Fifth Grade Earth/Space Science

EARTH'S PLACE IN SPACE: Seasonal Change

Background Information

A key Disciplinary Core Idea for understanding our place in space is that the orbits of Earth and the sun and of the moon around Earth cause observable patterns. These include day and night; daily changes in the length of shadows; and different positions of the sun, moon, and stars at different times. There are many misconceptions about earth's orbit but it is important to remember and to convey to students that Earth is moving around the Sun and the Moon is moving around us. What we see each day with the motion of the Sun moving across the sky is the result of the Earth rotating on its axis. Because the Earth spins on its axis, it looks like the Sun is moving across the sky. This movement produces observable changes in the position of the sun and in the shadows of objects.

A constellation is group of stars in the night sky that people have treated like a dot-to-dot puzzle. Many civilizations have their own unique object, animal, or person from the star patterns. Because the Earth travels around the Sun during the year, we see different star patterns in the night sky. Each night the star patterns rise and fall as the Earth rotates on its axis toward the east.

Most constellation names are Latin but their meanings often originated in the distant past of human civilization. Names and boundaries were "officially" assigned to 88 constellations by the International Astronomical Union in 1930, providing complete coverage of the entire sky and the standard constellations that you will find on any star finder.

The proper way to use a star chart is to hold the map over your head and look up at it Turn it so the northern horizon side is facing north. You may have to use a compass to tell you where north it. Depending upon the season of the year, the Big Dipper can be found high in the northern sky or low in the northern sky. There is an old saying *spring up and fall down*. On spring and summer evenings, the Big Dipper shines highest in the sky. On autumn and winter evenings, the Big Dipper sits closest to the horizon.

Polaris, the North Star, was important for navigation before GPS because of its location in the sky, not its brightness. It is very close to the North Celestial Pole (NCP), or the north pole of the sky which made it a useful star to navigate by.

The Big Dipper is an *asterism* – a star pattern that is *not* a constellation. The Big Dipper is a clipped version of the constellation Ursa Major, the Big Bear. The Big Dipper stars are brighter than the rest of the constellation. The two outer stars in the bowl of the Big Dipper are called Dubhe and Merak. If you draw an imaginary line between them and continue to line onward, it points to Polaris, the North Star. That's why Dubhe and Merak are known in as *The Pointers.*

Performance Expectation

ESS1-2 Earth's Place in the Universe: Represent data in graphical displays to reveal patterns of daily changes in length and direction of shadows, day and night and the seasonal appearance of some stars in the night sky. https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/5-ESS1-2%20Evidence%20Statements%20June%202015%20asterisks.pdf

Disciplinary Core Ideas

ESS1.B Earth and the Solar System: The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year.

Science and Engineering Practices

Analyzing and Interpreting Data: Represent data in graphical displays (bar graphs, pictographs and/or pie charts) to reveal patterns that indicate relationships

Obtaining, evaluating, and communicating information: Use evidence (e.g., measurements, observations, patterns) to construct or support an explanation

Crosscutting Concepts

Patterns: Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena.

Systems and system models: A system can be described in terms of its components and their interactions.

Materials

- Flashlights
- AA Batteries
- Assorted shapes for shadows
- Graph Paper
- Protractor
- Set of Constellation Cards (12)
- Ruler
- Monthly Star Finder Maps (Grouped)
- Student pages for Shadows and Constellations
- Scissors
- Pencil
- Highlighters/Markers
- Computer with Internet or books about constellations
- Art Paper
- Shadow Play PPT
- Computer
- Play-Doh or Clay

Advance Preparation

- Students will need to find out about their assigned constellations, so resources from the library should be gathered or a computer(s) located to search on approved sites online.

- Copy and collate the star maps into the following sets. (See the table on the following page.)

Set 1	December, April, August
Set 2	January, May, September
Set 3	February, June, October
Set 4	March, July, November

Resources

- *https://www.nasa.gov/audience/forstudents/k-4/stories/F_Keeping_Cool_With_Shadows.html*
- https://spaceplace.nasa.gov/starfinder/en/ Monthly Star Finder Charts
- https://starchild.gsfc.nasa.gov/docs/StarChild/questions/88constellations.html Constellation Cards
- https://stardate.org/nightsky/constellations (Constellation Drawings)

Suggested Implementation

Part 1. Sun and Shadow Play

Share the Shadow Play power point and have students make observations about the images.

Potential questions for a discussion follow:

- How are these shadows similar? How are they different?
- What time of day do you think these pictures were taken?
- How would you investigate how the sun makes different lengths of shadows?

Share that they will have chance to investigate shadows. Assist students in forming groups of 3. Provide each group with light colored paper and a flashlight. Students make shadows using the various small shapes. Encourage the students to record observations in a variety of methods. These may include drawing the shadow and the shape and the relative position of the flashlight to objects. Allow ample time for exploration. Save the protractors for the next step.

Review use of a protractor if needed. Challenge students by asking, "What measurements would you need to take to be able to predict what time of day a shadow would be the longest or the shortest?"

Using materials provided, student groups work together to determine how they will gather data that can be used to answer the question above. Groups record their testing plan when they have come to consensus. (Note: More than one plan may be used.) Encourage and assist groups as needed. Play-doh or clay may be used to hold the protractor in place on the paper. Coach groups to record their data so that it can be represented on a graph. Multiple types of graphs may be selected for this representation. A partially set-up graph is provided or you can provide graph paper if the students are capable of setting up their own graph.

Groups should engage in discussion and use their data to help form the answers. Host a class discussion once the groups are ready. You may wish to use the following prompts.

- If we think about the flashlight representing the sun, where would the sun be when the shadow is the longest?
- What time of the day would we find the longest shadows? (Is there more than one time of day when the shadows would be long?
- Where would the sun be when the shadow is the shortest?
- What time of day would we find the shortest shadows?

Extensions

- If you would like additional study in angles and sunlight, this activity might be useful. https://www.nasa.gov/centers/langley/pdf/245895main_MeteorologyTeacherRes-Ch4.r3.pdf
- A spectacular example of a shadow is a solar eclipse when the Moon's shadow falls somewhere on the Earth. You can find out when one will pass by your area at this site. https://eclipse.gsfc.nasa.gov/solar.html.
- Bill Nye's 2 minute video that demonstrates a solar eclipse. https://www.youtube.com/watch?v=XsmShFLTTI4
- Lunar eclipses occur when the Earth's shadow falls on the Moon. These are pretty common and can be seen all from most locations on Earth. Find out when one will occur at https://www.skyandtelescope.com.

Debrief

Show the power point again and ask the following questions:

- How are these shadows similar?
- How are they different?
- What time of day are these pictures taken?
- How do you know? Use your data while answering this question.
- Explain the relationships between the sun and shadows.

Part 2. Sky Patterns

Provide each student pair with a constellation card. Ask them to research that constellation in books or on trusted internet sites like these.

- https://stardate.org/nightsky/constellations
- http://www.seasky.org/constellations/constellations.html
- http://www.astro.wisc.edu/~dolan/constellations/constellation_list.html

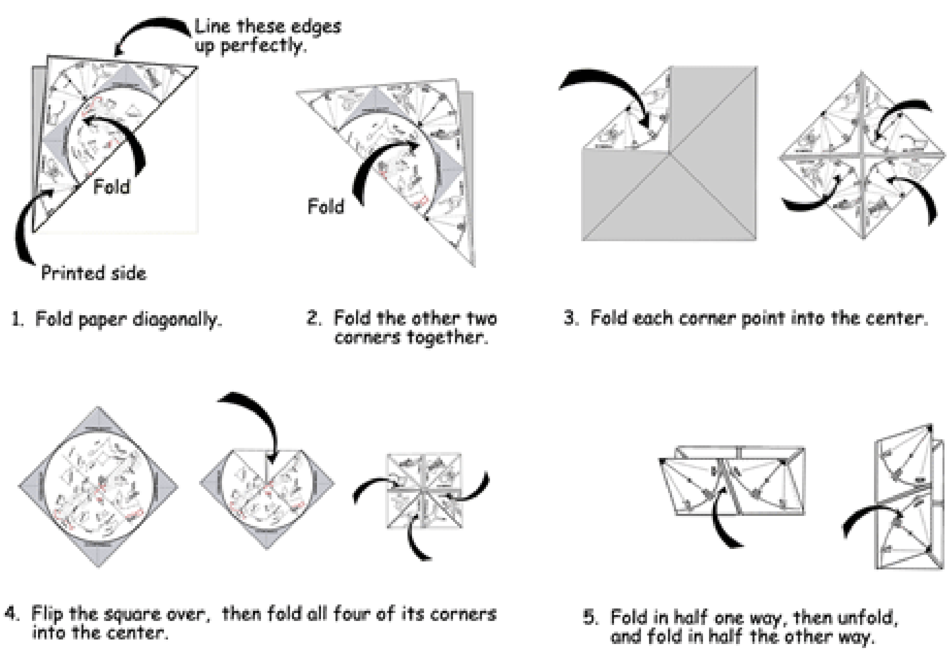
Ask the students to share what they found with at least 2 other pairs of students. Have them post the information that they found on the board for all to see.

Divide the class into groups of 3 students. Each group will get a set of 3 monthly star maps as follows. (See chart on the following page.)

Set 1	December, April, August
Set 2	January, May, September
Set 3	February, June, October
Set 4	March, July, November

It may be helpful to use the How to Make a Starfinder power point as a guide. Ask students to cut out the star finders along the outside solid black line. Each finder is marked with the month and the horizons. Ask students to fold their finders in the corners so that only the central square shows.

After the activity you can have them continue to do the folds of the starfinder. See the document "How to make a Starfinder" or the diagram below or at https://spaceplace.nasa.gov/starfinder/en/



Have students put a dot at the northern horizon where it bisects the month. We will have them measure 3 different distances in centimeters on their month and compare those measurements with 2 other months. Draw a line segment and measure (cm) distance from the dot on the northern horizon dot to Polaris. Record on the forms labeled Constellation Chart.

Draw a line segment and measure (cm) distance from Polaris to Dubhe in the Big Dipper. Dubhe is the outermost star in the Dipper closest to Polaris. Record.

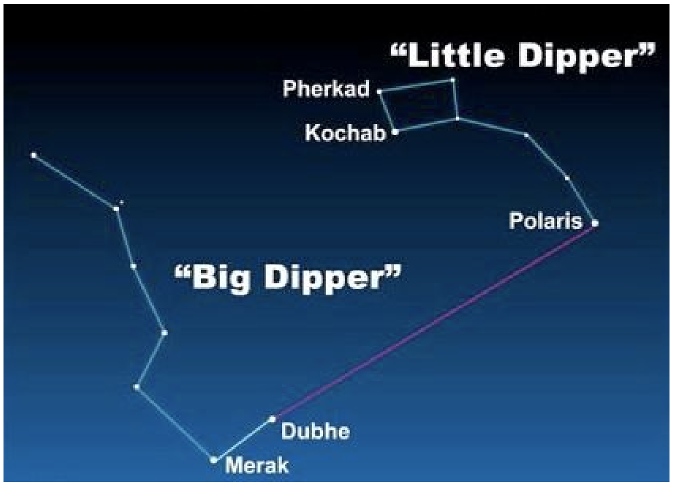
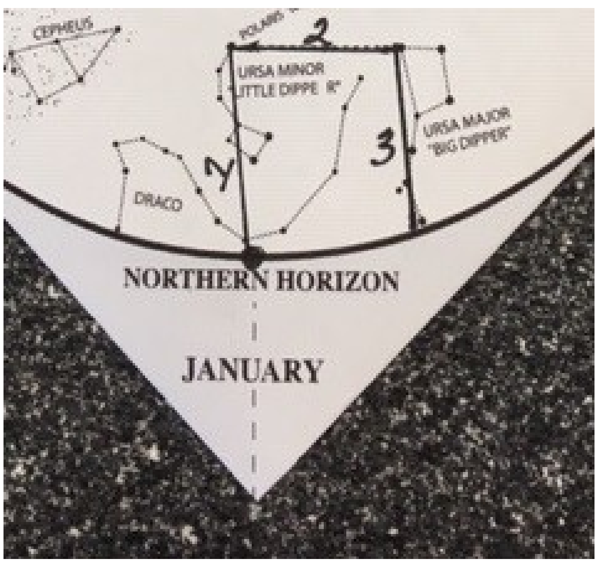
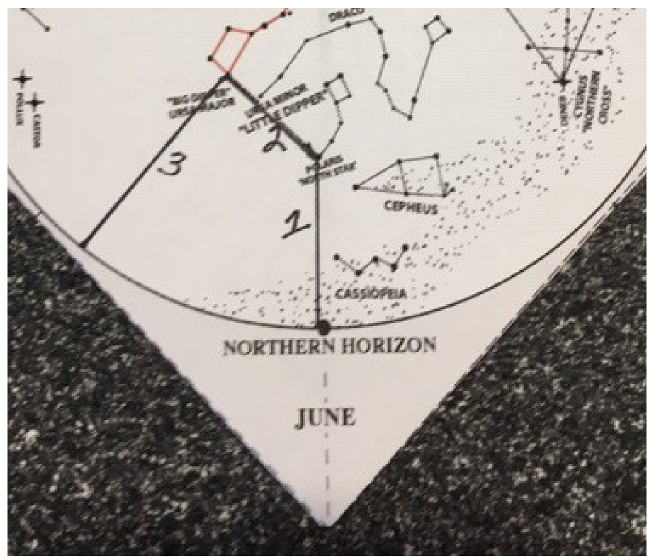


Image: https://earthsky.org/favorite-star-patterns/big-and-little-dippers-highlight-northern-sky

Draw a line segment and measure (cm) distance from Dubhe in the Big Dipper to closest point on the earth's horizon. Record.





Ask the students to look for the following stars on their star finders and record whether the stars appear in the sky during their assigned month in the table provided.

Castor in Gemini
Rigel in Orion
Spica in Virgo
Regulus in Leo

Assessment

The following single point rubric can be used to assess student understanding. For each of the four criteria listed below, either circle the proficient description or add notes to a box indicating why the student's performance was either lacking or exceptional.

Areas that need improvement. **Developing Performance**	Criteria for **Proficient Performance**	Evidence of exceeding standards. **Advanced Performance**
	Explained observable patterns of shadows throughout the day.	
	Explained observable seasonal patterns of star locations.	
	When asked "How do you know?" students reference observations from the perspective of their models.	
	When asked why the patterns exist, students reference the positional relationship between the Earth and sun.	

Debrief

- What conclusions can you make about the distances from Polaris to the northern horizon during the three months that you measured? (The Distance from the horizon to Polaris will change.)
- What conclusions can you make about the distances from Polaris to Dubhe during the three month that you measured (The distance from Polaris to Dubhe will not change.) What conclusions can you make about the distances from Dubhe to the nearest horizon during the three months that you measured? (The distance to the horizon from Dubhe will change.)
- Were you able to see the stars of the Big Dipper in all of the months? These are called circumpolar stars (moves around the pole, in this case, the North Pole). How does your data help explain this term? (The circumpolar stars and constellations appear to circle the North Pole. These are visible all year but their positions relative to the horizon with change with the seasons. Auriga, Camelopardalis, Cassiopeia, Cepheus, Draco, Lynx, Perseus, Ursa Major, and Ursa Minor are always visible in the night sky of the Northern Hemisphere.)
- Were you able to see Castor, Rigel, Spica and Regulus in all of the months? What is

happening that would make some of the constellations only visible at certain times of the year. (As the Earth travels around the Sun, different stars and constellations become visible in the night sky. This website has a listing of the constellations and the seasons when they are visible in the northern hemisphere.

- https://www.windows2universe.org/the_universe/Constellations/north_constellations.html)

If the students would like to use the star finders at night, help them learn how to orient their star finder over their head with the northern horizon pointing north. The stars will then be in the correct position.

Extension

Constellations were used by many past civilizations. Discuss how this apparent movement of stars would have helped in each situation.

(http://curious.astro.cornell.edu/about-us/117-the-universe/stars-and-star-clusters/constellations/375-what-are-constellations-used-for-intermediate)

Consider using components of the Smithsonian's Living in Maya Time. This activity provides an example of how the ancient Maya observed the movements of the Sun and tracked shadows. These observations allowed Maya astronomers to predict seasonal change to plan their agricultural and ceremonial cycles. Today, Maya farmers still observe the movements of the Sun to plan the planting of corn and their ceremonies.

https://maya.nmai.si.edu/sites/default/files/resources/lesson-plans/Observing%20and%20Tracking%20Shadows.pdf