PLANETARIUM LESSON PLAN: ECLIPSE DEMONSTRATION

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Objectives

This lesson will:

1. Demonstrate the scale and tilt of the Moon's orbit.
2. Demonstrate a lunar eclipse.
3. Demonstrate a solar eclipse.
4. Show that eclipses are rare, due to the scale and tilt of the Moon's orbit.

Target Audiences

- 5th Grade students (and up) studying eclipses and phases of the Moon.
- Supports NGSS DCI: MS-ESS1-1 Earth's Place in the Universe.
- General audiences with an interest in eclipses and phases of the Moon.

Materials and Participants

- One lamp or wide angle spotlight.
- One Earth globe, ideally no larger than 1/60th the width of the stage area.
- One moon globe, scaled to the Earth globe (approximately 1/4 the diameter of the Earth globe).
- One volunteer to hold the lamp.
- One volunteer to hold the Earth globe.
- One volunteer to hold the Moon globe.

Procedure

1. Begin by recruiting volunteers from the audience, one to hold the lamp, one to hold the Earth globe, and one to hold the Moon globe.
2. Position the lamp holder on one side of the stage. Ask the lamp holder to keep the lamp pointed toward the Earth globe.
3. Position the Earth holder at center stage. Ask the Earth holder to face the audience and hold the Earth globe steady.

Note: The Earth holder should be positioned such that the Moon holder will reach a distance of 30 Earth globe diameters to demonstrate the Earth-Moon distance. Depending on the relative scale of the globes, you may need to adjust the positions of the volunteers.

4. Position the Moon holder next to the Earth holder, opposite the lamp. Ask the Moon holder to face the audience and hold the Moon globe steady, nearly touching the Earth globe.

5. Explain that the Earth and Moon globes are to scale—"if the Earth was this big, the Moon would be about this big."

6. Ask the audience if the Moon orbits this close to the Earth. (The two globes are nearly touching, so they should say "no.")

7. Ask the Moon holder to begin moving away from the Earth holder.

8. As the Moon holder moves away from the Earth holder, ask the audience to give a thumbs-up when they think the Earth-Moon distance is correct. (Many will give a thumbs-up when the Moon is a few feet from the Earth, as commonly illustrated in books and other media.)

9. Encourage the Moon holder to continue moving until the Earth-Moon distance is correct (about 30 times the diameter of the Earth globe).

10. Explain that the Earth-Moon distance is about 30 times the Earth's diameter.

11. Explain that the Earth-Sun distance is about 400 times the Earth-Moon distance. (It would be useful to identify some landmark outside the theater to illustrate the scale of the Earth-Sun distance.)

12. Ask the audience to recall that the Moon orbits the Earth and ask the audience to imagine the Moon doing so (or if space allows, ask the Moon holder to orbit the Earth globe at the correct distance).

13. Explain that a lunar eclipse occurs when the Moon passes through Earth's shadow.

14. Ask the Moon holder to pass the Moon globe through the shadow of the Earth globe.

15. Ask the audience how often they think the Moon crosses into Earth's shadow during a typical lunar orbit. (Some audience members may say the Moon crosses Earth's shadow once per orbit.)

16. Remind the audience that the Moon takes almost four weeks to orbit the Earth and that the Moon moves quickly enough to pass through Earth's shadow in a matter of hours.

17. Ask the Moon holder to move the Moon globe just outside the shadow.

18. Ask the audience to imagine the Moon phase a person on the Earth globe would see (Full Moon is the correct response).

19. Ask the audience why we don't see a lunar eclipse during every full moon—“If this is the position of a full moon, why don't we see an eclipse during every full moon?”

20. Indicate that the Moon's orbit is tilted about 5º, causing the Moon to pass above or below Earth's shadow most of the time.

21. Ask the Moon holder to hold the Moon globe above his or her head to illustrate the tilt of the Moon's orbit. (This should miss the shadow completely; if not, the lamp is too close to the Earth globe.)

22. Ask the Moon holder to lower the Moon globe, moving it below the Earth globe's shadow.

23. Explain that the scale and tilt of the orbit make lunar and solar eclipses eclipses rare—“The size and tilt of the Moon's orbit cause it to miss Earth's shadow most of the time. The same is true for solar eclipses.”

24. Ask the Earth and Moon holders to move, so the Moon holder is now between the lamp and the Earth holder, then ask the Moon holder to cause a solar eclipse. (The Moon holder should move the Moon globe so a shadow is cast on the Earth globe. Ideally, the shadow should not cover the entire Earth globe; if it does, the lamp is too close to the Moon globe.)

25. Ask the audience to observe that the shadow does not cover the entire Earth globe.

26. Explain that only the people located in the Moon's shadow on Earth will see the solar eclipse; to everyone else, it will be a sunny day.

27. Ask the Moon holder to move the Moon globe so it is no longer casting a shadow on the Earth globe.

28. Ask the audience to imagine the Moon phase a person on the Earth globe would see (New Moon is the correct response).

29. Remind the audience that the tilt of the Moon's orbit also makes solar eclipses rare.

30. Ask the Moon holder to again demonstrate the tilt of the Moon by holding the Moon globe high and low, such that the Moon globe does not cast a shadow on the Earth globe.

31. Recap for the audience: “The tilt of the Moon's orbit is why eclipses are rare and special—we only see eclipses when the Earth, Moon, and Sun are in alignment and this only happens a few times each year.”

32. Thank and dismiss the volunteers. Discuss audience questions as time allows.

Questions for Discussion and Evaluation

1. What phase would the Moon be in during a lunar eclipse? (Full Moon.) Would it always be a full moon? (Yes.)

2. What phase would the Moon be in during a solar eclipse? (New Moon.) Would it always be a new moon? (Yes.)

3. If a lunar eclipse was happening, where would you need to be on Earth to see it? (Anyone on the side of the Earth facing the Moon can observe a lunar eclipse.)

4. If a solar eclipse was happening, where would you need to be on Earth to see it? (Only the people in the path of the Moon's shadow can observe a solar eclipse—the closer you are to the center of the shadow path, the deeper the eclipse will be.)

Resources and Additional Reading

Comins, N. (2001). *Heavenly Errors: Misconceptions about the real nature of the universe*, New York, NY: Columbia University Press.

Kavanagh, C., Agan, L., and Sneider, C., (2005). *Learning about Phases of the Moon and Eclipses: A Guide for Teachers and Curriculum Developers,* The Astronomy Education Review, Volume 4, p. 19–52.

Schneps, M. H., Sadler, P. M., Woll, S., & Crouse, L. (1989). *A private universe*. S. Burlington, VT: Annenberg Media. http://www.learner.org/resources/series28.html

Trundle, K.C., Atwood, R.K., & Christopher, J.E., (2002). *Preservice Elementary Teachers' Conceptions of Moon Phases Before and After Instruction,* Journal of Research in Science Teaching, 39(7) 633.

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