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# Science 101

Experts answer teachers' questions about everyday science

## Q: Do other planets have summer?

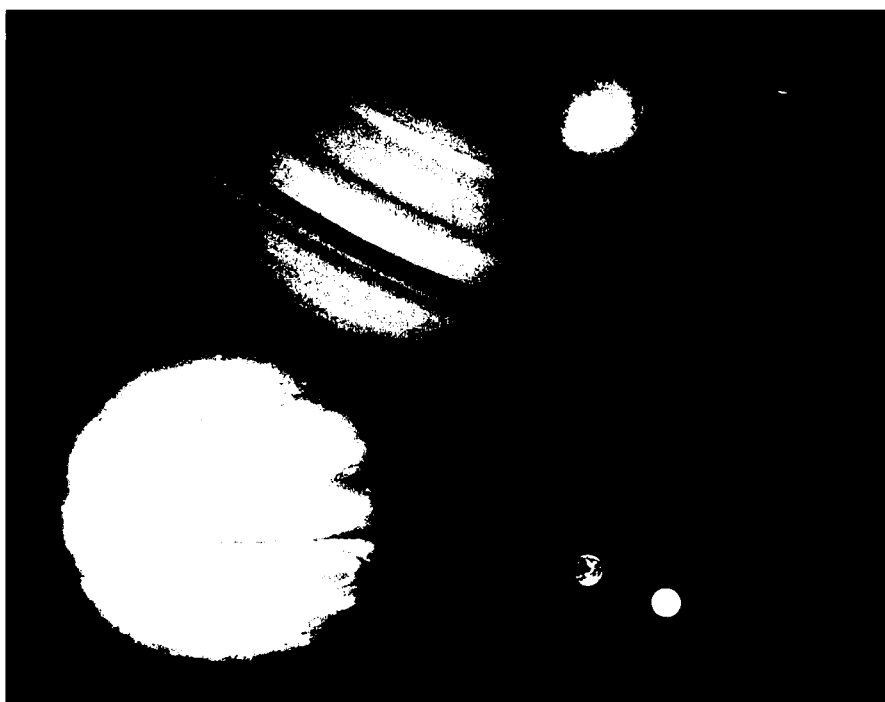
**A:** Ah Summer, time to relax and while away the warm days with idle thoughts. Just for fun, why don't we think about what summer would be like on the other planets in our solar system?

### Our Summer First

To start, let's remember why we have summer here on Earth. It's important to keep two things in mind when thinking about the cause of the seasons:

- Earth and all the other planets except Pluto and Mercury move around the Sun in almost perfect circles, getting neither closer nor farther away from the Sun during the year; and
- Earth's rotation axis is tilted with respect to the plane of its orbit around the Sun.

To elaborate on point number two, if you drew a line through the Earth's poles and think of Earth's orbit as a disk like a DVD, the line would make an angle with the disk of 23.5 degrees. This line always points in the same direction, towards the distant star Polaris in the north. The value of 23.5 degrees is not special. Like the tilts of most of the other planets, it probably started out close to zero degrees. Today's tilt was most likely caused when a big object crashed into a random place on the newly forming Earth from some random direction during the violent early years of the solar system.



A planet's distance from the Sun, its atmosphere (or lack thereof), and most importantly, its axis of rotation determine if it will have seasons.

For half the year, as Earth goes around the Sun, the northern hemisphere is tilted towards the Sun, just slightly the day after the first day of spring and most on the first day of summer. Think about standing in front of a fire with a globe. If you tilt the northern hemisphere towards the fire and wait, it will get warmer than the southern hemisphere, first because light (in this case the infrared light from the fire is carrying most of the energy) is shining on more of the north than the south, and second, because the Sun is higher in the sky the solar energy is less spread out across the surface. Every square meter absorbs more

energy every day during the summer than it does in the winter.

That's why it's warmer in the summer on Earth and that's why summer occurs during July and August in the northern hemisphere and during January and February in southern hemisphere. What about the other planets?

### It's in the Tilt

Because the planets are at such different distances from the Sun and have such different atmospheres, temperatures vary wildly from place to place. Let's think most about the effects of geometry—that is tilts and orbits—and ask, "Would there be

summers on the other planets and what might they be like?"

As it turns out, probably completely by coincidence, there are three other planets (Mars, Saturn, and Neptune) that have nearly the same tilt as the Earth and therefore have seasons similar to Earth. However, because these planets are farther from the Sun, their summers will be much colder and last much longer than Earth's summer, about twice as long on Mars, seven years on Saturn, and forty years on Neptune. Mars' orbit is also not quite a circle, causing winter in one hemisphere, currently the southern, to be longer and therefore colder than in the north.

### Running Hot and Cold

Three planets (Mercury, Venus, and Jupiter) have almost no tilt and as a result have no seasons. Actually, temperatures on Mercury and Venus are more interesting. Mercury is only about one-third as far from the Sun as Earth so it catches lots more sunlight. It also has a very, very thin atmosphere and doesn't retain much heat. The day on Mercury lasts 59 Earth days, so on the sunlit side it's really hot while in the dark it's freezing cold. Because Mercury's orbit is not quite a circle, it actually gets even hotter on the day side when the planet is closest to the Sun.

Venus, on the other hand, has a really thick atmosphere. It's always 900 degrees on Venus, day and night, north and south.

### Way Out There

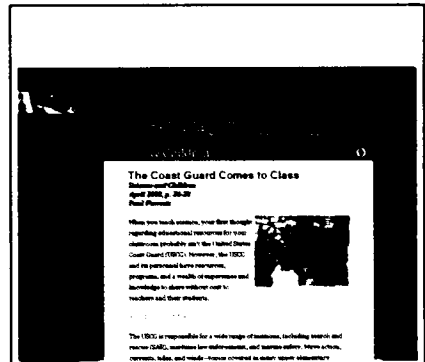
Uranus and Pluto are the two oddballs. Uranus is tilted almost

90 degrees so its rotation axis is lined up with its orbital plane. That means that once during Uranus' 84-year trip around the Sun, one pole is pointed directly at the Sun with the whole hemisphere in the Sun all day, and 42 years later it's pointed exactly away from the Sun and the whole hemisphere is in the dark. That's as extreme as seasons get!

Pluto is so far away and cold (-233 degrees C on the surface!) that it hardly makes sense to talk about seasons at all. But Pluto's orbit is the least circular of all the planets. It is the one planet in our solar system that is sometimes a lot closer to the Sun—sometimes even closer than Neptune though there is no chance of them ever colliding—so its seasons, such as they are, really are due to the change in distance from the Sun (a common misconception that people have about the cause of the Earth's seasons). During its 248-year trip around the Sun, Pluto receives almost three times more solar energy when it is closest to the Sun than when it is at its most distant. Pluto does have a tilt, it's 122 degrees, kind of sideways like Uranus, but it's not really important compared to the change in distance from the Sun. Cold is cold.

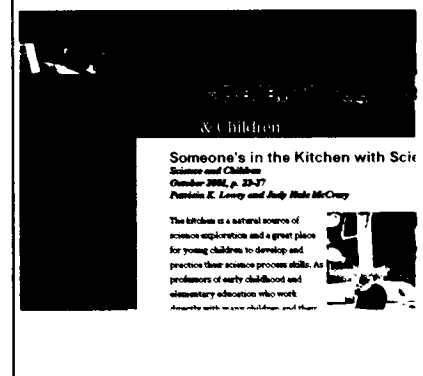
I'll take summer on good old Earth. Pass the iced tea, please!

*George Nelson is director of Science, Mathematics, and Technology Education at Western Washington University in Bellingham, Washington. He flew three missions on the Space Shuttle as a NASA astronaut.*



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