published by NSTA Press: my.nsta.org/resource/108257

9. Appendix—Solar Eclipse Handouts for Sharing with Students

The following pages are two handouts you are free to use (one about each eclipse) to give students to share with family and friends. Before you disseminate them, you will want to fill in the empty row of boxes with local eclipse information.



Views of the total solar eclipse of November 14, 2012, as seen from aboard a cruise ship in the South Pacific. The sequence runs from lower right to upper left.

Rick Fienberg / TravelQuest International / Wilderness Travel

The Great American Annular Eclipse of the Sun

Saturday, October 14, 2023

An Information Sheet by astronomers/educators Dennis Schatz & Andrew Fraknoi
Distributed courtesy of the National Science Teaching Association

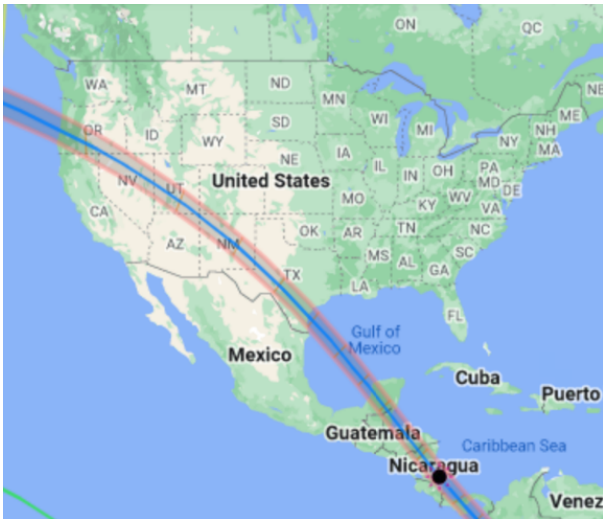
On Oct. 14, 2023, there will be a dramatic *annular* eclipse visible to people on a narrow path from Oregon going southeast to Texas (see map below). A partial eclipse of the Sun will be visible to everyone in North and Central America, with a bigger "bite" taken out of the Sun the closer you are to the path of the annular eclipse.

In this kind of eclipse, the Moon gets in front of the Sun, but it is too far away and, therefore, too small to cover it completely, leaving an annulus (or "ring of fire") around the dark disk of the Moon.

We talked about the annular eclipse in class, so your child should be able to tell you more about what to expect. On the next page is the information for what will happen in our location.

Most people in North America will see a partial eclipse.

Photo by Tomruren



The path of the annular eclipse. (Credit: Xavier Jubier)

Only those people in the narrow path of annularity will see the annular eclipse.

Photo by Kevin Baird

Your town	Partial Begins	Annular Begins (when applicable)	Eclipse Maximum	Annular Ends (when applicable)	Partial Ends

Source: SEAL Guide

Hopefully, the skies will be clear and you can get a great view of this rare astronomical event. There will also be a total eclipse visible in U.S. next April (Monday, April 8, 2024); information about that will be sent later in the school year.

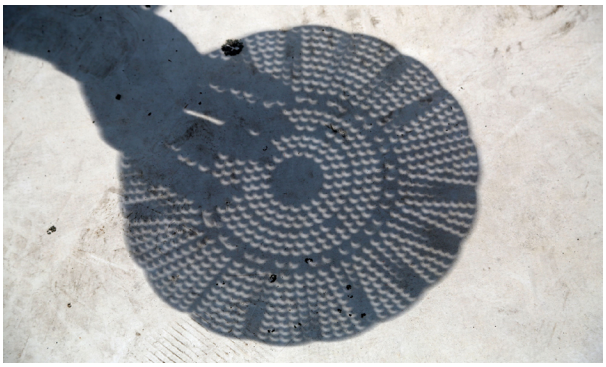
You can find out what will happen at other locations by going to: **www.timeanddate.com/eclipse/solar/2023-october-14**

There are many indirect ways to observe the eclipse, so having solar-viewing glasses is not required. Most homes already have the perfect pinhole projector to produce multiple images of the partially eclipsed Sun—a colander. To use it during the eclipse, stand with your back to the Sun and hold up a colander so that the Sun's light shines through it on the ground or a wall where there will be many tiny images of the eclipsed Sun in the colander's shadow.

Another easy method to observe the eclipse is to take two pieces of cardboard or thick paper. Put a pinhole in one (taking care to make a small, neat hole). Then, stand with your back to the Sun and let the Sun's light fall through the hole and onto the other sheet. You'll get a small but distinct image of the Sun. (A way to get a sharper pinhole is to cut a square out of the middle of one piece of cardboard, tape a sheet of aluminum foil over the hole, and put the pinhole in the foil instead of the cardboard.) The farther apart the two pieces of cardboard or paper, the larger the image of the Sun will be (but it will be a small image in any case).

Observing the Sun Safely

Because some part of the Sun will be showing throughout this eclipse, it will be important to use safe-viewing strategies to protect your eyes. It is never safe to look directly at the Sun. Regular sunglasses, swimming goggles, and most camera filters are NOT safe for looking directly at the Sun. You can observe the Sun indirectly using the ideas below. Or, you can safely protect your eyes with certified solar-viewing glasses from your library or another reliable institution (such as a local science museum or college/high-school science department). Make sure that on the back, in small print, they say that they are ISO 12312-2 certified.



NASA Image by Joy Ng

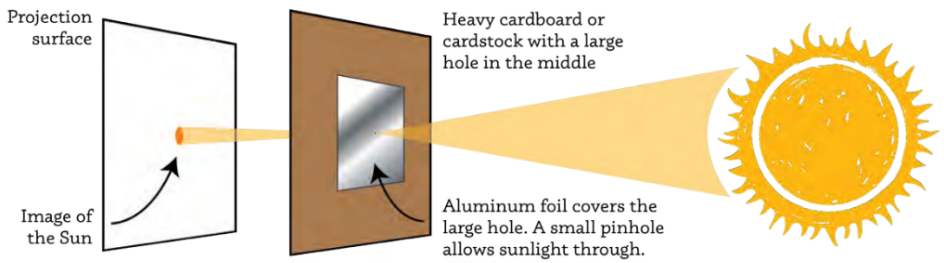


Image source: SEAL Guide, similar image is in Solar Science

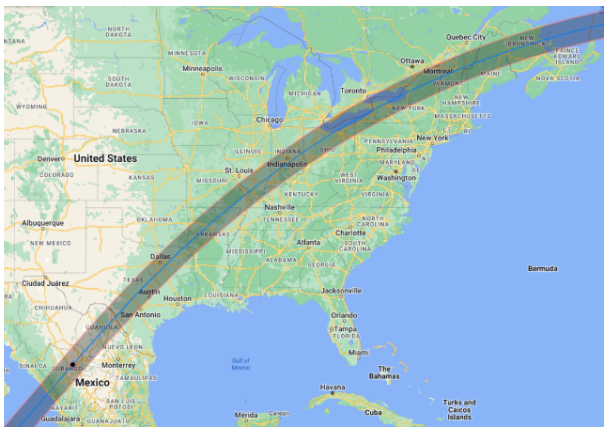
A North American Total Eclipse of the Sun

Monday, April 8, 2024

An Information Sheet by astronomers/educators Dennis Schatz & Andrew Fraknoi
Distributed courtesy of the National Science Teaching Association

On April 8, 2024, there will be a spectacular total eclipse of the Sun, visible on a narrow path that stretches from western Mexico through Texas, and then northeastward toward New York, New England and eastern Canada. In such a total eclipse, the Moon exactly covers the Sun, and our star's faint atmosphere (the *corona*) becomes visible. Everyone else in North and Central America will see a partial eclipse of the Sun, with a bigger "bite" taken out of the Sun the closer you are to the path of the total eclipse.

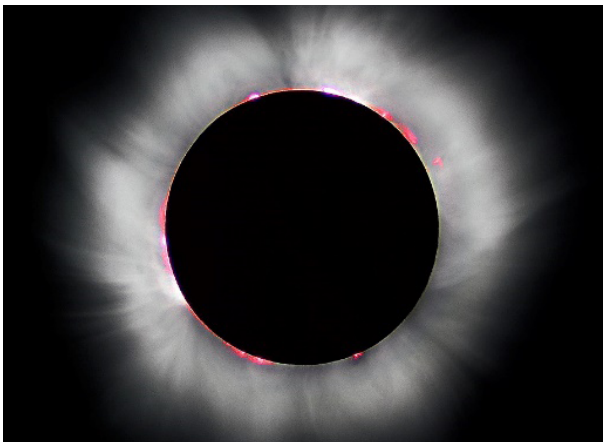
If you are on the path, when only a sliver of sunlight remains visible, your surroundings will begin to darken, as if the Sun were setting in the middle of the day. Temperatures will drop and birds will go to roost, thinking that night is coming. Finally, the Sun will be totally covered and the beautiful solar atmosphere (the corona) will become visible. Totality will last four minutes or less and then the Sun will slowly be uncovered.



The path of the total eclipse. (Credit: Xavier Jubier)

Most people in North America will see a partial eclipse.

Photo by Tomruren



Only those people in the narrow path of totality will see the total eclipse.

Photo by Luc Viatour

Your town	Partial Begins	Total Begins (when applicable)	Eclipse Maximum	Total Ends (when applicable)	Partial Ends

Source: SEAL Guide

We talked about the total eclipse in class, so your child should be able to tell you more about what to expect. At the top of this page is information for what will happen in your location. Hopefully, the skies will be clear and you can get a great view of this rare astronomical event. There will not be another total eclipse visible in the continental U.S. until 2045.

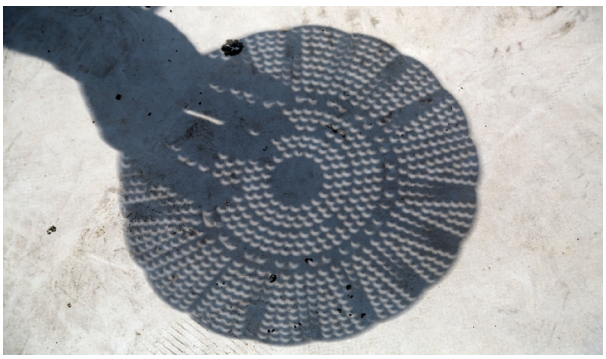
You can find out what will happen at other locations by going to: **www.timeanddate.com/eclipse/solar/2024-april-8**

There are many indirect ways to observe the eclipse, so having solar-viewing glasses is not required. Most homes already have the perfect pinhole projector to produce multiple images of the partially eclipsed Sun—a colander. To use it during the eclipse, stand with your back to the Sun and hold up a colander so that the Sun's light shines through it on the ground or a wall where there will be many tiny images of the eclipsed Sun in the Colander's shadow.

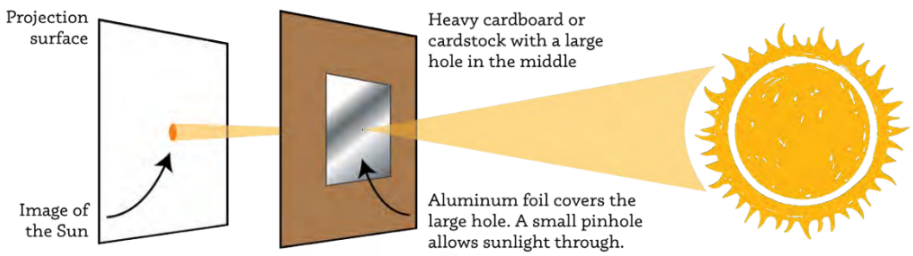
Another easy method to observe the eclipse is to take two pieces of cardboard or thick paper. Put a pinhole in one (taking care to make a small, neat hole). Then, stand with your back to the Sun and let the Sun's light fall through the hole and onto the other sheet. You'll get a small but distinct image of the Sun. (A way to get a sharper pinhole is to cut a square out of the middle of one piece of cardboard, tape a sheet of aluminum foil over the hole, and put the pinhole in the foil instead of the cardboard.) The farther apart the two pieces of cardboard or paper, the larger the image of the Sun will be (but it will be a small image in any case).

Observing the Sun Safely

Because some part of the Sun will be showing during most of this eclipse, it will be important to use safe-viewing strategies to protect your eyes. It is never safe to look directly at the Sun, except during the brief period of totality, when you can only see the faint solar corona by looking directly at the eclipsed Sun. Regular sunglasses, swimming goggles, and most camera filters are NOT safe for looking directly at the Sun. You can observe the Sun indirectly using the suggestions below. Or you can safely protect your eyes with certified solar-viewing glasses from your library or another reliable institution (such as a local science museum or college/high-school science department). Make sure that on the back, in small print, they say that they are ISO 12312-2 certified.



NASA Image by Joy Ng



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