1.E: Earth, Moon, and Sky (Exercise)

For Further Exploration

Articles

Bakich, M. “Your Twenty-Year Solar Eclipse Planner.” *Astronomy* (October 2008): 74. Describes the circumstances of upcoming total eclipses of the Sun.

Coco, M. “Not Just Another Pretty Phase.” *Astronomy* (July 1994): 76. Moon phases explained.

Espenak, F., & Anderson, J. “Get Ready for America’s Coast to Coast Experience.” *Sky & Telescope* (February 2016): 22.

Gingerich, O. “Notes on the Gregorian Calendar Reform.” *Sky & Telescope*(December 1982): 530.

Kluepfel, C. “How Accurate Is the Gregorian Calendar?” *Sky & Telescope*(November 1982): 417.

Krupp, E. “Calendar Worlds.” *Sky & Telescope* (January 2001): 103. On how the days of the week got their names.

Krupp, E. “Behind the Curve.” *Sky & Telescope* (September 2002): 68. On the reform of the calendar by Pope Gregory XIII.

MacRobert, A., & Sinnott, R. “Young Moon Hunting.” *Sky & Telescope*(February 2005): 75. Hints for finding the Moon as soon after its new phase as possible.

Pasachoff, J. “Solar Eclipse Science: Still Going Strong.” *Sky & Telescope*(February 2001): 40. On what we have learned and are still learning from eclipses.

Regas, D. “The Quest for Totality.” *Sky & Telescope* (July 2012): 36. On eclipse chasing as a hobby.

Schaefer, B. “Lunar Eclipses That Changed the World.” *Sky & Telescope*(December 1992): 639.

Schaefer, B. “Solar Eclipses That Changed the World.” *Sky & Telescope*(May 1994): 36.

Websites

Ancient Observatories, Timeless Knowledge (Stanford Solar Center): http://solar-center.stanford.edu/AO/. An introduction to ancient sites where the movements of celestial objects were tracked over the years (with a special focus on tracking the Sun).

Astronomical Data Services: aa.usno.navy.mil/data/index.php. This rich site from the U.S. Naval Observatory has information about Earth, the Moon, and the sky, with tables and online calculators.

Calendars through the Ages: http://www.webexhibits.org/calendars/index.html. Like a good museum exhibit on the Web.

Calendar Zone: http://www.calendarzone.com/. Everything you wanted to ask or know about calendars and timekeeping, with links from around the world.

Eclipse 2017 Information and Safe Viewing Instructions: www.nsta.org/publications/pre...enceInsert.pdf.

Eclipse Maps: http://www.eclipse-maps.com/Eclipse-Maps/Welcome.html. Michael Zeiler specializes in presenting helpful and interactive maps of where solar eclipses will be visible

Eclipse Predictions: astro.unl.edu/classaction/ani...ipsetable.html. This visual calendar provides dates for upcoming solar and lunar eclipses through 2029.EclipseWise: http://www.eclipsewise.com/intro.html. An introductory site on future eclipses and eclipse observing by NASA’s Fred Espenak.

History of the International Date Line: http://www.staff.science.uu.nl/~gent0113/idl/idl.htm. From R. H. van Gent at Utrecht University in the Netherlands.

Lunacy and the Full Moon: www.scientificamerican.com/ar...the-full-moon/. This *Scientific American* article explores whether the Moon’s phase is related to strange behavior.

Moon Phase Calculator: https://stardate.org/nightsky/moon. Keep track of the phases of the Moon with this calendar.

NASA Eclipse Website: http://eclipse.gsfc.nasa.gov/eclipse.html. This site, by NASA’s eclipse expert Fred Espenak, contains a wealth of information on lunar and solar eclipses, past and future, as well as observing and photography links.

Phases of the Moon Gallery and Information: http://astropixels.com/moon/phases/phasesgallery.html. Photographs and descriptions presented by NASA’s Fred Espenak.

Time and Date Website: http://www.timeanddate.com/. Comprehensive resource about how we keep time on Earth; has time zone converters and many other historical and mathematical tools.

Walk through Time: The Evolution of Time Measurement through the Ages (National Institute of Standards and Technology): http://www.nist.gov/pml/general/time/.

Videos

Bill Nye, the Science Guy, Explains the Seasons: https://www.youtube.com/watch?v=KUU7IyfR34o. For kids, but college students can enjoy the bad jokes, too (4:45).

Geography Lesson Idea: Time Zones: https://www.youtube.com/watch?v=-j-SWKtWEcU. (3:11).

How to View a Solar Eclipse: www.exploratorium.edu/eclipse...o-view-eclipse. (1:35).

Shadow of the Moon: https://www.youtube.com/watch?v=XNcfKUJwnjM. This NASA video explains eclipses of the Sun, with discussion and animation, focusing on a 2015 eclipse, and shows what an eclipse looks like from space (1:54).

Strangest Time Zones in the World: https://www.youtube.com/watch?v=uW6QqcmCfm8. (8:38).

Understanding Lunar Eclipses: https://www.youtube.com/watch?v=lNi5UFpales. This NASA video explains why there isn't an eclipse every month, with good animation (1:58).

Review Questions

1. Discuss how latitude and longitude on Earth are similar to declination and right ascension in the sky.
2. What is the latitude of the North Pole? The South Pole? Why does longitude have no meaning at the North and South Poles?
3. Make a list of each main phase of the Moon, describing roughly when the Moon rises and sets for each phase. During which phase can you see the Moon in the middle of the morning? In the middle of the afternoon?
4. What are advantages and disadvantages of apparent solar time? How is the situation improved by introducing mean solar time and standard time?
5. What are the two ways that the tilt of Earth's axis causes the summers in the United States to be warmer than the winters?
6. Why is it difficult to construct a practical calendar based on the Moon's cycle of phases?
7. Explain why there are two high tides and two low tides each day. Strictly speaking, should the period during which there are two high tides be 24 hours? If not, what should the interval be?
8. What is the phase of the Moon during a total solar eclipse? During a total lunar eclipse?
9. Explain three lines of evidence that indicate that the seasons in North America are not caused by the changing Earth-Sun distance as a result of Earth's elliptical orbit around the Sun.
10. What is the origin of the terms "a.m." and "p.m." in our timekeeping?
11. Explain the origin of the leap year. Why is it necessary?
12. What fraction of the Moon's visible face is illuminated during first quarter phase? Why is this phase called first quarter?
13. Why don't lunar eclipses happen during every full moon?
14. Why does the Moon create tidal bulges on both sides of Earth instead of only on the side of Earth closest to the Moon?
15. Why do the heights of the tides change over the course of a month?
16. Explain how tidal forces are causing Earth to slow down and the Moon to slowly recede from Earth.
17. Explain why the Gregorian calendar modified the nature of the leap year from its original definition in the Julian calendar.
18. The term *equinox* translates as "equal night." Explain why this translation makes sense from an astronomical point of view.
19. The term *solstice* translates as "Sun stop." Explain why this translation makes sense from an astronomical point of view.
20. Why is the warmest day of the year in the United States (or in the Northern Hemisphere temperate zone) usually in August rather than on the day of the summer solstice, in late June?

Thought Questions

1. When Earth's Northern Hemisphere is tilted toward the Sun during June, some would argue that the cause of our seasons is that the Northern Hemisphere is physically closer to the Sun than the Southern Hemisphere, and this is the primary reason the Northern Hemisphere is warmer. What argument or line of evidence could contradict this idea?
2. Where are you on Earth if you experience each of the following?

1. The stars rise and set perpendicular to the horizon.
2. The stars circle the sky parallel to the horizon.
3. The celestial equator passes through the zenith.
4. In the course of a year, all stars are visible.
5. The Sun rises on March 21 and does not set until September 21 (ideally).

3. In countries at far northern latitudes, the winter months tend to be so cloudy that astronomical observations are nearly impossible. Why can't good observations of the stars be made at those places during the summer months?
4. A car accident occurs around midnight on the night of a full moon. The driver at fault claims he was blinded momentarily by the Moon rising on the eastern horizon. Should the police believe him?
5. The secret recipe to the ever-popular veggie burgers in the college cafeteria is hidden in a drawer in the director's office. Two students decide to break in to get their hands on it, but they want to do it a few hours before dawn on a night when there is no Moon, so they are less likely to be caught. What phases of the Moon would suit their plans?
6. In a lunar eclipse, does the Moon enter the shadow of Earth from the east or west side? Explain.
7. Describe what an observer at the crater Copernicus would see while the Moon is eclipsed on Earth. What would the same observer see during what would be a total solar eclipse as viewed from Earth?
8. The day on Mars is 1.026 Earth-days long. The Martian year lasts 686.98 Earth-days. The two moons of Mars take 0.32 Earth-day (for Phobos) and 1.26 Earth-days (for Deimos) to circle the planet. You are given the task of coming up with a Martian calendar for a new Mars colony. Would a solar or lunar calendar be better for tracking the seasons?
9. What is the right ascension and declination of the vernal equinox?
10. What is the right ascension and declination of the autumnal equinox?
11. What is the right ascension and declination of the Sun at noon on the summer solstice in the Northern Hemisphere?
12. In a part of Earth's orbit where Earth is moving faster than usual around the Sun, would the length of the sidereal day change? If so, how? Explain.
13. In a part of Earth's orbit where Earth is moving faster than usual around the Sun, would the length of the solar day change? If so, how? Explain.
14. If Sirius rises at 8:00 p.m. tonight, at what time will it rise tomorrow night, to the nearest minute? Explain.
15. What are three lines of evidence you could use to indicate that the phases of the Moon are not caused by the shadow of Earth falling on the Moon?
16. If the Moon rises at a given location at 6:00 p.m. today, about what time will it rise tomorrow night?
17. Explain why some solar eclipses are total and some are annular.
18. Why do lunar eclipses typically last much longer than solar eclipses?
19. If a star rises at 8:30 p.m. tonight, approximately what time will it rise two months from now?
