Name_____

Seasons

Most places on Earth experience four seasons every year. These are spring, summer, fall (or autumn) and winter. In these investigations we are going to find out why we have different seasons.

The seasons are caused by a combination of things.

- ☼ The Earth is tilted as it moves around the sun.
- ☼ Direct sunlight produces more heat than indirect light.
- ☼ The Earth moves around the sun in a way you may not expect.

We will look at each of these in turn, and then see how all three, together produce the seasons.

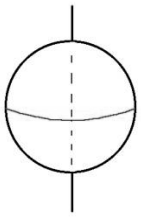
The Earth is Tilted

The Earth is a sphere. It can be divided into two hemispheres, the Northern and Southern Hemispheres.
The best way to understand this is to make a model. You will need a Styrofoam ball, or any other spherical object that you can pierce a marker and a knitting needle skewer or sharp, thin stick.

This has been done for you.

Take the needle, stick or skewer and pass it right through the center of the Styrofoam ball, from top to bottom. Where it enters the ball at the top is the North Pole, and where it comes out at the bottom is the South Pole.
Use the marker to draw a line around the middle of the orange, dividing it into a top and bottom half. The line represents the Equator, the top half is the Northern Hemisphere, and the bottom half is the Southern hemisphere.

Now your ball should look like this:



The stick represents the Earth's axis. The axis is an imaginary line running from the North to South poles. The Earth spins on this axis all the time, turning around completely once every 24 hours. Take your ball, hold it by both ends of your stick, and turn the stick between your fingers.

Notice how the ball turns around. That is what gives us night and day. However, it has nothing to do with the seasons. So far we have only shown that the earth has night and day. So what makes the seasons happen?

Write what you believe causes the seasons below:

_____

_____

_____

Right now you are holding your ball with the stick going straight up and down. This is not accurate. The Earth is actually **tilted**. Hold the ball in one hand and tip it, so that the top of the stick is nearer you than the bottom. THAT is how the Earth is in space. Now it should look like this:

Notice how the top half, or Northern Hemisphere, is tipped toward you, with more of it showing than the Southern Hemisphere.

Direct Light Produces More Heat

To demonstrate this idea we will do some simple investigations.
Materials needed are a flashlight, a piece of paper, ruler, and a textbook.

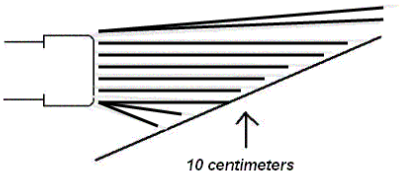
First of all you need to investigate with the flashlight. Put your hand up against the light source. Feel that it is warm. Move your hand away just a little. Notice how the heat is less, but it is still warm. Move your hand further and nearer the light, tip it so it is at an angle. Describe the differences you feel.

_____

_____

Now you can show the way light produces heat using your paper.
Prop a book up at an angle and lay the piece of paper on it. Lay the flashlight on another book so that it shines onto the paper. Feel the paper and notice when it starts to get warm. Measure 10 cm from the light source and mark the spot on the paper. Keep feeling that bit. How long does it take to get warm?

_____



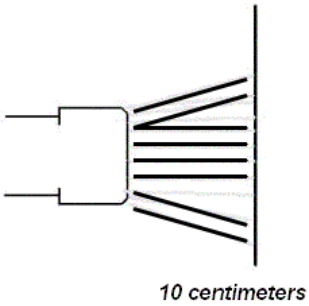
Record your observations:

_____

_____

_____

Now repeat the investigation. Let your paper cool off. This time prop your book upright 10 cm away from the light. Fix your paper to it with a piece of tape. Check the area of the paper opposite the center of the flashlight. How long does it take the paper to get warm this time? Feel the area to the top of the paper. Which is warmer, the top or the center?



_____

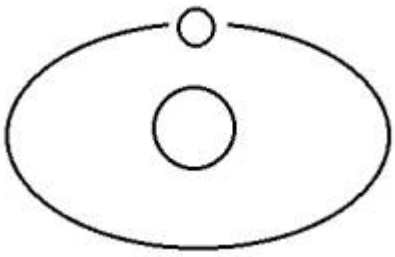
_____

_____

The reason that it was quicker the second time is that the light was falling directly onto the paper. The first time round it was striking the paper at an angle. **Direct light produces more heat than indirect light, or light striking something at an angle**. This is also why the top of the paper around was not as warm as the center the second time.

How the Earth Moves Around the Sun

Remember that the Earth is tilted all the time that it is moving around the Sun. The Earth moves around the Sun once every year. It follows an elliptical orbit. This means that it goes almost in a circle around the sun, but gets a little further away at some times. The path it takes is like an oval.



Now, take your ball again, tip it like before and hold it at arms length, keeping it tipped. Slowly turn around in a circle. Notice how the tilt stays the same. The Northern hemisphere is always tipped toward you. This is **NOT** how the earth moves.
Put your ball down for a minute and walk around a stool. The way you would normally do it, you would walk around with one side of you facing the chair the whole time. I want you to do it a different way. Place the chair between you and a window. Leave enough space between it and the window so you can walk around it. Start on the opposite side to the window, facing the chair AND the window. Now walk around the chair, all the way, but keep facing the window. Don't turn round (this means you will be walking backwards at some point, so **be careful**). THAT is how the Earth moves around the sun.

Now do it again, holding the ball at your side, starting with the top of the ball facing towards the chair. As you walk around, notice that the part of the ball facing the chair changes. First the Northern Hemisphere points to the chair (or Sun), then the tilt is sideways, with neither hemisphere pointing at the Sun, then the Southern hemisphere points at the Sun (when you are walking backwards) and finally neither hemisphere points at the Sun again. Then you are back to the beginning and the Northern hemisphere is pointing at the Sun again.

What Causes the Seasons?

As you have seen, the Earth is tilted and direct light causes more heat than indirect light. Remembering your walk around the chair, and how the tilt is at each point, can you work it out?

This is how it works. When the Northern hemisphere is pointing at the sun, sunlight falls most directly on it. This is summer in the Northern Hemisphere. As you get around to the side of the chair, neither hemisphere is pointing toward the Sun. The light strikes both equally and directly.

As the Earth moves around to the other side of the Sun the Northern Hemisphere is tilted away from the Sun. Now the light falls indirectly on it. It is winter. As it moves around to the fourth side, it the light again falls directly on it.

Notice that the exact opposite is happening in the Southern hemisphere. When the Northern Hemisphere has summer, the Southern Hemisphere has winter, and the other way round. So, how do you decide which has spring and which has fall? That is simple. Spring follows winter and fall follows summer!

The Earth's seasons are not caused by the differences in the distance from the Sun throughout the year (these differences are extremely small). The seasons are the result of the tilt of the Earth's axis.

The Earth's axis is tilted perpendicular to the plane of the ecliptic by 23.45°. **This tilting is what gives us the four seasons of the year:** Summer, Spring, Winter and Autumn. Since the axis is tilted, different parts of the globe are pointed towards the Sun at different times of the year.

Summer is warmer than winter (in each hemisphere) because the Sun's rays hit the Earth at a more direct angle during summer than during winter and also because the days are much longer than the nights during the summer.

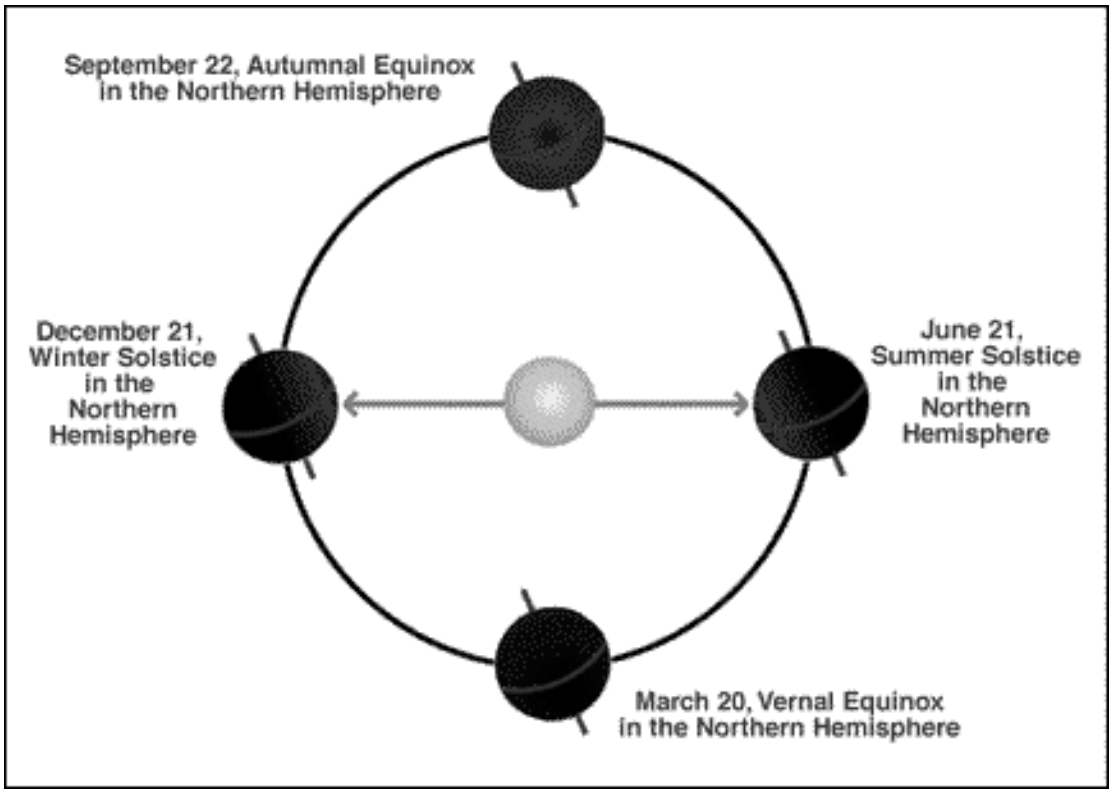
During the winter, the Sun's rays hit the Earth at an extreme angle, and the days are very short. These effects are due to the tilt of the Earth's axis.

Solstices

The solstices are days when the Sun is the greatest distance north or south of the equator. The winter solstice occurs on December 21 and marks the beginning of winter (this is the shortest day of the year). The summer solstice occurs on June 21 and marks the beginning of summer (this is the longest day of the year).

Equinoxes

Equinoxes are days in which day and night are of equal duration. **The two yearly equinoxes occur when the Sun is directly above the equator**.
The vernal equinox occurs in late March (this is the beginning of Spring in the Northern Hemisphere and the beginning of Fall in the Southern Hemisphere); the autumnal equinox occurs in late September (this is the beginning of Fall in the Northern Hemisphere and the beginning of Spring in the Southern Hemisphere).



To Do:

A second grade class thinks that the seasons are caused by the Sun being closer to the Earth in Spring and Summer and farther away in the Fall and Winter.
Make a handout for the students to show why this is not true and what really causes the seasons. Include diagrams. Use the space below.