Predict the Corona Activities

Next Generation Science Standard MS.ESS1-1 - 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.

Overview:

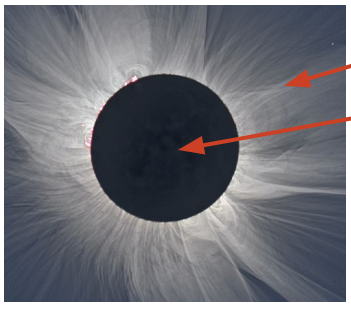
Predict what the corona will look like during the **Monday, April 8, 2024, total solar eclipse** with these engaging activities that focus on solar science.

- ➔ **Activity 1:** Observing the Corona Through Time (Page 2)
- ➔ **Activity 2:** Plotting Sunspots Through the Solar Cycle (Page 3)
- ➔ **Activity 3:** Predicting the Corona for April 8, 2024, with Chalk Art (Pages 4-6)
- ➔ **Activity 4:** Total Solar Eclipse Journal (Pages 7-9)
- ➔ **Extension Activity:** Predict the Corona Cake (Page 10)

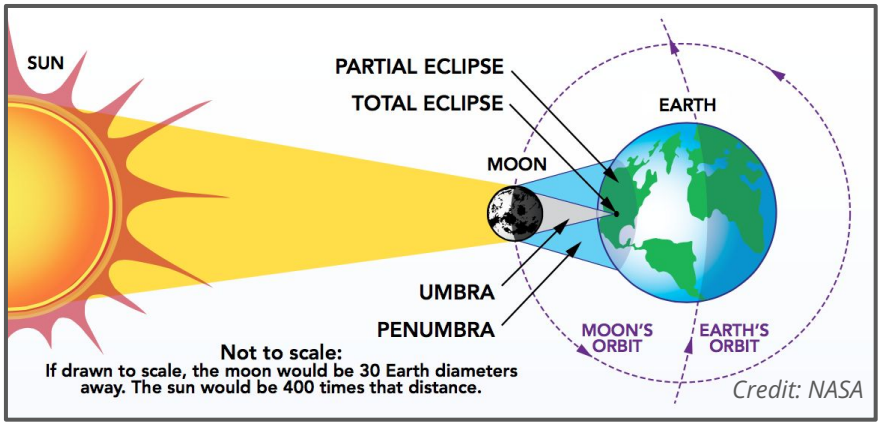
Background Knowledge:

Scientists use a variety of equipment to study the Sun. NASA is particularly interested in learning more about the Sun's atmosphere, called the **corona**. Studying the corona provides fundamental insights about how heat and energy are transferred from the Sun out into the **solar wind**, the constant source of particles that the Sun streams into the solar system. Understanding the solar wind is important because it is the source of something called **space weather**, which can affect technology on Earth and spacecraft in near-Earth orbit.

Long before there were cameras, telescopes, or spacecraft, the only opportunity early peoples would have had to view the Sun's corona was during a **total solar eclipse**, when the shadow of the Moon completely blocks the bright light of the Sun's surface. Today, scientists still use total solar eclipses as exciting opportunities to study the corona and the effect of the solar wind on Earth.



Modern Image of a Total Solar Eclipse over Chile March 20, 2015
Credit: S. Habbal, M. Druckmüller, and P. Aniol



A total solar eclipse is caused by a fairly rare alignment of the Sun, Earth, and Moon, so that the Moon casts a shadow on part of Earth's surface. A total solar eclipse can only occur during a new Moon, when the Moon is closest to Earth in its elliptical orbit. To experience a total solar eclipse, observers must be in the umbra shadow of the Moon, as seen in the diagram above. Observers in the penumbra shadow experience a partial solar eclipse.

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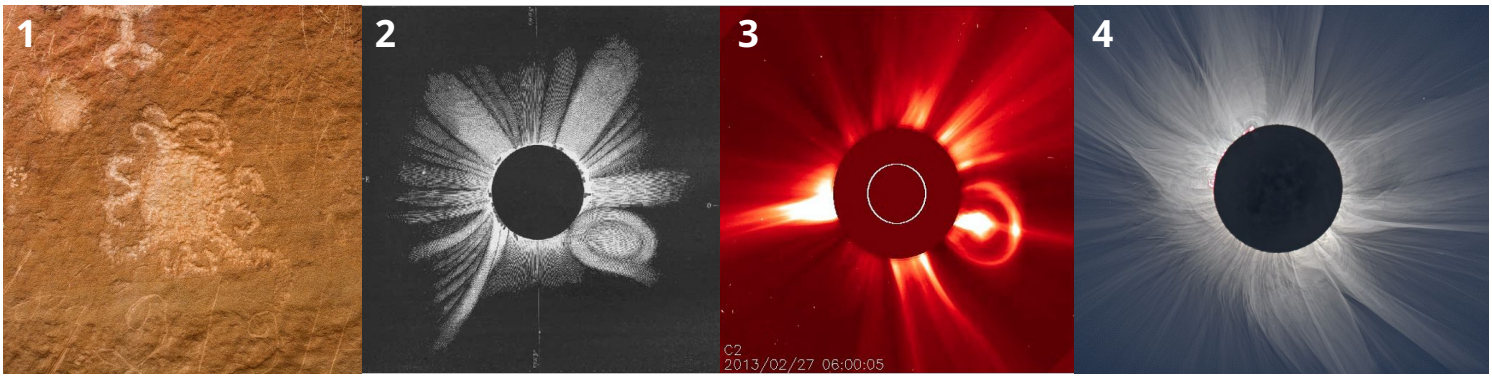
Activity 1: Observing the Corona Through Time

Early peoples recorded what they saw in the sky in words, carvings, drawings, and paintings. Examine these four images of the Sun's corona. What are the similarities and differences between these observations of the Sun? Record your observations in the graphic organizer below.



1. Ancient rock art in Chaco Canyon may depict a total solar eclipse in 1097. *Credit: National Park Service*
2. A drawing depicts the 1860 total solar eclipse. Additional drawings created by observers during this eclipse, in various locations, also depicted what appears to be a solar eruption, as seen as a loop in this drawing. *Credit: G. Tempel*
3. This coronagraph image was taken by the SOHO spacecraft. A coronagraph simulates a solar eclipse, blocking the Sun to reveal its outer atmosphere, the corona. *Credit: NASA/ESA SOHO*
4. This image of a total solar eclipse (2015) was taken with special equipment and includes multiple images on top of one another at different exposures. *Credit: S. Habbal, M. Druckmüller, and P. Aniol*

	Image 1	Image 2	Image 3	Image 4
Observations of the Corona				
Similarities				
Differences				

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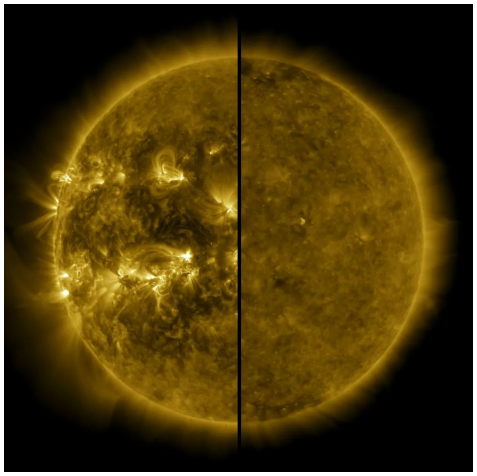
Activity 2: Plotting Sunspots through the Solar Cycle

The Sun experiences seasons, similar to how Earth does. There are times when there is "stormy weather" and times of "good weather." Predict where the Sun will be during its cycle of seasons (the **solar cycle**) by graphing the number of **sunspots** between 2011 and 2023.



A split image showing the difference between solar maximum and solar minimum.
Credits: NASA/SDO

Solar Cycle

Approximately every 11 years or so the Sun's magnetic poles switch, causing magnetic field lines to become tangled, snap, and reconnect which results in a huge release of energy. This split image shows the difference between an active, or stormy, Sun, during a time known as **solar maximum**, and a quiet Sun during a time known as **solar minimum**. The Sun at solar maximum (on the left, captured in April 2014) has more **sunspots**, **solar flares**, **coronal loops**, and **prominences**, all as a result of a stormy magnetic environment. The Sun at solar minimum (on the right, captured in December 2019) has fewer sunspots and not many other features, as a result of a stable, symmetric magnetic environment. Unlike during solar maximum, the Sun's magnetic poles are well-defined.

Steps:

1. Plot the sunspot data from the table on the graph.
2. Identify the year in this data set that shows a **solar minimum**, which is when the cycle restarts.
3. Identify the year in this data set that shows a **solar maximum**, which is the middle of the cycle.
4. **Solar Cycle 24** was exactly 11 years. Based on this data set, when did this cycle begin?
5. **Solar Cycle 25** is predicted to be similar to 24. When do you predict the solar maximum will occur during cycle 25?

	Year	Number of Sunspots
Solar Cycle 24	2011	93
	2012	98
	2013	108
	2014	116
	2015	89
	2016	55
	2017	28
	2018	14
Solar Cycle 25	2019	5
	2020	15
	2021	56
	2022	101
	2023	120

Credit: NOAA

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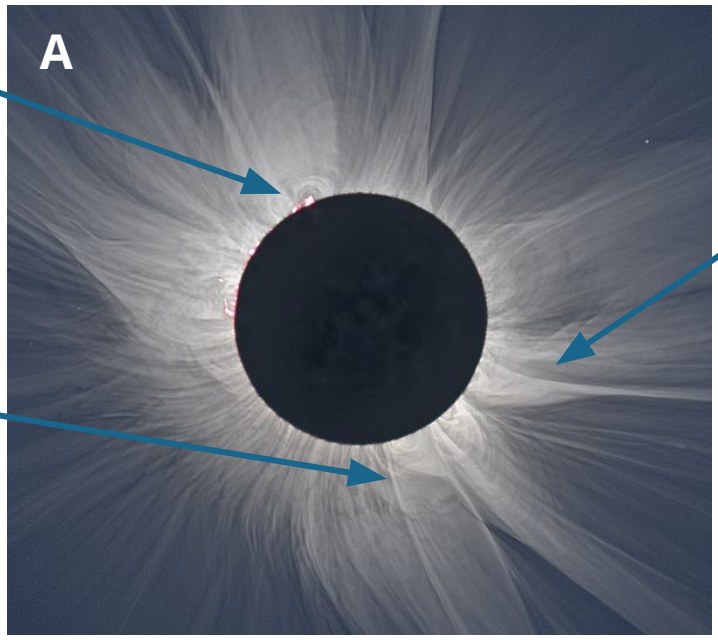
Activity 3, Part 1: Predict the Corona for April 8, 2024

The **corona** looks different depending on where the Sun is in the **solar cycle**. During **solar maximum**, the Sun is active because the magnetic field is unstable, which increases the velocity and density of the **solar wind**. This can be observed in the features of the corona during a **total solar eclipse**. Match the images on page 5 to the Solar Cycle Sunspot Progression graph below.

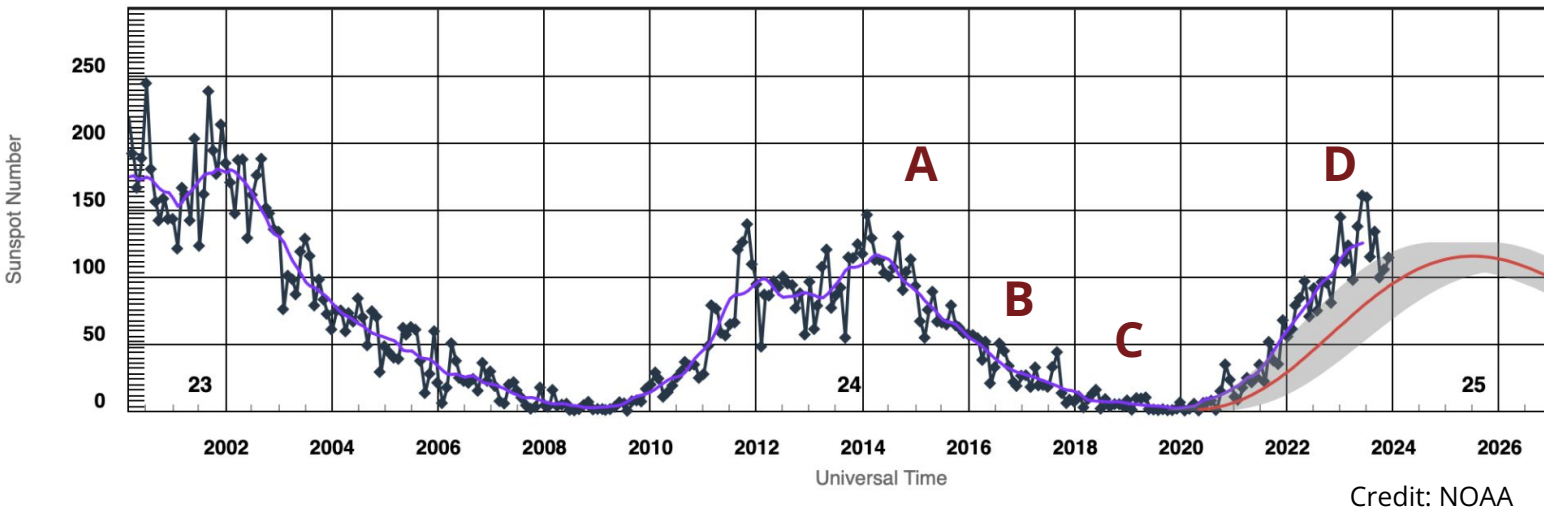
Prominences
Bright strands of cooler, denser solar material suspended above the Sun's surface by magnetic fields

Coronal Loops
Found near sunspots, these loops of solar material connect magnetic regions on the solar surface



Helmet Streamers
large cap-like structures with long pointed peaks that usually overlie sunspots and active regions

Total Solar Eclipse over Chile
March 20, 2015
Credit: S. Habbal, M. Druckmüller, and P. Aniol



Credit: NOAA

Solar Cycle Sunspot Progression

The Solar Cycle is approximately 11 years, as the Sun goes through a cycle of lower activity and higher activity, which is indicated by the number of sunspots. The red line represents predictions. Find more data at https://www.swpc.noaa.gov/products/solar-cycle-progression.

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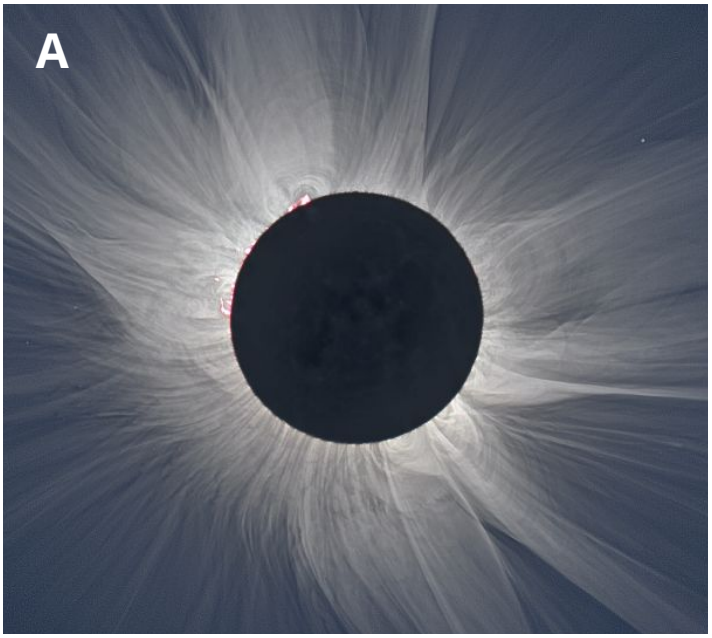
Activity 3, Part 1 continued: Predict the Corona for April 8, 2024

Using the graph on page 4, determine where the Sun is in the solar cycle *(at solar max, at solar min, approaching solar max, or approaching solar min)*. Label the coronal features you see in each image.

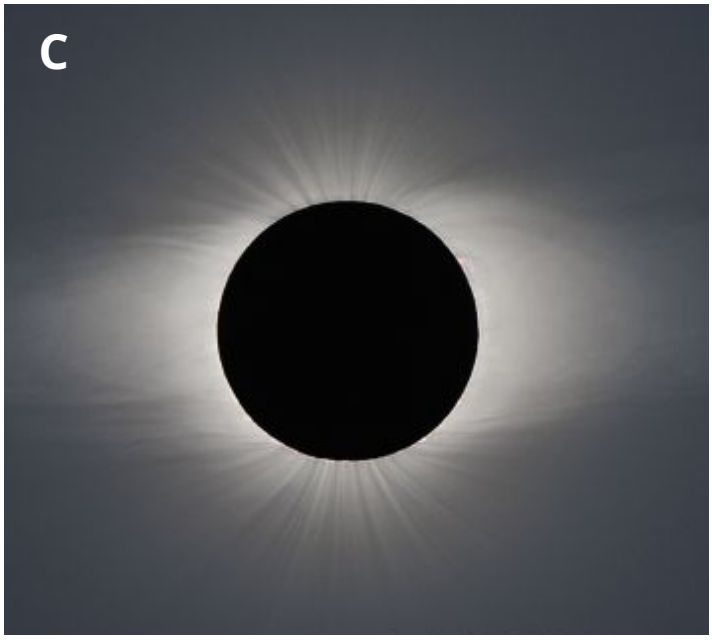


Total Solar Eclipse over Chile
March 20, 2015
Credit: S. Habbal, M. Druckmüller, and P. Aniol

A

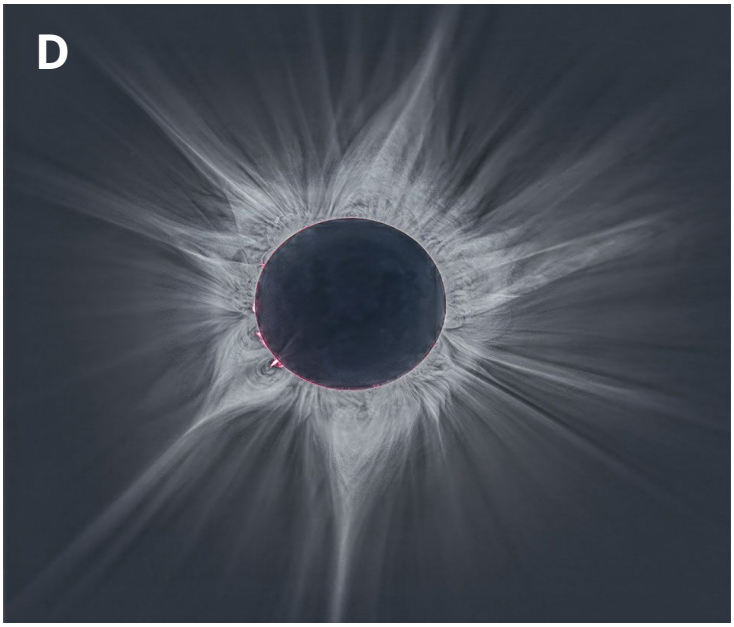
Total Solar Eclipse over USA
August 17, 2017
Credit: Nicholas Lefaudeux

B



Total Solar Eclipse over Argentina
July 2, 2019
Credit: Williams College Expedition Team

C



Total Solar Eclipse over Australia
April 20, 2023
Credit: Reinhold Wittich

D

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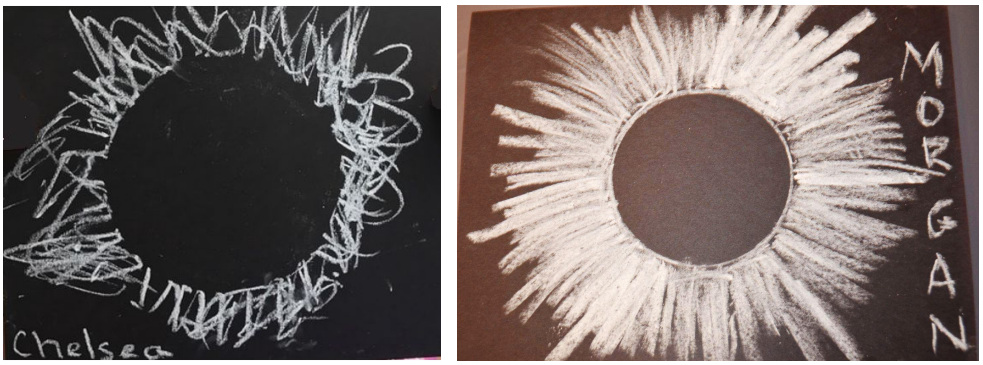
Activity 3, Part 2: Predict the Corona for April 8, 2024 with Chalk Art

In Activity 1 you examined different images of the Sun's corona. In Activity 2 you plotted sunspot data to predict when solar maximum will occur. Based on the knowledge you have gathered about the corona and the solar cycle, make a prediction of what the corona would look like during the **April 8, 2024, total solar eclipse**.

Materials:

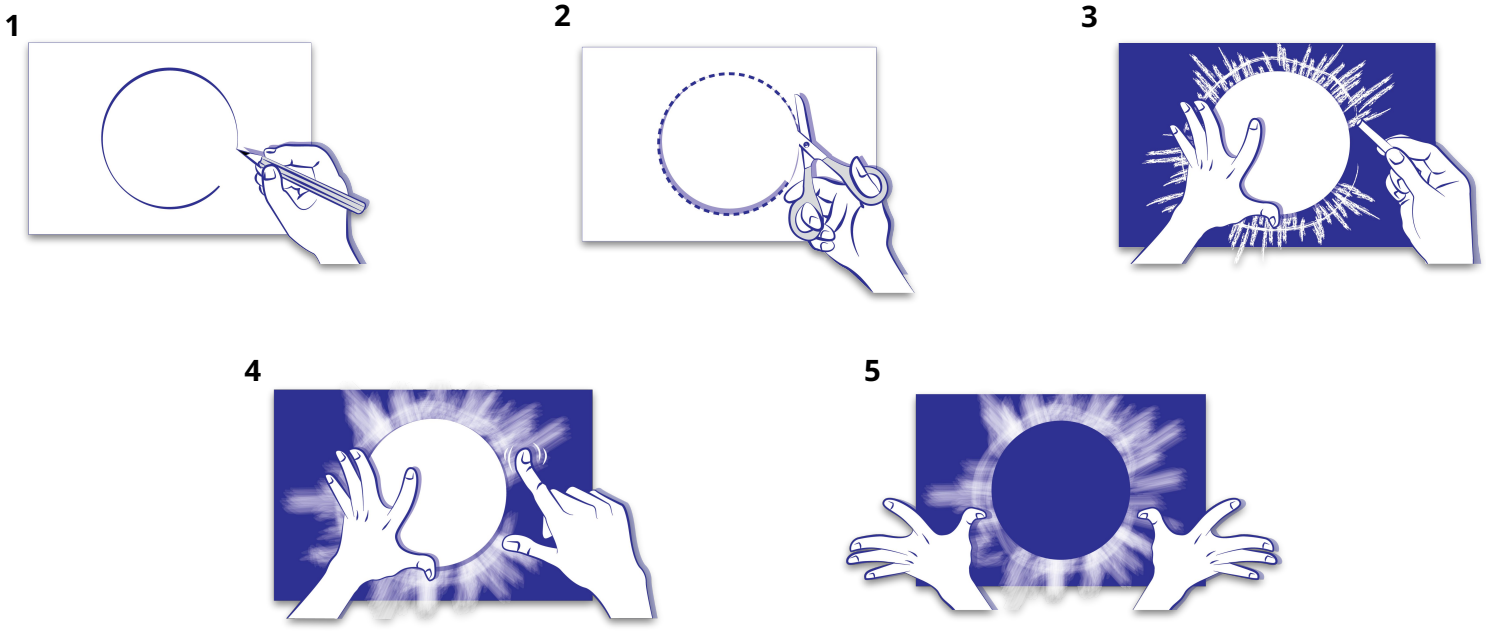
- ❏ Cardstock Paper
- ❏ Black or Dark Blue Construction Paper
- ❏ White Chalk
- ❏ Scissors
- ❏ Tape (Optional)



The whole family can get involved in learning about eclipses! Morgan (age 11) and Chelsea (age 8) drew their predictions of the corona.

Steps:

1. Trace a large circle (like a bowl or a cup) approximately 3 inches in diameter on stiff paper, like cardstock.
2. Carefully cut out the circle.
3. Place the circle template on construction paper and hold it down (or tape it). Draw a thick circle or lines of chalk around the template a few times – it doesn't need to be neat.
4. Holding the template in place with one hand, use the other hand to smudge the chalk away from the circle, outward in all directions to represent the corona of the Sun.
5. When you are done smudging, remove the circle. You've made total solar eclipse eclipse art like observers of the past did!



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National Aeronautics and Space Administration

Activity 4: Total Solar Eclipse Journal

You will have to be in a location within the umbra shadow to observe the corona.

The path of the umbra shadow, called the path of totality, is shown on the map below. Observers outside the path will experience a partial solar eclipse and will not be able to see the corona.

Start by finding your location on this map at svs.gsfc.nasa.gov/5123

Credit: Michala Garrison and the Scientific Visualization Studio (SVS), in collaboration with the NASA Heliophysics Education Activation Team (NASA HEAT). Eclipse Calculations by Ernie Wright, NASA Goddard Space Flight Center.

Eye Safety!

Observers outside the path must wear their solar viewing glasses for the entire duration of the solar eclipse. Observers within the path may remove their glasses only when the Moon's shadow is 100% blocking the Sun. See safety guidelines below.

YES!

View the eclipse with special eclipse glasses.

NO!

Regular sunglasses are not safe to view the eclipse.

Safety guidelines for viewing a total solar eclipse. Credit: AAS

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Activity 4 continued: Total Solar Eclipse Journal

Document your observations during the **April 8, 2024, total solar eclipse**.
Use the solar eclipse map on page 7 to determine if you are in the path of totality. Visit **https://nso.edu/for-public/eclipse-map-2024/**and find your location on the interactive map to plan your eclipse observation times. After the eclipse, compare your observations to the predictions you made in Activity 3. *If you are outside the path of totality, skip the starred fields.

Date: April 8, 2024

Location: _____

Maximum Obscuration (percentage of the Sun blocked by the Moon's shadow): _____%

Duration (entire eclipse): _____

***Duration of totality:** _____
**Must be in the path of totality, see map on page 7.*

Time
Time Zone (circle one): Eastern Central Mountain Pacific

Partial begins: _____ **GLASSES ON**
*Full (totality) begins: _____ **GLASSES OFF**
Must be in the path of totality. See map and safety information on page 7.
*Full (totality) ends: _____ **GLASSES ON**
Partial ends: _____ **GLASSES ON**

Weather Conditions
Temperature: _____
Cloud Cover: _____
Precipitation: _____

People you are observing with: _____

Other Observations:

Light changes during observations:

Temperature changes during observations:

Animal behavior changes during observations:

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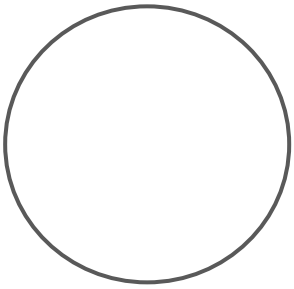
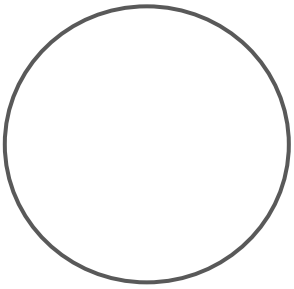
Activity 4 continued: Total Solar Eclipse Journal

Draw your observations:
Optional: make larger chalk art drawings like you did for your prediction.

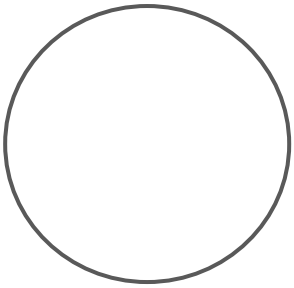
Time:
Phase (partial or total)**:**



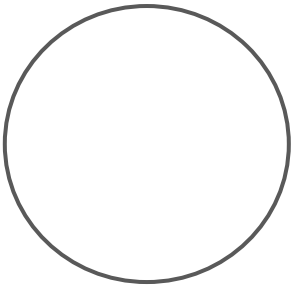
Time:
Phase (partial or total)**:**



Time:
Phase (partial or total)**:**



Time:
Phase (partial or total)**:**



How did your observations compare to your prediction?

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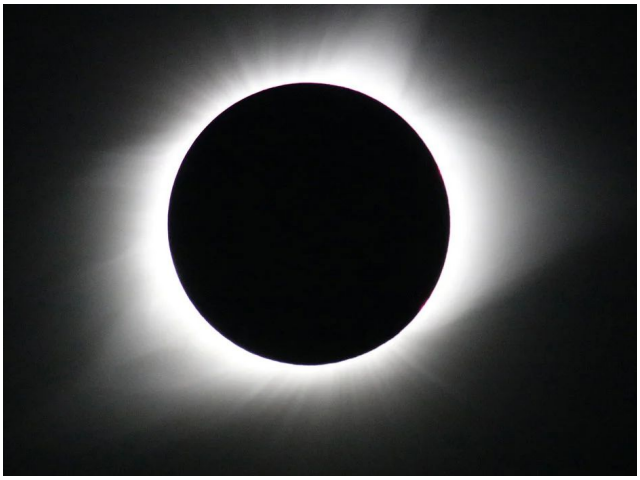
Extension Activity: Predict the Corona Cake Art

Try this delicious version of predicting the corona!



Total Solar Eclipse
Credit: NASA/Nat Gopalswamy

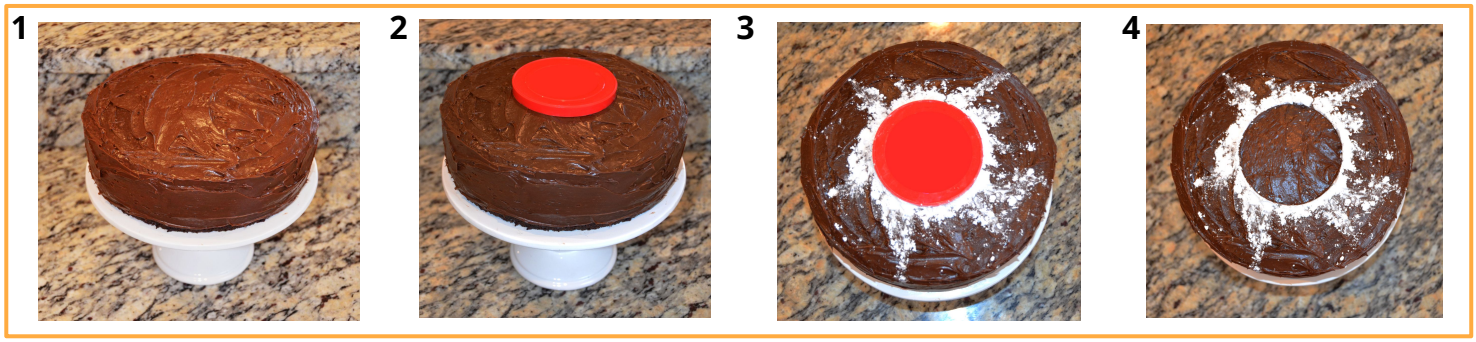
Credit: NASA HEAT/ Shannon Reed

Materials:

- ❏ 9” Circular Cake With Dark Icing or Frosting
- ❏ Powdered Sugar
- ❏ Approx. 3” Circular Object (an icing container lid works well)

Steps:

1. Bake a cake and frost it. Chocolate icing or frosting works well.
2. Place the circular object in the center of the iced cake. The circular object represents the Moon covering the Sun in the middle of the cake.
3. Sprinkle the powdered sugar around the circular object, creating shapes in the corona to match your prediction.
4. Remove the circular object. You’ve made total solar eclipse cake art! Take pictures of your corona cake and compare your prediction to your observations of the **April 8, 2024,** total solar eclipse.



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