

What causes the seasons?

By NASA and NOAA, adapted by Newsela staff on 03.17.17

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A photo of the Alps in Europe. Courtesy of Pixabay

Summer is warm, winter is cold, and spring and fall are in-between. What causes the changes in seasons?

Many people believe that Earth is closer to the sun in the summer and that is why it is hotter. And, likewise, they think Earth is farther from the sun in the winter.

Although this idea makes sense, it is incorrect.

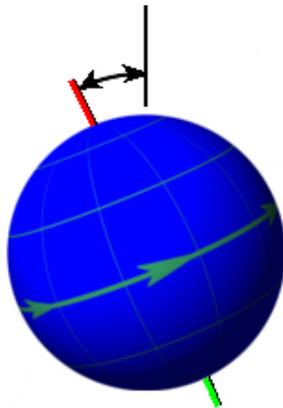
Lopsided Orbit, Tilted Rotation

It is true that Earth's orbit is not a perfect circle. It is a bit lopsided. During part of the year, Earth is closer to the sun than at other times. However, in the Northern Hemisphere, the northern half of the planet, we are having winter when Earth is closest to the sun. We have summer when it is farthest away! Compared to how far away the sun is, this change in Earth's distance throughout the year does not make much difference to our weather.

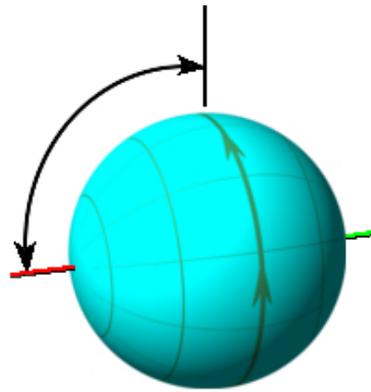
There is a different reason for Earth's seasons.

Earth's axis is an imaginary pole going right through the center of Earth from "top" to "bottom." Earth spins around this pole, making one complete turn each day. That is why we have day and night, and why every part of Earth's surface gets some of each.

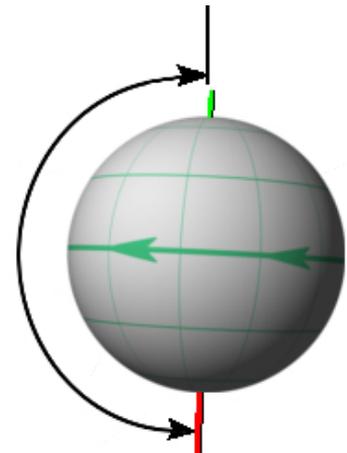
Earth has seasons because its axis doesn't stand up straight. It tilts at 23.5 degrees, and that tilt never changes.



Earth: 23°



Uranus: 97°



Venus: 177°

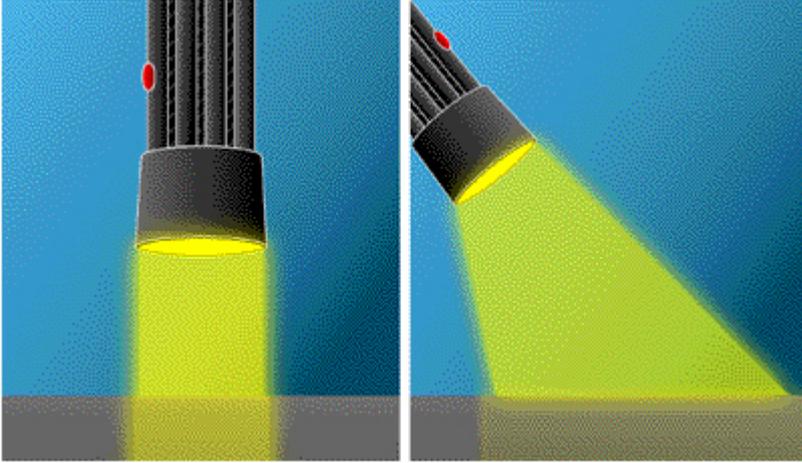


Concentrated Light Brings More Heat

Let's see what effect the tilt of the Earth's axis has on our seasons. First, we have to keep in mind a very important scientific principle.

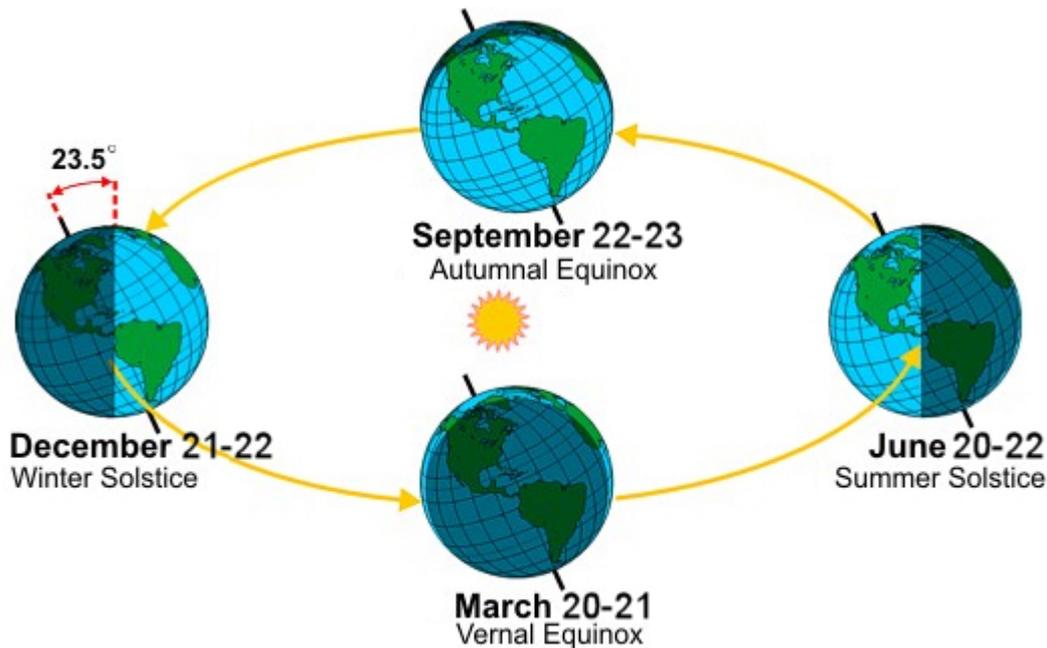
A beam of light that is concentrated will provide more light than one that is more spread out. Light brings heat.

Look at the following image of a flashlight to see this principle in action.



When the flashlight is directly overhead, isn't the beam of light more concentrated than when the flashlight is at an angle? The image on the left will receive more light and heat than the image on the right.

Now let's look at a picture showing the tilt of the Earth's axis as Earth orbits the sun.



Notice that during the Northern Hemisphere summer, the sun is more directly overhead than at any other time of year. However, during winter, the sun is at a definite angle with respect to the Northern Hemisphere, and the rays of the sun are not concentrated. Therefore, it follows that the more concentrated sun's rays will warm the land and water surfaces during summer. In winter when the rays are more spread out, the land and water surfaces will not get as warm.

During fall and spring, the sun's rays are not as concentrated as they are during summer but are more concentrated than they are during winter. Therefore, during fall and spring we experience temperatures that are lower than during summer, but are higher than during winter.

But What Caused Earth To Tilt?

Long, long ago, about 4.5 billion years ago, when Earth was young, it is thought that something big — the size of Mars — hit Earth and knocked it off-kilter. So instead of rotating with its axis straight up and down, it leans over a bit.

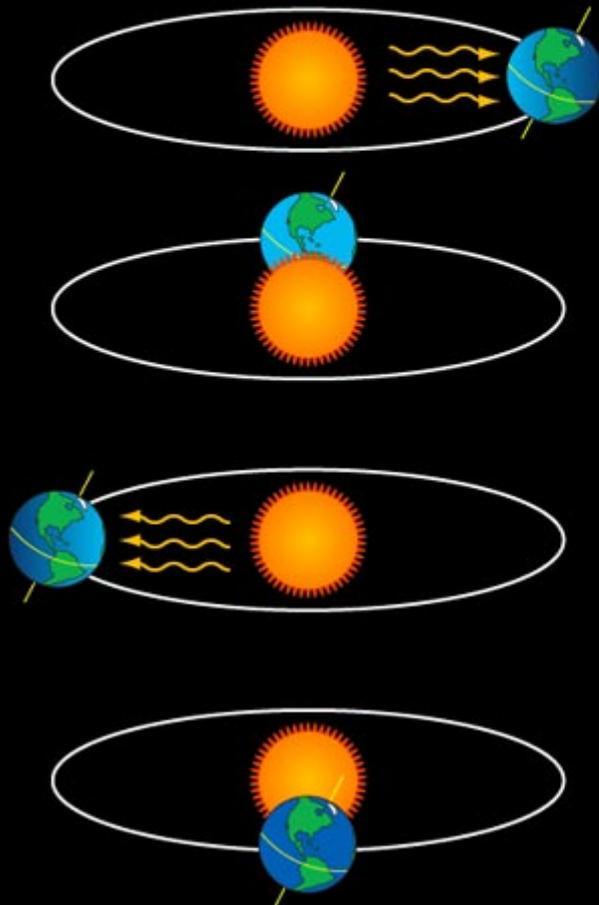
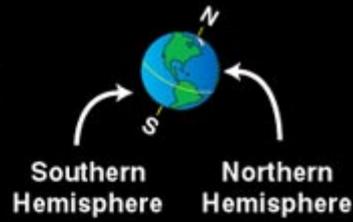
The big thing that hit Earth is called Theia, and it also blasted a big hole in the surface. That big hit sent a huge amount of dust and rubble into orbit. Most scientists think that that rubble, in time, became our moon.

As Earth orbits the sun, its tilted axis always points in the same direction. So, throughout the year, different parts of Earth get the sun's direct rays.

Sometimes it is the North Pole tilting toward the sun, which happens around June. Sometimes it is the South Pole tilting toward the sun, which happens around December.

It is summer in June in the Northern Hemisphere because the sun's rays hit that part of Earth more directly than at any other time of the year. It is winter in December in the Northern Hemisphere. That is when it is the South Pole's turn to be tilted toward the sun.

Earth has seasons because its axis is tilted. Earth rotates on its axis as it orbits the Sun, but the axis always points in the same direction.



December:
Summer south of the equator,
winter north of the equator.
The Sun shines directly on
the Southern Hemisphere
and indirectly on the Northern
Hemisphere

March:
Fall south of the equator,
spring north of the equator.
The Sun shines equally on
the Southern and Northern
Hemispheres

June:
Winter south of the equator,
summer north of the equator.
The Sun shines directly on
the Northern Hemisphere
and indirectly on the Southern
Hemisphere

September:
Spring south of the equator,
fall north of the equator.
The Sun shines equally on
the Southern and Northern
Hemispheres