

Lesson Plan A2

The Year and Seasons

Introduction

Earth's motions have shaped our natural history and continue to influence how we live. Earth's motions are periodic. They repeat over time. These motions produce day, night and the seasons. Nearly everything on Earth, from our body clocks to the planting and harvesting of crops, is governed by astronomical rhythms.

This lesson plan explores the mechanics of the seasons. Through a combination of hands-on activities and Starry Night computer exercises, you will model the motions of Earth that produce the seasons. The extensions and resources at the end of the lesson provide additional information.

After completing this lesson, students should understand why Earth has seasons, and why the seasons are reversed in the Northern and Southern Hemispheres.

Key Concepts

- The Earth's **revolution** around the Sun defines the year. It also causes the seasonal shift in the **constellations**.
- The tilt of the Earth's spin axis determines the amount of sunlight hitting the Earth's surface, which in turn causes the seasons.

Materials Required

- *Darkened room*
- *Lamp with clear, unfrosted bulb*
- *Earth globe*
- *Toy person, about an inch (2 cm) tall, to represent an observer on Earth*
- *Sticky tape*
- *Constellation cards for the 12 constellations of the **zodiac** (You can use Starry Night to make your own beautiful constellation cards. See the section **How to Make Star Charts** in the Appendix of this guide)*
- *One card (or piece of paper) marked "North Star"*

Time Required

Activity Part One: 10 minutes

Activity Part Two: 20 minutes

Starry Night Computer Exercise: 20-30 minutes

Conceptual Background

The Earth moves around the Sun in its yearly orbit. We do not feel this motion. To us on the surface of the Earth, it appears as if the Sun is moving. We say the Sun "traces a path" through the background stars. This apparent path of the Sun is called the **ecliptic**. It is a result of Earth's orbital motion around the Sun.

Earth is also tilted on its spin axis by 23.5 degrees. This tilt governs the amount of sunlight a given part of the Earth receives through the year. The Sun is above the horizon for more hours each day in summer, and fewer hours each day in winter. The Sun climbs higher in the sky during summer than it does during winter. The changing height of the Sun in the sky, along with the changing amount of daily sunlight, causes the seasons. Earth's tilted axis also causes the seasons to be reversed in the Northern and Southern **Hemispheres**.

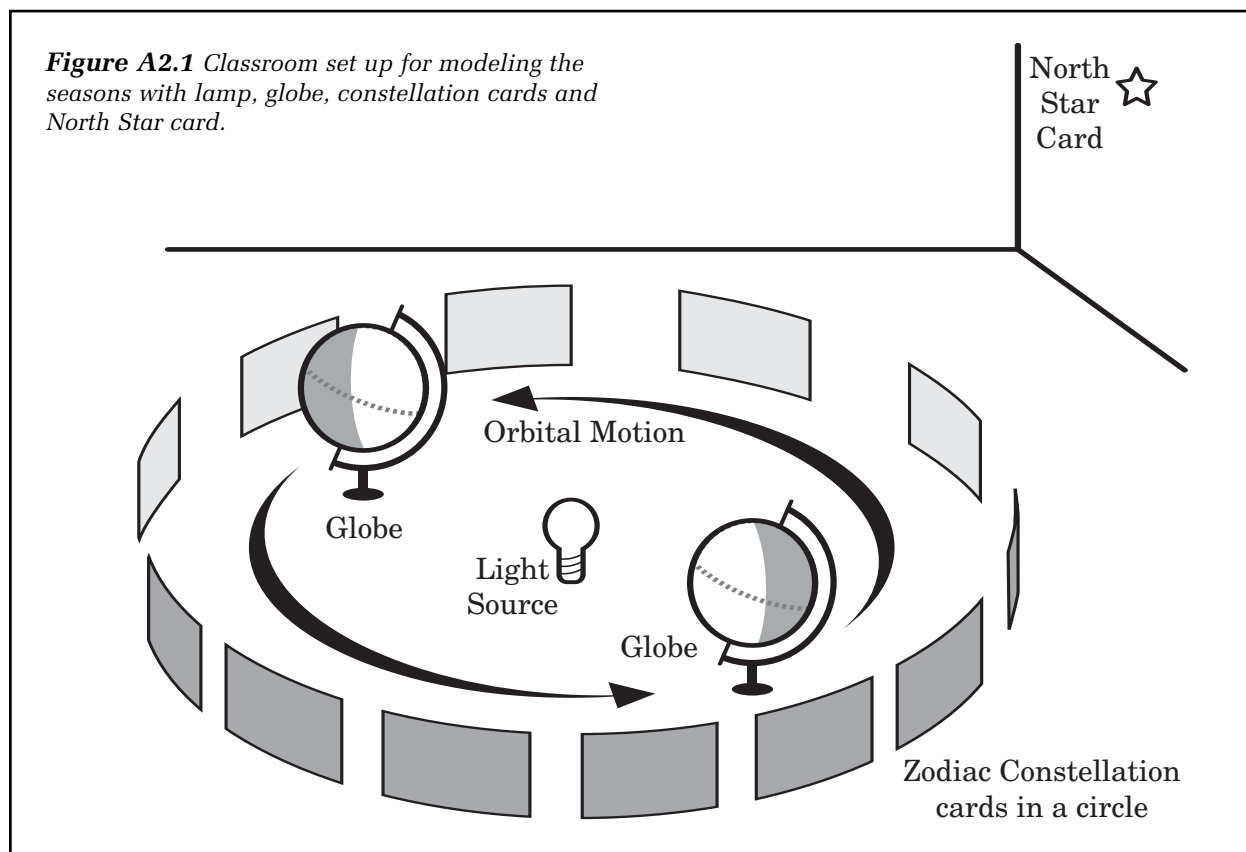


Activity Part One

This activity uses a physical model to reproduce the motions that result in the seasons on Earth. It also shows how the Sun appears to move in a circle through the constellations of the zodiac.

1. Arrange the room so there is a clear space large enough for you and your students to work in.
2. Place the lamp on a desk or table in the center of the clear space.
3. Arrange the 12 constellation cards evenly, and in order, in a large circle around the clear space. The order of the zodiac is: Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius, Capricorn, Aquarius, Pisces, and back to Aries.
4. The cards should be level with the lamp. Place the cards where the students can easily see them. Students should have enough room to move around inside the circle of cards.
5. Tape or tack the North Star card high up on the wall somewhere. Make sure it is well above the circle of constellation cards. It will be a fixed point of reference for this activity.
6. Darken the room and turn on the lamp.
7. Hold the globe so that its North Pole points in the general direction of the North Star card up on the wall. This north-star-pointing orientation must be maintained throughout the activity.
8. Now move the globe around the lamp in a circle. Keep the globe level with the lamp and keep its North Pole pointing in the direction of the North Star card as best you can.
9. You have just modeled one year. Have the students observe this orbital motion, and the changing view of the constellations from Earth, as Earth moves in its yearly **orbit**.
10. Replace the globe with a student. Have the student mimic the Earth by walking around the lamp and watching it appear to move against the background constellation cards.
11. From the student's point of view, the Sun appears to be moving through the constellations. This is exactly what happens in the real sky.

Figure A2.1 Classroom set up for modeling the seasons with lamp, globe, constellation cards and North Star card.



Activity Part One Discussion Questions

- A. As the globe moves around the lamp in its orbit, is the same hemisphere always tilted toward the lamp?
- B. If the same hemisphere is not always tilted toward the lamp, what effect might this have on the globe?
- C. As the globe moves around the lamp in its orbit, does its shaded (night) side always face the same constellations?
- D. Could a person standing on the globe see the stars and constellations that are behind the lamp? Why or why not?
- E. Would a person standing on the globe see the same constellations in the night sky every night of the year?

As the globe moves around the lamp Sun, the globe's axis remains tilted toward the North Star. This constant north-pointing orientation means first one and then the other hemisphere will be slowly tilted toward, and then away from, the lamp Sun. This tilt is what gives rise to the seasons.

As the globe moves in a circle around the lamp, the shaded portion of the globe is always opposite the lamp. This means the night side of the globe "looks out" in all the directions of a circle over the course of the year. Our nighttime view of the stars changes through the year. In summer we look out in one direction at certain constellations. Six months later, we have moved around in our orbit to the other side of the Sun. At night we now look out in the opposite direction, and we see a different group of constellations.

The stars are up in the sky all day and all night. During the day, the light from the Sun is so bright it washes out the faint light from the stars. We can't see the stars that are "behind" the Sun. As we move along in our orbit, they will slowly come into view. From the moving platform of the Earth, it appears to us as if the Sun is moving through the background stars and constellations.



Activity Part Two

This activity uses a physical model of the Earth-Sun system to examine the seasonal differences between the Northern and Southern Hemispheres. It will show how the changing height of the Sun in the sky is connected to the changing hours of daylight through the year.

1. Returning to the globe, observe how the lamp illuminates its sphere. Make sure the globe is properly tilted in its cradle, and that its North Pole points in the general direction of the North Star card.
2. Move the globe around the lamp, keeping the same north-star-pointing orientation as best you can, all the way around the circle.
3. Watch what happens. Is the same hemisphere always tilted toward the Sun?
4. Tape the toy person to the globe at your home latitude.
5. Spin the globe (to mimic day and night) and watch the toy person move into and out of the lit portion of the globe. On the lit part of the globe it is daytime. The portion in shadow is experiencing night.
6. Notice how the lampward-tilting (summer) hemisphere of the globe receives more light than the opposite (winter) hemisphere.
7. Look at the toy person on the spinning globe during summer and winter.
8. Move the toy person to other latitudes: the poles, the equator, and the southern equivalent to your home latitude. Spin the globe at each of these locations and watch the day-night cycle.
9. Move the globe around in its orbit. Stop at each quarter-way around the circle (winter, spring, summer and autumn). Experiment with the day-night cycle at each of these four points.

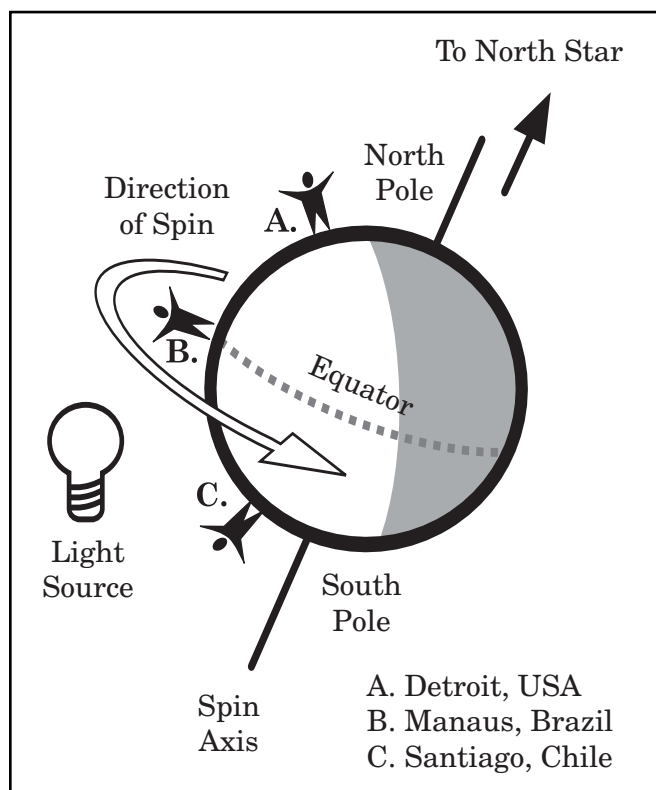


Figure A2.2
Hands-on set up for modeling the seasons at different latitudes and in different hemispheres.



Activity Part Two Discussion Questions

- From the toy person's point of view, when is it summer or winter?
- If it is winter in one hemisphere, what season is it in the opposite hemisphere?
- When is it spring or fall?
- From the toy's point of view, how high is the Sun in the sky during summer?
- How high is the Sun in the sky during winter?

As you and your students manipulate the model, think about what's going on from the toy person's point of view. During northern summer, the Northern Hemisphere is tilted toward the Sun. There are more hours of daylight, the Sun is higher in the sky, and incoming sunlight falls nearly straight down on the surface.

The opposite is true for the Southern Hemisphere. When it is summer in the North, it is winter in the South. During southern winter, the Southern Hemisphere is tilted away from the Sun. The hours of daylight are shorter, the Sun is lower in the sky, and incoming sunlight strikes the surface at a low angle. The Sun's rays are spread out over a larger area and do not heat the Earth as efficiently.

The changing daylight hours do not themselves produce the seasons. When the Sun is higher in the sky, the incoming light rays are coming more-or-less straight down. This straight-down radiation is very efficient at heating Earth's surface. The low-angle sunlight of winter does not heat Earth's surface as efficiently.

Spring and fall are much the same in both hemispheres. By looking at the model, you will see that during these seasons, the hours of daylight and darkness are equal in a 24-hour period. This is true for both hemispheres at the same time.

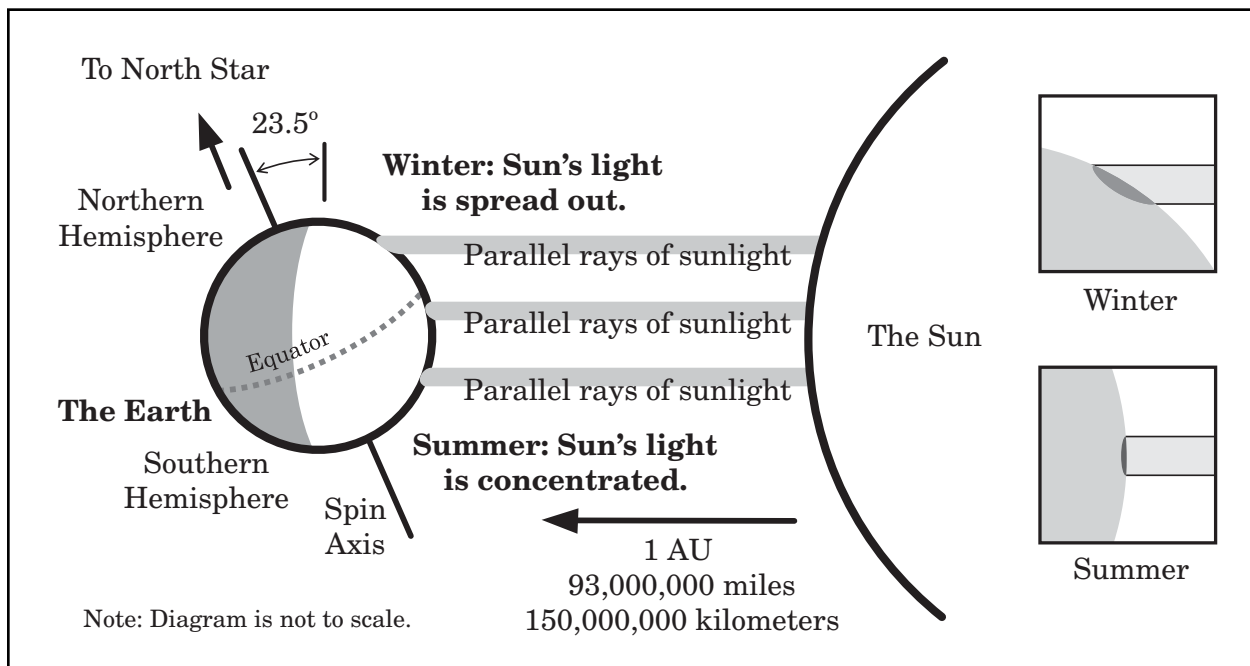


Figure A2.3

This diagram shows how incoming sunlight is concentrated or spread out over the tilted Earth's curved surface. The summer hemisphere is tilted toward the Sun. It receives concentrated sunlight. The winter hemisphere is tilted away from the Sun and incoming sunlight is spread out over a relatively larger surface area.



Starry Night Computer Exercise

Lesson A2: The Year and Seasons

As a follow-up to **Lesson A1: Day and Night Cycle**, this exercise covers the Earth's revolution around the Sun, the underlying cause of the seasons. Students will clearly see that it's not the Earth's distance from the Sun that determines the seasons, but rather the axial tilt of the Earth and the Earth's position along the track of its yearly motion around the Sun.

Teaching Strategies

This exercise should be used to reinforce the concepts introduced in Activity Part One and Two. It should follow **Lesson A1: Day and Night Cycle**.

Students should be reminded that the exercise questions in **SkyGuide** are the same as those on their exercise sheets and should be answered on these exercise sheets.

Students may need help filling in the charts, especially the position of the Sun at its highest point in June. Scroll the screen up to see the horizon and direction but don't forget to center the Sun afterwards or you will have difficulty completing the exercise.

When looking at the views showing a magnified Earth, remind students that the Earth is NOT to scale. The Earth has simply been magnified to better visualize the tilt.

Students should be able to complete this exercise in 20 to 30 minutes.

Conclusion

At the end of these hands-on and Starry Night computer activities, your students should see a correlation between the tilt of the Earth, the hours of daylight, the height of the Sun in the sky, and the seasons in the Northern and Southern Hemispheres. After having manipulated the physical models and seeing the Earth-Sun system in action with Starry Night, they should have an understanding of the system that they would not easily get from surface-based observations.

Lesson Specific Resources

SkyGuide

Guided Tours > First Night Out > The Earth in Motion



Starry Night Computer Exercises
Lesson A2: The Year and Seasons

Name: _____
Class: _____

Instructions for the Student:

Open the **SkyGuide** pane, and navigate to **Student Exercises > A–Earth, Moon and Sun > A2: The Year and Seasons** and follow the instructions given. Record your answers to the questions in the spaces provided.

Question 1: Earth’s Orbit

Is the Earth much closer to the Sun at any time during its motion around the Sun?

Question 2: Days of Winter

Complete the following Chart for December 21, 2006

	Approximate Direction	Approximate Time
Sunrise		
Sun at its highest point		
Sunset		

Question 3: Days of Summer

a) Complete the following Chart for June 21, 2006

	Approximate Direction	Approximate Time
Sunrise		
Sun at its highest point		
Sunset		

b) Using information from the two charts, describe how the motion of the Sun is different in summer and winter.

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Lesson A2: The Year and Seasons

Question 4: The Seasons Come and Go

What do you notice about the tilt of the Earth as it circles the Sun?

Question 5: Summer or Winter?

a) How much sunlight does North America get compared to South America?

b) On which continent does the Sun shine more directly?

c) On which continent is it summer?

Question 6: Winter or Summer?

a) How much sunlight does North America get compared to South America?

b) On which continent does the Sun shine more directly?

c) On which continent is it summer?

d) Explain why the tilt of the Earth causes the seasons.

Extra Credit

a) Use Starry Night to show that on the first day of spring or fall both North and South America get equal amounts of daylight.

b) Seasons on Mars?

Look at Mars as it circles the Sun. Use what you have learned in this exercise to answer the question: Does Mars have seasons like the Earth?

