Total Eclipse Training Resources

If you would like editable PowerPoint (.pptx) versions of these presentations, it is available in a Google Drive folder linked below, which also includes resources about using the training that aren't in this PDF. We encourage you to make your own copy of the folder and its contents. The Google Drive folder contains:

- Instructions with information about the resources in the folder and their intended use.
- A folder containing three editable slide decks with content on eclipse safety, science, and engagement opportunities along with each part's hi-resolution images and videos. (You are welcome to use the presentation as is, adapt it to your needs, or pick and choose content as needed.)
- A Google doc with compiled links to additional resources.
- A Google doc with sample questions to solicit feedback from your participants.
- A Google doc with a link to an eclipse question bank that will help you evaluate your eclipse lessons, and help NASA improve their educational resources.

The link below also includes an optional survey, which Oregon State University, in partnership with the NASA Heliophysics Education Activation Team (NASA HEAT), will use to understand the impact of this training and help guide future development of education and training materials.

Some imagery and activities offered by NASA contain eclipse imagery.

To access the Google Drive folder of Total Eclipse Training Resources and to take the survey, click the following link:
https://oregonstate.qualtrics.com/jfe/form/SV_6fWGZyawC3IuZPo

2024 Total Solar eclipse
THROUGH THE EYES OF NASA

National Aeronautics and Space Administration

NASA

April 8, 2024 Total Solar Eclipse Training

Training Overview

- Welcome Message
- Part 1: Eclipse Essentials
  - Lesson 1.1: Eclipse Basics: What Is a Total Solar Eclipse?
  - Lesson 1.2: Eclipse Viewing Safety
  - Lesson 1.3: NASA's Priorities and Key Messages for the 2024 Total Solar Eclipse
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  - Lesson 2.2: Science Investigations During the 2024 Total Solar Eclipse
  - Lesson 2.3: NASA Missions Explore the Sun
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  - Lesson 3.3: Stay Connected

Welcome

Welcome to NASA's Total Solar Eclipse Training

Credit: NASA/Bill Ingalls

A total solar eclipse happens when the Moon passes between the Sun and Earth, completely blocking the face of the Sun. The sky will darken as if it were dawn or dusk.

On **Monday, April 8, 2024**, a total solar eclipse will pass over Mexico, the United States, and Canada. Totality will be seen in parts of Texas, Oklahoma, Arkansas, Missouri, Tennessee, Illinois, Kentucky, Indiana, Ohio, Michigan, Pennsylvania, New York, Vermont, New Hampshire, and Maine.

Credit: Mantarays Ningaloo, Australia/MIT-NASA Eclipse Expedition

2024 Total Solar eclipse
THROUGH THE EYES OF NASA

Acknowledgments

NASA Heliophysics Education Activation Team (NASA HEAT) is providing eclipse support.

POC: Dr. Michael S. Kirk, michael.s.kirk@nasa.gov

Find More: go.nasa.gov/Eclipse2024

This product is supported by the NASA Heliophysics Education Activation Team (NASA HEAT), part of NASA's Science Activation portfolio.

Part 1:
Eclipse Essentials

Part 1 Lessons

Lesson 1.1: Eclipse Basics: What Is a Total Solar Eclipse?

Lesson 1.2: Eclipse Viewing Safety

Lesson 1.3: NASA's Priorities and Key Messages for the 2024 Total Solar Eclipse

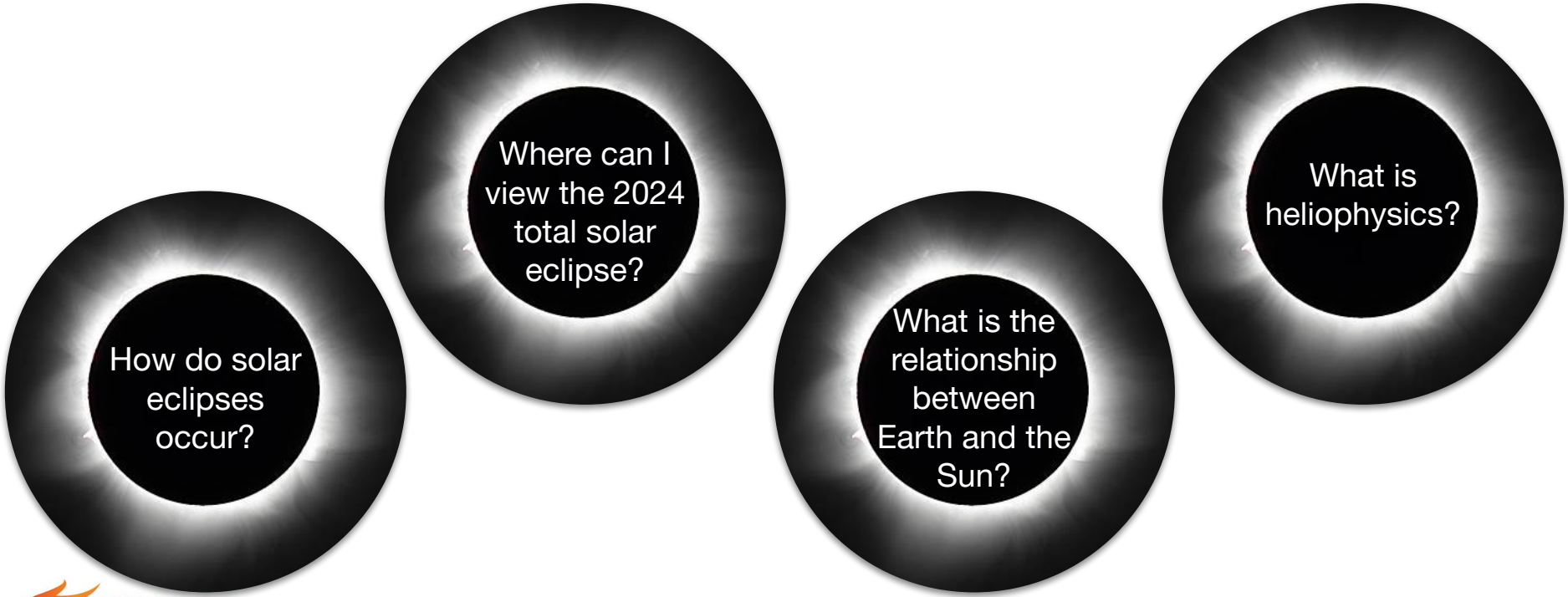
Lesson 1.1:
Eclipse Basics: What Is a Total Solar Eclipse?

The Moon is seen as it starts passing in front of the Sun during the August 2017 total solar eclipse above Ross Lake, Northern Cascades National Park, Washington. Credit: NASA/Bill Ingalls

Eclipse Basics

Lesson 1.1 Learning Objectives

By the end of this lesson, you will be able to answer the following questions:



Credit: Mantarays Ningaloo, Australia/MIT-NASA Eclipse Expedition

NASA's U.S. Eclipse Map for 2024

Credit: Michala Garrison and NASA/SVS, in collaboration with the NASA Heliophysics Education Activation Team (NASA HEAT), part of NASA's Science Activation portfolio. Eclipse calculations by Ernie Wright, NASA Goddard Space Flight Center.

Find More: svs.gsfc.nasa.gov/5123

Explore NASA's 2024 Total Solar Eclipse Map

Press play to learn more about how to use the NASA 2024 solar eclipse map to plan your experience for the total solar eclipse on April 8, 2024.

Credit: NASA

What Is a Solar Eclipse?

Animation not to scale.
Credit: NASA's Goddard Space Flight Center/David Ladd

A solar eclipse occurs when the Moon moves between the Sun and Earth during the new moon phase, resulting in the Moon casting a shadow onto the surface of Earth. The Moon will either partially or fully block the light of the Sun.

Why Don’t We Have a Solar Eclipse Every Month?

The time period when the Moon, Earth, and Sun are lined up and on the same plane – allowing for the Moon to cast a shadow on Earth – is called an **eclipse season**. Eclipse seasons last about 34 days and occur just shy of every six months, around the time of the equinoxes.

Play this animation to observe how the tilt of the Moon’s orbit often keeps it out of alignment with the Sun and Earth, preventing frequent eclipses.

Credit: NASA

Types of Eclipses Seen on April 8, 2024

On Monday, April 8, 2024, locations in fifteen U.S. states will experience a **total solar eclipse**. You may be familiar with a total solar eclipse because some parts of the U.S. experienced one in August 2017. All locations in the contiguous U.S. experienced a **partial solar eclipse** in 2017, which will also be the case for 2024.

Total Solar Eclipse

Credit: NASA/MSFC/Joseph Matus

Depending on where you are located, you may experience a **total solar eclipse**, as seen in the left image. During a total solar eclipse, the Moon completely (100%) obscures the Sun. Or you may be located where only part of the Sun is obscured, a **partial solar eclipse**, shown in the right image.

Partial Solar Eclipse

Credit: NASA/Bill Ingalls

Total Solar Eclipse Phases

Credit: AAS

At all times during a partial solar eclipse, or when no eclipse is occurring at all, view the Sun only through special-purpose solar filters that comply with the transmission requirements of the ISO 12312-2 standard.

1st contact - Partial eclipse begins	2nd contact - Totality starts	Total eclipse	3rd contact - Totality ends	4th contact - Partial eclipse ends
The Moon touches the Sun and takes its first tiny nibble out of the solar disk.	For a few seconds Baily's Beads, which look like beads of light, may be visible at the edge of the Moon's silhouette. Then the corona appears.	The Moon covers the entire disk of the Sun. This lasts up to a few minutes depending on the observer's location within the path of totality.	The Moon starts moving away from the disk of the Sun. Once again, Baily's Beads may be visible along the Moon's edge.	The Moon no longer covers any part of the solar surface. The eclipse is officially over.

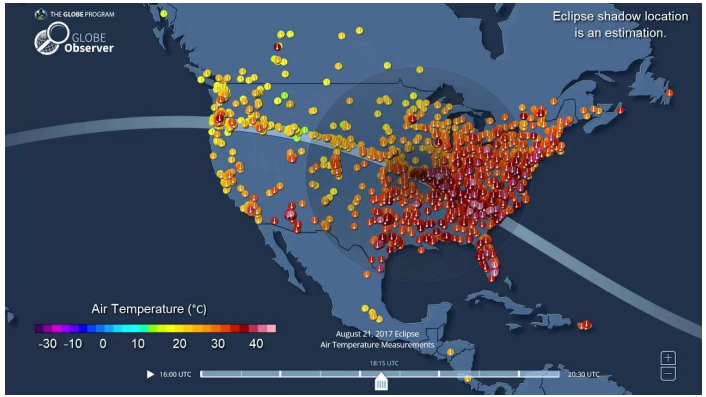
Experiencing a Total Solar Eclipse with Many Senses

Look! When the Sun is completely obscured by the Moon's shadow during totality, the sky gets darker and you will experience dusk-like conditions. You may even be able to see bright stars and planets in the sky.

Employees and visitors at NASA's Jet Propulsion Laboratory stopped to watch the solar eclipse on August 21, 2017. Credit: NASA

Listen! Do you hear birds or crickets? What else do you hear? During totality some animals think it is evening and may begin their night routine a little early. What about the people around you? Do you hear their excitement?

Wild southern sea otter mother and pup. Credit: Monterey Bay Aquarium



Cloud and temperature data collected during the 2017 total eclipse via the GLOBE Observer app. Credit: GLOBE Observer

Feel! Does it get cooler during totality? How much cooler?

Expectations for Viewing a Total Solar Eclipse

Many of the images you see in this presentation are taken with highly specialized equipment.

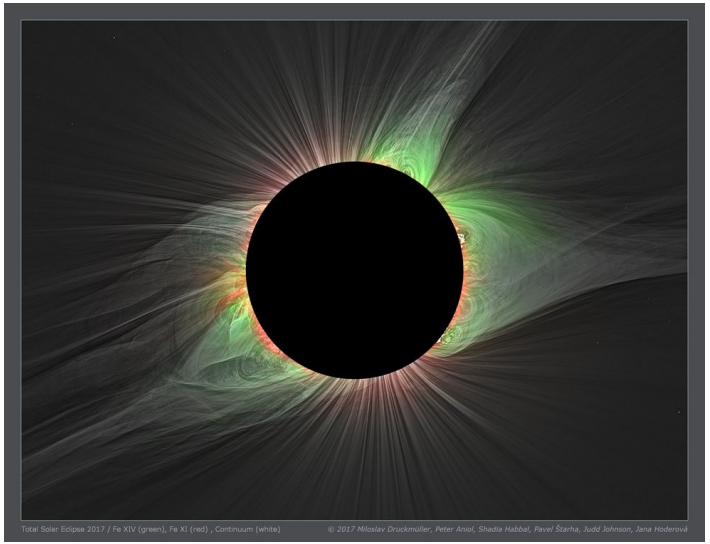
View with the Naked Eye During Totality

This is what observers should expect to actually see just as totality begins when they remove their solar viewing glasses during totality.

Credit: Jim Jeletic and his son Jordan

View with Special Cameras and Telescopes

Many eclipse images are actually multiple layers of different images, known as a composite image, like this image of the 2017 total solar eclipse that also use special filters.



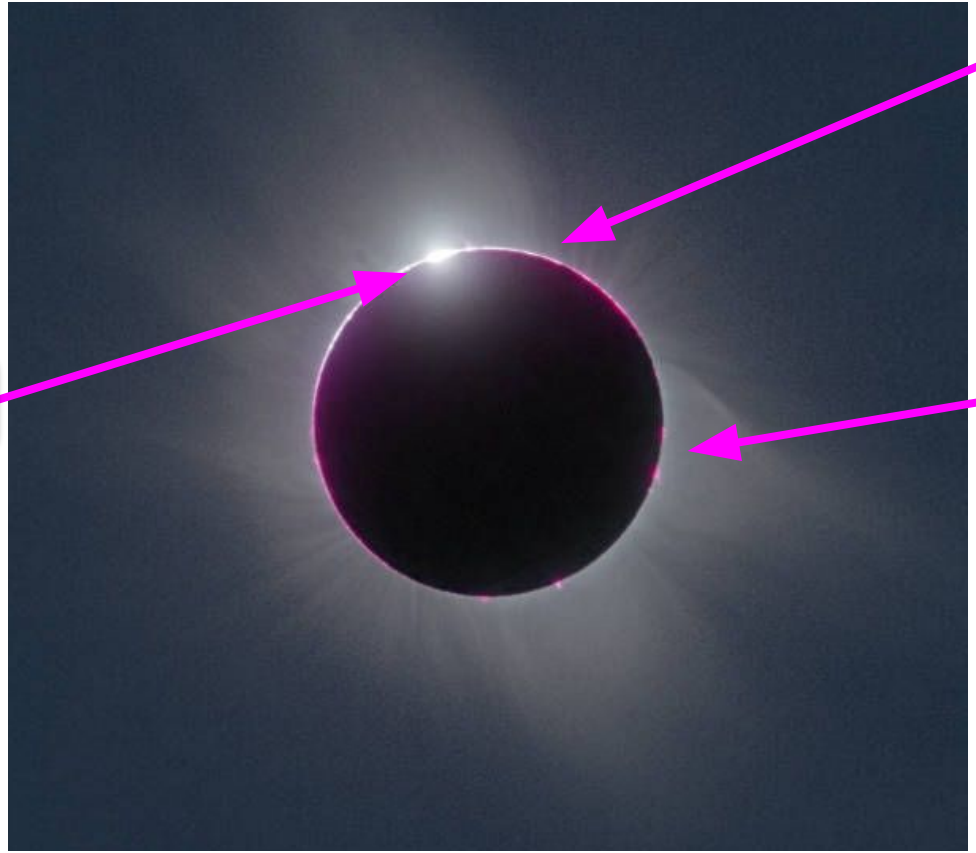
Credit: © 2005 Miloslav Druckmüller (used with permission)

Features You May Observe During Totality

The red part you see is a layer known as the chromosphere; the red color comes from hydrogen gas.

Diamond Ring Effect

The diamond ring effect occurs at the beginning and end of totality during a total solar eclipse. As the last bits of sunlight pass through the valleys on the Moon's limb, and the faint corona around the Sun is just becoming visible, it looks like a ring with glittering diamonds on it.



Credit: © 2005 Miloslav Druckmüller (used with permission)

Baily's Beads

This effect occurs when gaps in the Moon's rugged terrain allows sunlight to pass through in some places just before the total phase of the eclipse.

Prominences

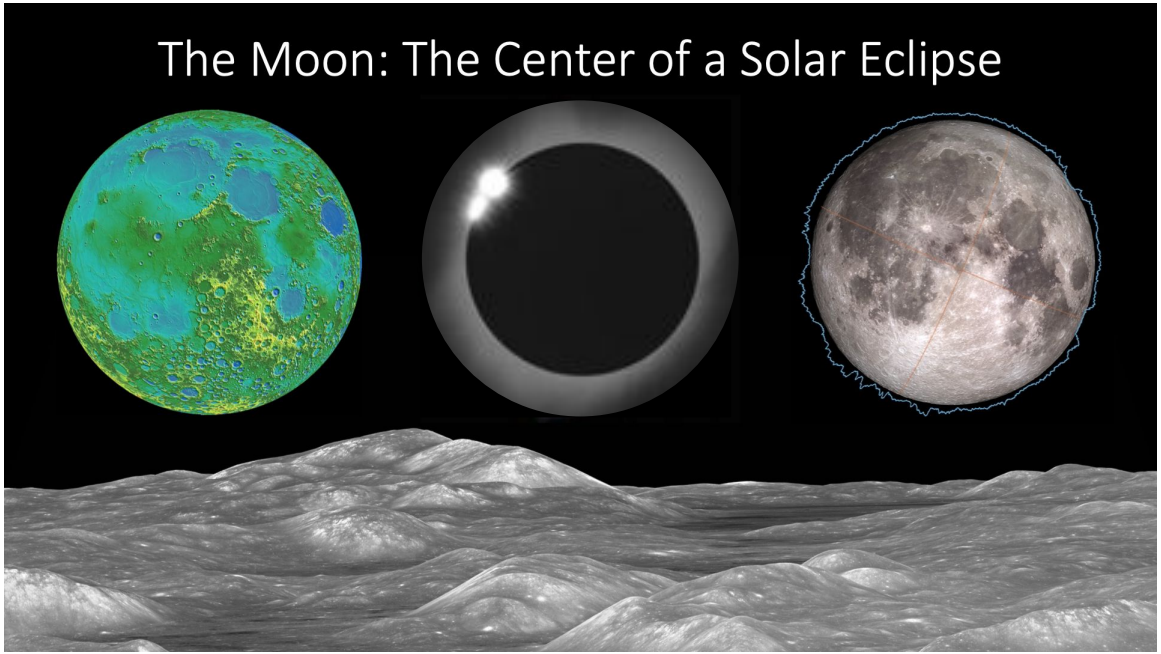
These structures in the corona are made of relatively cool plasma supported by magnetic fields. Prominences are bright structures when seen over the solar limb but appear dark when seen against the bright solar disk (where they're called filaments).

The Moon During Solar Eclipses

The Moon's rugged terrain affects our experience of a solar eclipse.

Thanks to data from NASA's Lunar Reconnaissance Orbiter, we know the shape of the Moon so well that we can precisely predict where and when a total or partial eclipse will be visible. Baily's Beads and the diamond ring effect, phenomena observable during a solar eclipse, occur when sunlight peeks through low points along the lunar limb.

We will learn more about the Moon, Earth, and our solar system through NASA's Artemis missions, which will return humans to the lunar surface.



(Left) Topographic map of the nearside of the Moon.Cool colors (e.g., blue) represent the lowest elevations; warm colors (yellow) represent the highest elevations. (Center) Baily's Beads (little bright lights) and the diamond ring effect happen during a total solar eclipse. (Right) The Moon's topographic limb profile, exaggerated 18 times, is shown in blue surrounding the Moon. (Bottom) An oblique view of the Orientale basin provides an example of the rough lunar topography. Credit: NASA/GSFC/LRO/SVS/ASU

The Sun-Earth Relationship

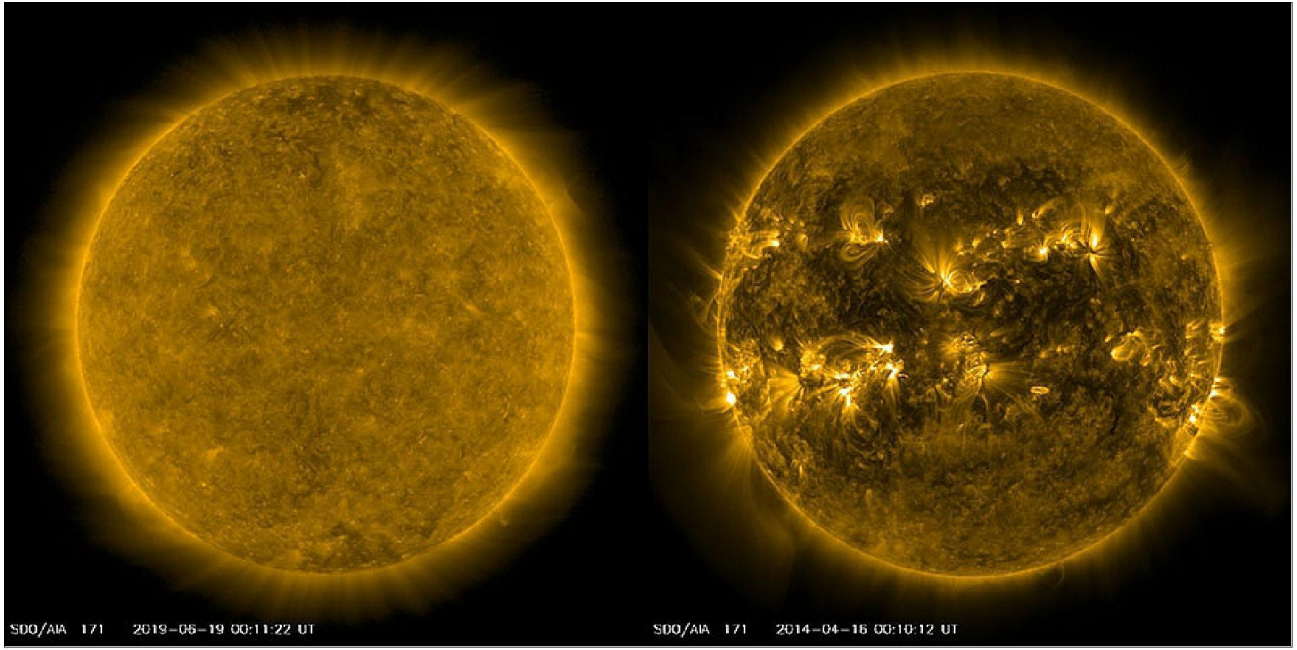
While the Moon is a key player in a solar eclipse, **total solar eclipses** in particular give scientists a rare opportunity to study the Sun and how it affects Earth systems.

This not-to-scale graphic illustrates the relationship between the Sun and Earth, showing features of the Sun's outer atmosphere, the corona, and Earth's magnetic field deflecting the solar wind.
Credit: NASA Conceptual Image Lab/NASA HEAT

- Our Sun and Earth have a special relationship. The Sun heats Earth just enough to make it habitable for life and is the origin of nearly all the energy necessary for life.
- The Sun is made of **plasma**, which is constantly flowing outward from the Sun as the **solar wind**.
- The solar wind originates in the **corona** and affects every object in our solar system, and the interplanetary space it influences is called the **heliosphere**.
- Solar storms originating from the Sun's atmosphere are deflected by Earth's magnetic field and atmosphere. These storms contribute to something called **space weather**.
- The Sun's corona can be seen during a **total solar eclipse,** when the Moon is blocking the light from the Sun's visible surface.

What Is the Sun? It's a Star!

The Sun is an averaged-sized star, providing light and most of the heat that allows most life to exist on Earth. The Sun is dynamic and goes through cycles. Each cycle lasts approximately 11 years from minimum activity (left image below) to maximum activity (right image below) and back to minimum again. The last solar minimum was in December 2019, and the next solar maximum is forecasted to be in 2024.



Credit: NASA SDO/AIA

Heliophysics is the study of our star, the Sun [helio], understanding why it behaves the way it does [physics], and how it affects everything in the solar system – especially Earth's atmosphere.

Knowledge Check

1. What needs to happen for a total solar eclipse to occur? Select all that apply.
    a. The Moon passes between the Sun and Earth.
    b. The Moon phase has to be a new moon.
    c. The Moon is closer than average to Earth in its elliptical orbit.
    d. It is during the eclipse season.
2. Why isn't there a solar eclipse every month?
    a. The Moon's orbit is tilted.
    b. The Moon is too far away.
    c. The Moon appears too small in the sky.
    d. The Sun appears too big in the sky.
3. What percent obscuration (how much of the Sun is blocked by the Moon) is considered totality?
    a. 99%
    b. 50%
    c. 100%
    d. 0%
4. True or false? Seeing a solar eclipse with your eyes is the only way to experience a solar eclipse.
5. What is heliophysics? Select all that apply.
    a. The study of the Sun and how it changes.
    b. The study of the Sun-Earth relationship.
    c. The study of how Earth's atmosphere is influenced by the Sun.
    d. The study of how the Sun affects the entire solar system.

Knowledge Check - Answers

1. What needs to happen for a total solar eclipse to occur? Select all that apply.
    - **a. The Moon passes between the Sun and Earth.**
    - **b. The Moon phase has to be a new moon.**
    - **c. The Moon is closer than average to Earth in its elliptical orbit.**
    - **d. It is during the eclipse season.**
2. Why isn't there a solar eclipse every month?
    - **a. The Moon's orbit is tilted.**
3. What percent obscuration (how much of the Sun is blocked by the Moon) is considered totality?
    - **c. 100%**
4. True or **false**? Seeing a solar eclipse with your eyes is the only way to experience a solar eclipse.
5. What is heliophysics? Select all that apply.
    - **a. The study of the Sun and how it changes.**
    - **b. The study of the Sun-Earth relationship.**
    - **c. The study of how Earth's atmosphere is influenced by the Sun.**
    - **d. The study of how the Sun affects the entire solar system.**

Lesson 1.2:
Eclipse Viewing Safety

The Moon is seen as it starts passing in front of the Sun during the August 2017 total solar eclipse above Ross Lake, Northern Cascades National Park, Washington. Credit: NASA/Bill Ingalls

Eclipse Safety

Lesson 1.2 Learning Objectives

By the end of this lesson, you will be able to answer the following questions:

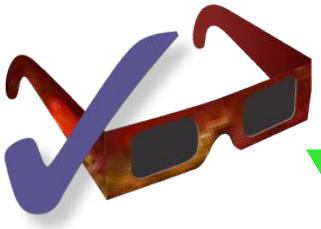
Credit: Mantarays Ningaloo, Australia/MIT-NASA Eclipse Expedition

2024 Total Solar Eclipse Safety

Looking directly at the Sun without eye protection can cause permanent eye damage, except during the brief moments of totality. When the Sun is 100% obscured by the Moon, you can view the eclipse directly without eye protection.

You will need to follow safety precautions and use special safety equipment to safely experience the partial phases of the solar eclipse. There are both safe **direct viewing methods** for observing the Sun, such as using solar viewing glasses (also known as “eclipse glasses”), and safe **indirect viewing methods** for observing the Sun, such as using a pinhole projector.

View the eclipse with special solar viewing glasses.



YES!

Regular sunglasses are not safe to view the eclipse.

NO!

Find More: go.nasa.gov/EclipseEyeSafety

Employees and visitors at NASA Headquarters put on solar viewing glasses to watch an eclipse in Washington, DC. Credit: NASA

Eclipse Viewing Tools: Direct Viewing Methods

A young eclipse viewer experiences the August 21, 2017, total solar eclipse in Cleveland, Ohio, using protective glasses.
Credit: NASA/Bridget Caswell

There are special solar telescopes designed to safely observe the Sun.
Credit: NASA/SOHO

Binoculars can be fitted with solar filters.
Credit: NASA/Ryan Milligan

Before each use, check the front and back of the lenses for scratches, pinholes, or separation from the frame. If damaged, cut into small pieces and discard.

When directly observing a partial solar eclipse, **you must look through an approved solar filter**, such as safe solar viewing glasses ("eclipse glasses"), handheld solar viewers, solar telescopes, and telescopes and binoculars with added solar filters. Solar viewers and filters must meet the ISO 12312-2 international standard.

Solar Viewing Glasses ("eclipse glasses")

Handheld Solar Viewer

Eclipse Viewing Tools: Indirect Viewing Methods

If you don't have solar viewing glasses or other special equipment, **you can use an indirect viewing method, such as a projecting telescope or pinhole projection** to produce an image of the Sun on a nearby surface.

Pinhole Projectors

You can make a simple pinhole projector by poking a small hole through a piece of cardstock, or use any sized cardboard box to create a darker environment to see the projection in.

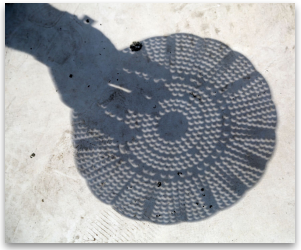
Credit: NASA

Always keep your back to the Sun when using a pinhole projector.

Do NOT look at the Sun through the pinhole!

Credit: AAS

Try using a colander, or if you don't have any equipment, simply use your hands.



Credit: NASA/Joy Ng

Projecting Telescopes

One kind of solar telescope can use lenses and mirrors to show a projection of the Sun's image.
Credit: NASA/Silvia Stoyanova

Eclipse Glasses Safety in the Path of Totality

Only observers in in the path of totality will be able to remove their solar viewing glasses, briefly, during totality, when the Sun is completely blocked.

Check the map for locations and times to find out if you can remove your glasses and for how long. Credit: NASA/SVS

Credit: NASA

At all times during a partial solar eclipse, or when no eclipse is occurring at all, view the Sun only through special-purpose solar filters that comply with the transmission requirements of the ISO 12312-2 standard.

2024 Total Solar Eclipse Glasses Safety

When it comes to solar eclipses, anything less than 100% is a partial solar eclipse; you must use eye protection for direct viewing.

99% is not the same as 100%

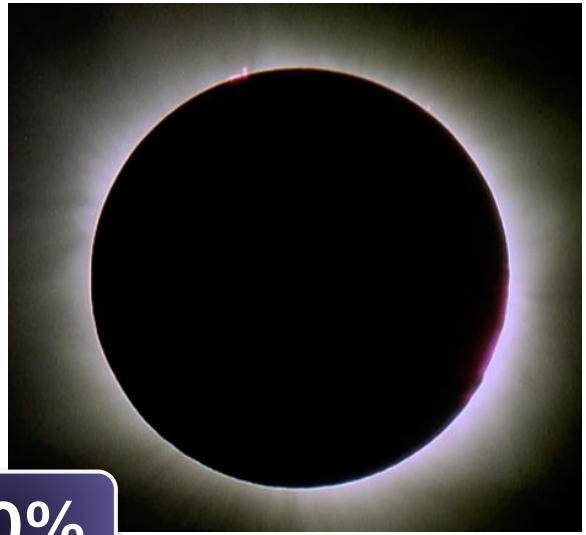
Glasses ON

Credit: Exploratorium

99%

Even if only 1% of the Sun's surface is visible, it is still extremely bright and can damage your eyes.

Glasses OFF



100%

Credit: Exploratorium

Knowledge Check

1. True or False? You can safely view a total solar eclipse using both direct and indirect methods.

2. Which tools can you use to safely observe a total solar eclipse with? Select all that apply.
   a. Eclipse glasses or a handheld solar viewer
   b. Telescope with a solar filter
   c. Pinhole projector
   d. Projecting telescope

3. True or False? Solar viewing glasses are much darker than sunglasses and block nearly all visible and ultraviolet light from the Sun.

4. When is it appropriate to remove your solar viewing glasses during a total solar eclipse?
   a. Anytime. It is always safe to look directly at an eclipse.
   b. Never. It is never safe to look directly at an eclipse.
   c. Only during totality, when the Sun is 100% blocked by the Moon.
   d. When the Sun is blocked 90% or more by the Moon during the partial phases of an eclipse.

5. True or False? You will get the same experience during a total solar eclipse in a location where the Sun is 99% blocked as you would get in a location in the path of totality (100% blocked).

Knowledge Check - Answers

1. **True** or False? You can safely view a total solar eclipse using both direct and indirect methods.

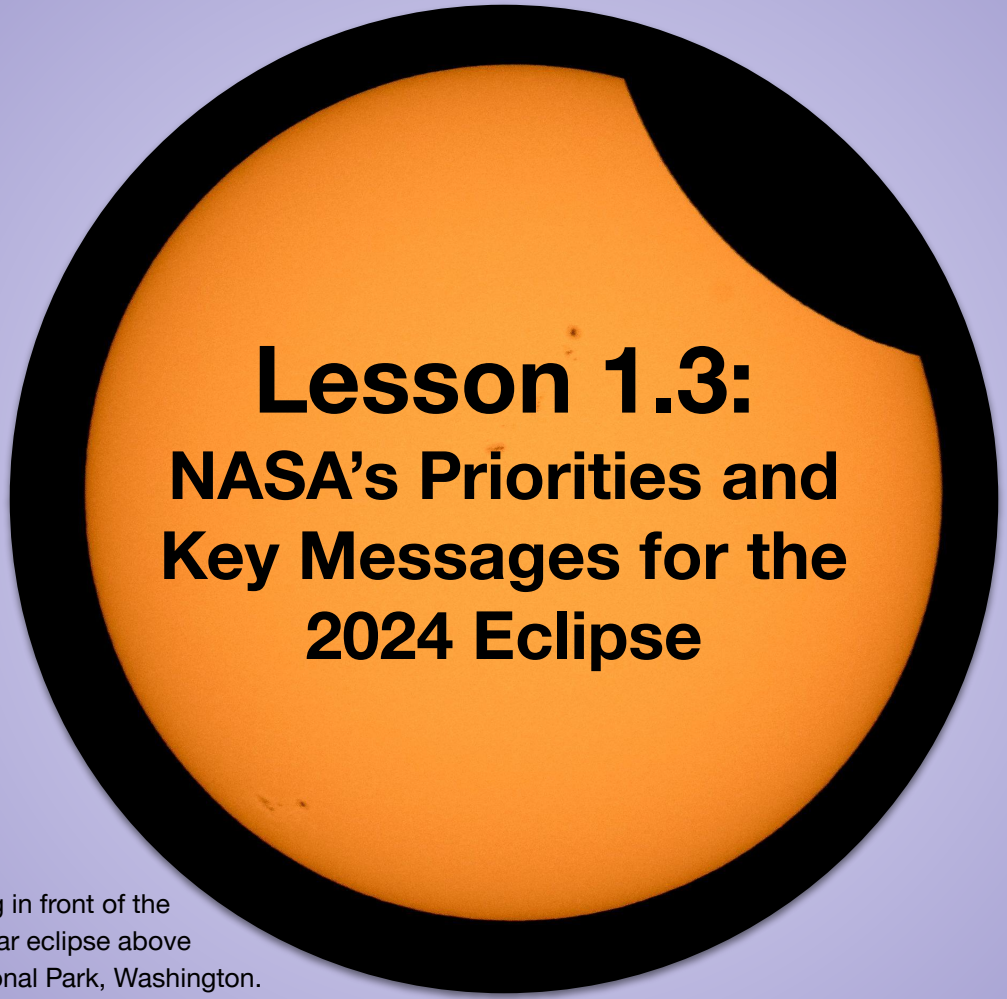
2. Which tools can you use to safely observe a total solar eclipse with? Select all that apply.
   a. **Eclipse glasses or a handheld solar viewer**
   b. **Telescope with a solar filter**
   c. **Pinhole projector**
   d. **Projecting telescope**

3. **True** or False? Solar eclipse glasses are critically much darker than sunglasses and block nearly all visible and ultraviolet light from the Sun.

4. When is it appropriate to remove your solar eclipse glasses during a total solar eclipse?
   c. **Only during totality, when the Sun is 100% blocked by the Moon.**

5. True or **False**? You will get the same experience during a total solar eclipse in a location where the Sun is 99% blocked as you would get in a location in the path of totality (100% blocked).

Lesson 1.3:
NASA's Priorities and Key Messages for the 2024 Eclipse



The Moon is seen as it starts passing in front of the Sun during the August 2017 total solar eclipse above Ross Lake, Northern Cascades National Park, Washington. Credit: NASA/Bill Ingalls

NASA Key Messages

Lesson 1.3 Learning Objectives

By the end of this lesson, you will be able to answer the following questions:

2024 Total Solar eclipse
THROUGH THE EYES OF NASA

Credit: Mantarays Ningaloo, Australia/MIT-NASA Eclipse Expedition

NASA Observes Solar Eclipses

Eclipses aren't just beautiful – they're great for science. In addition to inspiring artists and musicians, eclipses have driven numerous scientific discoveries.

For over a century, solar eclipses have helped scientists decipher the Sun's structure and explosive events, find evidence for the theory of general relativity, and discover the element helium, among other things.

Credit: NASA/Balloon Program Office

Suborbital sounding rockets and high-altitude scientific balloons, like the one seen in the image, carry instruments to study a variety of phenomena, including the Sun's impact on Earth's upper atmosphere. Rockets and balloons are just two ways NASA studies eclipses. NASA will fund six new experiments during the April 8, 2024, total solar eclipse, which also include experiments done with instruments on planes.

NASA Priorities for the 2024 Total Solar Eclipse

Safety	Keeping everyone safe is NASA's #1 core value and the #1 priority during any event
Broadening Participation	Inviting all voices to the conversation
Science	Making the public aware of missions, research, and new discoveries
Public Engagement	Providing a unique opportunity to participate in a celestial event
Science Activation	Connecting science with communities
Citizen Science	Encouraging citizens to gather data for scientific analysis

A crowd uses handheld solar viewers and solar eclipse glasses to safely view a solar eclipse.
Credit: National Park Service

NASA Key Messages

1

Observing our star, the Sun, can be safe and inspirational.

2

Experiencing an eclipse is one way that everyone can participate in NASA science.

3

Innovative NASA missions help us learn about our closest star, the Sun, and its interactions with Earth.

NASA Key Messages

1. Observing our star, the Sun, can be safe and inspirational.

- **Always wear solar viewing glasses or use a solar filter when looking at an uneclipsed or partially eclipsed Sun.** Or you can also use an indirect viewing method, such as a pinhole projector.
- Solar filters can be used at any time to safely view the Sun.
- For a **total solar eclipse**, observers in the path of totality may remove their solar filter only when the Sun is completely blocked by the Moon, just during the brief moments of totality.

Reflect: Did you observe the 2017 total solar eclipse (or another eclipse)? How did you safely observe the eclipse?

- Solar viewing glasses
- Pinhole projector
- Other methods
- I have not observed any solar eclipses

Employees and visitors at NASA's Jet Propulsion Laboratory stopped to watch the solar eclipse on August 21, 2017. Credit: NASA/Josh Krohn

NASA Key Messages

2. Experiencing an eclipse is one way that everyone can participate in NASA science.

A partially eclipsed Sun from 2017 appears purple because of the type of filter used.
Credit: NASA TV

- Eclipses are a unique opportunity to participate in a celestial event.
- You can work together with NASA to make discoveries possible before, during, and after an eclipse.
- Scientists can use solar eclipses to study the Sun-Earth relationship, especially how the Sun affects Earth's atmosphere.
- You do not have to be in the path of totality to participate. Many in North America who are outside the path will experience a partial solar eclipse on April 8, 2024.

NASA Key Messages

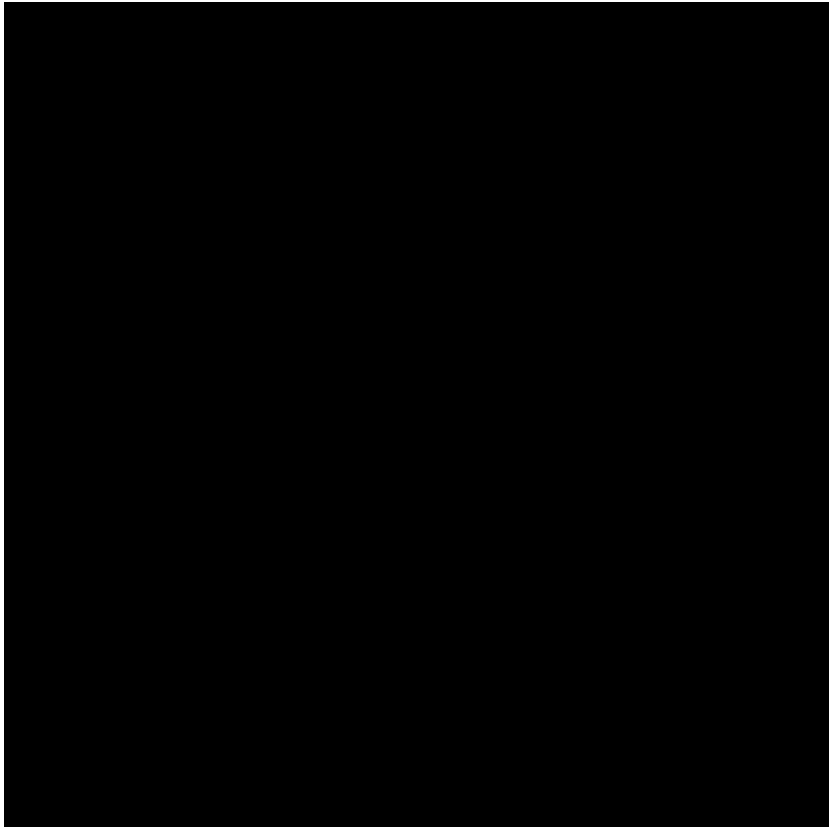
3. Innovative NASA missions help us learn about our closest star, the Sun, and its interactions with Earth.

- You can ask questions about our closest star to learn how studying the Sun and its interactions with Earth is possible through innovative NASA missions.
- You can learn more about the risks of space weather with NASA missions that study the magnetic fields of both the Sun and Earth. Particles and material ejected by the Sun pass through the corona and are accelerated into the solar system, interacting with the magnetic fields of Earth and the other planets.
- Advances in technology are allowing us to send spacecraft closer to the Sun than ever before, and even study the outer atmosphere of the Sun, the corona, from within it.

The Parker Solar Probe spacecraft was prepped for launch in a cleanroom at Astrotech Space Operations in Titusville, Florida, in July 2018. Credit: NASA/Johns Hopkins APL/Ed Whitman

Parker Solar Probe is one of NASA's most innovative missions. It is the fastest human-made object in the solar system and will fly within 4 million miles of the Sun.

Beyond the Eclipse



The Heliophysics Big Year is a global celebration of solar science and the Sun's influence on Earth and the entire solar system.

During the Heliophysics Big Year, you will have the opportunity to participate in many solar science events such as watching solar eclipses, experiencing an aurora, participating in citizen science projects, and other fun Sun-related activities. Join us from October 2023 until December 2024!

Just experiencing a solar eclipse means that you are participating in the Heliophysics Big Year!

Find More: go.nasa.gov/HelioBigYear

Knowledge Check

1. True or False? Solar eclipses are very beautiful but hold no scientific interest.
2. How does NASA study solar eclipses?
    a. With instruments on scientific balloons
    b. With instruments on sounding rockets
    c. With instruments on planes
    d. All of the above
3. True or False? NASA's number one priority during the 2024 total solar eclipse is safety.
4. Which of the following statements align with NASA's key messages for the 2024 total solar eclipse?
    a. Safely viewing the eclipse is possible with proper equipment and/or precautions.
    b. The eclipse is a great opportunity for the public to engage in NASA science.
    c. NASA missions are studying the eclipse to understand the Sun-Earth relationship.
    d. All of the above
5. True or false? The public can only engage in NASA eclipse activities if they are in the path of totality.

Knowledge Check - Answers

1. True or **False**? Solar eclipses are very beautiful but hold no scientific interest.
2. How does NASA study solar eclipses?
   d. All of the above
3. **True** or False? NASA's number one priority during the 2024 total solar eclipse is safety.
4. Which of the following statements aligns with NASA's key messages for the 2024 total solar eclipse?
   d. All of the above
5. True or **false**? The public can only engage in NASA eclipse activities if they are in the path of totality.