An eclipse of the Sun (or solar eclipse) can only occur at New Moon when the Moon passes between Earth and Sun. If the Moon's shadow happens to fall upon Earth's surface at that time, we see some portion of the Sun's disk covered or 'eclipsed' by the Moon. Since New Moon occurs every 29 1/2 days, you might think that we should have a solar eclipse about once a month. Unfortunately, this doesn't happen because the Moon's orbit around Earth is tilted 5 degrees to Earth's orbit around the Sun. As a result, the Moon's shadow usually misses Earth as it passes above or below our planet at New Moon. At least twice a year, the geometry lines up just right so that some part of the Moon's shadow falls on Earth's surface and an eclipse of the Sun is seen from that region.

The Moon's shadow actually has two parts:

- **1. Penumbra**
  - The Moon's faint outer shadow.
  - Partial solar eclipses are visible from within the penumbral shadow.

- **2. Umbra**
  - The Moon's dark inner shadow.
  - Total solar eclipses are visible from within the umbral shadow.

When the Moon's penumbral shadow strikes Earth, we see a partial eclipse of the Sun from that region. Partial eclipses are dangerous to look at because the un-eclipsed part of the Sun is still very bright. You must use special filters or a home-made pinhole projector to safely watch a partial eclipse of the Sun (see: [Observing Solar Eclipses Safely](http://www.mreclipse.com/Special/SEprimer.html)).

What is the difference between a solar eclipse and a lunar eclipse? A lunar eclipse is an eclipse of the Moon rather than the Sun. It happens when the Moon passes through Earth's shadow. This is only possible when the Moon is in the Full Moon phase.
10,000 miles long but only about 100 miles wide. It covers less than 1% of Earth's entire surface area. In order to see the Sun become completely eclipsed by the Moon, you must be somewhere inside the narrow path of totality.

The path of a total eclipse can cross any part of Earth. Even the North and South Poles get a total eclipse sooner or later. Just one total eclipse occurs each year or two. Since each total eclipse is only visible from a very narrow track, it is rare to see one from any single location. You'd have to wait an average of 375 years to see two total eclipses from one place. Of course, the interval between seeing two eclipses from one particular place can be shorter or longer. For instance, the last total eclipse visible from Princeton, NJ was in 1478 and the next is in 2079. That's an interval of 601 years. However, the following total eclipse from Princeton is in 2144, after a period of only 65 years.

![Visual B: 2006 Total Solar Eclipse](image)


**Awesome Totality**

The total phase of a solar eclipse is very brief. It rarely lasts more than several minutes. Nevertheless, it is considered to be one of the most awe inspiring spectacles in all of nature. The sky takes on an eerie twilight as the Sun's bright face is replaced by the black disk of the Moon. Surrounding the Moon is a beautiful gossemer halo. This is the Sun's spectacular solar corona, a super heated plasma two million degrees in temperature. The corona can only be seen during the few brief minutes of totality. To witness such an event is a singularly memorable experience which cannot be conveyed adequately through words or photographs.

![Visual C: Annular Solar Eclipse and the Path of Annularity](image)

**Visual C: Annular Solar Eclipse and the Path of Annularity**
Annular Solar Eclipses

Unfortunately, not every eclipse of the Sun is a total eclipse. Sometimes, the Moon is too small to cover the entire Sun's disk. To understand why, we need to talk about the Moon's orbit around Earth. That orbit is not perfectly round but is oval or elliptical in shape. As the Moon orbits our planet, it's distance varies from about 221,000 to 252,000 miles. This 13% variation in the Moon's distance makes the Moon's apparent size in our sky vary by the same amount. When the Moon is on the near side of its orbit, the Moon appears larger than the Sun. If an eclipse occurs at that time, it will be a total eclipse. However, if an eclipse occurs while the Moon is on the far side of its orbit, the Moon appears smaller than the Sun and can't completely cover it. Looking down from space, we would see that the Moon's umbral shadow is not long enough to reach Earth. Instead, the antumbra shadow reaches Earth.

The track of the antumbra is called the path of annularity. If you are within this path, you will see an eclipse where a ring or annulus of bright sunlight surrounds the Moon at the maximum phase. Annular eclipses are also dangerous to look directly with the naked eye. You must use the same precautions needed for safely viewing a partial eclipse of the Sun (see: Observing Solar Eclipses Safely).

Annularity can last as long as a dozen minutes, but is more typically about half that length. Since the annular phase is so bright, the Sun's gorgeous corona remains hidden from view. But annular eclipses are still quite interesting to watch.

Visual D: 2005 Annular Solar Eclipse: This sequence shows the eclipse just before, during and after annularity.

Questions for Eclipses

1. Which idea from the text does Visual A illustrate?
   a. “When the Moon's penumbral shadow strikes Earth, we see a partial eclipse of the Sun from that region.”
   b. “As a result, the Moon's shadow usually misses Earth as it passes above or below our planet at New Moon.”
   c. “If the Moon's inner or umbral shadow sweeps across Earth's surface, then a total eclipse of the Sun is seen. The track of the Moon's umbral shadow across Earth is called the Path of Totality.”
   d. “Partial eclipses are dangerous to look at because the un-eclipsed part of the Sun is still very bright.”

I chose ________ because ______________________________________________________________
2. **What is the purpose of including Visual B?**

   a. To illustrate the phase of a total eclipse is brief.

   b. To illustrate a solar corona is a beautiful halo surrounding the moon which is caused by a total solar eclipse.

   c. To illustrate a memorable experience that cannot be explained through words or pictures.

   d. To illustrate how the sky takes on an eerie twilight.

   I chose _______ because ________________________________________________________________

3. **How do the photographs in Visual C and D affect the explanation of the text?**

   a. The images show a path of annularity, and the sequence of this type of eclipse.

   b. The images show the sun’s gorgeous corona.

   c. The images show the track of the umbra is called the path of annularity.

   d. The images show an eclipse where a ring of bright sunlight surrounds the Moon during an annularity.

   I chose _______ because ________________________________________________________________

4. **How does Visual A help to develop the main idea of the text? Support your answer with evidence from the text.**

5. **What is the relationship between Visual C and Visual D, and how do these visuals affect the explanation of the text? Support your answer with evidence from the text.**