Tilting Into The Seasons

Why Do We Have Seasons?

September 22, Autumnal Equinox in the Northern Hemisphere

December 21, Winter Solstice in the Northern Hemisphere

June 21, Summer Solstice in the Northern Hemisphere

March 20, Vernal Equinox in the Northern Hemisphere

Deborah Cubillos and Barb Roth
Module Development

Deborah Cubillos
Document Development

El Camino College
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Resources and References

APPENDIX A: Student Workbook
**Topic of the Module**

Topics to be taught in this module include:
1. Daily definitions relating to Earth movement and seasons.
2. Seasons are caused by the tilt of the Earth.
3. The North Star (Polaris).
4. The Earth is warmed by the Sun, and because of the tilt, the Northern and Southern hemispheres receive Sunlight and direct or indirectly warming.
5. Two- and Three-dimensional activities.

**Goal of Module**

Students will understand that the seasons are caused by the tilt of the Earth and the effects of Sunlight on the Earth.

**Targeted Grade Level**

This module is designed for third grade students. This module can be adapted to higher grade levels, including the middle school grades.

**Objectives**

At the end of the module, all students will reach the following objectives:

- On a globe/Earth, students will be able to identify sphere, Northern Hemisphere, Southern Hemisphere, equator and locate countries in the hemispheres.
- Students will be able to explain how the tilt of the Earth and position of the Sun causes the seasons.
- Students will be able to explain how the direction of the Sunlight affects the seasons.
- The students will demonstrate how we have seasons by doing a 2-dimensional activity and a 3-dimensional activity.
Time Needed

The expected timeline for this module is four days with one hour per day. Organization of the module is presented below:

<table>
<thead>
<tr>
<th>Day</th>
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<td>1</td>
<td>What is a sphere? How is it different from a circle? Where is the Northern and Southern Hemispheres? Where is the equator? Where are the North and South Poles? What are the names of the seasons? How are the seasons different from one another?</td>
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<td>What is an axis? Does the Earth tilt? What does the Earth orbit? How does the Earth rotate? How can we act out axis, tilt, orbit, and rotate? What is the name of the North Star? Where does the Earth always tilt towards?</td>
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<tr>
<td>3</td>
<td>What is the difference between direct and indirect light? How does direct and indirect light affect the temperature of the Earth? How big is the Sun compared to the Earth? When are the two solstices? When are the two equinoxes?</td>
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<td>What are the terms we learned during the last three days? Show how the seasons occur in 2- and 3-dimensions.</td>
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Standards

California Science Content Standards for Grade 3

Earth Science

4. Objects in the sky move in regular and predictable patterns. As a basis for understanding this concept:
   e. Students know the position of the Sun in the sky changes during the course of the day and from season to season.

Investigation and Experimentation

5. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:
   a. Repeat observations to improve accuracy and know that the results of similar scientific investigations seldom turn out exactly the same because of differences in the things being investigated, methods being used, or uncertainty in the observation.
   b. Differentiate evidence from opinion and know that scientists do not rely on claims or conclusions unless they are backed by observations that can be confirmed.
   c. Use numerical data in describing and comparing objects, events, and measurements.
   d. Predict the outcome of a simple investigation and compare the result with the prediction.
   e. Collect data in an investigation and analyze those data to develop a logical conclusion.

English Language Arts

3.0 Literary Response and Analysis

Narrative Analysis of Grade-Level-Appropriate Text

3.4 Determine the underlying theme or author’s message in fiction and nonfiction text.
Mathematics

Measurement and Geometry

2.0 Students describe and compare the attributes of plane and solid geometric figures and use their understanding to show relationships and solve problems:

2.5 Identify, describe, and classify common three-dimensional geometric objects (e.g., cube, rectangular solid, sphere, prism, pyramid, cone, and cylinder).

National Science Education Standards

Earth and Space Science Standards

Levels K-4

1. Objects in the sky
2. Changes in Earth and sky

Pre-Requisite Skills and Knowledge

No pre-requisite skills or knowledge is needed. If student(s) are unsure how the seasons are caused, use Microsoft Encarta Encyclopedia 2004, type in the word "seasons" in the search field and an excellent explanation is provided.
Glossary

The following words and their definitions should be addressed before completion of the module.

sphere – any round object that has a surface that is the same distance from its center at all points, for example, a ball or globe.

ehemisphere – one half of a sphere or globe. The Earth is divided at the equator into the Northern and Southern Hemispheres.

equator – an imaginary line around the middle of the Earth, at an equal distance from the North Pole and the South Pole.

axis – a real or imaginary straight line about which something turns. The imaginary axis of the Earth passes through the North and South Pole.

tilt – to slant or tip.

orbit – the path followed by a planet, moon, or other heavenly body as it travels around another body. The path of the Earth around the Sun is an orbit.

rotate – to turn around a center point or axis. The Earth rotates on its axis.

direct – without turning or stopping; straight; the shortest way.

indirect – not direct or straight; by a longer way.

solstice – either of two times of the year when the sun is farthest from the equator in the north or south.

equinox – either of two times of the year when the sun crosses the plane of the earth's equator and day and night are of equal length.
Introduction

The seasons, known as winter, spring, summer, and fall or autumn, differ from each other in regard to average temperature and the duration of daylight. Thus, the seasons not only divide up the calendar year, they also identify the position of the Earth in its orbit around the Sun.

Most people know that the Earth revolves around the Sun in one year (actually 365.24 days and we add one day to the calendar every four years, for a “leap year”). Most also know that it takes 24 hours (actually 23 hours and 56 minutes) for the Earth to make a full rotation on its axis. Fewer people know that the Earth’s orbit is elliptical, or oval shaped, and that the Earth is sometimes slightly closer to the Sun than at other times, but this is not what causes the seasons, in fact we are closest to the Sun in January!

Seasons are caused by the fact that the “Earth is tilted” (see Figure 1). What we mean by that is that the Earth’s axial tilt is at an angle of 23.5 degrees relative to the plane of the Ecliptic, its plane of orbit around the Sun. And the imaginary line, on which the Earth rotates, its axis, is tilted close to Polaris, the North Star. This is just a coincidence, but it does make it easy for us to identify which direction is north in the northern hemisphere (there is no “south star” equivalent in the southern hemisphere).

Remember that a plane is an imaginary flat surface. A piece of paper laying flat is a good example that defines a plane. So the plane of the Earth’s orbit is that imaginary flat surface that contains the earth as it orbits around the Sun. But situating the Earth in its plane reveals that that the North and South Poles are not perpendicular to the plane. In other words, the North and South Poles are not at a 90 degree angle to the plane, the Poles are not straight up and down.

Imagine for a moment that the Earth was not tilted, that its axis was perpendicular to the plane of orbit. It would have an important effect on how much sunlight the Earth receives and where it receives it. If the Earth were not tilted as it revolved around the Sun, but vertical, every place on Earth would get 12 hours of light and 12 hours of dark daily. But, since the Earth is tilted, the northern hemisphere sometimes points toward the Sun and sometimes points away from the Sun. It is this tilt that causes the seasons.
Length of Day and Temperature

Why does the length of days change throughout the year? Because of the Earth’s tilt, the North Pole is tilted towards the Sun than the South Pole for half of the year and the South Pole is tilted towards the sun than the North Pole for the other half of the year. When the northern hemisphere points toward the Sun, parts of the Earth near the North Pole see the Sun 24 hours a day. This period lasts for six months during which the entire northern hemisphere gets more sunlight and most importantly, it gets it at a more direct angle than the southern hemisphere. This is when it is spring and summer in the northern hemisphere and fall and winter in the southern hemisphere (see Figure 2).

The other six month period is when the southern hemisphere points more directly toward the Sun and receives a high density of incident rays making it the warmer seasons in the southern hemisphere and the cooler seasons in the northern hemisphere (see Figure 2). So the varying length of days accompanies the seasons and differs greatly at different latitudinal points on the globe. At the North and South Poles, summer is six months of daylight and winter is six months of darkness. On the other hand, at the points near the equator the days and nights are a constant 12 hours in length throughout the year. So it is the hemisphere that is tilted toward the Sun that has a longer day and receives the sun’s rays more directly than the hemisphere tilted away from the sun which has a shorter day and receives the sun’s rays more indirectly.

But why does the temperature vary so much around the globe? Temperature variation around the globe has several components. First, the days when the sun is near the summer solstice are not necessarily the hottest days of the year. It is true that the hemisphere experiencing summer receives the greatest amount of direct sunlight and radiation from

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the sun (see Figure 3). But, temperature also relates to the amount of heat that the atmosphere receives and stores as well as the amount of heat that the atmosphere loses through absorption by water and ground and through reflection.

In reality, the seasons “lag.” By this it is meant that the hottest temperatures in the summer typically lag behind by a month or more after the time of maximum insolation. Maximum insolation is when maximum solar energy is received during a day at a point on the surface of the Earth and absorbed.

While it is true that the atmosphere warms up quickly in the spring and summer, it takes longer for the land and ocean masses to warm up. So even though the northern hemisphere is receiving the greatest heating on the summer solstice (June 21), the hottest days of the year usually occur between mid-July or in August for most locations north of the equator.

Equinox and Solstice

The geographic equator is that imaginary circle on the surface of the Earth that is equidistant from the North and South Poles and divides the Earth into the northern and southern hemispheres. The geographical equator is also the line from which latitudes are measured whereby the latitude of any single point on the equator is 0 degrees. But in astronomy, it is that great circle in which the plane of the equator of the earth intersects the celestial sphere. The celestial equator is the line from which the declination (just another name for celestial latitude) of stars and planets is measured. Even though the Earth revolves around the Sun, it appears to us that the Sun revolves around us during the course of the year. The path followed by the Sun as seen from the Earth is called the ecliptic, which is also simply the plane of our orbit (see previous discussion).

The two points at which the ecliptic crosses the celestial equator are called equinoxes, or nodes. The sun is at the vernal equinox about March 20 and at the autumnal equinox about September 22. Halfway on the ecliptic between the equinoxes are the summer and winter solstices. The Sun arrives at these points

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2 Source: http://www.physics.uc.edu/~hanson/astro/lecturenotes/F01/Lec2/sun_angle.gif
about June 21 and December 21, respectively. The names of the four points correspond to the seasons beginning in the northern hemisphere on these dates.

The northern hemisphere’s vernal equinox occurs in March and marks the beginning of spring and its autumnal equinox occurs in September signaling the beginning of autumn. In the southern hemisphere, the vernal equinox occurs in September and the autumnal equinox occurs in March (see Figure 4).³

A view from outer space makes it possible for us to view this phenomenon (see Figure 5).⁴ The sunlight on the Earth at the equinoxes and solstices is shown at exactly the same time of day. Notice that the equinoxes have the same amount of sunlight in the northern and southern hemispheres (the line between night and day runs vertically, from the North Pole to the South Pole). Notice also on the solstices, there is a large asymmetry in the amount of light that is received in the northern and southern hemispheres (the line between day and night appears tilted).

In December, the North Pole is tilted away from the Sun. When the South Pole is tilted farthest toward the sun as we saw in Figure 2, this characterizes the southern hemisphere’s summer solstice and the northern hemisphere’s winter solstice. The hemisphere that is most tilted toward the sun on the solstice experiences its longest day of sunlight and its shortest night. The other hemisphere experiences its longest night and shortest day.

³ Source: http://www.bigelow.org/virtual/handson/seasons_rotation.html
⁴ Source: http://en.wikipedia.org/wiki/image;seasonearth.png
Because the earth’s orbit is slightly elliptical (it is oval shaped and so the Sun is not at the exact center of the Earth’s orbit), the seasons have an unequal number of days. When the Earth travels nearest the Sun it moves slightly faster than when it is at a greater distance from the Sun. Therefore, the seasons occurring when the Earth is close to the Sun elapse more quickly. This means that as the Earth is nearest the Sun in January and farthest away in July, the summer is longer than the winter in the northern hemisphere. And the winter is longer than the summer in the southern hemisphere.

Common Fallacies About the Seasons

This section addresses common misconceptions among students regarding the Earth and the seasons.

1. **Seasons are caused by the earth being closer to the sun in the summer and farther in the winter due to Earth’s elliptical orbit.**

   Many people believe that the Earth is closer to the Sun thereby causing summer and when the Earth is further from the Sun winter occurs. This misconception may be caused by the idea that the Earth’s orbit around the Sun is almost circular, which is perhaps misconstrued from our children’s science textbooks where they are typically drawn in a very elongated fashion. Thus, the Earth’s distance from the Sun is believed to vary dramatically at differing points. IN FACT, the Earth’s orbit is elliptical, but not as elongated as many believe. It is very near to a perfect circle.

   If this change in distance was what caused the seasons, then the southern and hemispheres would experience summer and winter at the same time, which is not the case. As was already mentioned, we are in fact closest to the Sun during the first week of January, which is when some of the coldest weather occurs in the northern hemisphere.

2. **The Sun is not at the center of the Earth’s orbit, therefore the Earth is closer or farther away from the Sun at different times of the year.**

   IN FACT, the Sun is at one focal point of the Earth’s elliptical orbit, but the fact that the orbit is nearly a perfect circle indicates that the distance from Earth to the Sun remains nearly constant all year long.
3. While some people are aware that the Earth’s tilt has something to do with the seasons, they believe that it is the tilt that brings the Earth significantly nearer to the Sun during the hotter times of the year.

It is the tilt of the Earth that is primarily responsible for our seasons, but this tilt does not bring us closer to the Sun. IN FACT, we need to remember that the distance from the Sun to the Earth is so great at 93 million miles (93,000,000 miles) that any difference caused by tilt is insignificant. This is easy to visualize. Imagine a pinhead and consider it to be the Earth and a basketball for the Sun. Now, imagine them about 10 meters (30 feet approximately) apart. It does not make much difference in the distance between them if the pinhead tilts a bit (even 23.5 degrees).

For those who are interested in more of the details on this, a calculation might be helpful: If the part of the Earth closest to the sun was 3,000 miles closer than a part further away, and the earth was 93,000,000 miles away from the sun, then this would make a difference of about 3 thousands of one percent (.003%) of our distance from the sun. This is indeed a very small amount—not enough to make a difference in the temperature between summer and winter.

4. Seasons are caused by the wobble (precession) of the Earth on its axis.

The phenomenon of precession is regularly seen in a spinning toy top, but any rotating object can demonstrate precession (also referred to as gyroscopic precession). When a spinning motion (torque or rotational force) is applied to a rotating object it precesses. In other words, the tilt of its axis goes around in a circle (a complete circle is one gyration) in the opposite direction from which the object is spinning.

While the precession of the Earth’s axis is a very sluggish effect (it takes approximately 26,000 years to complete one gyration), it is still accounted for by astronomers. Moreover, precession has no effect on the inclination (or "tilt") of the plane of the Earth’s equator (and thus its axis of rotation) on its orbital plane. It is 23.5 degrees and precession does not change that. Therefore, the wobble of the Earth on its axis (precession) does not cause the seasons.
DAY ONE

Objectives
On a globe/Earth, students will be able to identify sphere, Northern Hemisphere, Southern Hemisphere, equator and locate countries in the hemispheres.

Materials Needing to Be Prepared By the Teacher Prior to Teaching the Introduction and Activities 1 & 2
The pages that a teacher needs to copy for students and for the overhead transparencies are provided at end of the text for Day One.

A. Overhead transparencies of the following
   • Poem – "Some Rhymes for all Seasons" (a condensed version from the original poem for third graders)
   • Definitions of the Day
     i. sphere – any round object that has a surface that is the same distance from its center at all point. For example, a ball or globe.
     ii. hemisphere – one half of a sphere or globe. The Earth is divided by the equator into the Northern and Southern Hemispheres.
     iii. equator – an imaginary line around the middle of the Earth, at an equal distance from the North Pole and the South Pole.
   • The Four Seasons transparency
   • Color Copy of Earth

B. Photocopies for students
   • Tilting Into the Seasons Student Workbook.

C. Inflatable Globe/Earth (about 10 inches in diameter) with equator darkened with permanent marker (inflatable globes can be purchased at www.orientaltrading.com). These globes (see Picture 3) are ideal for other subjects such as geography and social studies. Store inflatable globes in large trash bags to keep them from rolling around the room until finished with Day Four.
D. Hang a 12 inch cardboard star anywhere in the room (can be made from poster board or purchased from a party supply store). The Star will represent the North Star. The name of the North Star is Polaris.

E. One 8" or 10" Styrofoam ball cut in half with dowel or skewer through the middle and labeled with the Northern & Southern Hemisphere (see Picture 2).

F. Examples of spherical-shaped items (marble, ping-pong ball, classroom globe) and circular-shaped items (coin, paper).

G. Names of Countries/Oceans/States printed (in large text) on colored paper (that correspond to the color of countries on inflatable globe). The names are Borneo, Argentina, Arctic Ocean, Australia, China, Indian Ocean, Mexico, California, Canada, Colombia, and Sweden. A teacher can use any country, ocean, or state that he/she chooses. Be sure to select places that are in the in the Northern or Southern Hemispheres (see Picture 3).

**Materials for the Students**

A. Tilting Into The Seasons Student Workbook.

B. One inflatable globe per two students.
Introduction

...Let’s get the students thinking...

Questions & Answers: Ask students, “Name the seasons that occur throughout the year.” Students should answer: “Spring, Summer, Winter, Fall or Autumn.”

Write these answers either on the board or on a blank overhead transparency. Then, ask the students questions such as, “What sports do we watch or play during these seasons?” “What type of clothing do we wear?” and “What holidays do we have during these seasons?” Write the answers near the appropriate season.

Poem: Distribute Seasons Folders with poem on the cover.

Place the poem "Some Rhymes for All Seasons“ on the overhead and have a student read it aloud. Ask the students if they think this poem is fact or fiction. (Grade Three, Reading, Standard 3.4). [Answer: Fact. Explain that seasons do come and go, we have seasons because of the tilt of the Earth, and seasons are also caused by the way the Sun shines on the Earth.]

Visual Aid: Distribute The Four Season picture. Place an identical copy on the overhead.

Explain to the class that the seasons represented on the paper are written for the Northern hemisphere and that the Southern hemisphere is opposite. The dark areas represent night; the light areas represent the day. The horizontal line on the Earth is the equator that separates the Northern and Southern hemispheres.

Point to the Northern axis on Earth in the Four Season Picture and show how it is tilted toward the North Star. The arrow that is pointing around the axis is showing the rotation of the Earth. (Note that on paper, or two-dimensionally, the North Star is on the upper right hand corner of the paper. Technically, in three dimensional space, the North Star is over Winter, that is where the Earth tilts towards in space). Point to the North Star (Polaris) hanging in your room to give the three-dimensional explanation.

The arrows between the four images of the Earth on The Four Seasons picture in the Student Workbook represent the Earth orbiting around the Sun. Each Earth orbiting the Sun is labeled by the Season, Solstice/Equinox and approximate date of when the season begins.
ACTIVITY #1 – Definitions Come to Life!

Intent of Activity #1
The intent of the first activity is to have students not only memorize definitions of terms, but to understand them through a hands-on demonstration. The students will be asked questions after reading the definitions aloud and shown props to better understand the globe/Earth. After reading the definitions, students will answer questions aloud while the definitions are demonstrated by the teacher.

Content Preparation by the Teacher Before Teaching the Activity
1. Teacher should know and fully understand the definitions and be able to explain them using the props.
   
   sphere – any round three dimensional object where any point on the surface is the same distance from its center, for example, a ball or globe. [Third Grade, Measurement and Geometry, Standard 2.5]

   hemisphere-- one half of a sphere or globe. The Earth is divided by the equator into the Northern and Southern Hemispheres.

   equator – an imaginary line around the middle of the Earth, at an equal distance from the North Pole and the South Pole.

Directions for the Teacher
Distribute Definitions of the Day Student Worksheet

1. Place terms and definitions on overhead and cover with paper.

2. Reveal the first definition ("sphere") and ask a student to say the term and read the definition.

3. Ask students to write the word "sphere" on their worksheet and say "sphere" (Note: some students will say "spear." Remind them that "ph" makes an "f" sound).

4. Show examples of items that are circles and spheres and ask the students:
   a. "Is this a sphere?" [Answer: yes] "Why?"
   b. "Is this a circle?" [Answer: yes] "Why?"

5. Show second definition ("hemisphere") on overhead and ask a student to say the term and read the definition.
6. Ask students to write the word "hemisphere" on their worksheet and say "hemisphere."

7. Show the Styrofoam ball on dowel and ask students:
   a. "What shape is this?" [Answer: sphere]
   b. "If I pull it in half on the dowel, what is each half called?" [Answer: hemisphere]

8. Now show the inflated globe and ask students:
   a. "What shape is this?" [Answer: sphere]
   b. Place your hand above the black line (equator) and ask, "What shape is above the black line?" [Answer: hemisphere]
   c. Place your hand below the black line and ask, "What shape is below the black line?" [Answer: hemisphere]

9. Explain to students the top half of the Earth is the Northern Hemisphere and the bottom half is the Southern Hemisphere – also point out the North Pole and South Pole.
   a. Place your hand on the top half of the globe again and ask students, "What area of the globe am I holding?" [Answer: Northern Hemisphere]
   b. Place your hand on the bottom of the globe and ask the students, "What is my hand holding now?" [Answer: Southern Hemisphere]
   (NOTE: Students need to understand and say "Northern" or "Southern Hemisphere." This is important to their understanding how the seasons are caused as the days progress).

10. Show third definition ("equator") on the overhead and ask a student to say the term and read the definition.

11. Ask students to write the word "equator" on their worksheet and say "equator."

12. Show students the classroom globe and inflatable globe/Earth and point out the equator.

13. Place the transparency of the Earth (NASA Lithograph) on the overhead. Ask students "Is there a line around the Earth?" [Answer: no] Show students there is no black line around the Earth, it is imaginary and is used in maps as a location.
ACTIVITY #2 –Northern Hemisphere Or Southern Hemisphere?

Intent of Activity #2
The intent of the second activity is for the students to practice finding countries in either the Northern or Southern Hemisphere. This activity will give students an opportunity to practice identifying Northern and Southern Hemispheres which is an important concept to understand how the seasons are opposite for countries in the Northern and Southern Hemispheres.

Content Preparation by the Teacher Before Teaching the Activity
1. Teacher should know where the countries are that have been selected. Remember to have the colored paper coordinate with the country color on the globe/Earth (this helps in finding the countries—but don’t tell the students, they will figure it out).

2. Check the correct spelling of each country (for example, Colombia is the correct spelling for this South American country—it may accidentally be spelled C-o-l-u-m-b-i-a).

Directions for the Teacher
1. Explain to the students that they are going to be given a globe/Earth and they are NOT to throw it, roll it, bounce it, or let the air out of it. (The teacher can decide how to handle students who do not follow these rules or the teacher can say it will be taken away if it is not used properly).

2. Give each student an inflatable globe/Earth (or give one globe /Earth per two students).

3. Hold up the sign with a country’s name on it. Announce to the students, “Find and point to this country.” Have the students place their finger on it. (Note: make sure every student has found the country before proceeding to the next step).

4. Ask, "Is this country in the Northern Hemisphere or Southern Hemisphere or on the Equator?" [Make sure the student correctly responds with "Northern Hemisphere" or "Southern Hemisphere" or "Equator," hemisphere is very important here].

5. Holding up a sign indicating another country ask, “Where is this country?” [Answers could be Northern or Southern Hemispheres or on the Equator. Make sure students include “hemisphere” in their answers].
6. After finding all of the countries have a student collect the globes/Earths and put them in the trash bags (keeping them in two large trash bags works great for storage until you are done with day four).

**Assessment for Day 1**

Using an oral assessment procedure, ask students to recount the definitions to determine their understanding of the content presented.

Using an inflated globe/Earth, place your hand either on the top or bottom and ask which hemisphere is your hand on.

Place The Four Seasons transparency on the overhead, point to Northern hemisphere on one of the Earth’s, ask the question, “Is this the Northern Hemisphere?” [Answer: yes]. Point to the Southern Hemisphere and ask “What area am I pointing to?” [Answer: Southern Hemisphere]. Lastly, point to the equator and ask, “What is this?” [Answer: the equator], then ask is there really a line on the Earth? [Answer: no].

Have students place all handouts in their Seasons Folder.
Overhead
Transparencies for
Day One
Some Rhymes for all Seasons
(by L.B.)

The seasons come and then they go
  Do you know what makes it so?
  Can you explain the reasons why
The seasons come and then pass by?

The seasons come and then they wilt
  It has to do with the Earth’s tilt
  The angle of the Sun’s bright light
The Sun and Earth’s connected flight!
Definitions of the Day

sphere -- any round object that has a surface that is the same distance from its center at all points. For example, a ball or globe.

hemisphere -- one half of a sphere or globe. The Earth is divided by the equator into the Northern and Southern Hemispheres.

equator -- an imaginary line around the middle of the Earth, at an equal distance from the North Pole and the South Pole.
DAY TWO

Objectives
Students will be able to explain how the tilt of the Earth and position of the Sun causes the seasons.

Materials Needing to Be Prepared By the Teacher Prior to Teaching the Introduction and Activities 1 & 2
The pages that a teacher needs to copy for students and for the overhead transparencies are provided at end of the text for Day Two. (Reminder to Teacher: some of these have been prepared in Day One).

A. Overheads transparencies
   • Poem – "Some Rhymes for all Seasons" (a condensed version from the original poem for third graders)
   • Definitions of the Day
      i. axis – a real or imaginary straight line about which something turns. The imaginary axis of the Earth passes through the North and South Poles.
      ii. tilt – to slant or tip
      iii. orbit – the path followed by a planet, moon, or other heavenly body as it travels around another object. The path of the Earth around the Sun is an orbit.
      iv. rotate – to turn around a center point or axis. For example, the Earth rotates on its axis.
   • The Four Seasons transparency
   • Color Copy of Earth

B. Photocopies for the students
   • Tilting Into the Seasons Student Workbook.

C. 100 watt light bulb with clip-on socket and extension cord (can be purchased at any hardware store; see Picture 4)

D. One inflatable globe/Earth

E. Star hanging in room

F. One basketball
Materials for the Students

A. Tilting Into The Seasons Student Workbook.

Introduction

... Let’s get the students thinking...

Questions & Answers: Review the three definitions, using the props, from Day One. Ask students to come to the front and demonstrate the definitions using the props.

Visual Aid: Distribute The Four Season handout. Place the identical transparency on the overhead.

Explain to the class that the seasons represented on the paper are written for the Northern hemisphere and that the Southern Hemisphere is opposite. The dark areas represent night; the light areas represent the day. The horizontal line on the Earth is the equator that separates the Northern and Southern Hemispheres.

Point to the Northern axis on Earth in the Four Season Picture and show how it is tilted toward the North Star. The arrow that is pointing around the axis is showing the rotation of the Earth. (Note that on paper, or two-dimensionally, the North Star is on the upper right hand corner of the paper. Technically, in three dimensional space, the North Star is over Winter, that is where the Earth tilts towards in space). Point to the North Star (Polaris) hanging in your room to give the three-dimensional explanation.

The arrows between the four images of the Earth on The Four Seasons transparency represent the Earth orbiting around the Sun. Each Earth orbiting the Sun is labeled by the Season, Solstice/Equinox and approximate date of when the season begins.
ACTIVITY #1 – Definitions Come to Life!

Intent of Activity #1
The intent of the Activity #1 is to have students not only memorize definitions of terms, but to understand them through a hands-on demonstration. The students will be asked questions after reading the definitions aloud and shown props to better understand the globe/Earth. After reading the definitions, students will answer questions aloud while the definitions are demonstrated by the teacher.

Content Preparation by the Teacher Before Teaching the Lesson
1. Teacher should know and fully understand the definitions and be able to explain by using props.

   axis – a real or imaginary straight line about which something turns. The imaginary axis of the Earth passes through the North and South Pole.

   tilt – to slant or tip.

   orbit – the path followed by a planet, moon, or other heavenly body as it travels around another object. The path of the Earth around the Sun is an orbit.

   rotate – to turn around a center point or axis. The Earth rotates on its axis.

Directions for the Teacher
Ask students to refer to the Definitions of the Day in their Student Workbook.

1. Place terms and definitions on overhead and cover with paper.

2. Reveal the first definition ("axis") and ask a student to say the term and the definition.

3. Ask students to write the word "axis" on their worksheet and say "axis." Show the students the Styrofoam ball with the dowel through the middle (from props on Day One). Point to the dowel and ask the students "Is this the axis?" [Answer: yes]

4. Show second definition ("tilt"), and ask a student to say the term and read the definition.

5. Ask students write the word "tilt" on their worksheet and say "tilt."
6. Show the Styrofoam on dowel and hold it vertically and ask students
   a. “Is this tilted?” [Answer: no] Then, position the dowel at a 23.5
degree angle still holding it up for the students to view and ask “Is
this tilting?” [Answer: yes]
   b. Hold the dowel at a 45 degree angle and ask “If I am holding this at
an angel, what is this called?” [Answer: tilt]
   c. Show how the globe in the room is at a tilt and hold up an inflatable
globe/Earth and tilt it approximately 23.5 degrees. Explain to the
students that the Earth is always tilted at 23.5 degrees.
   d. Ask students to stand up and tilt their bodies towards the North Star,
the Star that was placed in the room on Day One. Ask students to tilt
the parts of their bodies above the waist. Tell the students that the
Earth’s North Pole axis always points to the North Star (Polaris), and is
always tilted at a 23.5 degree angle. Then tell the students that every
time they hear the word “tilt” they need to stand and tilt their body
towards the North Star in the room at the 23.5 degree angle. Tell the
students after they tilt they must immediately sit back down.

7. Show third definition (“orbit”) and ask a student to say the term and read
the definition.

8. Ask students to write the word “orbit” on their worksheet and say “orbit.”
Show the students the inflated globe/Earth and show how the Earth orbits
the Sun by moving the globe/Earth around a clamped light bulb. Ask the
students “What does this light represent?” [Answer: the Sun]. Ask two
students to come to the front of the classroom to demonstrate orbit. Select
one student to be the Sun and he/she will remain stationary. The second
student will represent the Earth, with the 23.5 degree tilt. Since the Earth
orbits, or revolves around the Sun, the student representing the Earth will
orbit around the student representing the Sun. Ask the class “How long
does it take for the Earth to orbit the Sun?” [Answer: 365 days].

9. Show fourth definition (“rotate”) and ask a student to say the term and read
the definition.

10. Ask the students write the word “rotate” on their worksheet and say
“rotate.”

11. Show the students the inflated globe/Earth and show how the Earth
rotates on its axis by turning the ball in your hand. Also, use the Styrofoam
ball and rotate it on the dowel/skewer to explain rotation. Using a
basketball, have a student or students volunteer to rotate the ball on their
index finger. Ask the students if any of them know how long it takes for
the Earth to complete a full rotation. [Answer: 24 hours].
ACTIVITY #2 – Tilting Into the Seasons

Intent of Activity #2
The intent of this activity is for students to demonstrate their conceptual understanding of how we get the seasons.

Content Preparation by the Teacher Before Teaching the Lesson
The teacher should fully understand how the tilt of the Earth and the position of the Sun dictate the seasons. See the Content Section of the module for this information.

Directions for the Teacher

[Reminder: Every time you say tilt during this activity the students will stand up and tilt towards the North Star in the room!]

1. Ask students to place their chairs in large circle around light with the seats facing towards the light, which is attached to a chair (see Picture 5). Ask the students “What do you think the light bulb represents?” [Answer: the Sun].

2. Point to North Star placed in room from ceiling. Ask students the name of the North Star. [Answer: Polaris]


4. Ask a student to orbit the Sun. (The student will walk around the light/chair).

5. Ask a student to rotate the globe/ Earth and orbit around the Sun. (The Earth will be rotating while walking (orbit) around the Sun).

6. Ask students “What else is missing while the student is orbiting and rotating the Earth?” (Answer: “The Earth should be tilting”).
7. Ask "Tilting toward what?" (Answer: "North Star / Polaris").

8. Ask the student to demonstrate the tilt of the Earth. Pose the question to the class, "Is there anything missing from the demo?" (Possible answers are: "Orbit," "tilt," "rotation").

9. Darken the classroom. If the classroom is not easily darkened, place poster or butcher paper on the windows.

10. Ask students to line up in a circle surrounding the chair holding the light. Students will then move in a counterclockwise direction.

   a. Starting at what would be winter (the North Pole and Northern Hemisphere will be tilted away from the Sun and tilted toward the North Star). Explain that it is winter in the Northern Hemisphere because the Sun light is shining less on the Northern Hemisphere and more on the Southern Hemisphere. Ask the students "What would the season be in the Southern Hemisphere?" [Answer: Summer].

   b. Now move ¼ of the way around, the Earth should still be tilted toward the North Star, ask "What season would this be in the Northern Hemisphere?" [Answer: Spring]. Explain that it is Spring because the Sun is shining evenly on both hemispheres and Spring follows Winter and that it is Fall in the Southern Hemisphere.

   c. Move another ¼ of the way around. Ask "What season is it now in the Northern Hemisphere?" [Answer: Summer]. "What season is it in the Southern Hemisphere?" [Answer: Winter]. "Why?" [Answer: The Sun is shining more direct on the Northern Hemisphere that causes summer, and indirect on the Southern Hemisphere which makes it winter].

   d. Move another ¼ way around. Ask "What season is it now in the
Northern Hemisphere?” [Answer: Fall]. Then ask “What season is it in the Southern Hemisphere?” [Answer: Spring]. “Why?” [Answer: because the Sunlight is shining evenly on both hemispheres].

e. Now move the last ¼ [the student should be back where they started]. Ask again, “What season is it in the Northern Hemisphere?” [Answer: Winter]. “What season in the Southern Hemisphere?” [Answer: Summer]. Make sure that the Earth is always tilted towards the North Star and at a 23.5 degree angle (see Picture 6).

11. While holding the globe/Earth, explain and show the students that when the Sun is shining on the globe/Earth it is day and the opposite side of the globe/Earth is night.

12. Position a student at winter in the Northern Hemisphere. Ask the class, “Which do you think has longer days, the North Pole or the South Pole? [Answer: longer at the South Pole].

13. Position the student at summer in the Northern Hemisphere. Ask students to identify if the Earth’s position has: longer days at the South Pole or the North Pole? [Answer: longer at the North Pole].

14. Have another student hold the globe/Earth. Have North Pole tilted toward the Sun—the Northern Hemisphere’s summer position. Ask, “If Alaskans are watching the midnight Sun, what are people seeing in Antarctica?” [Answer: stars and 24 hour nights].

15. Have students put the room back in order.

**Assessment for Day 2**
Review the Definitions of the Day and make sure the students have an understanding of each definition by using the props.

Place The Four Seasons transparency on the overhead, point to Northern Hemisphere on one of the pictures of the Earth and ask, “Is this the Northern Hemisphere?” [Answer: yes]. Point to the Southern Hemisphere and ask, “What area am I pointing to?” [Answer: Southern Hemisphere]. Lastly, point to the equator and ask “What is this?” [Answer: the equator], then ask is there really a line on the Earth? [Answer: no]

Have students place all handouts in their Seasons folder.
Overhead Transparencies for Day Two
Definitions of the Day

axis -- a real or imaginary straight line about which something turns. The imaginary axis of the Earth passes through the North and South Poles.

tilt -- to slant or tip.

orbit -- the path followed by a planet, moon, or other heavenly body as it travels around another object. The path of the Earth around the Sun is an orbit.

rotate -- to turn around a center point or axis. For example, the Earth rotates on its axis.
DAY THREE

Objective
Students will be able to explain how the direction of the Sunlight affects the seasons.

Materials Needing to Be Prepared By the Teacher Prior to Teaching the Introduction and Activities 1& 2
The pages that a teacher needs to photocopy for students and copy for overhead transparencies are provided at end of Day Three.

A. Overhead transparencies of the following
   • Definitions of the Day
     i. direct – without turning or stopping; straight; the shortest way.
     ii. indirect – not direct or straight; by longer way.
     iii. solstice – either of two times of the year when the sun is farthest from the equator in the north or south.
     iv. equinox – either of two times of the year when the sun crosses the plane of the earth’s equator and day and night are of equal length.
   • Four Seasons picture
   • Color copy of the Sun
   • Direct and Indirect Observation Sheet
   • Why Do we Have Seasons? (Crossword Puzzle)

B. Photocopies for Students
   • Tilting Into the Seasons Student Workbook

C. Flashlights (1 per 2 students)

D. Black paper measuring 8.5” x 11” (1 per 2 students)

E. Black paper measuring 8.5” x 11” (one labeled A and one labeled B)

F. Two table lights with bendable necks (see Picture 7 in Activity #2) with 60 watt bulbs

G. Two Fever Reader (forehead) Thermometer Strips
H. Observation sheet (1 per student)  
(see handouts at the end of Day Three)

I. Basketball and straight pin with small sphere head (see Picture 7; note: tiny white dot is the pin head)

Materials for the Students
A. Tilting Into the Seasons Student Workbook

Introduction
... Let's get the students thinking...

Questions & Answers: Review all definitions, using the props, from Day One and Day Two. Ask students to come to the front and demonstrate the definitions using the props.

Visual Aid: Refer to The Four Season picture from Day One. Place the identical transparency copy on the overhead.

Explain to the class that the seasons represented on the paper are written for the Northern hemisphere and that the Southern hemisphere is opposite. The dark areas represent night; the light areas represent the day. The horizontal line on the Earth is the equator that separates the Northern and Southern hemispheres.

Point to the Northern axis on Earth in the Four Season Picture and show how it is tilted toward the North Star. The arrow that is pointing around the axis is showing the rotation of the Earth. (Note that on paper, or on a two-dimensional surface, the North Star is on the upper right hand corner of the paper. Technically, in three dimensional space, the North Star is over Winter, that is where the Earth tilts towards in space). Point to the North Star (Polaris) hanging in your room to give the three-dimensional explanation.

The arrows between the four images of the Earth on the Four Seasons Picture represent the Earth orbiting around the Sun. Each Earth orbiting the Sun is labeled by the Season, Solstice/Equinox and approximate date of when the season begins.

Fun Facts of Astronomy (handout) — Place the transparency picture of the Sun on the overhead projector. Discuss with students that the Sun is 93,000,000 miles from the Earth. Show, using a basketball and the pin
head, that it would take 1,000,000 Earths to fill up the volume of the Sun. The students should know that the Sun is a star.
ACTIVITY #1 – Definitions Come to Life!

Intent of Activity #1
The intent of the first activity is to have students practice spelling words, learn about angles and light, and review what has been learned thus far in the lesson and to keep the students focused and occupied while involved in an observation activity.

Content Preparation by the Teacher Before Teaching the Activity
1. Teacher should know and fully understand the definitions and be able to explain by using props.
   - direct – without turning or stopping; straight; the shortest way.
   - indirect – not direct or straight; by longer way.
   - solstice – either of two times of the year when the sun is farthest from the equator in the north or south.
   - equinox – either of two times of the year when the sun crosses the plane of the earth’s equator and day and night are of equal length.

Directions for the Teacher
Distribute Definitions of the Day Student Worksheet
1. Place terms and definitions on the overhead and cover with paper.
2. Reveal the first definition (“direct”) and ask the students to say the term and read the definition.
3. Ask the students to write the word “direct” on their worksheet and say “direct”. Using a flashlight, with light on, hold the flashlight straight up over a piece of black paper, and show the students how the light is “direct” over the paper. OR, the light is also shining directly over the paper. This is how the Sunlight shines on the Earth producing the season we call summer.
4. Reveal the second definition (“indirect”) and ask the students say the term and read the definition.
5. Ask the students to write the word “indirect” on their worksheet and say “indirect”. Using a flashlight with the light on, hold the flashlight at an angle (see Picture 8) over the black piece of paper, and show the students how the light is “indirect” over the paper. OR, the light is shining indirectly.
over the paper. This is how the Sunlight shines on the Earth producing the season we call winter.

6. Reveal the third definition ("solstice") and ask the students to say the term and read the definition.

7. Ask the students to write the word "solstice" on their worksheet and say "solstice". Explain to the students that this is when we have the seasons Winter and Summer. The date of the Winter solstice is around December 21 and the Summer solstice is around June 21. We also call these days the First Day of Winter and the First Day of Summer.

8. Reveal the fourth definition ("equinox") and ask the students to say the term and read the definition.

9. Ask the students to write the word "equinox" on their worksheet and say "equinox". Explain to the students that this is when we have the seasons Fall and Spring. The date of the Fall equinox is around September 22 and the Spring equinox is around March 20. We also call these days the First Day of Fall and the First Day of Spring.

10. Distribute one flashlight per 2 students and one piece of black paper. Explain to the students that the flashlights are NOT to be shone in each others eyes.

11. Have one student hold the flashlight, with the light on, straight up and down over the black paper and ask "is the light direct or in direct?" [Answer: direct]

12. Have the other student hold the flashlight, with the light on, at an angle over the black paper and ask "Is the light direct or indirect?" [Answer: indirect]

13. Have the students shine the light over the black paper again show "direct" light. Ask "Does the light look very intense or bright and concentrated in one area?" [Answer: yes]

14. Have the students compare the direct light with the indirect light. Ask "What differences do you see?" [Answers may vary. Note that for direct light, a circular shape of light shines on the paper, the light is stronger/brighter, more intense; for indirect, an oval shape of light shines
on the paper, the light is less intense or less bright and disbursed at the far edge]

15. Ask the students “Which direction of light represents summer?” [Answer: direct]

16. Ask the students, “Which direction of light represents winter?” [Answer: indirect]

17. For fun have a student pretend they are a lizard (they must crawl on the floor). Have another student hold the flashlight “direct” on one spot on the floor and have another student position a flashlight “indirect” on another spot on the floor.

18. Tell the lizard that the Sun has just risen in the morning and he has just come out from under a rock. It is still cool from the night and he wants to get warm. Which light should he crawl under to get to the warmest? [Answer: direct]

19. Ask the class “Why?” [Answer: the direct light has the most intense light and therefore, is the warmest]

20. Explain to the class that when the Earth’s hemisphere is tilted toward the Sun, the light is direct and that is why summer is so warm. The hemisphere that is tilted away from the Sun get the indirect light and that is why winter is so cold.
ACTIVITY #2 – Crossword Puzzle and Observation of Light

Intent of Activity #2
The intent of this activity is to have the students understand how Sunlight affects temperature directly and indirectly through observation. Students will also assess their knowledge of previous terms through a crossword puzzle.

Content Preparation by the Teacher Before Teaching the Activity
1. Teacher should understand direct and indirect Sunlight and how it affects the Earth's temperature during the seasons. See the Content Section of the module for this information.

Directions for the Teacher
1. Set up for Direct and Indirect Observation (see Picture 9).
   a. Clamp lights, approximately 1 foot apart, to the edge of the table opposite from where the children will be standing.
   b. Place black paper labeled "A" under one of the lights. Have this light shine directly over the paper. Place the thermometer strip in the center of the black paper. The light bulb should be 12 inches directly above the thermometer strip.
   c. Place black paper labeled "B" under the other light. Have this light shine indirectly over the paper. Place the other thermometer strip in the center of the black paper. The light bulb should be 12 inches indirectly above the thermometer strip.
   d. Turn on lights.
   e. Label "A" thermometer strip should have a higher temperature than paper "B".
   f. Turn off lights until ready for observation (Note: the thermometer strips may get too warm. If this happens turn off lights for a few minutes and let them cool down, then start the observation again).
2. Distribute the blank crossword puzzles, "Why Do We Have Seasons?" (1 per student).

3. Instruct students to complete the blanks on the crossword puzzle without using their "Definitions of the Day" worksheet. Have students work quietly during this time because other students will be observing an experiment.

4. After students have made an attempt on their own solving the crossword puzzle, then they can use the "Definitions of the Day" worksheets to complete any of the answers.

5. In groups of 2-3, ask students to go to the observation table and fill in the observation sheet. Remind them NOT to touch the lights, thermometer strips, or the black paper.

6. When each student has completed the observation sheet, they can select another group of 2-3 students to do the observation next. Continue until all of the students have completed the observation. Any student not participating in the observation should be working on the "Why Do We Have Seasons?" crossword puzzle.

7. Place transparency of the crossword puzzle "Why Do We Have Seasons" on overhead.

8. Ask students, "What was number one across?" and instruct the students to spell the words and you write the letters in the blanks. (Note: A student can help with this)

9. Continue completing the crossword puzzle blanks in this fashion.

10. Review the observation sheet with the students and discuss the answers to the observations (numbers 1-7), listed below as letters a through g below:
   a. Is light A direct or indirect light? [Answer: direct]
   b. Is light B direct or indirect light? [Answer: indirect]
   c. Which season is light A, summer or winter? [Answer: Summer]
   d. Which season is light B, summer or winter? [Answer: Winter]
   e. What is the temperature of light A? [Answer will vary]
   f. What is the temperature of light B? [Answer will vary]
   g. Which light is the hottest light, A or B? [Answer: A]
h. Why is light A hotter? [Answer: direct light is hotter and more intense than indirect light]

**Assessment for Day 3**

Review the Definitions of the Day and make sure the students have an understanding of each definition and the concepts of direct and indirect by using the props.

The crossword puzzle can be an additional form of assessment to determine if the students demonstrate that they know the definitions of each word from Day One, Day Two, and Day Three.

Have students place all handouts in their Seasons folder.
Overhead Transparencies for Day Three
Definitions of the Day

direct -- without turning or stopping; straight; by the shortest way.

indirect -- not direct or straight; by longer way.

solstice -- either of two times of the year when the Sun is farthest from the equator in the North or South.

equinox -- either of the two times of the year when the Sun crosses the plane of the Earth's equator and day and night are of equal length.

Day Three Definitions
Direct and Indirect Observation Sheet

Without touching the papers, the lights, or the thermometers, answer the following questions:

1. Is light A direct or indirect light? _______________

2. Is light B direct or indirect light? _______________

3. Which season is light A, summer or winter?
   _______________

4. Which season is light B, summer or winter?
   _______________

5. What is the temperature of light A?
   ____________ degrees Fahrenheit

6. What is the temperature of light B?
   ____________ degrees Fahrenheit

7. Which light is the hottest, light A or light B?
   _________

8. Why is light A hotter? _______________________
   __________________________________________
9. The shortest way, without turning or stopping, straight.

7. The path followed by a planet, moon, or other heavenly body as it travels around another body.

6. To stand or stop

4. A real or imaginary straight line about which something turns.

3. Any round object that has a surface that is the same distance from its center at all points. For example, a ball of globe.

DOWN

8. Not direct or straight; by a longer way.

5. An imaginary line around the middle of the earth at an equal distance from the North Pole and the South Pole.

2. To turn around a center or axis.

1. One half of a sphere or globe.

ACROSS

Why do we have seasons?
Objective

Students will demonstrate how we have seasons by doing a 2-dimensional activity and a 3-dimensional activity.

Materials Needing to Be Prepared By the Teacher Prior to Teaching the Introduction and Activities 1 & 2

The pages that a teacher needs to copy for students and for the overhead transparencies are provided at the end of the text for Day Four. As Day Four is designed as a review of the last three days, the transparencies and props from all three days must be available for use.

A. Overhead transparency, "Label your poster with the following terms."

B. Laminate the following paper materials so students can write with dry erase markers and wipe clean with paper towels (also use 409 cleaner if needed). Once these materials are made, they can be reused. Store small pieces (in sets) in zip lock bags. Store tickey-tack/poster gum in wax paper (it will stick to plastic). The following materials are shown in Picture 10:

   Make one set of the following per 4 students:

   • 22” x 28” poster board any colors
   • Four 5” in diameter blue circles (the blue circles represent the Earth so Earth not pad paper can be used instead)
   • Two 5” in diameter black circles, cut one of the circles in half
   • One orange or yellow die cut Sun
   • One white die cut Star
   • One black dry erase pen
   • Two to three paper towels
   • Ticky-tack or poster gum (must be removable and can be reused)

C. One “Dum Dum” lollypop per student (use this brand)
because the shape is a "sphere". There is an "equator" that divides the lollypop into Northern and Southern hemispheres and the stick is the "axis").

D. One Party Size play dough in container (see Pictures in Activity #2). This can be purchased at party supply stores.

**Materials for Students**

A. Tilting Into The Seasons Student Workbook.

**Introduction**

...Let's get the students thinking...

**Questions & Answers:** This is the last day of the module and all terms will be reviewed.

1. Select a student and ask him/her to select a vocabulary term that has been discussed during the Seasons Module.

2. Locate the term on the vocabulary list on the overhead transparency and show the definition to the class.

**Visual Aid:** Overhead transparencies available for the students to help them define the terms and all props from the past three days.
**ACTIVITY #1 – Seasons on a Board: A Two-Dimensional Activity**

**Intent of Activity #1**
The intent of the fourth day activity is to review and assess students’ understanding of why we have seasons in 2-dimensional perspective by creating a poster of the seasons.

**Content Preparation by the Teacher Before Teaching the Lesson**
None

**Directions for the Teacher**
Use The Four Seasons handout for this activity.

1. Ask students to form groups of 3 to 4.

2. Place the "Label your poster with the following terms" transparency on the overhead projector.

3. Instruct the students to recreate The Four Seasons picture in the Student Workbook and label using the terms from the overhead projector. If done correctly they will do the following:

   - Place the Sun and the North Star (Polaris) in the correct position on the laminated poster board (with ticky-tack) as shown in Picture 11.

   - Using ticky-tack, they will place the four Earths in the correct locations to represent the seasons.

   - They will label (using a dry erase marker) the axis with tilt (write North or South Pole), draw and label the equator, write the name the season (summer, fall-autumn, winter, and spring-vernal) above the correct position of the Earths.

   - Then, cover the earths with the black paper cut-outs to represent night (see Picture 12).
• Finally, they will draw arrows in the direction of the Earth orbiting the Sun.

4. Each group will take turns placing their poster on the white board with ticky-tack, show their poster to the class, and explain why we have seasons (see Picture 13).

5. The class will review each group's work and decide if the group left out anything on their poster and if everything is positioned correctly.

Picture 12

Picture 13
ACTIVITY # 2 - Tilting Into the Seasons –Lollypop Style: A Three-Dimensional Activity

Intent of Activity #2
The intent of the activity is to review and assess students’ understanding of why we have seasons in 3-dimensional perspective.

Content Preparation by the Teacher Before Teaching the Lesson
None

Directions for the Teacher
1. Ask students to refer to The Four Seasons picture in the Student Workbook.

2. Hand out one "dum dum" lollypop per student.

3. Hand out one party size play dough per student.

4. Have the students remove the wrapper from the lollypop.

5. Ask the students to observe the lollypop then ask, "If the lollypop were the Earth, what can you tell me about the lollypop? [Answer: make sure all of the answers are covered, the shape is a sphere, there is an equator, the handle can be the axis, and there is a northern hemisphere and a southern hemisphere].

6. Have the students remove the lid from the play dough and place the lollypop stick at an angle in the play dough (leave the play dough in the container). The angle represents the tilt of the Earth (See Picture 14).

7. Have the students place the container in the Earth at winter on The Four Seasons picture in the Student Workbook (See Picture 14).

8. Ask the students "Where is it winter?" [Answer: the Northern Hemisphere]

9. Have the students move the play dough container counter clockwise to Spring/Vernal. The students must move the container with the Earth tilting toward the North Star (Polaris) on the paper.

10. Repeat the orbiting around the Sun (See Pictures 14 through 17), ask the students questions such as:

   • Which hemisphere is it winter? [Answer: will vary depending where the Earth is located on the handout]
- What is the angle of the tilt of the Earth? [Answer: 23.5 degrees]

- Where is it day and where is it night? [Answer: the part of the Earth facing the Sun will be day and the side of the Earth that is away from the Sun will be night]

- Show the position of the Earth in the Spring/ Vernal [Answer: it is labeled on the handout] Why? [Answer: because the Sun light is shining evenly on the hemispheres and the Earths orbit around the Sun is between winter and summer]

- When it is winter in the southern hemisphere, near the pole, is there 24 hours of darkness or 24 of light? [Answer: darkness] Why? [Answer: because the Earth is tilted away from the Sun]
Assessment for Day 4

The two activities for day four can be used as a group assessment.
Overhead Transparency for Day Four
Label your poster with the following terms:

- equator
- axis
- orbit (draw arrows)
- Winter
- Spring (Vernal)
- Summer
- Fall (Autumn)
- North Star (Polaris)
- South Pole
- North Pole
- Sun
Resources and References
The following references were helpful in designing this module.

BOOKS


WEBSITES

http://www.cde.ca.gov/be/st/ss/
The California State Board of Education website has the content standards for science available in a PDF format.

http://www.enchantedlearning.com/subjects/astronomy/planets/earth/Seasons.shtml
The Enchanted Learning site has a wide variety of useful scientific information for elementary aged students.
“Imagine the Universe” is one of NASA’s sites answering the question “How does the earth’s tilt affect the changing of the seasons, and what different angles cause those different seasons?”

The National Weather Service Forecast Office web site discusses the cause of the seasons.

Kindergarten through sixth grade downloads, links, and threads that focus more on “logical discovery” than adherence to the National Science Education Standards.

The Lawrence Hall of Science site at the University of California, Berkeley, has elementary age appropriate science information including very interesting and helpful information on the cause of the seasons.

Prof. Jon Kahl’s "Reasons for the Seasons" site at The University of Wisconsin at Milwaukee has very helpful graphics and images.

This is the Internet encyclopedia that provides its information and images to everyone free of charge without any copyright restrictions.

The following resources are available through The Eisenhower National Clearinghouse for Mathematics and Science Education (ENC) which is located at The Ohio State University and is funded through a contract with the U.S. Department of Education; their site is at http://www.enc.org:

**Winter solstice (grades 3-8)**

*Date: 2001 Grade[s]: 3 - 8 Cost: Free ENC#: 100748*

This resource about the winter solstice can be used by teachers of grades 3-8 to explore the seasons with their students. It presents background information and activity ideas, with emphasis on some common misconceptions about the Earth's rotation and that of other planets.
Eyes on the sky, feet on the ground: hands on astronomy activities for kids

Date: 1998 Grade(s): 2 - 6 Cost: Free ENC#: 025820

This Internet site provides hands-on astronomy activities for students in grades 2-6. Each activity promotes an understanding of the scientific process and includes suggestions for discussions before and after the explorations.

OTHER REFERENCE MATERIALS

*A Private Universe* (Pyramid Film & Video) is an educational video that features a study by Dr. Philip M. Sadler of the Harvard-Smithsonian Center for Astrophysics that asked Harvard graduates to explain why the Earth experiences seasons. The graduates gave the same wrong answers that many people do: that seasons are caused by the Earth orbiting farther or nearer to the sun at different times of the year.
APPENDIX A

Student Workbook
Tilting Into The Seasons

Student Workbook

Name ________________________________________
Some Rhymes for all Seasons
(by L.B.)

The seasons come and then they go
Do you know what makes it so?
Can you explain the reasons why
The seasons come and then pass by?
The seasons come and then they wilt
It has to do with the Earth’s tilt
The angle of the Sun’s bright light
The Sun and Earth’s connected flight!
Definitions of the Day
Day One

1. _________ -- any round object that has a surface that is the same distance from its center at all points. For example, a ball or globe.

2. _________ -- one half of a sphere or globe. The Earth is divided by the equator into the Northern and Southern Hemispheres.

3. _________ -- an imaginary line around the middle of the Earth, at an equal distance from the North Pole and the South Poles.
The Four Seasons

- Summer Solstice: June 21
- Vernal Equinox: March 21
- Autumnal Equinox: September 22
- Winter Solstice: December 21

Earth's orbit

Sun's rays

Circle of illumination

Arctic Circle

Day
Definitions of the Day
Day Two

1. ________ -- a real or imaginary straight line about which something turns. The imaginary axis of the Earth passes through the North and South Poles.

2. ________ -- to slope or tip.

3. ________ -- the path followed by a planet, moon, or other heavenly body as it travels around another body. The path of the Earth around the Sun is an orbit.

4. ________ -- to turn around a center point or axis. For example, the Earth rotates on its axis.
Definitions of the Day
Day Three

1. __________ -- without turning or stopping; straight; by the shortest way.

2. __________ -- not direct or straight; by longer way.

3. __________ -- either of two times of the year when the Sun is farthest from the equator in the North or South.

4. __________ -- either of the two times of the year when the Sun crosses the plane of the Earth's equator and day and night are of equal length.
Direct and Indirect Observation Sheet

Without touching the papers, the lights, or the thermometers, answer the following questions:

1. Is light A direct or indirect light? ____________________

2. Is light B direct or indirect light? ____________________

3. Which season is light A, summer or winter? ________________

4. Which season is light B, summer or winter? ________________

5. What is the temperature of light A? ________________ degrees Fahrenheit

6. What is the temperature of light B? ________________ degrees Fahrenheit

7. Which light is the hottest, light A or light B? __________

8. Why is light A hotter? ____________________________________

__________________________________________
1. The shortest way to encompass the Earth is by a sphere, which is a surface all of whose points are equidistant from a common center.

2. The path followed by a planet, moon, or other heavenly body as it travels around another body is called its orbit.

3. Any round object that has a surface that is the same distance from its center at all points. For example, a ball or globe

4. A real or imaginary straight line about which something turns

5. An imaginary line around the middle of the Earth, at an equal distance from the North Pole and the South Pole

6. To turn around a center or axis

7. The path followed by a planet, moon, or other heavenly body as it travels around another body

8. Not direct or straight; by a longer way

9. The shortest way to encompass the Earth is by a sphere, which is a surface all of whose points are equidistant from a common center.

ACROSS

1. One half of a sphere or globe

2. To turn around a center or axis

3. Any round object that has a surface that is the same distance from its center at all points. For example, a ball or globe

4. A real or imaginary straight line about which something turns

5. An imaginary line around the middle of the Earth, at an equal distance from the North Pole and the South Pole

6. To turn around a center or axis

7. The path followed by a planet, moon, or other heavenly body as it travels around another body

8. Not direct or straight; by a longer way

9. The shortest way to encompass the Earth is by a sphere, which is a surface all of whose points are equidistant from a common center.

DOWN

1. One half of a sphere or globe

2. To turn around a center or axis

3. Any round object that has a surface that is the same distance from its center at all points. For example, a ball or globe

4. A real or imaginary straight line about which something turns

5. An imaginary line around the middle of the Earth, at an equal distance from the North Pole and the South Pole

6. To turn around a center or axis

7. The path followed by a planet, moon, or other heavenly body as it travels around another body

8. Not direct or straight; by a longer way

9. The shortest way to encompass the Earth is by a sphere, which is a surface all of whose points are equidistant from a common center.

Crossword Puzzle

Why do we have seasons?
FUN FACTS OF ASTRONOMY

The Earth is
93,000,000 miles from the Sun!

It would take 1,000,000 Earths to equal
the size of the Sun!

The Sun is a star!