WHAT IS A SOLAR ECLIPSE

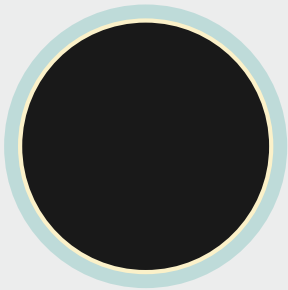
A solar eclipse is when part or all of the sun is covered by the moon. On average, there are 2 to 3 solar eclipses during the year.

There are three main types of solar eclipses:

Partial
Only covers part of the sun.

Annular
Due to distance and the moon's place in orbit, the moon will only partially cover the sun.

Total
Due to distance and the moon's place in orbit, the moon will almost completely cover the sun.



MISCELLANEOUS ECLIPSE FACTS:

1. When King Henry I died shortly after an eclipse, many cultures claimed that eclipses were a bad omen for rulers.
2. July 28th, 1851: Berkowski, a Prussian photographer, took the first photograph of the Sun's corona.
3. The longest total solar eclipse of the 21st century happened on July 21, 2009. Totality lasted for 6 minutes and 39 seconds.
4. A solar eclipse lead to the discovery of helium. Helium was named after the Greek word for sun: Helios.
5. There are serving records dating back to 2500 BCE about eclipses.

We want to hear from you!
Let us know what you thought of the lessons
or send us a picture of youth participating in the lessons.

#NE4HSTEM #ECLIPSE2017

6. A solar eclipse helped to prove Einstein's Theory of Relativity.
7. The word "eclipse" comes from an ancient Greek word for being abandoned (ekleipsis).

DETAILS ABOUT AUGUST 2017 ECLIPSE

(per https://eclipse2017.NASA.gov)

Date: August 21, 2017

Time: Will vary based on location.

- In Hastings, NE totality starts at 12:58 pm and should last about 2 minutes and 14 seconds
- In Grand Island, NE totality starts at 12:59 pm and should last about 2 minutes and 20 seconds
- NASA has an interactive map (https://eclipse2017.nasa.gov/event-locations) to see what time / how much of the eclipse you will see for anywhere else.

Duration: Totality will last about 2 minutes and 14 seconds.

Who Can See It?

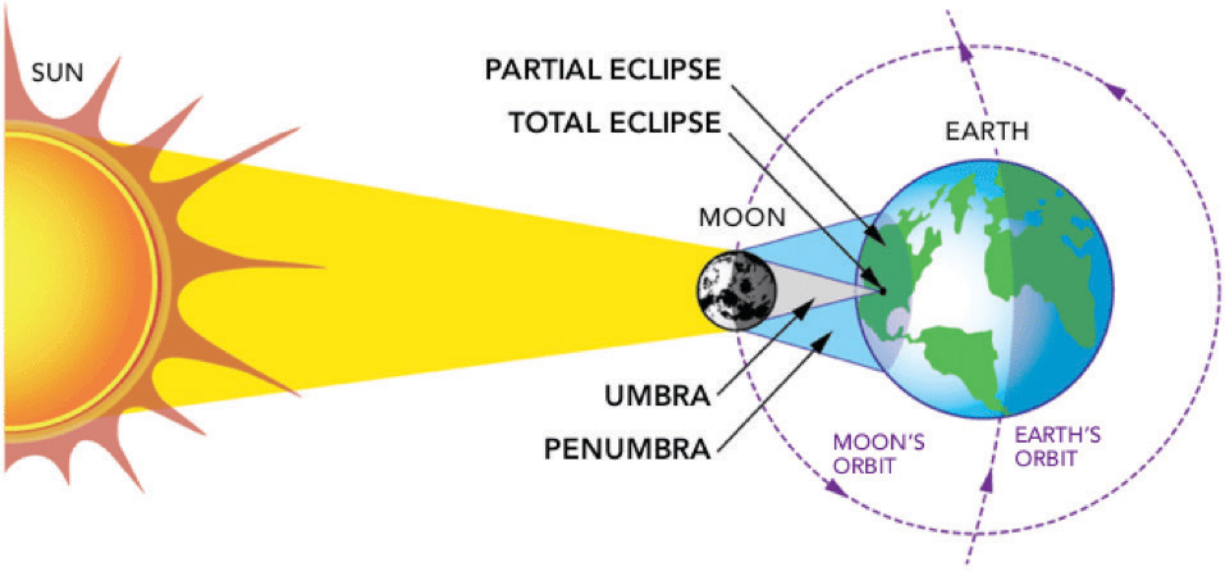
- Everyone in North America plus parts of South America, Africa, and Europe will see at least a partial solar eclipse, while the thin path of totality will pass through portions of 12 states.
- A solar eclipse only happens about once in every 375 years at a certain location.
- The last time the contiguous U.S. saw a total eclipse was in 1979. Our area only got to see part of that.
- April 8, 2024 is the next total solar eclipse we will see. We are in the VERY edge of the shadow, so we will not see totality that time.
    - On July 2, 2019 there will also be a total eclipse; however, it will be mainly over the Pacific Ocean.

How Can You See It Safely?

- The only safe way to look directly at the uneclipsed or partially eclipsed sun is through special-purpose solar filters, such as eclipse glasses.
- Do not look at the uneclipsed or partially eclipsed sun through an unfiltered camera, telescope, binoculars, or other optical device. Similarly, do not look at the sun through a camera, a telescope, binoculars, or any other optical device while using your eclipse glasses or hand-held solar viewer — the concentrated solar rays will damage the filter and enter your eye(s), causing serious injury.
- If you are within the path of totality, remove your solar filter only when the moon completely covers the sun's bright face and it suddenly gets quite dark. Experience totality, then, as soon as the bright sun begins to reappear, replace your solar viewer to glance at the remaining partial phases.

What will you see during the 2017 Total Solar Eclipse?

- The Moon's shadow actually has two parts:
    - Penumbra (faint outer shadow)
    - Umbra (dark inner shadow)
- You see the corona from the Sun (that is the glowing ring around the moon in images)
- It will look like dusk time and brighter stars will be visible



GENERAL QUESTIONS AND ANSWERS

All information found below can be found at: https://eclipse2017.nasa.gov/faq

What causes an eclipse to occur?

Eclipses occur due to the special coincidence of the moon and the Sun being the same angular size. The Sun is 400 times wider than the moon, but it is also 400 times farther away, so they coincidentally appear to be the same size in our sky. This is what allows us the phenomenal beauty of the total solar eclipse. (Note: You can give the audience the experience of the change in apparent size of an object close by and the same object farther away. They can use their hands to measure angular size.)

What was the most famous total solar eclipse in history?

King Henry I of England, the son of William the Conqueror, died in 1133 CE. This event coincided with a total solar eclipse that lasted over four minutes on August 2. Historian William of Malmesbury recounts this "hideous darkness agitated the hearts of men". After King Henry's death, a struggle for the throne threw the kingdom into chaos and civil war.

Also, the 1919 total solar eclipse, proved Einstein's General Theory. He predicted that the Sun's gravity would bend star light causing the positions of the background stars, near the Sun, to be in slightly different positions than they are in the night sky. This was confirmed during the eclipse, which is the only time you can observe stars near the Sun.

Typically, how big a temperature drop do you get during a total solar eclipse?

It would probably be equal to the typical daytime minus nighttime temperature difference at that time of year and location on the Earth. It would be modified a bit by the fact that it only lasts a few minutes, which means the environment would not have had much time to thermally respond to its lowest temperature, so it would probably only be 3/4 or 1/2 the maximum day-night temperature difference. The main effect is in the "radiant heating" component which goes away suddenly at the moment of eclipse and produces a very fast temperature decrease. If the wind is blowing, your body probably exaggerates, by evaporative cooling, how large the actual temperature

swing actually is.

When can I see the next total solar eclipse from North America?

The next total solar eclipse visible from the United States occurs on August 21, 2017. The track goes from Oregon at its start, and exits on the east coast near South Carolina. After that, the next one visible from the Lower-48 will be on April 8, 2024 which will track northeast from Texas to Main and cross the path of the 2017 eclipse near Carbondale, Illinois. Since 1503, there have been 15 total solar eclipse paths that have crossed the path of the August 2017 eclipse. Calculations show that it will take about 1000 years for every geographic location in the Lower-48 to be able to view a total solar eclipse.

When was the last solar eclipse seen from North America, and when will the next one happen?

The last total solar eclipse viewed from North America was on July 7, 1972 whose path went from Northern Alaska to Nova Scotia. A second, more recent, total solar eclipse was visible on July 11, 1991 from Southern Baja California to Panama. After the August 2017 total solar eclipse, the next annular solar eclipse that can be seen in the continental United States will be on October 14, 2023 which will be visible from Northern California to Florida. Following this, we will have a total solar eclipse on April 8, 2024 visible from Texas to Maine.

Are there any locations in the continental USA that have not seen a TSE in a long time?

According to a map in which the tracks of all total solar eclipses from 1000 to 2000 BCE have been overlain, there are two such areas; one in north eastern Colorado centered on Fort Morgan, and one in Nebraska centered near Lewellen, that have not seen a total solar eclipse in over 1000 years. Each area is about 50 km across.

How many eclipses are there every year?

During the 5,000-year period from -1999 to +3000 (2000 BCE to 3000 CE), Earth will experience 11,898 eclipses of the Sun. The statistical distribution of eclipse types for this interval is as follows: 4,200 partial eclipses, 3,956 annular eclipses, 3,173 total eclipses and 569 hybrid eclipses. That means that, every 1000 years you have 840 partial eclipses, 791 annular eclipses, 635 total eclipses and 114 hybrid eclipses. That works out to 2-3 eclipses of all kinds each year, and about 2 total solar eclipses every 3 years.

BRIEF HISTORY OF PAST SOLAR ECLIPSES:

All information found below can be found at: https://eclipse2017.nasa.gov/eclipse-history

The earliest writings we have showing that people paid attention to eclipses in any official way are around 5,000 years old.

In 1999, Irish Archeoastronomer Paul Griffin investigated the Loughcrew Cairn L Megalithic Monument in Ireland, and discovered that a set of spiral-shaped petroglyphs that might correspond to a solar eclipse which occurred on November 30, 3340 BCE. The symbols display a consistent coding of the sun, moon and horizon, and of the 92 tracks of total solar eclipses, only the one for 3340 BCE visible at this site displayed the same geometric relationships.

Ancient Chinese Records —in particular, the Shu Ching—of the solar eclipse that occurred (most likely) on October 2134 B.C.E. include a passage that translates in English to "the Sun and Moon did not meet harmoniously."

In Ancient China, solar and lunar eclipses were regarded as heavenly signs that foretold the future of the Emperor. The ancient Chinese believed that solar eclipses occur when a celestial dragon devours the sun. They also believed that this dragon attacks the Moon during lunar eclipses. In the Chinese language, the term for eclipse

was “shi” which also means “to eat”.

One ancient Chinese solar eclipse record describes a solar eclipse as “the sun has been eaten”. It was a tradition in ancient China to bang drums and pots and make loud noise during eclipses to frighten the dragon away. The Chinese Imperial Emperor Chung K’ang (B.C.E. 2159 – 2146) learned of an eclipse when he heard much noise in the streets as his subjects tried to drive away the dragon that was eating the sun. They were successful, but the Emperor’s two court astronomers, Hsi and Ho, were reportedly beheaded for failing to predict the event.

Babylonian Clay Tablets such as the one below, provide physical records of ancient eclipses viewed by humans, in this instance between 518 and 465 BCE. Babylonian astrologers kept careful records of celestial events including the motions of Mercury, Venus, the sun, and the moon on tablets dating from 1700 to 1681 BCE. Later records identified a total solar eclipse on July 31, 1063 BCE, that “turned day into night,” and the famous eclipse of June 15, 763 BCE, recorded by Assyrian observers in Nineveh.

By carefully noting local lunar and solar eclipses, Babylonian astronomers were able to predict lunar eclipses and later, solar eclipses, with a fair accuracy. Their tool was the so-called Saros-cycle: this is the period of 223 synodic months (or 18 years and 11.3 days) after which lunar and solar eclipses repeat themselves.

There are many stories of how eclipses have been used to foretell important political events, and for nearly all human civilizations with a recorded history, total solar eclipses were regarded with fear and dread prior to the advent of mathematical schemes for predicting when they would occur.

The Ancient Greeks also recorded eclipse events. The poet Archilochus spoke of the total solar eclipse of 6 April 647 B.C.E. in mythic terms:

> *“There is nothing beyond hope, nothing that can be sworn impossible,*
> *nothing wonderful, since Zeus, father of the Olympians, made night from mid-day,*
> *hiding the light of the shining Sun, and sore fear came upon men.”*

Around 460 BCE, the Greek historian, Herodotus wrote that Thales was able to predict the year when a total solar eclipse would occur. Details of how this prediction was made did not survive. The eclipse occurred in either 610 BCE or 585 BCE. Apparently the method used worked only once because what is known of Greek scientific history does not suggest that the method was ever reliably used again.

Thales is said to have visited Egypt, and from the empirical rules in use there for land surveying, brought back to Greece the ideas of deductive geometry later codified by Euclid. Before 450 BCE, Meton realized that a single period of 235 lunar months (19 years) would cause the popular lunar calendar to return to synchrony with the solar, seasonal calendar.

At this time, the same lunar phase would be recorded at the same time of the solar calendar year. This period also gives a rough guide to when a lunar eclipse will recur at the same geographic location.
The famous Greek astronomer, Ptolemy (ca 150 CE) recorded his observations of eclipses in the Almagest and showed he had a sophisticated scheme for predicting both lunar and solar eclipses. Ptolemy knew, for example, the details of the orbit of the Moon including its nodal points.

He also knew that the sun must be within 20 degrees 41’ of the node point for an eclipse to occur. From this information, Ptolemy figured that up to two solar eclipses could occur within seven months in the same part of the

world. Lunar eclipses were especially easy to calculate because of the vast area covered by Earth's shadow on the Moon. Solar eclipses however required much greater knowledge.
So by the Second Century CE, total solar eclipses could be predicted with some reasonable accuracy. For a growing segment of the human population they were no longer messages from hostile gods or supernatural forces, but simply an interesting regularity of the orbits of the Moon and Earth about the Sun.

More Recent Accounts come to us, as well, through numerous writings about eclipses through the ages. The British poet John Milton writes in Paradise Lost;

"As when the Sun, new risen, Looks through the horizontal misty air, Shorn of his beams, or from behind the Moon, In dim eclipse, disastrous twilight sheds On half the nations and with fear of change Perplexes monarchs."

Solar eclipses were by all accounts events of wondrous and magical proportions. Today, of course, we understand eclipses very well. We know how and why they happen, and when and where they happen. We have seen eclipses from space. We have even used eclipses to probe the laws of physics and to discover new worlds outside the Solar System. Still, eclipses of the sun hold their ancient magic and are fascinating to watch.

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