

Reasons for Seasons

4th or 5th Grade

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Benchmarks:

(4th) SLC 5: A. Students will identify and explain events and cycles (i.e., phases of the moon, daily and seasonal orientation of the sun, life cycles of plants and animals, motion of gears etc.) and the next likely occurrences.

(5th) SLC 10: A. Students will investigate daily patterns of light and shadow due to the orientation of the sun and the earth.

Objectives:

After this 2-day lesson the students should clearly be able to:

- Model the tilt of the Earth as it orbits the Sun
- Be familiar with solstices and equinoxes and their role regarding the Sun's motion
- Understand that sunlight hits the Earth at different angles at different locations
- Know what causes seasonal changes

Materials:

- 1 battery per team
- writing and construction paper
- a globe and a base per team
- measuring tape
- 2 push pins per team
- 1 penlight per team
- 2 extension cords
- inflatable globe
- 2 light bulbs and light sources

Day 1:

Initial Demonstration:

Divide the class into groups of four. Give each group a globe and 2 push pins, and have them place the push pins into each of the two poles on their globes. Place a light source in the middle of the room on a table. Darken the room, and have all the groups gather in a circle around the light source in the center. Ask the students how the Earth, the globe, revolves around the sun, the light source: In which direction does the Earth move around the Sun? How long does the Earth take to revolve around the Sun? Have one member from the group hold the globe and “revolve” around the Sun in the correct direction. Explain to the students the orbit of the Earth is basically circular, but not perfectly.

Target Model:

-The Earth revolves around the sun in a counter-clockwise direction.

-A year, by definition, is the length of time the Earth requires to revolve around the Sun.

Procedure:

As the students are revolving around the Sun, ask them (and the rest of the class) if the Earth is upright like this when it is revolving around the Sun? Have the students

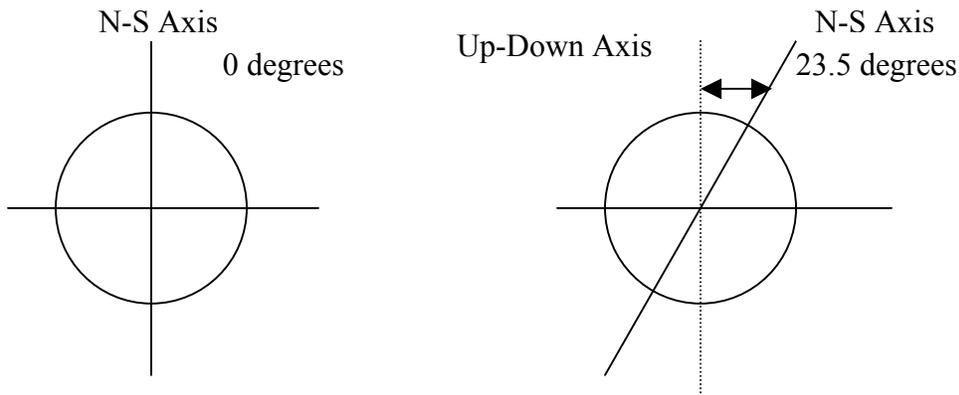
hold the globes upright – what would the days in certain places be like if the Earth was upright? How do we tilt the Earth?

Target Observations:

- When the globe is held with the poles upright, some parts of the globe don't get a whole lot of light.

Target Model:

- The Earth revolves around the sun in a counter-clockwise direction.
- A year, by definition, is the length of time the Earth requires to revolve around the Sun.
- The Earth is not upright as it revolves around the earth, but is tilted at 23.5 degrees.



Procedure:

Model how to tilt the globe 23.5 degrees toward the front wall of the classroom. Have the students stop “revolving” for a moment. Ask the students, “what does the Earth do to create day and night? Try it: is there going to be any difference between day and night with the direction the Earth is pointed?”

Target Observations:

- The globe spins on its Up-Down Axis to create day and night.
- Spinning the globe on its Up-Down Axis changes where the poles are pointed.
- The globe spins on its N-S Axis to create day and night.
- Spinning the globe on its N-S Axis does not change where the poles are pointed.

Target Model:

- The Earth revolves around the sun in a counter-clockwise direction.
- A year, by definition, is the length of time the Earth requires to revolve around the Sun.
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Day/Night:

- As the Earth spins on its Up-Down Axis, the direction the Earth is pointed changes.
- As the Earth spins on its N-S Axis, the direction the Earth is pointed does not change.

Procedure:

We have two different ways of creating day and night – one where the Earth revolves on its North-South Axis, and one where the Earth revolves on its Up-Down (in relation to the classroom) Axis. Which one is correct? Why?

If the students don't have any evidence other than "I know it is," shelve this discrepancy for a moment – it will be resolved soon. Have the students once again point their axis towards the front of the classroom. Switch students so that different students are holding the globe and "revolving." Spread the "revolving" students into a circle around the Sun. If it takes one year for the Earth to revolve around the Sun, then we should be able to mark out some places where it is summer, winter, spring, and fall for Ohio. First have the students think about summer and winter – let's suppose that *student A* is where summer is for Ohio...where is winter for Ohio? How do you know? Where would spring be? Fall?

Target Observations:

- If *student A* is at summer for Ohio, then winter is straight across from her on the other side of the Sun because summer and winter are opposites of each other/they are 12 months apart (half a revolution)
- Spring will be halfway between summer and winter
- Fall will be halfway between summer and winter, and across from spring
- Spring and fall should be put so that as the globe revolves counter-clockwise, it goes through summer -> fall -> winter -> spring

Target Model

-The Earth revolves around the sun in a counter-clockwise direction.

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Day/Night:

-As the Earth spins on its Up-Down Axis, the direction the Earth is pointed changes.

-As the Earth spins on its N-S Axis, the direction the Earth is pointed does not change.

-*Winter and summer are opposite each other, and so are spring and fall.*

Procedure:

Okay, so picking *student A* as summer for Ohio was just picking randomly. Keeping your globes tilted in the right direction, who thinks they know where summer for Ohio really is? Why? If that is summer for Ohio, what is different in winter?

Target Observations:

- Summer for Ohio is when the Earth is closest to the Sun. Winter for Ohio is when the Earth is furthest from the Sun
- Summer for Ohio is when the Earth's N-S Axis is pointed towards the Sun. Winter for Ohio is when the Earth's N-S Axis is pointed away from the Sun.

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Day/Night:

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- As the Earth spins on its N-S Axis, the direction the Earth is pointed does not change.
- Winter and summer are opposite each other, and so are spring and fall.

Seasons:

- The seasons are caused by the distance of the Earth to the Sun in its orbit.*
- The seasons are caused by the tilt of the Earth to the Sun.*

Procedure:

Again, we have two explanations! Let's sort this out: why do I keep saying "summer/winter for Ohio"? What's so special about Ohio? When it is summer in Ohio, is it winter in other places? Actually, yes! When it is summer in Ohio, it is winter in Australia. Likewise, when it is winter in Ohio, it is summer in Australia. Let's see which of our two explanations for the seasons has this. If the seasons are caused by the distance of the Earth to the Sun in its orbit, will there be different seasons on Earth at the same time? If the seasons of the Earth are caused by the tilt of the Earth to the Sun, will there be different seasons on Earth at the same time?

Target Observations:

- If seasons are caused by the distance of the Earth to the Sun in its orbit, there cannot be different seasons at the same time – the whole planet has the same season because it is all at the same distance from the Sun.
- If seasons are caused by the tilt of the Earth to the Sun, there can be different seasons because when the top of the Earth is tilted towards the Sun, the bottom of the Earth is tilted away from the Sun. Likewise, when the top of the Earth is tilted away from the Sun, the bottom of the Earth is tilted towards the Sun.

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Day/Night:

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- As the Earth spins on its N-S Axis, the direction the Earth is pointed does not change.
- Winter and summer are opposite each other, and so are spring and fall.

Seasons:

- ~~-The seasons are caused by the distance of the Earth to the Sun in its orbit.~~
- The seasons are caused by the tilt of the Earth to the Sun.

Procedure:

We found that the seasons have to be caused by the tilt of the Earth because that was the only explanation that gave us different seasons at the same time. Let's now go back and see if we can fix the day/night problem. Knowing that the tilt of the Earth causes the seasons, which day/night description says we should have all 4 seasons in one day?!

Target Observations:

- If the Earth spins on its Up-Down Axis in a day, the tilt of the Earth changes
- Since the tilt of the Earth causes the seasons, the Up-Down Axis says that the seasons change in a day
- If the Earth spins on its N-S Axis in a day, the tilt of the Earth does not change
- The Earth spinning on its N-S Axis does not change the seasons during the day

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-Winter and summer are opposite each other, and so are spring and fall.

Seasons:

~~-The seasons are caused by the distance of the Earth to the Sun in its orbit.~~

-The seasons are caused by the tilt of the Earth to the Sun.

Procedure:

We have now been able to figure out how the seasons work, and how the Earth spins to make day and night. Let's see if it makes sense. Have a student with a globe start at summer – where the top of the globe is tilted towards the Sun. See how the northern part of the globe, where Ohio is, gets more sun than the southern part? This is why it is summer in Ohio. Now have this student revolve around the light source so that she is in fall for Ohio, while another student takes her place in summer. Notice the difference between summer and fall? Neither the top nor the bottom part of the globe is getting more light in fall, as opposed to summer in Ohio. Have the students revolve one more season, bringing in another student at summer. What season is the first student at (for Ohio)? Notice how the top of the globe is tilted away from the light, giving the bottom of the globe more light. This is why it is summer for Australia and winter for Ohio. Have the students revolve once more, bringing in another student at summer. What season is the first student at now? Is this much different from fall? Does this sound right – are spring and fall about the same temperatures?

Day 2:

Procedure:

Arrange both light sources in the room so that half of the teams can work around one. Give each team Activity Sheet 9, measuring tape, push pins, a globe and a globe base.

Tell teams to put the globes on the base and insert one pushpin to pinpoint their own location on Earth (Ohio). The top of the pushpin is the top of their head (make sure the students insert the pin at a right angle to the surface of the globe).

Have one team at each light source stand between their light source and the front wall. On the floor next to these teams lay a "winter" sign. Moving counter-clockwise, position another team from each light source to stand between their light source and the side wall. Next to each of these teams lay a "spring" sign. Continue around the circle laying summer beside the teams toward the fourth wall. Likewise with fall.

Darken the room. Have the teams at each light source revolve with their globes around the light source, observing the angle of the pushpin with respect to the Sun. Remind students to keep the Earth's tilt to the front of the room, but to rotate the globe so that the pushpin always faces the Sun. As they reach each of the season signs, they should stop and fill out the appropriate part on the activity sheet. (Encourage the students to imagine that they are the pushpin looking at the Sun. The more directly the top of the pushpin faces the Sun, the higher in the sky the Sun would appear to them. The larger the angle between the top of the pushpin and the Sun, the lower in the sky the Sun would appear to be to them.

How does the pushpin's view of the Sun change as the Earth revolves? Record your observations on step one of the activity sheet.

Target Observations:

- When the top of the globe is tipped towards the light source, the pushpin is pointed nearly directly towards the light
- When the top of the globe is tipped away from the light source, the pushpin is not pointed towards the light (the light source is lower)
- When the top of the globe is not tipped towards or away from the light source, the pushpin is not pointed towards the light, but is not far away either

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Day/Night:

-As the Earth spins on its N-S Axis, the direction the Earth is pointed does not change.

-Winter and summer are opposite each other, and so are spring and fall.

Seasons:

-The seasons are caused by the tilt of the Earth to the Sun.

-During summer in Ohio, the sun should seem high in the sky. During winter in Ohio, the Sun should seem low in the sky. During spring or fall, the Sun should seem neither high nor low in the sky.

Procedure:

Does the height of the Sun in the sky change the length of the day? Find a way to test this with your globe, light source, and a centimeter measuring tape.

Target Experiment:

Remove the pin, stick it through a centimeter mark on the measuring tape, then replace it in the globe. At each season time, one teammate should hold the globe at the proper tilt, starting with the pushpin at the sunrise position (the western edge of the sunny side). Another teammate should hold the measuring tape while the person holding the globe rotates it until it reaches the sunset position (the eastern edge of the sunny side). Then the teams can measure the length of the pin's daytime path (the distance from the pin to the where light meets dark for sunrise on the measuring tape) and record it in step 2 on the activity sheet.

Next the students measure and record the length of the pin's nighttime path—from the western to eastern edge of the dark side of the globe. Does the pushpin spend more time in daylight or night during the summer? During winter? What about spring and fall?

Target Observations:

- The pin travels a longer path in summer during the day than in winter
- The pin travels a longer path during the day than during the night in summer, and a shorter path during the day in winter

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-The days are longer during the summer than in the winter. During spring and fall, day and night are equal.

Procedure:

Write the words *solstice* and *equinox* on the board. Tell the students they just demonstrated both of these. Ask them if they can identify which seasons correspond to which words. Hint: the word equal is hiding in one of them...which seasons have something to do with equalness?

Target Observations:

- The equinoxes are when the day and night are equal – spring and fall
- The solstices are when day and night are unequal – summer and winter

Procedure:

As we have seen, such a simple thing like the tilt of the Earth can cause a lot of different things, like different amounts of daylight, different heights of the Sun during different seasons, and the seasons themselves.

To illustrate how the tilt causes different seasons (mainly different temperatures) further, we can see the effect tilting has on the intensity of sunlight. Turn on the lights and hand out construction paper and a penlight to each team. Have them draw a dot in the center of the paper and put it on their desks. The paper is the surface of the Earth, and the dot is an observer, and the penlight is the Sun.

Darken the room again and have them shine the light on the dot as if it were the summer solstice. Draw the shape of the lighted area in Step 3 on the activity sheet. Now have them use their penlights to show the spring and fall equinoxes, copying this onto their sheets as well. Finally, have the students shine their penlights as if it were winter, and record what the light looks like.

Target Observations:

- When the penlight is shined directly on the paper you see a brightly lit circle
- When the penlight is tilted a little bit, the light on the paper becomes an oval and is a little duller
- When the penlight is tilted a lot the light on the paper becomes a long oval and is very dull

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-*During summer the Sun shines directly onto the Earth (where it is summer) and is very bright. During winter the Sun shines at a tilt to the Earth and is dull.*

Procedure:

Write *direct sunlight* and *indirect sunlight* on the board. When does the northern part of Earth get direct sunlight? Indirect sunlight? Have the students compare direct and indirect sunlight with their models or in the drawings on their activity sheets.

Have the students shine the penlight on the globe to show the angle of sunlight during the solstices and equinoxes, and that it is the same as was found with the paper and penlights.