Name: _____
Lab Section: _____

Solar and Lunar Eclipses

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Goals

To investigate and understand why solar and lunar eclipses occur and the mechanics of how they work. To learn the differences between lunar and solar eclipses.

Materials

♦ *Starry Night* computer software
♦ Pencil

Introduction

People have been observing both lunar and solar eclipses for centuries. In the past, eclipses were thought to be heavenly signs that foretell the future or dire omens. We now know that an eclipse is simply the result of a special alignment between the Sun, Moon, and Earth.

During a lunar eclipse, the Moon is opposite the Sun in its orbit around Earth which allows it to move through the Earth's shadow creating the eclipse. The Earth's shadow consists of two parts: the **umbra** is the small, inner part of the shadow and blocks the most light, while the **penumbra** is the larger, outer part of the shadow and is not as dark. As the Moon moves through the Earth's shadow it will become darker and take on a red hue. This is due to sunlight from the day side of Earth scattering around the edges of the Earth's atmosphere and onto the surface of the Moon. Even though we have a full Moon every month, we do not have a lunar eclipse every month. This is because the plane of the Moon's orbit around the Earth is tilted about **5°** with respect to the Earth's plane of orbit around the Sun, meaning it will not always be correctly lined up to pass through Earth's shadow. There are three types of lunar eclipses: **total**, **partial**, and **penumbral**.

During a solar eclipse, the Moon is on the same side of the Earth as the Sun. As the Moon moves in front of the Sun it causes a shadow to be cast on the Earth. The Moon's shadow has the same components as the Earth's shadow. During the short time that the Sun is totally eclipsed, the corona, the extreme outer layer of the Sun's atmosphere, is easily visible. There are three types of solar eclipses: **total**, **partial**, and **annular**.

Today, we will investigate a total and partial lunar eclipse, and a total and annular solar eclipse to learn how these astronomical events work and what differences exist between them.

Part 1 – Lunar Eclipses

Begin by opening the Starry Night program on the desktop and set up the program to view a total lunar eclipse by following these steps:

♦ Go to **Options** → **Solar System** → **Planets-Moons...**
♦ Make sure that the **'Show Earth/Moon shadow outlines', 'Umbra Cone'** and '**Labels**' boxes are checked → Click **OK**
♦ Set your viewing location to **Atlanta, GA**
♦ Make sure the **Time Flow Rate** is stopped for now. Set the date and time to **February 20th, 2008** at **8:40 pm.** (Click on the date/time to change it).
♦ Click on the **Find** tab on the left hand side of the screen and check **Moon** (in the first column).
♦ Click the small blue arrow next to the check box and choose **Centre**
♦ Go to **View** → **Hide Horizon**
♦ Set the **Zoom** to **7°** (also called the FOV, or field of view). You will need to scroll down to **other FOV** to find 7º**.**

You should now be able to see the Moon centered on your screen and the outline of the Earth's shadow next to it. You can collapse the Find tab back to the left to give you a larger viewing window.

Set the **Time Flow Rate** to **300x** and watch the Moon move through the Earth's shadow. You can adjust the **Time Flow Rate** and move backward and forward as desired to answer the following questions.

1. What phase is the Moon? In your own words AND with a simple diagram, explain why this phase makes sense given that we are viewing a lunar eclipse.

2. How long does the entire lunar eclipse last? Round to the nearest half-hour.

3. How long is the Moon totally eclipsed (completely inside the umbra)? Round to the nearest half-hour.

4. From about what fraction of the Earth's surface can this eclipse be viewed?

5. In words, please explain why there isn't a lunar eclipse every month? Draw a simple diagram to illustrate your reasoning.

Next, let's look at a partial lunar eclipse. Set the time and date to **December 9th, 1973** at **7:40 p.m.** Set the time moving forward and watch the eclipse.

6. Why is this eclipse considered a partial lunar eclipse? (Hint: use Google if you are still unsure of what a partial lunar eclipse is).

7. How long does this eclipse last? Round to the nearest half-hour.

You can see that there is a dramatic difference in how dark the Moon gets between a total and partial eclipse. Some partial (and penumbral) eclipses can be difficult to detect with the naked eye.

Part 2 – Solar Eclipses

Now, we want to investigate solar eclipses. Set up the program to view a solar eclipse by following these steps:

♦ Set the date and time to **June 24th, 1778** at **9:15 am**
♦ In the **Find** tab check the **Sun** and the **Moon** and **Centre** the **Sun**
♦ If you can still see stars go to **View** and make sure **Show Daylight** is on.
♦ Click the blue arrow next to the Sun and under **Halo Effects** check **Never**, and make sure **Lens Flare** is unchecked
♦ Set **Zoom** to **7°** and **Time Flow Rate** to **300x**

Set time moving forward and watch the solar eclipse.

8. What phase is the Moon? In your own words AND with a simple diagram, explain why this phase makes sense given that we are viewing a solar eclipse.

9. How long does the entire eclipse last? Round to the nearest half-hour.

10. How long is the Sun *completely* eclipsed? *(Set the **Time Flow Rate** to **30x** and use single steps forward and back to get an accurate measurement of this.)*

11. Why are solar eclipses useful to astronomers trying to study the Sun? Hint: What part of the Sun is visible during a total solar eclipse?

12. Record the current distance *from observer* to the Moon. This information can be found by hovering your cursor over the Moon.

13. How does the size of the Moon in the sky compare to the size of the Sun in the sky? Thinking about the size of the Earth's shadow in the sky from the lunar eclipse, why do lunar eclipses last longer than solar eclipses?

Now, let's view the eclipse happening from the Moon by following these steps:

♦ Go to **Options** and choose **Viewing Location**
♦ Set the location to view from: **The surface of**...**Moon**
♦ Use the **Find** tab to **Centre** the **Earth**
♦ **Zoom** in until you can clearly see the Earth and the Moon's shadow
♦ Note: the time will now be displayed in UT, or universal time.

Watch the eclipse happen again from space.

14. Would everyone on the daylight side of Earth be able to see this solar eclipse? Why or why not?

15. From what continents could one view the *total* eclipse?

16. Why isn't there a solar eclipse every month?

Finally, let's look at another type of solar eclipse called an annular eclipse.

♦ Change the **viewing location** back to **the surface of** the **Earth** and go to **Albuquerque, NM**
♦ Set the date and time to **May 20th, 2012** at **6:20 pm**
♦ Use the **Find** tab to **Centre** the **Sun** and set the **Zoom** to **3°**

Set time moving forward and watch the eclipse happen.

17. What is different about this eclipse? Pay close attention to what the Sun looks like when the Moon is centered on top of it.

18. The term 'annular' means ring-shaped. Why does it make sense to call this eclipse an annular eclipse?

19. Record the current distance *from observer* to the Moon. This information can be found by hovering your cursor over the Moon.

20. For which of these two eclipses is the distance to the Moon greater? What feature of the Moon's orbit causes its distance from the Earth to vary with time? How does this variation cause some solar eclipses to be annular and some not?