13.2: Modeling a Lunar Eclipse

At first glance, our lunar eclipse activity will look much like the solar eclipse (Activity #34), but there are subtle differences worth noting. We will use the same rubber T-ball model Earth and foam core lunar orbit ring that we used last time, but this time we will be using a paper cone to represent the Earth's shadow instead of the Moon's shadow.

Academic Standards

Science and Engineering Practices

- Developing and using models.
- Using mathematics.
- Constructing explanations.
- Argument from evidence.

Crosscutting Concepts

- Patterns in nature.
- Cause and effect.
- Systems and system models.
- Structure and function.
- Stability and change.

Next Generation Science Standards

- Space systems (K-5, 6-8, 9-12).
- Structure and function (K-5, 6-8, 9-12).
- Waves and electromagnetic radiation (6-8, 9-12).
- The Earth-Moon system (6-8, 9-12).

For the Educator

Facts you need to know

1. Lunar eclipses are far easier to observe than solar eclipses, this depends upon two facts:
    - First, the Earth's shadow is far larger than the Moon's shadow. The Moon's shadow tapers down to just a few miles wide by the time it strikes the Earth in a solar eclipse. The Earth's shadow is large enough to engulf the entire Moon by the time it travels the same distance.
    - Because the entire Moon is covered by the Earth's shadow, and the eclipse takes several hours to finish, at least 75% of the globe can witness every lunar eclipse.
2. Lunar eclipses are colorful – and different every time. The Earth's atmosphere bends the light as it passes through the atmosphere, and filters out all the blue and green portions of the spectrum. We see this when we enjoy colorful sunsets! It is these 'sunset colors' that illuminate the Moon during totality making the Moon appear anywhere from a pale orange to a deep red color.

Teaching and Pedagogy

It won't take long for your students to figure out that a lunar eclipse happens when the full Moon passes through the Earth's shadow at the node of the orbit. There is however, more to learn here. Set the model up with the Moon on its orbital ring inside the Earth's shadow. Ask your students: "What is being eclipsed?" In other words, what is going dark? The Moon is obviously going dark here, but how? The Moon experiences darkness as its ***orbital motion*** carries it through the Earth's massive shadow! This shadow is large and it takes several hours for the Moon to pass completely through the Earth's shadow. Unlike a total solar eclipse which lasts just a few minutes, the total lunar eclipse can last ***more than two hours!***

Take another look at your model and ask your students: "Who can see this eclipse?" With the solar eclipse, only those people who were exactly underneath the point of the Moon's shadow could see the total event. But with the lunar eclipse, ***half the Earth*** is inside that giant shadow! And since the total eclipse event, from the Moon's first contact with the Earth's shadow until it finally passes out of the shadow completely can take 5-6 hours, ***even more people*** rotate into position to see the lunar eclipse as it wears on. Generally speaking, about 75% of the surface of the Earth can see at least some part of a lunar eclipse! A lunar eclipse is truly

an eclipse for everyone! There is no need to travel to exotic locations or arrive at a precise time; the long lasting lunar eclipse is a show that is usually visible right in your back yard and lasts for many hours for you to enjoy.

We are not completely done with eclipses yet! Our last eclipse activity is a short one, and easy to make. This one will show us why eclipses are so rare, and so special

Student Outcomes

What will the student discover?

1. There is a substantial difference between a solar and lunar eclipse. Timing, appearance, ease of observing all differ – and most of the difference has to do with the Earth's atmosphere, and the size of the Earth's shadow in space.
2. Where the solar eclipse is a blackout of the Sun, the lunar eclipse never totally darkens the Moon's disk. The students will discover the role of the Earth's atmosphere in this phenomenon.

What will your students learn about science?

1. The power and flexibility of the scientific model to explain what we see in the night sky should be apparent to your students by this point in the course.
2. The student has learned that scientific models are flexible – not rigid. It is always possible to go back to our model, modify it, add new features, even change it as required by new data and observations. The science is ***never settled.***

Conducting the Activity

Materials

1. All materials from the solar eclipse model (Activity #34). You will probably want to start with a new marble, but you can keep the marble with the paper shadow cone on it for more realism if you wish.
2. Another sheet of black construction paper (any dark color works).

Exploring the Lunar Eclipse Model

1. Place your Earth model on the sunshine arrow as you did before in Activity #28. If you have marked the lunar orbit with lunar phases, make sure that the new moon phase is on the same side as the base of your solar arrow, and the full moon phase is on the pointed side of the solar arrow.
2. You will be using paper to make another shadow cone, but this time, the cone will be moving away from the Earth in the direction that the arrow is pointing. The Earth's shadow cone only needs to go out as far as the lunar orbit ring. This will be more of a paper tube than a paper cone, the Earth is much larger than the Moon, and the Earth's shadow does not taper very much in that distance.
3. Take your construction paper and cut it to the correct length to fit just inside the lunar orbit ring. Wrap the paper around the Earth to form a tapering tube and tape it to the Earth model with masking tape.

Discussion Questions

1. Why is the lunar eclipse visible to almost the entire Earth when it happens?
    - **Answer:** The Earth's shadow is much larger than the Moon's. As the Moon moves through the shadow, it is visible from most of the Earth's surface. As the Earth rotates, almost 75% of the planet can see at least some of the eclipse.
2. Why are lunar eclipses less rare than solar eclipses?
    - **Answer:** The large size of the Earth's shadow makes it much easier for the Moon to be eclipsed than the Earth.
    - **Answer:** The eclipse is also visible to most of the Earth making it easy to see without traveling to a special location.
    - **Answer:** The lunar eclipse lasts for hours, compared to just minutes for a total solar eclipse. This also makes it much easier to spot.

Supplemental Materials

Going Deeper

Unlike a solar eclipse, the lunar eclipse is relatively common and any given eclipse is visible over 70% of the Earth or more. Both of these factors make it much easier to see a lunar eclipse. Unlike a solar eclipse however, a lunar eclipse always occurs at night. Sometimes we are lucky and get an eclipse that occurs shortly after dark, other times we must stay up late (or get up very early!) to see a lunar eclipse.

The timing means that if you are to have students observe a lunar eclipse, you will have to get parents involved and make the event a 'Family Eclipse Night' at your school. The effort will be well worth it! There is also the safety factor to consider – unlike a solar eclipse, no one needs special equipment to look at and enjoy a lunar eclipse!

Being an Astronomer

Lunar eclipses are not that rare, chances are you will not have to wait more than 1-2 years to see the next one. Be sure you investigate and find out when your next lunar eclipse will be!

Work with your parent groups, PTA, and local astronomy club. Chances are that your local high school football field is an excellent place to hold an eclipse party! Parents and students can bring lawn chairs and blankets to sit on, and football stadiums generally have bathroom facilities and even snack shop areas for preparing food for the hungry observers!

Make your next lunar eclipse an exciting night for everyone in your community!

Being a Scientist

Photographing and recording an eclipse can be an exciting event. You can photograph an eclipse with a simple camera, even a cell phone camera will do.

Never the less, photographing the eclipse through a telescope will give you a much better photograph to enjoy and study later. Once again, working with your local astronomy club will be a terrific benefit.

Following Up

The color of the Moon during a lunar eclipse can vary from a bright orange to a deep red. In fact, when the Moon enters the Earth's shadow, the only light that falls on the Moon is ***sunset light***. The reds and oranges that we see at sunset happen because our atmosphere scatters and filters out blue, green, and yellow colors – only the red light bends easily around the curve of the Earth, this is why sunsets are red.

With the red color of sunset illuminating the Moon, it changes color to a lovely orange-red, and the exact color of the Moon during a lunar eclipse is always different; just like the exact color of tomorrow's sunset will be different from today's.
