

Teacher Notes- “Seasons-Two Reasons For The Four Seasons”

The seasons. Is there another topic as misunderstood, as elegant, or as frustrating to teach?

Teaching the seasons to our students involves getting most of them to let go of a commonly-held notion: that how hot and cold we are is caused by how close we are to the sun. Undoing that learning is difficult. And doing a good job with this lesson means that you will have to do more than just present this one lesson. To push those old ideas out for good you’ll need to revisit this a few more times.



Materials per student/group:

- 1-Student Handout (see p. 6)
- 1-Ruler
- 2-Calculators
- Red and blue colored pencils
- Ring stand and jaws clamp (optional)
- Flashlight
- Globe

And...

PowerPoint-Seasons (see p. 6)

An orbiter would be a perfect compliment (item #WW63873M01 at sciencekit.com), but they are pricey. (optional)

Beforehand:

1. Round up enough globes for students in groups of 4 to have one. The ones shown in the PowerPoint slides are 12 inches across but any size will work.
2. If you’re using the PowerPoint, we put some hidden cues on the slides to help in your presentation. In the lower left it states what’s on the next slide, and the red dot in lower-right corner appears when the next click (or space bar tap) changes to the next slide. That way your talk can flow from one thing right into the next.
3. Closing the blinds in your room will help students see the light on the globes better.

4. Keep a flashlight, globe, and stand setup for yourself up front so you can *show* students what to do.
5. If you're limited on flashlights or globes, or just want a simpler way of doing this, you can have just 1 flashlight/globe set up that you the teacher operate in Part 1. That's not a bad way to do the lesson. In fact, it has some advantages- like being quicker and requiring fewer instructions and therefore confusion. But students won't see up close how the light intensity changes, and won't get the thrill of doing it themselves.
6. The first PowerPoint slide is very simple- title on black. You might want to add a seasonal picture or two to the background to spruce it up. If it's larger than the title, right-click it and go to "Order" → "Send to Back" .

Procedure:

1. Announce to everyone that you're taking an imaginary field trip right now to the mall (close your eyes if you want):

"But we're not going for fun this time. We have business to do. We're going to talk to some unsuspecting shoppers about the seasons. See that clipboard in your hand? I want you to ask 10 random shoppers what causes the seasons. After you're done and everyone reports back, we'll discover that almost everyone is wrong.

Class, the cause of the seasons is one of the most misunderstood things in all of science. Most people, even the super intelligent, think that we experience summer when... (earth is closer to the sun), and that we experience winter when... (we're further away). Makes sense, but it's not true.

We can disprove it right now with two statements. Ready? When it's summer here, what is it like in Australia? (winter). So how can the thing that causes us to be hot cause them to be cold at the same time?

The other thing is even more devastating. You know how it's always cold here in January? Well, it turns out that January 4th is when earth is the closest to the sun (~91,000,000 miles) it will be on its journey around the sun (its orbit is slightly eccentric, or oval, causing this effect). And 6 months later, in the middle of summer, is when we're furthest (95,000,000 miles)*¹.

2. Go right into filling in the blanks next to "1.". The sub-points below it are meant to reinforce the first, most important idea- the earth's axis is tilted.*²

1. The tilt of earth's axis.

•It leans 23 ½ °

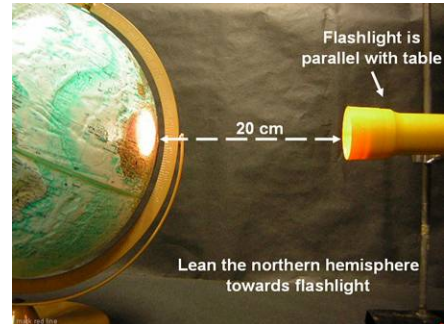
•Is the result of a massive collision , perhaps the same one that created the moon

3. Have students label the equator, axis, latitudes at 15, 30,

and 45 north and south, north and south pole on their earth maps. Notice the arrows, indicating sunlight coming from the right.

4. Now it's time to use the flashlights. First, make sure you have everyone's attention. Students not listening have no business touching anything. The concept we're about to show is simple, but it still needs to be done properly.

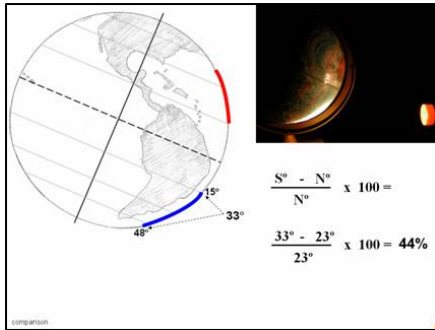
Have each student group clamp the flashlight in the jaws of the utility clamp and set it parallel to the table. Then move it 20 centimeters away from the globe, which should have the northern hemisphere leaning towards it. *It also works about as well if students just hold the flashlight in their hands about 20 cm away from the globe as they do the next step.*



5. Turn off the lights and ask students for their attention:

“Now that our flashlights are ready, let me demonstrate what I want you to do, and how to do it. Watch as I loosen the nut holding the clamp and then slowly slide it with the flashlight up and down the post. Notice I'm not moving the ring stand base or the globe, just the height of the flashlight. (*demonstrate*). Now, when you do this, what I want you to notice is when the circle of light on the globe is smallest and when it's the largest. You'll notice as you move it from the north pole slowly and steadily to the south pole that the beam of light keeps changing size. Again, when/where is the beam of light biggest and smallest. Ready? Go ahead and do that now.”

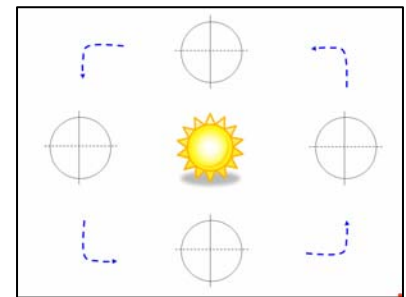
6. Walk around the room and make sure students are doing what you asked the way you asked, and are noticing the beam is most focused/smallest around 15° north, and most spread towards the poles, especially south.
7. In the next few PowerPoint slides the size of a beam of light beginning at 15° north and 15° south are compared mathematically. It's best to have students just watch the screen (or listen to you) and copy these notations on their handout. It's a much easier and neater process when everyone is using the same numbers (believe us- it doesn't work nearly as well when each group uses their own observations and numbers!)
8. Here is a summary of those results: when the northern hemisphere leans towards the flashlight and the beam begins at 15° north, it stretches to 38°. In other words, it covers an area of 23° (the difference between the numbers). When you get to this, *have students take a red colored pencil and shade that same section on their papers.* When the same flashlight is adjusted down so the beam begins at 15° south, it stretches to 48° south. The difference between those is 33°. *Have students shade this part of their papers blue.*



When you plug those numbers into a comparative math formula $(33-23/23 * 100)$, you get 44. What that tells you is that beam number 2 in the southern hemisphere is 44% bigger, or more spread, than beam 1. Put another way, in both cases the same amount of “heat” from the sun was broadcast to 2 places. Which area is going to be warmer- the one under the smaller, focused beam or under the larger one? (hint-not the second)

- Now move onto point “2.” and fill in those blanks for revolution. As with point 1., the sub-points are meant to reinforce the main idea, to make it stick longer/better.
- Direct students to the sun and 4 earth’s below that. Have them draw an equator and axis on each. Double check that the axis are all “leaning” the same way- to the right in this case. If you have an orbiter this would be a great time to ask if they’ve ever noticed if earth’s axis stays pointed at the same spot all throughout its orbit (up there is the north star-Polaris), or if it swings out on one side and then comes back in. Until they see it here, many don’t realize the axis leans the same way all around the sun.

- The next slide has students put arrows on to note the earth moving around the sun.*³ Then you can ask them about the earths on the left and right side and see if any of this makes sense to your students. Go ahead and point out which hemisphere is leaning towards the sun, and which isn’t.



- As you begin to wrap things up, summarize the lesson with the 2 statements that students will write at the top of the back page.
- The next 2 sections are for homework. The first is a matching section that was meant more for fun. If you have 5-10 extra minutes this is an easy way to fill it in.

The 2 “What If” questions will challenge your students, so decide if you want to grade that homework assignment, or use it as class discussion starter the next day (see next point). Try to leave your students at least 5 minutes to play with globes/flashlights before it’s time to go. Question 1 asks what the effect would be if earth’s axis was not tilted. If that was the case, then, as shown, the equator would always get the most direct sun (hot summer), the poles would receive such indirect sunlight that it would amount to almost nothing (winter), with everything in between getting colder towards the poles and warmer towards the equator. And since the directness of sunlight wouldn’t change at any point around the sun if there was no tilt, then neither would the seasons ever change. Ever. Question 2 asks what it would be like if revolution was stopped. Well, in this case the tilt, as we learned in the lesson, would cause the hemisphere leaning towards the sun to be warmer, and the other to be cooler. But since it’s not moving, it’s stuck, and so are our seasons again.

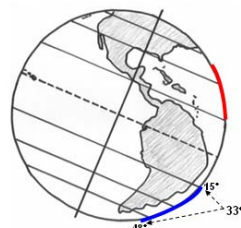
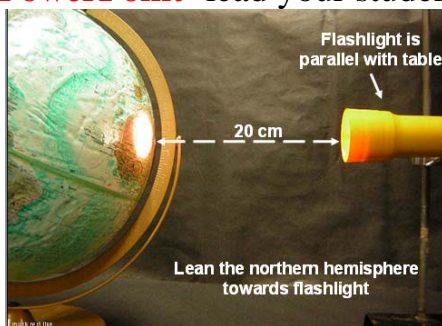
14. Unlearning anything is difficult, and the seasons is no exception. You will need to touch back on this a couple of more times for all this to begin to sink in. After this lesson, student's heads will be full of information, so they need a refresher tomorrow and the next day to keep things straight. And, depending on the age and grasp your students have, it may be to your advantage to hold off on the 2 "what if" homework questions until after you've revisited on day 2. That way they can have more play time with the globes and flashlights as they research their answers.

Accessories: Other sub-topics you can add for more length and depth.

- *¹ "Perihelion" is when the earth is closest to the sun, usually on/around January 4th. "Aphelion" is the farthest- July 4th.
- *² But the axis didn't used to lean. When the earth was around 30 million years old it suffered a traumatic event- a mars-sized asteroid ("Theia") collided with it. Fortunately, it was a glancing blow, not a direct hit. A chunk of earth broke lose, and that became our moon. We owe our seasons to this event, as your students will discover in the homework assignment.
- *³ Since you've got the globes out and are talking about the revolution of the earth anyway, go ahead and clarify the difference between rotation and revolution. Although it may seem like everyone understands the difference, talk slow and deliberately- there may be someone in the room that never realized what even causes day and night.

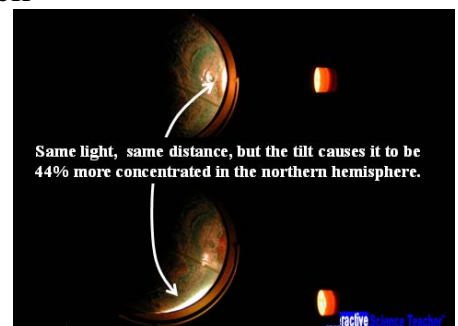
Come back and visit InteractiveScienceTeacher.com to upgrade this lesson with:

PowerPoint- lead your students through the lesson click-by-click



$$\frac{S^\circ - N^\circ}{N^\circ} \times 100 =$$

$$\frac{33^\circ - 23^\circ}{23^\circ} \times 100 = 44\%$$



Student Handout

Seasons

Two factors cause Earth's seasons:

1. The _____ of earth's axis.

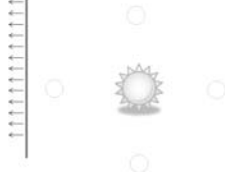
- It leans _____.
- Is the result of a massive _____, perhaps the same one that created the _____.



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2. The _____ of earth around the sun.

- Average speed _____ mph.
- It takes earth _____ days to make the _____ mile journey.
- But it's always in the same place on the same day every year.



QuickNotes

Teacher Quick Notes- "Seasons"

Materials per student/group:

- 1-Handout- "Student Handout-Seasons" (located in the Resources folder)
- 1-Ruler
- 2-Calculators
- Red and blue colored pencils
- Ring stand and jaws clamp (optional)
- Flashlight
- Globe

And...

PowerPoint-Seasons (located in Resources folder, optional)

An orbiter would be a perfect compliment

Procedure:

1. Filling in the blanks on the student sheet next to 1. dealing with earth's tilted axis.
2. Have students label the equator, axis, latitudes at 15, 30, and 45 north and south, north and south pole on their earth maps.
3. Have each student group clamp the flashlight in the jaws of the utility clamp and set it 30 centimeters away from the globe, which should have the northern hemisphere leaning towards it. *It also works about as well if students just hold the flashlight in their hands.*
4. Have students now move a flashlight beam up and down the globe, noticing where the beam is smallest and largest (most spread).
5. Use the PowerPoint slides to compare mathematically the size of the beams at 15° north and 15° south.
6. Have students shade with red and blue the areas of the north and south covered by the beam, just like on the PowerPoint slide.
7. Now move onto point 2. and fill in those blanks for revolution.
8. Have them draw an equator and axis on the 4 earths below the revolution blanks.
9. Put arrows in between the earths to note the earth moving around the sun.
10. Summarize the lesson with the 2 statements on the top of the back.
11. Homework- do the matching section (for fun) and then the 2 "what if" questions. Ideally leave 5 minutes for students to play with globes/flashlights to help them with their answers.

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