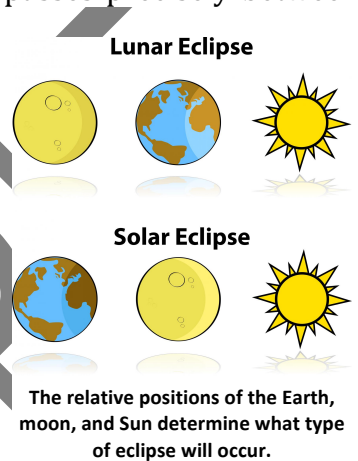


Solar and Lunar Eclipses



Eclipses occur due to shadowing of one celestial body by another.

between four and seven eclipses per year. Why not more? Eclipses do not occur for every new and full moon because the moon's orbit is slightly off in relation to the Earth's orbital plane about the Sun (the **ecliptic**). It orbits at about a 5° angle to our ecliptic. This means that the moon doesn't always line up with our ecliptic at the new and full moon. Only when it does, at points called **lunar nodes**, do we observe an eclipse. During all other new and full moons, the shadows cast by the moon just miss the Earth or the shadows cast by the Earth just miss the moon.



Solar Eclipses

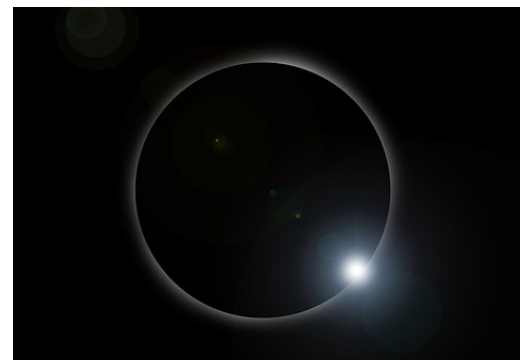
Solar eclipses can be total, partial, annular, or (rarely) a hybrid between annular and total. There are two to five solar eclipses per year, but some are only observable in places with few to no people. Solar eclipses are named for their darkest phase. If a total solar eclipse is experienced anywhere on Earth, it is considered a total solar eclipse, even though other parts of the world experience only a partial eclipse.



In a total solar eclipse, the moon completely blocks the Sun.

of the Sun. In the second contact phase, the moon covers the whole Sun, but some parts of the Sun remain visible. These visible sections result in such phenomena as the **diamond ring effect** and **Baily's beads**. The diamond ring effect occurs around 10-15 seconds prior to and following totality. In this phenomenon, the Sun's **corona** (outer atmosphere) can be seen around the edges of the moon as well as a single point of sunlight at one end, giving the appearance of a ring set with a single diamond. Baily's beads can be seen around 5 seconds prior to and following totality. They are small pinpoints of light

Total solar eclipses occur when the moon fully covers the Sun, casting the darkest part of its shadow (the **umbra**) on Earth. The darkest point of the eclipse is almost as dark as night, but can only be seen in a narrow band, generally around 160 kilometers (100 miles) wide. This darkest phase is called **totality**. There are five phases of a total solar eclipse: first contact, second contact, totality, third contact, and fourth contact. During **first contact**, the moon just begins to cover part



The diamond ring effect occurs before and after totality.

all around the moon, caused by sunlight shining through valleys and gaps between the moon's

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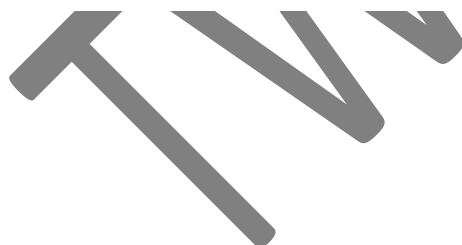
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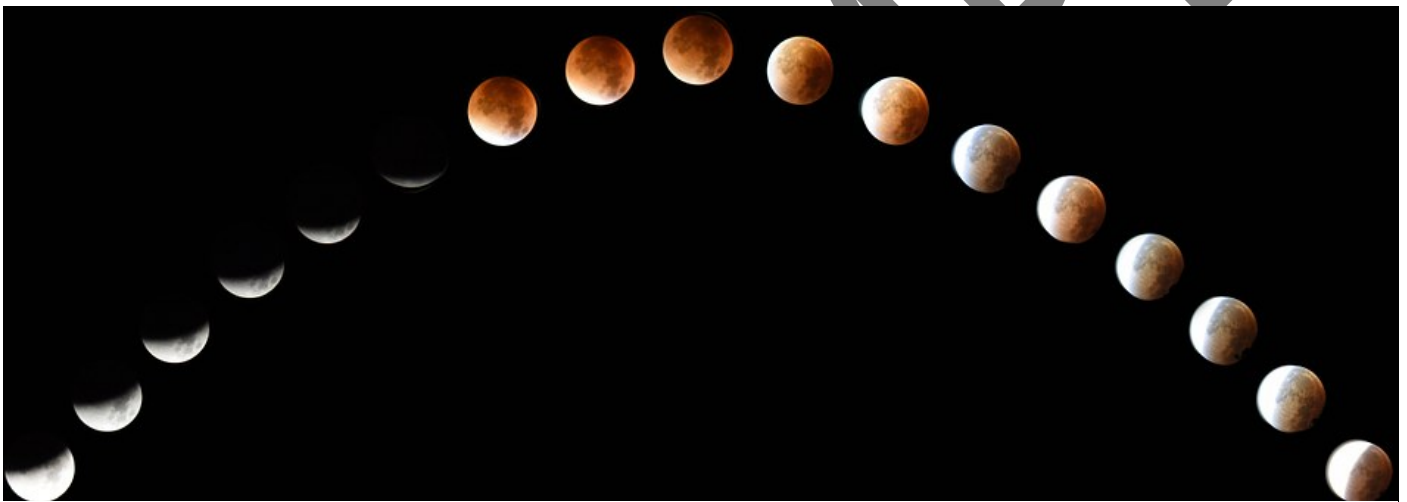


solar eclipse will occur on December 26, 2019, and will be visible throughout much of southeastern Europe, all of Asia, and part of western Africa and northern Australia. Its maximum will be visible in a narrow band through northeastern Saudi Arabia and Oman, southern India, and parts of Malaysia and Indonesia.

A **hybrid** solar eclipse can appear to be either an annular or total solar eclipse. Its appearance is dependent upon where an observer is along the eclipse's path. Because of the shape of the Earth, sometimes part of the eclipse path falls under the umbra of the moon and other parts fall outside that umbra. Just like annular or total eclipses, a hybrid eclipse begins as a partial eclipse. However, during its maximum, it will look different to people in different areas. Hybrid eclipses are relatively rare, usually occurring only once a decade.

Lunar Eclipses

Lunar eclipses can be total, partial, or penumbral. Lunar eclipses may not happen every year, but there can be up to three in a given year. Most years have two. Unlike solar eclipses, lunar eclipses are



In a total lunar eclipse, the Earth fully shadows the moon.

visible to the entire night side of the Earth.

Total lunar eclipses occur when the Earth completely shadows the surface of the moon, blocking all light from the Sun. It is reflected sunlight that causes the moon to shine; it does not produce its own light. In a total lunar eclipse, Earth's umbra falls on the moon, which remains visible due to the refraction of the Sun's rays through Earth's atmosphere. This results in indirect light falling on the moon, keeping it slightly illuminated. The atmosphere also only allows longer wavelengths to pass through. This causes the moon to appear red during most total lunar eclipses. However, dust and clouds within the atmosphere can filter out different wavelengths, resulting in the moon taking on yellow, orange, or brown hues. There are seven phases of a total lunar eclipse: beginning of the penumbral eclipse, beginning of the partial eclipse, beginning of the total eclipse, maximum eclipse, ending of the total eclipse, ending of the partial eclipse, and ending of the penumbral eclipse. During the **beginning of the penumbral eclipse**, the penumbral (outer) portion of Earth's shadow begins to cover part of the moon. This phase is generally slight and hard to see with the unaided eye. As the **partial eclipse begins**, the umbra of Earth's shadow begins to move over the moon. This phase is easier to see than the prior phase. During the **beginning of the total eclipse**, Earth's umbra fully covers the moon. It is during this phase that the color of the moon changes. At its **maximum**, the midpoint of the eclipse, the moon is completely in Earth's shadow. As the **total eclipse ends**, Earth's

umbra begins to move off the moon. Next, the **partial eclipse ends** as the umbra moves fully off the moon's surface. Finally, the **penumbral eclipse ends**, and Earth's shadow no longer covers any part

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Reading Comprehension Questions

1. What
2. What is a solar eclipse?
3. What
4. During what phases of the moon do eclipses occur?
5. Why
6. What
7. What is the darkest part of a shadow called?
8. What
9. What
10. What is an annular solar eclipse?
11. What are the three types of lunar eclipse?
12. What
13. What parts of the Earth's shadow falls on the moon during a partial lunar eclipse?
14. Why

Extension Question

15. The moon is gradually moving away from the Earth. What do you think this will mean for solar eclipses in the future?

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