Modeling axial tilt and daylight

Modified from "Modeling the Seasons" activity, Exploratorium
Modified for 5th grade

Why do some places on the Earth have 24 hours of darkness at certain times of year?

During the summer, depending on where you are on the Earth, you may find that the Sun sets later (and maybe rises earlier…) than it sets during the winter. Maybe you've heard about the long, dark winters at the North and South Poles…Perhaps you've seen a documentary about the Emperor Penguins and their long wait in the darkness as they incubate their eggs in Antarctica.

Why does this happen? We are going to "model" the Earth and the Sun throughout the year and try to explain why the period of daylight gets longer and shorter at different times.

Materials

You will need a bright lightbulb, and a socket for it (with a switch) that you can put in the middle of a room.

Each person will also need a Styrofoam ball, a wooden skewer, a pair of scissors to trim the point from the skewer, and one or two push-pins to represent locations on the Earth.

Put the skewer all the way through the center of each Styrofoam ball, and trim off the pointed end with the scissors *(your teacher may have done this step for you)*.

Modeling the tilt of the Earth

The Earth's axis is tilted relative to the Sun; instead of the Earth's equator and the Sun's equator being "lined up" on the same plane, the Earth is inclined about 23.5° relative to the Sun's equator. Right now, the Earth's axis points at the "North Star," which is a star called *Polaris*. Polaris has been used for navigation in the Northern Hemisphere for thousands of years. There is no "South Star" at the moment, and the "pole stars" change as the Earth "wobbles" over thousands of years.

Pick a "North Star" in your classroom (a clock works well), and keep the axis of your Earth pointed toward your "North Star" during the activity!

Modeling a day on the Earth

Darken the room and turn on your light source. Make sure to keep your axis pointed at your classroom's "North Star"!

Take a push-pin and mark your approximate location by putting the pin into the Styrofoam in about the right place. To model a "day" on the Earth, spin your Earth counter-clockwise (when looking down on the North Pole).

As you rotate your model Earth, notice how long the push-pin is in shadow, and how long it is in light.

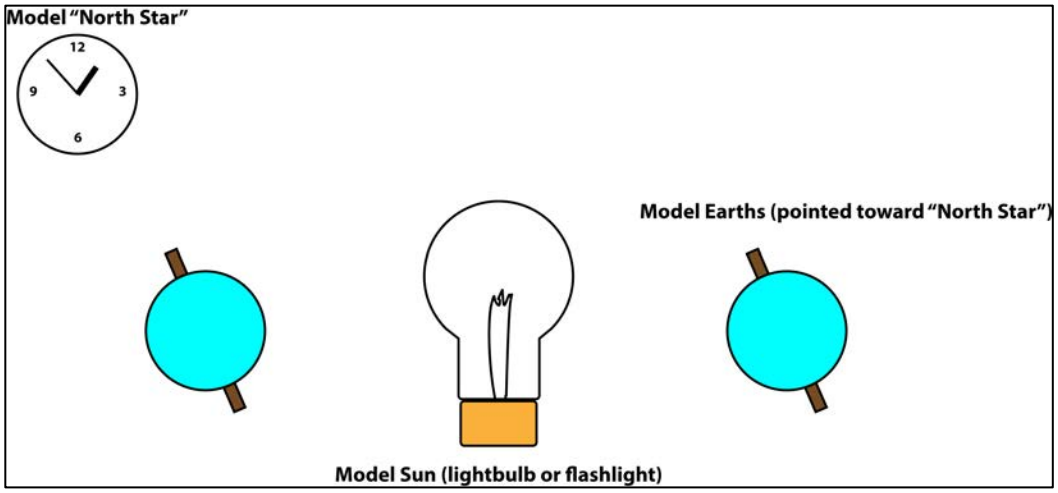


Figure 1. Example setup of the activity. Push-pins not shown. The tilt of your model Earths will depend on the location of your "North Star" in the room.

Daylight period over the course of the year

Keep your Earth's axis pointed at your "North Star," and move to a different place around your model Sun. This simulates a different time of year (since the Earth is at a different place in its orbit). Simulate a "day" by spinning your Earth counter-clockwise again. As you rotate your model Earth, notice how long the push-pin is in shadow, and how long it is in light.

Compare this observation to your previous observations. **Did the amount of time the push-pin is in light change when you changed position around your model Sun?**

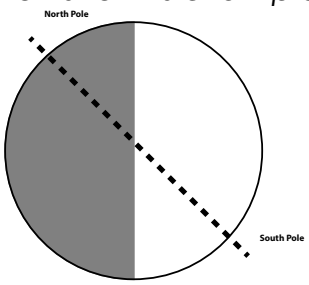
Repeat this several times at different places around the model Sun (simulating different times of year). Does the amount of time the push-pin spends in the light versus darkness change during different times of the year?

Questions

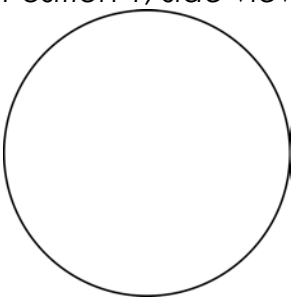
1) **Record your observations of your model Earth from two different positions. Mark the shaded side, the axis, and the poles. Add arrows to show where the light is coming from, and the direction of rotation.**

Side View

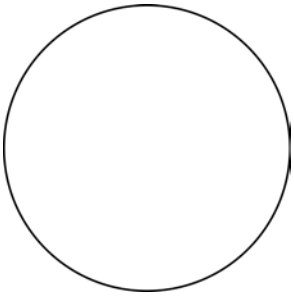
Example side view
(Add arrows to this example!)



Position 1, side view

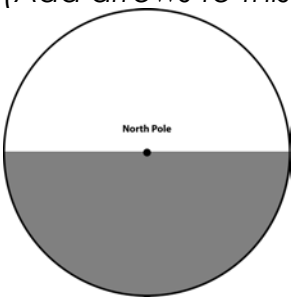


Position 2, side view

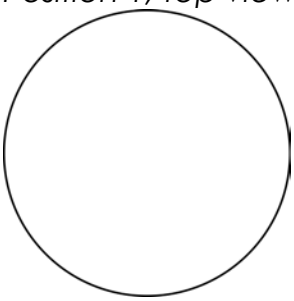


Top View

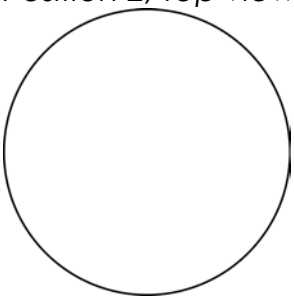
Example top view
(Add arrows to this example!)



Position 1, top view



Position 2, top view



2) **Describe what happens to the amount of time a push-pin spends in the lighted and shadowed regions of your "Earth" at different times of the year. Why do you think that is?**