Multi-Disciplinary Solar Eclipse Unit

7th grade

This unit was developed by Ohio educators in preparation for the April 8, 2024, total solar eclipse. It is the intent that the unit provides enough flexibility to meet the needs of the diverse educational settings found throughout Ohio. The unit addresses Ohio Learning Standards at Grade 7 from a variety of content areas including mathematics, English language arts, science and the arts. The overarching lesson is based on the 5E lesson cycle as it engages students with an initial experience, allows them to explore it in depth as they develop and support explanations with evidence, connect their new knowledge to other content and then extend and apply it in novel settings. Seventh grade teams could use the materials in a variety of ways. An entire team could use the ideas presented here to take an integrated approach with students immersed in eclipse studies across the curriculum. Alternatively, 1 or 2 teachers could provide a multi-disciplinary experience by selecting lessons from the other content areas that are applicable to their subjects. Less ideally, an individual content teacher could focus on only the lesson set specific to that subject. For those wishing to use a more open-ended integrated approach, a companion transdisciplinary problem-based lesson was developed.

# Science Standards:

**7.ESS.4 The relative patterns of motion and positions of Earth, moon and sun cause solar and lunar eclipses, tides and phases of the moon.**

* The moon’s orbit and its change of position relative to Earth and sun result in different parts of the moon being visible from Earth (phases of the moon).
* A solar eclipse is when Earth moves into the shadow of the moon (during a new moon). A lunar eclipse is when the moon moves into the shadow of Earth (during a full moon).

**Nature of Science**

* Scientific and Engineering Practices
* Science is a Human Endeavor
* Science Knowledge Changes in the Light of New Evidence

# Math Standards:

* **7.G.1** Solve problems involving similar figures with right triangles, other triangles, and special quadrilaterals.
* **7.G.4** Work with circles.
* **7.SP.1** Understand that statistics can be used to gain information about a population by examining a sample of the population.
* **7.SP.2** Broaden statistical reasoning by using the GAISE model.

# Fine Arts Standards:

* **VA.7.1CR** Explore influence on style and choice of subject matter.
* **VA.7.3PE** Demonstrate artistic style through the use of elements of art and principles of design.
* **VA.7.3RE** Interpret art by analyzing the characteristics of its context and media.
* **VA.7.4RE** Connect various art forms to their social, cultural or historical purposes.
* **MA.7.2CO** Examine ways in which media art expands cultural understandings.
* **DA.7.2CR** Create movement studies using a variety of stimuli (music, observed dance, literary forms, notation, natural phenomena, personal experience).
* **DA.7.2PE** Demonstrate kinesthetic awareness of the expressive body as it moves and feels in relation to the elements of dance.
* **DA.7.4PE** Demonstrate technical dance skills (alignment, coordination, balance, core support, kinesthetic awareness, clarity of movement, weight shifts, flexibility, or range of motion).
* **DA.7.1RE** Recognize how thoughts and ideas influence dance and articulate the relationship between production elements, music and movement in creating meaning for dances performed or observed.

# ELA Standards:

* **RI 7.1** Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text.
* **RI.7.7**. Compare and contrast a text to an audio, video, or multimedia version of the text, analyzing each medium’s portrayal of the subject (e.g., how the delivery of a speech affects the impact of the words).
* **W.7.2.** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.
* **W. 7.8** Gather relevant information from multiple print and digital sources, using search terms effectively; asses the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.
* **SL.7.1** Engage effectively in a range of collective discussions (one-on-one, in groups, and teacher-led) with diverse partners of grade 7 topics, texts and issues, building on others’ ideas and expressing their own clearly.
* **SL.7.5** Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points.

# Main Eclipse Lesson Using the 5E Learning Cycle

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| **Engage-**Introduce a phenomenon |
| **Do not tell students they will be investigating solar eclipses prior to doing this activity.** One at a time, listen to the individual Soundcloud clips at the link below. After each clip, have students record observations and thoughts on the Engage: Student Data Sheet.Use clips in this order (please note-they are not in the order they appear in the source)1. “That’s so cool! Brooklyn, New York” (1st on the list)
2. “Once in a Lifetime Event. Greenville, SC” (2nd on the list)
3. “It Was Beautiful.! Greenville, SC”(5th on the list)
4. “I See it! Brooklyn, NY” (4th on the list)
5. “Thank You Moon! Jefferson City, Missouri” (3rd on the list)

[Link to Soundcloud clips](https://www.sciencefriday.com/segments/that-is-unreal-experiencing-the-total-solar-eclipse/): Hold a class discussion to debrief student thoughts about the audio clips. Once the class has settled on the idea that the event represented was a solar eclipse, play [this video](https://www.youtube.com/watch?v=BsFsw7DeUY0&t=64s) to showcase experiences from the 2017 total solar eclipse in preparation for learning about the upcoming April 8, 2024 eclipse.  |

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| **Explore**-Investigate the phenomenon**Explain-**Justify explanations with evidence |
| This section features sets of activities specific to science, mathematics, social studies, fine arts and English language arts. The activity grids for these core content areas are interconnected with common themes that should not be addressed in isolation. Review the grids and connect as a seventh-grade team to get the most educational impact. [**Science**](#_Solar_Eclipse_Science)**:** Use this link to view suggestions for various science activities. |
| [**Mathematics**](#_Solar_Eclipse_Math)**:** Use this link to view suggestions for various math activities. |
| [**English Language Arts**](#_Solar_Eclipse_English)**:** Use this link to view suggestions for various English language arts activities. |
| [**Fine Arts**](#_Solar_Eclipse_Arts)**:** Use this link to view suggestions for various fine arts activities. |

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| **Elaborate-**Extend and apply understanding with culminating or extension activities |
| **Community eclipse party**Plan an eclipse party for your local community to be held at your local library or other community location. Science Friday has some suggestions for [eclipse party activities](https://www.sciencefriday.com/educational-resources/eclipse-party-activities/).**Share your eclipse knowledge*** Community or School Science Nights
* Presenting to an authentic audience (PTO, school board, community group, church group, family)
* Leading lessons in elementary classes in your district
* Displays at art shows or in local businesses.

**Possible venues for viewing the actual eclipse*** Partnership with local parks
* Partnering with school on the fringe and the area of totality (virtual).

**Eclipse gallery night**Set up an after-school gallery/display of student work for the community. **Animal behavior during an eclipse**Check the webcam of your local zoo to observe various animal behaviors during the eclipse.**Citizen science projects**Participate in a citizen science project related to eclipses.* NASA has one called the [Eclipse Soundscapes Project](https://eclipsesoundscapes.org/) which gathers data on animal behavior.
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| **Evaluate-**Monitor student understanding throughout the learning process |
| There are no specific items flagged for assessment in this unit. It is impossible to predict when, or what, each teacher will wish to assess because of the variety of ways materials might be used across the disciplines. Many of the student activities provided lend themselves to use as either formative or summative assessments. Teachers are encouraged to draw from these materials, along with teacher created items, to create a diverse combination of self-reflection, formative and summative opportunities for the best overall assessment of learning. |

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# ENGAGE

1. Listen to the first soundtrack. Make careful observations. What do you hear? Pay attention to the words and tones. Make inferences about what might be occurring.

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| --- | --- |
| What I heard (observations) | What I think it might mean |
|  |  |

1. Listen to the second soundtrack. Make careful observations. List what you heard and what you think it might mean. Has the second soundtrack changed your thinking about what is occurring?

|  |  |
| --- | --- |
| What I heard (observations) | How my thinking changed |
|  |  |

1. Listen to the third soundtrack. Make careful observations. List what you heard and what you think it might mean. What additional clues did you get from the third soundtrack?

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| --- | --- |
| What I heard (observations) | What clues this gives me |
|  |  |

1. Listen to the fourth soundtrack. Make careful observations. List new things you heard and how they changed your ideas about what is occurring. Describe your current thinking.

|  |  |
| --- | --- |
| What I heard (observations) | My new thinking |
|  |  |

1. Listen to the last soundtrack. Make careful observations. List any additional information gained.

|  |  |
| --- | --- |
| What I heard (observations) | My new thinking |
|  |  |

1. Make some final notes below. Think about the evidence from all the soundtracks. Do you have enough evidence to make a conclusion about what you are hearing? What additional information would be nice to have?

|  |  |  |
| --- | --- | --- |
| My final ideas | My best evidence | I wish I knew more about: |
|  |  |  |

1. Meet with your group. Use your notes to discuss the soundtracks. Try to reach consensus about what is occurring. Make a group claim and support it with evidence from your observations.

|  |  |
| --- | --- |
| Our claim (what we think is occurring in the soundtracks) | Write your group’s claim here |
| Evidence that supports our claim: | We think this evidence supports our claim because: |

# Solar Eclipse Science Stations

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| **Science Standards:****7.ESS.4 The relative patterns of motion and positions of Earth, moon and sun cause solar and lunar eclipses, tides and phases of the moon.*** The moon’s orbit and its change of position relative to Earth and sun result in different parts of the moon being visible from Earth (phases of the moon).
* A solar eclipse is when Earth moves into the shadow of the moon (during a new moon). A lunar eclipse is when the moon moves into the shadow of Earth (during a full moon). [Return to main lesson](#_Main_Eclipse_Lesson)
 |
| **Watch** | **Read** | **Research** |
| Watch the video titled [Solar Eclipse 101 by National Geographic](https://youtu.be/cxrLRbkOwKs) and complete the [*Watch Station Viewing Guide*](#_Watch_Station_Viewing)  | Read the [NASA article](https://www.nasa.gov/feature/goddard/2017/eclipse-2017-science-from-the-moon-s-shadow) about the scientific research conducted during the 2017 total solar eclipse. Jigsaw portions of the article and have groups report to the class. See extension below. | Research how ancient cultures thought about eclipses. Note: some content might be disturbing to certain students. Begin recording ideas from the article [Eclipses in ancient cultures Mayank Vahia](https://www2.nao.ac.jp/~mitsurusoma/WS2014/vahia.pdf) on the [*Research Station Reading Guide*](#_Research_Station_Reading)*.* Continue to explore these and other cultures with additional research. See timeline extension belowTeaching Tip: Consider using the [Project Zero](https://pz.harvard.edu/thinking-routines) thinking routine [Projecting Across Time](https://pz.harvard.edu/sites/default/files/Projecting%20Across%20Time.pdf) as you engage students with this research. |
| **Investigate** | **Model** | **Experiment** |
| Watch the [flyover](https://vimeo.com/835625178) of the April 8th solar eclipse. Complete the[*Solar Eclipse Geometry Lesson*](#_Solar_Eclipse_Geometry)Complete the[*Investigate Station Handout*.](#_Investigate_Station) See graphing extension below. | Use a light source and various sized spherical objects to explore how a smaller object can eclipse a larger object. Explain the relationship between the sun, Earth & moon during an eclipse by completing the [*Model Station Handout*](#_Model_Station)  | Use [***Introduction to Scientific Articles***](#_Introduction_to_Scientific) to study the article [Total Eclipse of the Zoo: Animal Behavior during a Total Solar Eclipse](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7222787/). If you prefer to just do a brief overview of the article you can complete the [*Zoo Article Summary*](#_Zoo_Article_Summary) instead*.* Read the article titled [Surprising Ways Animals React to Solar Eclipse by Andrew Fazekas](https://www.nationalgeographic.com/science/article/animals-react-total-solar-eclipse-august-space-science) and design an experiment to complete during the solar eclipse.See citizen science extension below. |
| **Extensions** |
| * **Real World Connections** NASA learned new information during the 2017 total solar eclipse. Based on the article explored in the “Read” section above, research how this information has progressed since 2017.
* **Timeline** Construct a timeline of solar eclipses using information from the “Research” section above. Discuss why different civilizations observe solar eclipses at different times.
* **Citizen Science** NASA has an opportunity to participate in [Soundscapes](https://eclipsesoundscapes.org/#about), a project for gathering and analyzing data on animal (including insect) behavior, during the April 8, 2024 eclipse. There are various levels of engagement explained under the “Participate” tab.
* **Graphing** Use a still image of the moon’s shadow from the video in the “Investigate” section above. Draw parallel lines across the shadow in the direction of motion (parallel to the edge lines). Measure each line. Explain how this data supports the claim that areas in the center of the shadow will experience the longest totality periods. The measurements could be displayed on a graph (ordered from edge to edge of the shadow) to help in analyzing the data.
* **Real World Connections** NASA technologies have benefited life on Earth in the form of commercial products. Research the history of NASA Spinoff. Create an anchor chart or tri-fold brochure to share what you learned.
* **Interpersonal/Body Kinesthetic** Share eclipse knowledge. Create a cooperative game to teach someone else about eclipses or construct a model, dance or other representation to teach others about eclipses. See [Solar Eclipse Arts Stations](#_Solar_Eclipse_Arts) for more ideas.
* **Verbal/Linguistic** Create a story, poem, concept map or crossword puzzle to teach others about eclipses.
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| **Resources** |
| * <https://www.generationgenius.com/solar-and-lunar-eclipses-reading-material-grades-6-8/>
* [**NASA Exploration of size: How can the little Moon hide the giant sun?**](file:///C%3A//Users/10160213/Downloads/eclipse_smallmoon_bigsun%20%283%29.pdf)

**Personal accounts/stories*** <https://americanliterature.com/author/james-fenimore-cooper/short-story/the-eclipse>
* <https://www.cmnh.org/science-news/blog/august-2017/an-eclipse-story>
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## Watch Station Viewing Guide

**I can. . .**

* explain how a solar eclipse happens. [Return to main science grid](#_Solar_Eclipse_Science)

**Watch the video titled** [**Solar Eclipse 101 | National Geographic**](https://www.youtube.com/watch?v=cxrLRbkOwKs) **and answer the questions below.**

1. How are the Earth, moon and sun aligned to cause a solar eclipse?
2. Why do the sun and moon appear to be approximately the same size in the sky?
3. Why isn’t there a solar eclipse every month?
4. Describe or draw the umbra produced during a solar eclipse.
5. Describe or draw the penumbra produced during a solar eclipse.
6. What are the differences between total, partial and annular eclipses?
7. How frequently can a certain location on Earth expect to experience a total solar eclipse?
8. Why should you use special safety glasses when viewing the solar eclipse?
9. What is a pinhole viewer?
10. How long does totality typically last during a total solar eclipse?

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_ Section \_\_\_\_\_\_\_

## Research Station Reading Guide

**I can. . .**

* research eclipses and ancient cultures starting with the article titled [Eclipses in ancient cultures Mayank Vahia](https://www2.nao.ac.jp/~mitsurusoma/WS2014/vahia.pdf).
* compare how ancient cultures, including China, Egypt and Greece, reacted to eclipses. [Return to main science grid](#_Solar_Eclipse_Science)

Cultures have had a variety of responses to the occurrence of eclipses. Most cultures have elaborate stories or myths explaining how and why eclipses occur.

1. Why is studying eclipses beneficial to historians and scientists? Use information from the text to support your answer.
2. List some facts or traditions from ancient cultures that you found interesting.

**Ancient China**:

1. How did the ancient Chinese explain eclipses? How did they react during eclipses?
2. Why was it important for the ancient Chinese to be able to predict eclipses?
3. When were the Chinese first able to accurately understand the causes and make accurate eclipse predictions?

**Ancient Egypt:**

1. Our understanding of ancient Egyptian civilization's knowledge of astronomy comes to us from three places. Name them.
2. List two tools for tracking stars that existed in ancient Egypt that are still in use today.

**Ancient Greece:**

1. Aristarchus proposed the first known heliocentric model of the Universe. Describe or draw the heliocentric model.
2. Before Aristarchus proposed the heliocentric model, ancient cultures believed that our universe was geocentric. What does geocentric mean?
3. Why do you think the appearance of a solar eclipse may have caused the Medes and the Lydians to want to stop fighting and negotiate a peace treaty?

**Final Takeaway:**

Observe a [map of upcoming eclipses.](https://www.timeanddate.com/eclipse/list-solar.html) Use it along with information from the article to answer the last question.

1. Why is there so much variety in the years when ancient civilizations recorded solar eclipses?

## Investigate Station

**I can. . .**

* explain why different locations experience different lengths of totality during a solar eclipse.
* compare the length of totality for two cities on a map.
* determine an ideal viewing location near my hometown. [Return to main science grid](#_Solar_Eclipse_Science)

**Use the video of the April 8th eclipse to investigate the following questions.**

1. How long will the entire North American totality experience last?
2. At what time will the moon’s shadow first touch the western border of Ohio?
3. Why do areas near the edges of the totality path have a shorter length of totality than places near the center of the shadow?

**Find your location in Ohio.**

1. Approximately how long will totality last in your location?
2. Stop the video on Ohio. Find the cities of Lorain and Toledo. Which city will experience a longer totality? What evidence supports your answer.

**There are many factors that affect viewing. These include weather, surrounding terrain/buildings, anticipated crowd sizes, travel time to location, environment, availability of supplies, etc.**

1. What location would you choose for viewing totality during the 2024 eclipse? Explain why this is an ideal location based on your interests and constraints.

**View this** [**flyover of the annular solar eclipse**](https://vimeo.com/845760222) **which crossed North America on October 14, 2023. Ohio had only partial eclipsing during this event. Use additional resources to help you investigate the variety of experiences that occur during eclipses.**

1. Explain what makes an eclipse annular rather than total.
2. What differences do you notice between the annular and total eclipse videos? Which of these differences are because of the eclipse type and which are just variations that generally occur among eclipses in general?
3. Observe the speed of the moon’s shadow in each of the videos. How do the speeds compare and how do they change? Discuss with your group what might be causing these effects. Consult your research for answers.

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## Model Station

**I can. . .**

* create a model of a solar eclipse using a light source and spheres.
* create a model of a lunar eclipse using a light source and spheres.
* explain why the little moon can hide the giant sun. [Return to main science grid](#_Solar_Eclipse_Science)

**Model the relationship between the sun, Earth & moon during eclipses.** **Choose from the following materials. You do not need to use all the materials.**

* **Basketball**
* **Beach ball**
* **Tennis ball**
* **Golf ball**
* **Marble**
* **Peppercorn**
* **Lamp**
* **Flashlight**
* **Candle**
* **String**
* **Cardboard box**
1. Arrange your materials to construct a model showing a solar eclipse. Draw and label your model below. Explain what is happening in your model.
2. How is a lunar eclipse model different from the solar eclipse model you drew above? Draw and label your model below. Explain what is happening in your model.

## Introduction to Scientific Articles

[Return to main science grid](#_Solar_Eclipse_Science)

Scientific papers are one way that scientists communicate their investigations and findings to other scientists and the public at large.

Almost all journal articles have 6 major sections: abstract, introduction, methods, results, discussion, and references. Usually, the sections are labeled this way, although sometimes the introduction and abstract are not labeled. Sometimes alternative section titles are used. The abstract is sometimes called the "summary", the methods are sometimes called "materials and methods", and the discussion is sometimes called "conclusions". Some journals also include the minor sections of "key words", and "acknowledgments" following the discussion. In some journals, the sections may even be divided into subsections that are given descriptive titles. However, the general division into the six major sections is nearly universal.

We are going to become familiar with scientific journal articles by examining an article written about an experiment with animals and their behaviors during a solar eclipse in 2017. Scientific papers will likely read much differently than a paper you may have written for your other classes. In narrative writing, such as the kind you have read in a fiction essay or novel, active voice is often preferred because it is more illustrative. However, scientific writing uses passive voice because it emphasizes the actions of the procedure over the person who completed the task. The “I” or “we” who is performing the experiment or recording the data should be less important than the action performed. Because these are written differently than previous papers you have read, it may take some adjustment to learn how to read and understand. As you read through the research article, use your science journal to record any notes, questions and answers to the prompts.

1. **Begin by reading the introduction (not the abstract).**

The introduction provides background information needed to understand why the described experiment was conducted. The introduction should describe previous research on the topic that has led to the unanswered questions being addressed by the experiment and should cite or mention important previous papers that form the background for the experiment. The introduction should also state the goals of the research, such as the specific questions that will be tested in the experiment(s).

A good introduction should have several citations of previous research mentioned. This tells the reader that the authors are informed about previous work on the topic and are not working in a vacuum. Citations also provide jumping-off points to allow the reader to explore other ideas that are not directly addressed in the paper. If the paper supports or refutes previous work, readers can look up the citations and make a comparison for themselves.

As you read the introduction:

1. **Underline any words that are new or unfamiliar to you.**
2. **Identify the BIG QUESTION.**

**What problem is this experiment and those mentioned in the introduction trying to solve?” This helps you focus on why this research is being done.**

1. **Try to summarize the background in five sentences or less.**
2. **Identify the SPECIFIC QUESTION(S)**

What **exactly** are the authors trying to answer with their research? There may be multiple questions, or just one. Write them down.

1. **Identify the approach.**

What are the authors going to do to answer the SPECIFIC QUESTION(S)?

1. **Discuss your findings with your table partners.**

**If there are words that you underlined that your partners are familiar with, please share definitions, otherwise, the class will go over these together.**

1. **Next, read sections 2.1, 2.2 and 2.3 (including Table 1) of the Materials and Methods section.**

The function of this section is to describe all experimental procedures, including the controlled variables. The description should be complete enough to enable someone else to repeat the experiment being described. Sometimes this section is called the Methods section. However, the researcher who wrote this paper chose to include Materials and Methods together. Materials refer to any equipment, tools, statistical analysis, sample size and type that was used in the experiment. The methods are the techniques used, the data gathered, which may be ***quantitative,*** which means it can be counted or measured, and given a numerical value or the data may be ***qualitative***. Qualitative data is descriptive in nature, expressed in terms of language rather than numerical values.

As you read the Materials and Methods section:

1. **Underline any words that are new or unfamiliar to you.**
2. **Identify the approach of the researchers. What are they going to do to answer their questions?**
3. **Read through the ethogram behaviors and descriptions listed in Table 1. If any of them are not familiar to you, ask the teacher or a table partner to describe them for you in a different way.**
	* **Have you ever completed an *ethogram*? An ethogram is a listing of all the behaviors by an organism. Often, an ethogram will also record how often or for how long of a time the organism engages in the behavior within a particular block of time.**
	* **How many of these behaviors in Table 1 have you observed animals displaying? What kind of animal was it? What was going on with the animal when you observed it? Does the labeling of the behavior (Normal/baseline, Evening, Apparent Anxiety and Novel make sense with your observations of the behavior? If not, what was different about your observation?**
4. **Take a couple of minutes and discuss your observations of these behaviors with your table partners.**
5. **Taking in the information given in sections 2.1, 2.2 and 2.3, draw a diagram for the experiment involving the animal taxa from Table 2 assigned to you by your teacher. Showing exactly what the authors did, adding as much detail as you need to be able to tell the story of what happened with this experiment to another person.**
6. **Read section 3, the Results section.**

The function of this section is to summarize general trends in the data without comment, bias, or interpretation. The results of statistical tests applied to your data are reported in this section although conclusions about original hypotheses are saved for the Discussion section.Sometimes you may find that results are summarized in the figures and tables. Pay careful attention to them! You may also need to go to supplementary online information files to find some of the results.

Also pay attention to:

* The words "significant" or "non-significant." These have precise statistical meanings.
* Graphs. Do they have error bars on them? For certain types of studies, the absence of confidence intervals is a major red flag when thinking about the reliability of the research.
* The sample size. Has the study been conducted on 10 individuals or 10,000 individuals? For some research purposes a sample size of 10 is enough, but for most studies larger is better.
1. **Read all the Results section.**
2. **With your partner, re-read the section that describes the behavior of the animal assigned to you by your teacher.**
3. **Are you familiar with this animal? Have you ever observed this animal before? If this animal is new to you, look up a little information about it. There are several websites that can give you valuable information about the animal’s adaptations, behaviors and habitat needs.**
4. **What type of behavior did your selected animal exhibit during the eclipse event?**
5. **Write a paragraph to summarize the results for the animal you were assigned. Don't try to decide what the results mean yet; just write down what they are.**
6. **Do you think the results given about your assigned animal answer the specific question(s). What do you think the results mean? Don't move to the next task until you have thought about this. It's completely OK to change your mind as you consider the authors' interpretation, but it's a good habit to start creating your own interpretations before you read those of others.**
7. **Join a group of students who have discussed other animal group observations. Discuss what you think the observations of the various animal groups mean about the effects of the solar eclipse?**
8. **Read sections 4 and 5, the Discussion and Conclusion sections.**

Some scientific papers will have either a Discussion or a Conclusion section. This article has both. The function of this Discussion section is to analyze the data and relate it to other studies. To "analyze" means to evaluate the meaning of your results in terms of the original question or hypothesis and point out their biological significance. The conclusion is typically a restating of the research problem combined with a synthesis of the key points of the research. In this article, the authors discuss what the results of this study can mean for future research on animal behaviors.

1. **What do the authors think the results mean?**
2. **Do you agree with them?**
3. **Can you come up with any alternative way of interpreting them?**
4. **Do the authors identify any weaknesses in their own study?**
5. **Are there things that you would have done differently in this experiment?**
6. **What do they propose to do as a next step? What would you do if this was your study and why?**
7. **Go Back and read the Abstract Section**

The abstract is a short summary (150-200 words or less) of the important points of the paper. It does not generally include background information. There may be a very brief statement of the rationale for conducting the study. It describes what was done, but without details. It also describes the results in a summarized way that usually includes whether the statistical tests were significant. It usually concludes with a brief statement of the importance of the results. Abstracts do not include references. When writing a paper, the abstract is always the last part to be written.

The purpose of the abstract is to allow potential readers of a paper to find out the important points of the paper without having to read the paper. It should be a self-contained unit capable of being understood without the benefit of the text of the article. It essentially serves as an "advertisement" for the paper that readers use to determine whether they want to wade through the entire paper or not. Abstracts are generally freely available in electronic form and are often presented in the results of an electronic search. If searchers do not have electronic access to the journal in which the article is published, the abstract is the only means that they have to decide whether to go through the effort (going to the library to look up the paper journal, requesting a reprint from the author, buying a copy of the article from a service, requesting the article by Interlibrary Loan) of acquiring the article. Therefore, it is important that the abstract accurately and succinctly presents the most important information in the article.

1. **Does the content of the abstract match what the authors said in the paper?**
2. **Does it fit with your interpretation of the paper?**
3. **What questions do you have after reading this article?**
4. **Could you develop an experiment on your own to answer your questions?**

**Extension:**

* **Explore what other experts have to say about this article/research project.**

Scientists that are reading a scientific journal article will typically find out what other researchers say about the paper they have read.

Who are the (acknowledged or self-proclaimed) experts in this particular field? Do they have criticisms of the study that you haven't thought of, or do they mostly support it? Don't neglect to do this! Here's a place where you may want to use Google, but do it last, so you are better prepared to think critically about what other people have to say about this research study.

* **Do your own research.**

Take some time to observe animals in your own area before, during, and after the eclipse on April 8, 2024. You can observe native animals in your neighborhood during the eclipse, pets if you have some as part of your family. You could also view the eclipse from Toledo Zoo or Cleveland Metroparks Zoo, which are in the path of totality here in Ohio. It is not possible to travel to a zoo, you might observe the animals featured on the live cameras from other Zoos in the totality path. For the 2024 Total Solar Eclipse the [Indianapolis Zoo](https://www.indianapoliszoo.com/webcams/) is one zoo that is in the totality path.

**References**:

1. Total Eclipse of the Zoo: Animal Behavior during a Total Solar Eclipse<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7222787/>
2. Components of a scientific paper Vanderbilt University <https://researchguides.library.vanderbilt.edu/c.php?g=69346&p=831743>
3. How to read a scientific article- <https://libguides.citytech.cuny.edu/advancedResearch/nonscientist>

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_ Section \_\_\_\_\_\_\_

## Zoo Article Summary

[Return to main science grid](#_Solar_Eclipse_Science)

**Discuss with your group how you think an eclipse changes the behavior of animals.**

In a 2020 study, seventeen species of mammals, birds, and reptiles housed at The Riverbanks Zoo and Garden in Columbia, South Carolina, were investigated during the total solar eclipse of 21 August 2017.

1. Read the section titled summary in the article, [**Total Eclipse of the Zoo: Animal Behavior during a Total Solar Eclips**](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7222787/)**e** by Adam Hartstone-Rose et.al.
2. Go to the results section. Choose five animals to learn more about.
3. Complete the chart below.
	1. List the name of the animals you are researching.
	2. Describe the behaviors demonstrated during the early stages of the eclipse.
	3. Describe the behaviors demonstrated during the totality of the eclipse.
	4. Answer the question: What differences occurred in the animal’s behavior?

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| **Animal** | **Early Stages of Eclipse** | **During Totality** | **Differences in behavior?** |
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**Share your findings with the entire class. Predict how various local animals (wildlife and pets) will behavior during an eclipse. If possible, observe them during an upcoming total solar eclipse.**

# Solar Eclipse English Language Arts Stations

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| **English Language Arts Standards:****RI 7.1** Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text. **RI.7.7**. Compare and contrast a text to an audio, video, or multimedia version of the text, analyzing each medium’s portrayal of the subject (e.g., how the delivery of a speech affects the impact of the words).**W.7.2.** Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. **W. 7.8** Gather relevant information from multiple print and digital sources, using search terms effectively; asses the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation. **SL.7.1** Engage effectively in a range of collective discussions (one-on-one, in groups, and teacher-led) with diverse partners of grade 7 topics, texts and issues, building on others’ ideas and expressing their own clearly.**SL.7.5** Include multimedia components and visual displays in presentations to clarify claims and findings and emphasize salient points. [Return to main lesson](#_Main_Eclipse_Lesson) |
| **Summarize** | **Research** | **Discuss** |
| Have students search the internet for reliable sources, or use sources provided by the teacher, about a solar eclipse. Write a summary of what causes a solar eclipse. Cite evidence from the text that supports information in the summary. | Have students research solar eclipses using multiple sources, assessing the credibility of each. Use reliable sources to write a detailed multi-paragraph essay analyzing their discoveries. Include quotes or paraphrasing with proper citation. Topics could include mechanisms of solar eclipses, histories of solar eclipses, solar eclipses across cultures, eclipse mythology, when future solar eclipses will occur, animal reactions to eclipses, how astronomers predict eclipses, the geometry that allows eclipses to occur and how different types of eclipses occur.  | Have small groups of students discuss a driving question such as those listed below. Have groups share out in a large class wide discussion.* How will the April 8, 2024 eclipse affect my community? What are some ways we could measure the impact?
* Considering our location where would be the best viewing location for the April 8, 2024 eclipse? Discuss reasons for choices.
 |
| **Write** | **Compare and Contrast** | **Produce** |
| Have students write a short story, poem, drama or myth about eclipses.  | Have students investigate solar eclipses by engaging with several texts, videos and other media. Compare and contrast the portrayals in each medium. | Create a video showcasing solar eclipses. Students can enter videos in a statewide contest sponsored by the [Ohio Academy of Science](https://www.ohiosci.org/).  |

# Solar Eclipse Arts Stations

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| **Visualizing an Eclipse as an Artist** (Drafted Fine Arts Standards) [Return to main lesson](#_Main_Eclipse_Lesson)**VA.7.1CR** Explore influence on style and choice of subject matter. **VA.7.3PE** Demonstrate artistic style through the use of elements of art and principles  of design. **VA.7.3RE** Interpret art by analyzing the characteristics of its context and media. **VA.7.4RE** Connect various art forms to their social, cultural or historical purposes. **MA.7.2CO** Examine ways in which media art expands cultural understandings. 1. Using Princeton University’s Art Museum collection of [Eclipses in Art](https://artmuseum.princeton.edu/transient-effects/eclipses-art), select an image to share with students.
2. Students share statements of meaning from what they see/observe in the image. A sentence starter could be, “I see [art concept], so I think it might represent [science concept]” or “I observe [art concept], so I wonder about [science concept]”. Read the description of the work after students share statements of meaning and see if student perceptions change with the added information. (This could be an anticipatory set and/or assessment of prior knowledge that could be used before direct instruction on the science concepts). *(VA.7.3RE, VA.7.4RE)*
3. The teacher asks questions, such as “What in this image represents what we know about eclipses with accuracy?” “What in this image appears to be an artistic choice, or is not accurate based on what we know about eclipses?” “Why do you think the artist chose to represent an eclipse in this way?” “How might you make different choices to represent what we know about eclipses more accurately or more artistically?” (This could follow direct instruction to check understanding as well as to lead into a creative arts-integration activity). *(VA.7.3RE, VA.7.4RE, MA.7.2CO)*
4. Planning for student creation: “How might we make artistic choices to represent what we know about eclipses?” “What more do we need to know before we can create an artistic representation of eclipses?” *(VA.7.1CR)*
5. Students can choose to create a representation of an eclipse based on an artist’s work or design their own representation. (This could be done in cooperation with a visual arts teacher or teaching artist). *(VA.7.3PE)*

**Dance Variation** (Draft Fine Arts Standards)**DA.7.2CR** Create movement studies using a variety of stimuli (music, observed dance, literary forms, notation, natural phenomena, personal experience).**DA.7.2PE** Demonstrate kinesthetic awareness of the expressive body as it moves and feels in relation to the elements of dance. DA.7.4PE Demonstrate technical dance skills (alignment, coordination, balance, core support, kinesthetic awareness, clarity of movement, weight shifts, flexibility, or range of motion).DA.7.1RE Recognize how thoughts and ideas influence dance and articulate the relationship between production elements, music and movement in creating meaning for dances performed or observed.1. Using Princeton University’s Art Museum collection of [Eclipses in Art](https://artmuseum.princeton.edu/transient-effects/eclipses-art), select an image to share with students.
2. Students share statements of meaning from what they see/observe in the image. A sentence starter could be, “I see [art concept], so I think it might represent [science concept]” or “I observe [art concept], so I wonder about [science concept]”. Read the description of the work after students share statements of meaning and see if student perceptions change with the added information. (This could be an anticipatory set and/or assessment of prior knowledge that could be used before direct instruction on the science concepts). *(DA.7.1RE)*
3. Planning for student creation: Teacher asks students to brainstorm how to explore their shared observations using elements of dance (body, energy, space, shape, relationships) and technical skills from a genre/style of the student or teachers choosing.  Other guiding questions: “How might we make artistic choices to represent what we know about eclipses?” “What more do we need to know before we can create an artistic representation of eclipses?” *(DA7.2CR, DA7.2PE, DA7.4PE)*
4. Students use their bodies to create a representation of an eclipse based on an artist’s work or an abstract adaptation of their own representation. (This could be done in cooperation with a visual arts teacher or teaching artist). *(DA.7.2PE, DA7.4PE)*
5. Reflect on the process using a feedback protocol of the teacher’s choosing. This could be Critical Response Process or “See, Think, Wonder” as an example. *(DA7.1RE)*

Lesson from Smithsonian Learning Labs: [Collections :: Alma Thomas: Making EMS Visible | Smithsonian Learning Lab](https://learninglab.si.edu/collections/alma-thomas-making-ems-visible/rBJgEbujO52Dq08K) [Return to main lesson](#_Main_Eclipse_Lesson) |
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| **Arts Idea Board** |
| **Visual Arts**: Students can create a mixed-media collage depicting the different phases of a solar eclipse, using materials like tissue paper, paint, and charcoal.  | **Music**: Students can compose a piece of music inspired by the rhythms and patterns of a solar eclipse, using percussion instruments and electronic soundscapes.   | **Dance**: Students can choreograph a contemporary dance piece that explores the movement and energy of a solar eclipse, incorporating elements of dance (e.g., shape, energy, relationship of performers in space).  |
| **Photography**: Students can experiment with different photographic techniques to capture the visual beauty of a solar eclipse, including long-exposure and silhouette photography.  | **Poetry**: Students can write haikus or sonnets that capture the essence of a solar eclipse, using sensory language and vivid imagery.   | **Drama**: Students can work in small groups to create a shadow play that tells the story of a solar eclipse, using puppets, props, and lighting effects.  |
| **Mural Painting**: Students can work together to create a large-scale mural that depicts a solar eclipse, using bold colors and striking imagery to create dynamic and engaging artwork.  | **Graphic Design**: Students can create a series of posters that promote safe viewing practices for a solar eclipse, using bold typography and eye-catching graphics.  | **Film**: Students can create a short film that documents the experience of watching a solar eclipse, using a combination of live-action footage and animation.  |
| **Sculpture**: Students can sculpt a series of papier-mâché models that represent the sun, moon, and earth during a solar eclipse, using wire armatures and tissue paper to demonstrate the process of an eclipse.  | **Digital Art**: Students can use computer software to create digital animations or interactive simulations of a solar eclipse, showcasing the mechanics and movement of the event.   | **Animation**: Students can create a short, animated film that explores the scientific and cultural aspects of a solar eclipse, using a combination of traditional animation techniques and digital software to create a visually stunning and informative film.  |
| **Ceramic Arts**: Students can create clay sculptures that represent the shapes and colors of the sun and moon during a solar eclipse, using glazes and firing techniques to create a realistic effect.  | **Printmaking**: Students can use printmaking techniques to create a series of linocut prints that depict the different phases of a solar eclipse, experimenting with color, texture, and negative space.  | **Kinetic Sculpture**: Students can create a kinetic sculpture that represents the motion and dynamics of a solar eclipse, using materials like wire, paper, and motors to create a moving and interactive artwork.  |
| **Collage**: Students can create a collage of images and texts that explore the cultural significance and symbolism of a solar eclipse, using found materials and creative juxtapositions.  | **Journalism:** Students can create a press release for the school or community about the school’s activities for viewing the eclipse.  | **Creative Movement:** Students explore revolution, rotation, and relationship in space through movement and creative observation.   |

# Solar Eclipse Math Lessons

## Solar Eclipse Statistics Lesson

**Mathematics Standard:**

## 7.SP.2 Broaden statistical reasoning by using the GAISE model. [Return to main lesson](#_Main_Eclipse_Lesson)

**Engage teams of students with one or more of the projects below.**

## Collect data on traffic in your area.

Formulate a statistical question around traffic in your area the time before and during the eclipse.

Design and make a plan to collect data in your area during the following days:

* March 29 – April 3, 2024
* April 5 – April 10, 2024

Analyze the data. Can you show your data in a graph, does it show variability?

Interpret the results of your research. Write your interpretation as a news article. Perhaps you could post it on your school webpage or submit it to a local newspaper.

## Collect data on visitors to local grocery stores.

Formulate a statistical question around visitors to a local grocery store in your area the time before and during the eclipse.

Design and make a plan to collect data in your area during the following days:

* March 29 – April 3, 2024
* April 5 – April 10, 2024

Analyze the data. Can you show your data in a graph, does it show variability?

Interpret the results of your research. Write your interpretation as a news article. Perhaps you could post it on your school webpage or submit it to a local newspaper.

## Collect data on visitors to local restaurants.

Formulate a statistical question around visitors to a local restaurant in your area the time before and during the eclipse.

Design and make a plan to collect data in your area during the following days:

* March 29 – April 3, 2024
* April 5 – April 10, 2024

Analyze the data. Can you show your data in a graph, does it show variability?

Interpret the results of your research. Write your interpretation as a news article. Perhaps you could post it on your school webpage or submit it to a local newspaper.

## Collect data on visitors to local hotels.

Formulate a statistical question around visitors to a local hotel in your area the time before and during the eclipse.

Design and make a plan to collect data in your area during the following days:

* March 29 – April 3, 2024
* April 5 – April 10, 2024

Analyze the data. Can you show your data in a graph, does it show variability?

Interpret the results of your research. Write your interpretation as a news article. Perhaps you could post it on your school webpage or submit it to a local newspaper.

## Solar Eclipse Geometry Lesson

**Mathematics Standards:**

* **7.G.1** Solve problems involving similar figures with right triangles, other triangles, and special quadrilaterals. [Return to main lesson](#_Main_Eclipse_Lesson)
* **7.G.4** Work with circles. [Return to main science grid](#_Solar_Eclipse_Science)
* **7.SP.1** Understand that statistics can be used to gain information about a population by examining a sample of the population.

Diameter of Sun: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Circumference of Sun: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Distance between Sun and Earth: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Distance between Sun and Moon: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Diameter of Moon:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Circumference of Moon: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Diameter of Earth: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Circumference of Earth: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What do you notice? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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What do you wonder?

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Explore the things you wonder about and would like to find answers to. Be sure to explain and share your findings. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Draw an accurate scale-drawing of the Earth, the Moon, and the Sun**.

How many times longer is the distance from the Earth to the Sun compared to the distance from the Earth to the Moon? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How many times longer is the diameter of the Sun compared to the diameter of the Moon? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What percentage of the Sun’s diameter is the Earth’s? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What percentage of the Sun’s diameter is the Moon’s? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What do you notice? What do you wonder? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Explore the things you wonder about and would like to find answers to. Be sure to explain and share your findings. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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The moon shadow on Earth at any given time during the Eclipse is approximately 7,000 square miles.

Research the population density in Ohio. How many people per square mile are there? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How many people approximately would be in one full moon shadow at any given time? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Discuss the accuracy of this number. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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