

Reading 11.3 – Lunar Eclipses

Getting Ready

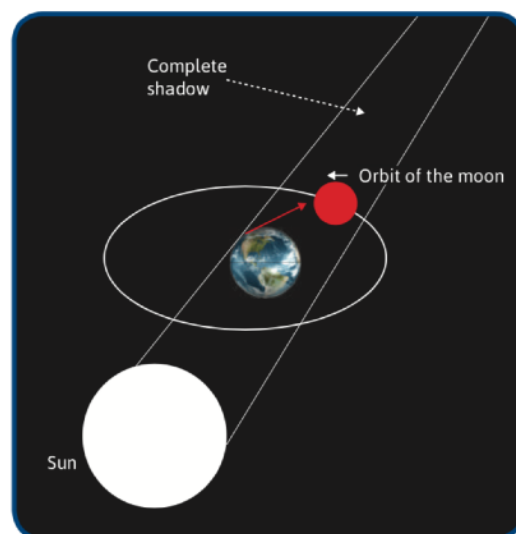
Every day the sun appears to rise in the east, go across the sky, and then set in the west. Every month the moon goes through its phases from new moon to full moon and back again. It all seems so ordered until something unexpected happens. One night the moon rises full and beautiful, but then, within a few minutes, it starts to change; it gets darker and darker, until it disappears. Then it turns red. A lunar eclipse occurs.

Our ancestors were intimidated by the sight of a lunar eclipse. They could not understand what was happening—they feared the end of the world was coming. They prayed and begged for the moon to return. Today, thanks to advances in scientific knowledge, we know what causes a lunar eclipse and we can enjoy its beauty, knowing it is a natural phenomenon which does not cause any harm. In this reading, you will learn about lunar eclipses: why, when, and how they happen.

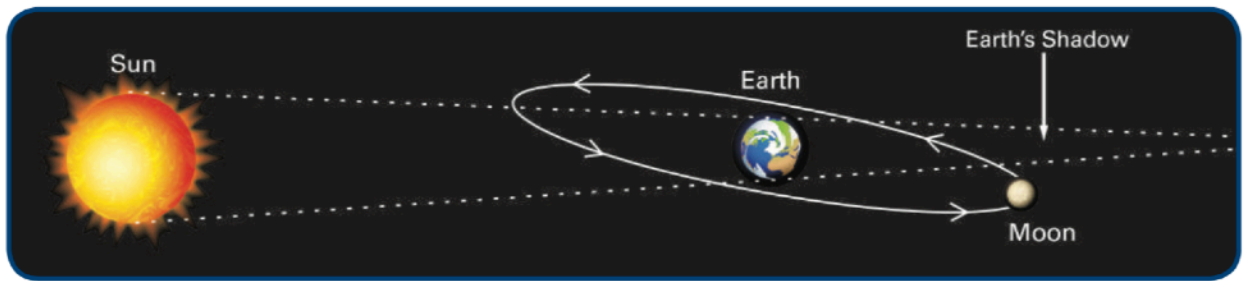
Earth's Shadow

A lunar eclipse takes place when there is a full moon. You learned before that a full moon exists when Earth is between the sun and the moon. If you look closely again at the model showing the phase of a full moon, you will notice something that does not make sense. If the sun, the earth, and the moon are all aligned and the moon is exactly behind Earth, how does the moon get lit by the sun? Shadows are actually dark areas caused by an object blocking light. Earth is an object that blocks the sun's light; therefore there is a shadowed area behind Earth. Why does the earth not always block the sun's light from reaching the moon? Is the moon not in Earth's shadow?

The truth is that every once in a while Earth does block the sun's light from reaching the moon, and this is what causes a lunar eclipse. How often do you think a lunar eclipse occurs? Explain.



Lunar eclipses can only happen when the moon is full and it passes behind Earth and into its shadow. If we have a full moon once every month, then we should also have a lunar eclipse once every month. This thought makes sense if you think of Earth's orbit and the moon's orbits as being in the same plane. However, the moon's orbit is inclined about five degrees to Earth's orbit. Look at this image carefully.



That means that most of the time, during full moon, the moon passes above or below Earth's shadow and misses it entirely. No eclipse takes place. Only once or twice a year, on average, does the moon pass through some portion of Earth's shadow, causing an eclipse to occur.

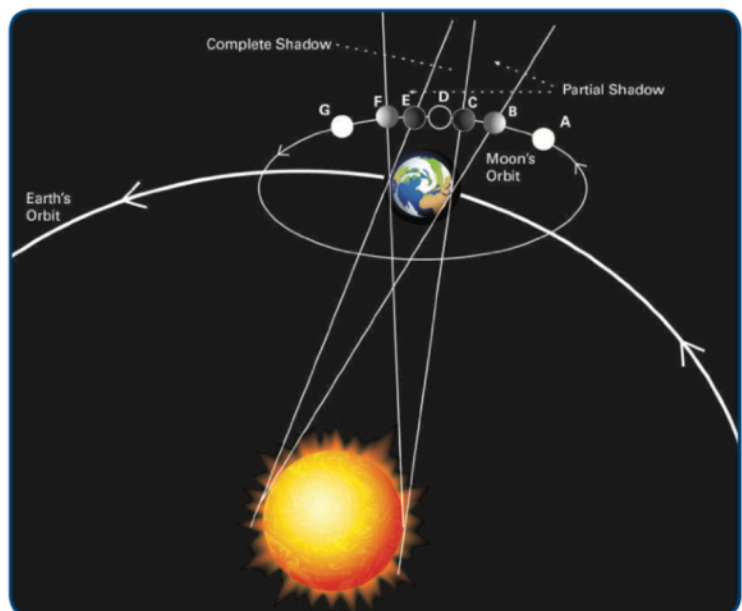
Imagine you are an astronaut standing on the moon during a total lunar eclipse and watching Earth. What would you see?

If during a full moon, the sun, the earth, and the moon are all one behind the other, how does Earth not block the sun's light from reaching the moon?

Types of Eclipses

When the moon is in Earth's shadow, no light from the sun reaches it, and thus, even though it is in the position of a full moon, it is not illuminated and cannot be seen. Because the moon is in constant motion around Earth, it gradually enters the shadowed area—slowly disappearing until it cannot be seen at all. Then as it keeps moving, it gradually leaves the shadowed area, entering the area where sunlight can reach it again—slowly reappearing. These changes— from brightness to darkness and back again into brightness—can take up to four hours.

Since the sun is a large light source, it creates shadows that have fully dark areas and partially dark areas. For this reason, the shadow of Earth is actually composed of two areas. Look at the model. The outer parts of the shadow are the partial shadow—areas where Earth blocks part but not all of the sun's rays. In contrast, the inner part of the shadow is a complete shadow where Earth blocks all direct sunlight.



Look at the model. In which positions is the moon (A, B, C, D, E, F, or G) fully shadowed? In which position or positions is it partially shadowed? Explain.

There are three types of lunar eclipse:

1. When the entire moon is in the fully shadowed area, it is fully darkened. This is called a total lunar eclipse.
2. When only part of the moon is in the fully shadowed area, a partial lunar eclipse occurs—part of the moon is dark and the other part is partially illuminated.
3. When the moon is completely in the partially shadowed area, it is still somewhat lighted. It is difficult to notice any change with the naked eye. We need professional telescopes to observe the changes in this kind of eclipse.

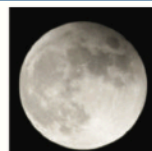
Following are photos of the moon in different types of eclipses. Please write beneath each one whether it is a total eclipse, a partial eclipse, or no eclipse. Also write which position of the moon in the previous model (A, B, C, D, E, F, or G) fits each photo.



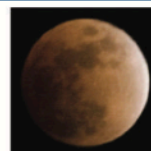
Partial Eclipse
Position C or E



Partial Eclipse
(kind of)
Position B or F



No Eclipse
Position A or G



Total Eclipse
Position D



Partial Eclipse
Position C or E

Why Does the Moon Turn Red during a Total Lunar Eclipse?

A very special feature of the total lunar eclipse is that after the moon has gone dark, it turns red. (You might want to watch an eclipse video and pay special attention to that.) The reddish color is a result of indirect lighting of the moon.

While the moon is completely within Earth's shadow, indirect sunlight still manages to reach and light it. This sunlight passes through the Earth's atmosphere. Then, it often changes direction by bouncing off the gas molecules in the air. Some of this light reaches the moon. The Earth's atmosphere acts like a filter,

absorbing many colors. The remaining light is colored reddish- orange. It is much dimmer than original white sunlight. This light reaches the moon and makes it appear red. The exact color and brightness of the light reaching the moon during an eclipse depends on the how much dust is in Earth's atmosphere. After a volcanic eruption, for example, a total eclipse is very dark because there is a lot of volcanic ash in Earth's atmosphere. During the total lunar eclipse of December 1992, the moon was nearly invisible because of dust from a volcano that erupted in the Philippines.

In this reading, you learned what causes a lunar eclipse and what kinds of eclipses there are. You saw that even an amazing event, such as a lunar eclipse, can be explained by a few scientific ideas you already know. This is an example of the power of science. A small number of ideas can explain a large variety of phenomena!

