Reasons for the Seasons Symposium: Direction of Earth's Axis

RESEARCH TEAM ASSIGNMENT SHEET

Research Goal

Your goal is to determine what effect the direction of Earth's axis of rotation has on the number of hours of daylight received at different locations on Earth and how this might affect Earth's seasons.

Background

As you may already know, Earth spins on its axis every 24 hours, as if someone pushed a large needle through Earth from the North Pole to the South Pole and then made Earth spin on the needle. The direction of Earth's axis is not perpendicular to the direction to the Sun but tilted by 23.5°. In this activity, you will make a model that shows the Sun and the Earth and how the Earth orbits the Sun. This will let you determine how much daylight shines on different parts of Earth at different times of the year. You will then use this information to predict what effect this may have on Earth's seasons.

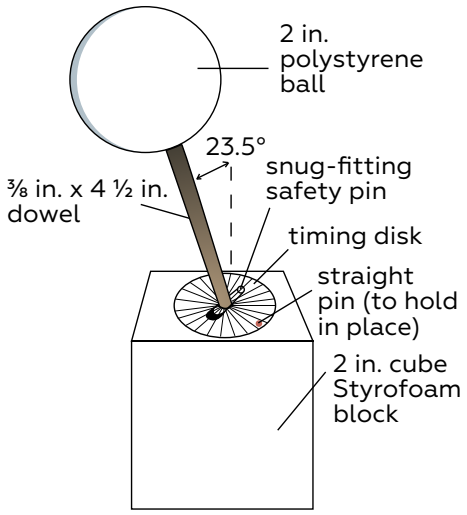
Be sure to keep a log in your astronomy lab notebook of the steps you follow throughout the activity and include any results and conclusions you make.

MATERIALS

- 40 W lightbulb in short desk lamp, shade removed (*Safety note:* This lightbulb will get very hot. Be careful not to touch it.)
- Black butcher paper showing orbit of Earth around Sun
- Model Earth setup (Styrofoam ball on dowel, 2 in. × 2 in. Styrofoam block, timing circle, and a safety pin that just fits around the dowel; see diagram below)
- Three map pins of different colors
- "Direction of Earth's Axis Research Team Assignment Sheet"
- Space to work that is relatively dark

Procedure

1. Find a darkened space where you can carry out your research.
2. Lay out the black paper showing Earth's orbit. Be sure to leave room around all sides for your team to work.
3. Place the lamp with the lightbulb in the Sun's location on the black paper, and turn on the lamp.
4. Be sure the model Earth setup is assembled as shown in the diagram to the right. Be sure the safety pin fits snugly on the wood stick. Also, make sure the model Earth and the lightbulb are at the same height.



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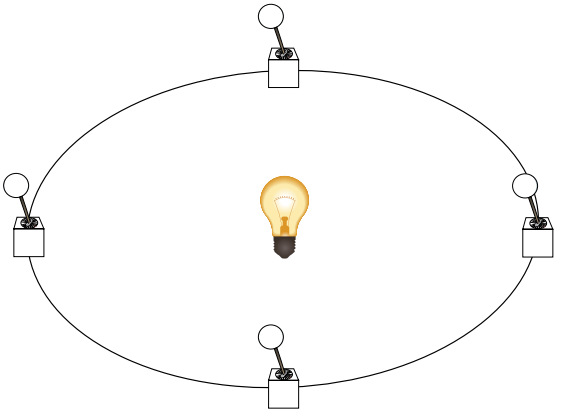

5. Find the latitude of your location on a globe or by searching online and place one of the map pins near your latitude on your model Earth. Push the pin in so the head is close to the surface of the Styrofoam ball.
6. Set the model Earth on the poster paper at the location marked summer solstice. Be sure Earth's axis (the stick) is tilted with the top of the stick pointing toward the direction north shown on the poster paper (as shown in the left side of the diagram on p. 110).
7. Earth rotates counterclockwise on its axis (when viewed from above) once every 24 hours. Practice turning the model Earth in the proper direction and note that the safety pin also makes one complete turn and passes across all 24 hour indicators on the timing circle with each complete rotation.
8. You are now ready to use your model Sun and Earth to determine the number of hours of daylight at your location on Earth at different times of the year.
9. Turn Earth counterclockwise until the map pin marking your location is just moving from the nighttime side (dark side) of your model Earth into the daylight side (lighted side). This is when the Sun would rise for a model person riding along with the pin. Hold the model Earth in place while another team member moves the safety pin so it is over one of the hour lines.
10. Now rotate Earth until the map pin is at sunset (where the pin goes from the lit side of the model Earth into the dark side). On the timing circle, count the number of hours the safety pin has passed over (including an estimate of any fraction of an hour at the time of sunset). This is the number of hours of sunlight you experience at your location on the summer solstice.

11. Record this information in your astronomy lab notebook. Let everyone in the group do this so that you repeat the observation for the summer solstice several times and record the average number of hours of sunlight your group measured.
12. Move the model Earth to each of the other three locations marked on the poster paper and repeat the observations. *Be sure that Earth's axis is always pointed toward the north direction at each location.* Record the data in your astronomy lab notebook. Then prepare a table and a graph of the data you collected that shows how the amount of daylight varies at different times of year.
13. Use the data to have a discussion among the members of your research group to predict what effect the tilt of Earth's axis will have on Earth's seasons.
14. Using appropriate visual aids, prepare a presentation for the rest of the class that explains the research activity you performed and what conclusions you reached. Be sure to include the following:
    - The problem you explored
    - The procedure you followed
    - The data you collected, including any graphs
    - The conclusions you reached
15. (*Optional*) Repeat your observations, except remove the tilt of Earth's axis toward or away from the Sun. What can you conclude about how daylight hours would change if the Earth's axis were not tilted?
16. (*Optional*) Tilt the Earth again and place a new map pin at the equator. Repeat your observations at all four positions in Earth's orbit around the Sun. Record these observations in your astronomy lab notebook. Discuss with your group what you think the implication for the seasons for people who live near the equator is. Record your predictions in your astronomy lab notebook.
17. (*Optional*) With the Earth still tilted, place a new map pin at a location on the other side of the equator (in Earth's Southern Hemisphere) that is the same distance away from the equator as your home location. Repeat your observations at all four positions (dates) in Earth's orbit around the Sun. Record these observations in your astronomy lab notebook. Discuss with your research team what these observations tell you about the length of daylight at different locations on the Earth and what this means in terms of the Earth's seasons.