Makeup Lab: Eclipses

1 Lab Overview

This take-home lab is meant to act as extra credit or as a make up for any absences from the in-person labs. It therefore will rely on some independent research, and will include writing/essay-style questions. Feel free to follow the included links, or to look elsewhere online— but, make sure that all writing is your own original work. Don't copy any text without proper attribution.

- NASA Eclipse guide; Wikipedia pages for lunar and solar eclipses

2 Eclipse Geometry

Eclipses refer to times when three bodies in space all fall on the same plane - the exoplanet transits we considered a few weeks ago can be classified as eclipses, since during transit the planet-star-Earth all fall on the same plane. Within our solar system, eclipses fall into two flavors: lunar eclipses, when the Earth falls between the moon and the sun, and much more dramatic solar eclipses, when the moon falls between the Earth and the sun.

With information from the above pages (or other sources), answer the following:

1. During what moon phase are lunar eclipses possible, new or full moons?
2. During what moon phase are solar eclipses possible, new or full moons?
3. Why don't we see a lunar and solar eclipse every month?

With the basics of eclipse geometry covered, let's visually combine those answers. Create diagrams of the following situations:

4. A top-down view of the Sun, Moon, and Earth during a *lunar eclipse* happening on the autumnal equinox. Include the locations of each body, circles marking the paths of their orbits, and labels for where the Earth would be at autumnal equinox, spring equinox, summer solstice, and winter solstice. The convention of top-down views of the Earth's orbit is to place the spring equinox along the positive X axis and assume the Earth moves counterclockwise.
5. A top-down view of the Sun, Moon, and Earth during a *solar eclipse* happening on the summer solstice. Include all the same labels as before.

Lastly, let's think about the angular sizes of the Moon and the Sun. The formula for angular size is $\delta = 2\arctan(D/2d)$, where d is the distance from the observer to the object, and D is the diameter of the object. δ will be in degrees.

6. Sketch a diagram of the geometry of the equation, to prove to yourself that the equation is correct. *Hint: think about right triangles!*

7. The Moon and Sun appear to have the same angular sizes during a solar eclipse, so that the moon nearly perfectly eclipses the Sun. Show this numerically using the equation to calculate angular sizes. Feel free to look up the absolute sizes/distances of the Moon and Sun.

3 Lunar Eclipse Colors

Solar eclipses are dramatic, beautiful events where the sun seems to disappear in the middle of the day. Lunar eclipses are more subtle, but still very strange: the moon doesn't disappear, it just gets darker, then turns a dark red.

8. Explain why the moon turns red, not some other color.

9. If the Earth didn't have an atmosphere, what would the moon look like during a lunar eclipse?

4 Planning for the Next Eclipse

On August 12th, 2026, a total solar eclipse will be visible along a narrow corridor running across parts of Russia, Greenland, Iceland, and Spain.

10. Using information from timeanddate or elsewhere, write a ∼500 word hypothetical plan to view the eclipse. Be sure to include:

    - Where you would go. When deciding, consider the visibility of the eclipse from your location, the feasibility of getting there, how cloudy it is in August historically (it'd be sad to plan a trip far away, only to encounter clouds!), and if there's any other draws to the area besides the eclipse.
    - A timeline of what you would see in the sky- when would you notice something weird was happening with the naked eye? When would you notice something was weird if using eclipse glasses?
    - What you would see during the eclipse: what is the outermost edge of the sun called? What does it look like? What about the stars?
    - Any equipment you would need to observe the sun.
    - This isn't strictly part of a plan, but it'd be fun to imagine: if you were standing on the moon looking up at the Earth during this event, what would you see? Why?

5 Conclusions

11. What was your favorite and least favorite parts of this lab?
12. What is a question you still have at the end of this lab?