ACTIVITY 1

**The Celestial Sphere and Sky Maps**

**Introduction**

In this activity, students learn more about the features of the sky: where to look, when to look, how the sky changes, and why it changes. The Background section introduces the terms of the celestial sphere. This information would serve as a good review for students if they already have familiarity with the related concepts from their reading and lectures. This activity will then guide them through applying that knowledge to star maps.

We have found that many students do not know the difference between rotate and revolve. This leads to confusion when we ask about daily changes in the sky due to Earth’s rotation versus yearly changes due to Earth’s orbit. This activity introduces the fact that the motion of the stars around Polaris—the star closest to the north celestial pole—is due to Earth’s rotation. We also bring in the relationship between the altitude of Polaris and an observer’s latitude.

The next topic is the change in the sky due to Earth’s revolution around the Sun. We introduce the zodiac and the motion of the Sun along the ecliptic. Before covering this yearly motion, ask students why the constellation Orion is viewable at night in the winter but not in the summer. Alternatively, bring in Harry Potter’s impossible astronomy assignment of finding and charting Orion in June during his O.W.L. exam.

The four star maps for the activity are located in the Appendix on pages A1–A4. They represent the night sky at approximately midnight on the equinoxes and solstices.

Question 20 in the Putting It Together section would be good as a post-activity class discussion using think-pair-share, groups, or short writing exercise. Students are asked to compare images of a Sun-centered image with the views of the celestial sphere (essentially Earth-centered) over a year. The question is “Was investigating the sky from these two points of view helpful or not? Explain.”

No additional materials are needed for this activity.

**Learning Goals**

After completing this activity, students will be able to

1. contrast daily and yearly motion of the stars.
2. state the altitude of the north celestial pole (Polaris) from their locations.
3. describe how stars move over the course of a year.
4. identify constellations that lie on the meridian and the ecliptic.
5. identify the locations of the solstices and equinoxes on the celestial sphere.
6. evaluate the effectiveness of viewing the night sky from different reference frames.

**Key Terms**

celestial sphere, constellation, ecliptic, zodiac, celestial equator, equinox, solstice, zenith, horizon, meridian, latitude, north celestial pole (NCP), circumpolar, rotate, revolve

**Pre- and Post-Activity Questions: Overview of Smartwork Questions and PowerPoint Slides**

Pre-activity student actions include

* ranking locations on Earth based on altitude of Polaris.
* deciding which celestial events are due to rotation or revolution of Earth.
* labeling parts of the celestial sphere.
* identifying when the Sun is at its highest at noon.

Post-activity student actions include

* ranking of celestial occurrences.
* sorting of constellations based on their location relative to the meridian.
* labeling the position of the Sun on a star map over a period of months.
* determining why constellations change positions throughout a year.

**Workbook Activity Steps and Solutions**

**Step 1**—**Background**

This activity starts with an emphasis on the vocabulary of the celestial sphere. It relates the position of the Sun to the equinoxes and solstices. The first figure of the activity sketches the Earth’s orbit and its direction of rotation and revolution.

1. The locations on the celestial sphere where the ecliptic and celestial equator cross are called

 **equinoxes**.

**Step 2**—**Daily versus Yearly Motions of the Sky**

2. The altitude of the NCP above the northern horizon increases from 0° at the equator to 90° at the North Pole. The figure shows it increasing from 0° to 30° to 45°.

3. Asks for student latitude, so answers will vary.

4. Asks for number of degrees Polaris would be above the northern horizon, so answers will vary. Should be the same as the previous answer.

5. The motion of the stars around Polaris is due to the **rotation** of Earth.

6. The Sun would “stay” in each constellation of the zodiac for 1 month, if they were evenly distributed along the ecliptic.

7. The Sun will still be in **Gemini**.

**Step 3**—**Reading Star Maps**

8. For locations north of 45°, constellations listed could include Ursa Minor, Draco, Ursa Major, Canes Venatici, Coma Berenices, Leo, Virgo, Crater, Corvus. For locations north of 30°, add Centaurus.

9. The Sun is in **Virgo** on the autumnal equinox.

10. For locations north of 45°, constellations listed could include Ursa Minor, Draco, Lyra, Aquila, Serpens, Scutum, Sagittarius, Corona Austrina. For locations north of 30°, add Telescopium.

11. Answers will vary as students are asked to compare locations of a constellation at midnight on the spring equinox and describe how its location in the sky changed. One example is Draco. On the spring equinox, the meridian barely goes through its tail, but on the summer solstice, the meridian cuts through its body and head, which are not even visible on the spring map.

12. The star map of Figure 1.6 shows the Sun **below** the celestial equator at noon in the winter.

13. The Sun is in Sagittarius on December 21.

14. Approximately 3 months have passed between Figures 1.6 and 1.7.

15. That time block is about one-fourth of a year and Vega moved about one-fourth across the celestial sphere.

16. The Sun is in Pisces at noon on March 21. Note, stars of the constellation Cetus are also close to the equinox in this figure.

17. Constellations that lie on the ecliptic in Figure 1.8 include Leo, Cancer, Gemini, Taurus, Pisces. Note, stars of the constellation Cetus are also close to the equinox in this figure.

18. The Sun is located **above** the celestial equator in the summer.

19. The Sun is in Gemini on June 21.

**Step 4**—**Putting It Together**

20. Answers will vary. The questions that make up this part should make for a good discussion.

21. Students are asked to list three points (topics, concepts, visualizations) that the activity covered, and then write an essay of around 200–300 words that summarizes what they learned about those points. Possible topics students could include in their essays using some or all of the key terms:

Topics:

* **constellations**
* **celestial sphere**
* seasons
* meaning of **solstice** and **equinox**
* **rotation** versus **revolution**
* reading star maps

Concepts:

* the sky changes
* there are meaningful dates during a year
* Polaris stays in the same position but altitude changes
* some stars are **circumpolar**
* star maps tell us about the sky

Visualizations:

* locating Polaris above the northern horizon
* positions of constellations-Sun-Earth throughout the year
* the Sun is located on the **ecliptic** of thecelestial sphere
* motion of stars and constellations over a season
* what constellations are on the **meridian**