

Activity 05 - Use Simulation Software to Investigate Partial and Total Lunar Eclipses.

Year Level: Grades 5–12 (typically from 10 to 18 years of age)

Background: A solar eclipse occurs when the Moon makes a shadow on the Earth's surface. The Earth can also make a shadow on the Moon. This is known as a lunar eclipse. In ancient times lunar eclipses were used to calculate the relative size of the Moon compared to the Earth. Not every full moon experiences a Lunar Eclipse. This lesson allows students to explore the circumstances of lunar eclipses by using free astronomical simulation software programs.

Aim: Students will explore Lunar eclipses using software and compare what they see to what actually happens.

References:

- Section 2.6 "Lunar Eclipses" of the AAQ/STAQ teacher booklet.
- PowerPoint presentation PP07 "The Moon and Lunar Eclipses"

Shape of the Australian Curriculum: Science strands on focus areas.

Content descriptors: Years 7 and 10

Science Understanding	Science as a Human Endeavour	Science Inquiry Skills
<p>Yr 7</p> <p>Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the Sun, Earth and the Moon (ACSSU115)</p>	<p>Yr 7</p> <p>Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people's understanding of the world (ACSHE119)</p>	<p>Yr 7</p> <p>Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (AC SIS124)</p> <p>Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (AC SIS125)</p> <p>In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task (AC SIS126)</p> <p>Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of the data collected, and identify improvements to the method (AC SIS131)</p>

		Communicate ideas, findings and solutions to problems using scientific language and representations using digital technologies as appropriate (AC SIS133)
<p>Yr 10</p> <p>The universe contains features including galaxies, stars and solar systems and the Big Bang theory can be used to explain the origin of the universe (ACSSU188)</p>	<p>Yr 10</p> <p>Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community (ACSHE191)</p> <p>Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (ACSHE192)</p> <p>People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions (ACSHE194)</p>	<p>Yr 10</p> <p>Plan, select and use appropriate investigation methods, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (AC SIS199)</p> <p>Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data (AC SIS200)</p> <p>Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (AC SIS204)</p> <p>Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (AC SIS208)</p>

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Using Software to Simulate a Lunar Eclipse

Grades 5 – 12

Lunar eclipses occur in a similar way to solar eclipses except that the Moon enters into the Earth's shadow instead of the Moon's shadow passing across the Earth.

Students can research the circumstances of a recent lunar Eclipse seen in Australia and use free software to simulate the event.

There are two software programs that are particularly useful that can be used.

Stellarium (<http://stellarium.org/>) is a planetarium style simulator that can show the sky at any time from any point on the Earth.

Celestia (<http://shatters.net/celestia/>) is a simulator that allows users to explore the universe in three dimensions (four if you include time as a dimension).

A good reference site for past and future Lunar eclipses is <http://eclipse.gsfc.nasa.gov/lunar.html>.

The prepared PowerPoint presentation PP07 The Moon and Lunar Eclipses would be a useful introduction for the students.

Stellarium Tutorial

For instructions on using Stellarium see the Activity 04 Stellarium Tutorial.

Celestia Tutorial

Once Celestia is opened there are some basic controls to learn. Maximise the window to see the full view of the Earth. The top left gives information on what has been selected, pressing "v" changes the amount of information about the target from nothing to some to lots. The time is displayed in the top right as the local time or UTC (Universal Time Co-ordinated which is the new name for Greenwich Mean Time and is 10 hours behind Australian Eastern Standard Time). The type of time displayed can be changed from the time drop down menu. The bottom right is what you are actually locked onto – you can select objects that are not what you are locked onto by using the mouse and left clicking.

The "I" key turns clouds on planets on and off and "Ctrl" and "L" turns the night side lights on and off.

To look around the object that you are locked onto use the right mouse button. Zoom in and out using the scroll wheel or the "Home" and "End" keys.

The left mouse button lets you look around in general. To look "out the back window" press the "*" key.

Use the left mouse button and click on a star, the information will be in the top left of the screen. To go to that target press the "G" key. This gets you there almost instantly (scientific term for very fast). To get back to our Solar system press "H" and then "G". If there are planets in a system the number keys will select them in order. For our Solar system "1" will select Mercury, "2" will select Venus, "3" will select Earth etc. Try it out by pressing "6" then "G" to see Saturn.

To view a demonstration of what else Celestia can do, press the "D" key.

Student Activity

Find definitions of the various phases of the eclipse on the worksheet and label the diagram with the following words:

Sunlight, Earth, Moon, Penumbral Shadow, Total Eclipse Shadow. (The Total Eclipse Shadow is known as the Umbral Shadow.)

Research a recent Lunar eclipse and fill in the details of that eclipse on the Student Worksheet, you will need to know the date and time, the Continents that will see the eclipse and the times that various phases occur in Universal Time (UT) and Australian Eastern Standard Time (AEST). Universal Time is sometimes known as Greenwich Mean Time (GMT). Queensland (AEST) is 10 hours earlier than UT.

Complete the Basic Tutorials to learn the basic controls before using the software for the activity.

Using both Stellarium and Celestia look at what happens at the phases and record the times that they occur and write down what can be seen. You might have to increase and reverse the rate of time to see what is happening. Comment specifically on where the Earth's shadow is observed to be and any colour changes.

Once the table has been filled in answer the questions that follow on the next page.

Viewing Eclipses in Celestia

There are 2 ways to view eclipses in Celestia, you can enter the exact time and try to find the eclipse or you can use the "Eclipse finder" which is in the "Navigation" drop down menu.

For practice have the Eclipse finder set to solar eclipse on Earth and press "Compute". Choose the 13 Nov 2012 eclipse and press the "Set date and go to planet" button then close the "Eclipse finder" window.

Use the left, right mouse buttons and the * key to explore. You can speed up time by pressing the "L" key, "K" will slow time down again and "J" will reverse time so you can quickly watch and re-watch the eclipse go forwards or backwards.

Use the "Eclipse finder" to view the lunar eclipse that you have researched to help fill in the worksheet.

Student Worksheet

Date of Lunar Eclipse (UT):

Continents that saw the entire eclipse:

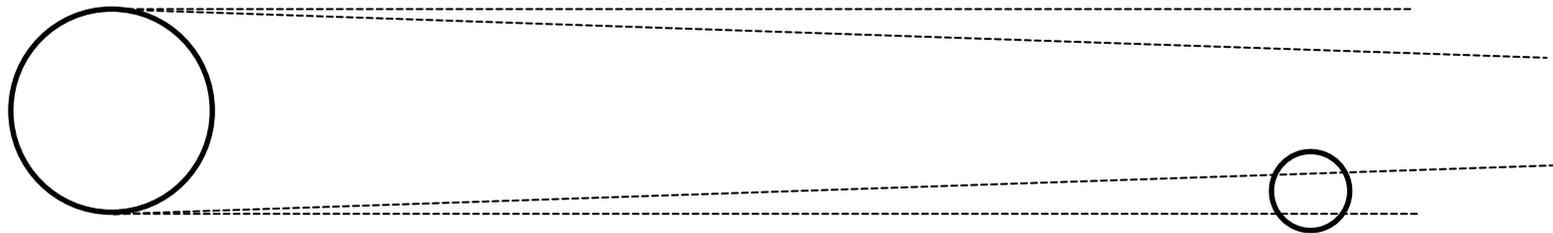
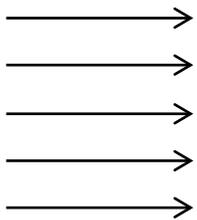
Definitions:

Penumbral Eclipse

Partial Lunar Eclipse

Total Lunar Eclipse

Part B - Diagram:



Phase	Researched Time		Stellarium		Celestia	
	UT	AEST	Time (UT or AEST)	Observations	Time (UT or AEST)	Observations
Penumbral Eclipse begins						
Partial Eclipse begins						
Total Eclipse begins						
Greatest Eclipse						
Total Eclipse ends						
Partial Eclipse ends						
Penumbral Eclipse ends						

Questions

1. What is the major difference between the viewpoints of the simulations?

2. What was the major difference in how the two simulations showed the eclipse and which one would be more realistic?

3. Which simulation was more accurate with respect to the times that the phases occurred and why might this happen?
