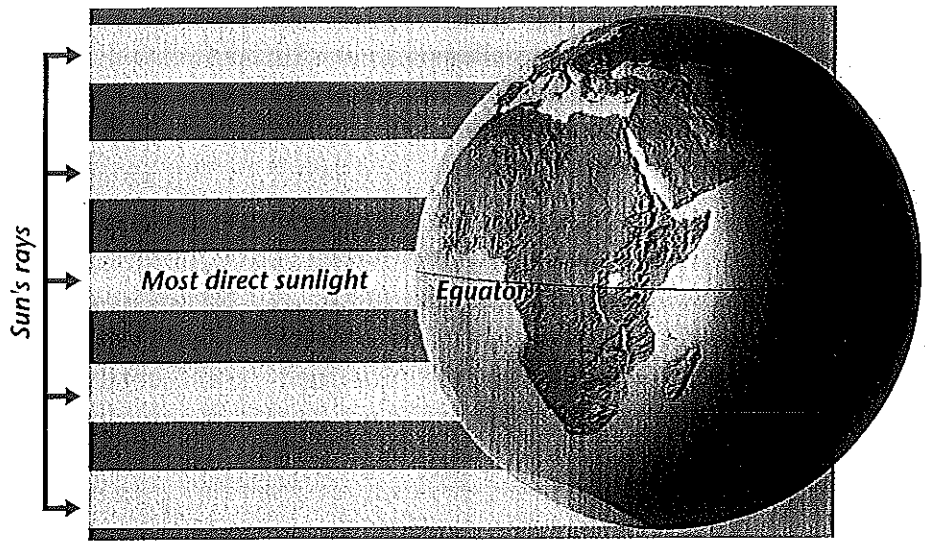


Figure 2 It is warm near the equator because sunlight hits Earth's surface directly and is less spread out. *Interpreting Diagrams Why is it colder near the poles?*

Seasons on Earth

Most places outside the tropics have four distinct seasons: winter, spring, summer, and autumn. But there are great differences in temperature from place to place. For instance, it is warmer near the equator than near the poles. Why is this so?

How Sunlight Hits Earth Figure 2 shows how sunlight hits Earth's surface. Notice that at the equator, sunlight hits Earth's surface directly. Closer to the poles, sunlight hits Earth's surface at an angle. Near the poles, energy from the sun is spread out over a greater area. That is why it is warmer near the equator than near the poles.

Earth's Tilted Axis If Earth's axis were straight up and down relative to the sun, as it appears in Figure 2, temperatures would remain fairly constant year-round. There would be no seasons. **Earth has seasons because its axis is tilted as it moves around the sun.**

Look at Earth's position in space in *Exploring the Seasons* on the next page. Notice that Earth's axis is tilted at an angle of 23.5° from the vertical. As Earth revolves around the sun, its axis is tilted away from the sun for part of the year and toward the sun for part of the year.

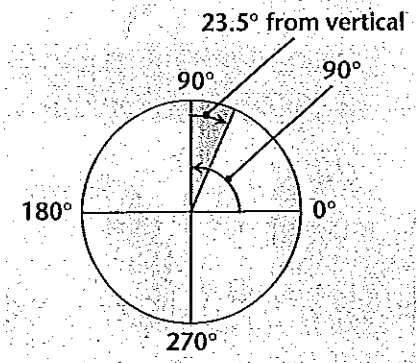
When the north end of Earth's axis is tilted toward the sun, the Northern Hemisphere has summer. At the same time, the south end of Earth's axis is tilted away from the sun. As a result, the Southern Hemisphere has winter.

Summer and winter are not affected by changes in Earth's distance from the sun. In fact, when the Northern Hemisphere is having summer, Earth is actually at its greatest distance from the sun.

Math TOOLBOX

Angles

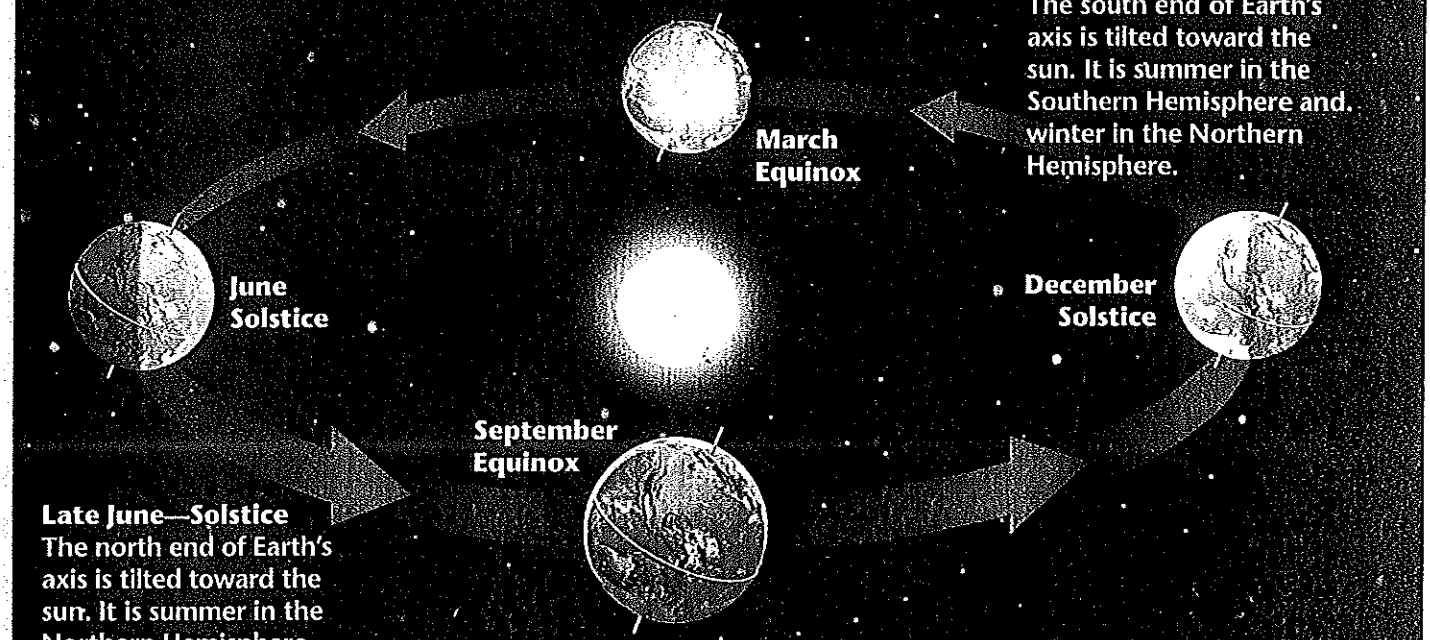
An angle is formed when two lines meet at a point. Angles are measured in degrees (symbol °). A full circle has 360 degrees.



Earth's axis is tilted at an angle of 23.5° from the vertical. When the sun is directly overhead at noon near the equator, its angle from the horizon is 90°. What fraction of a circle is this?

EXPLORING *the Seasons*

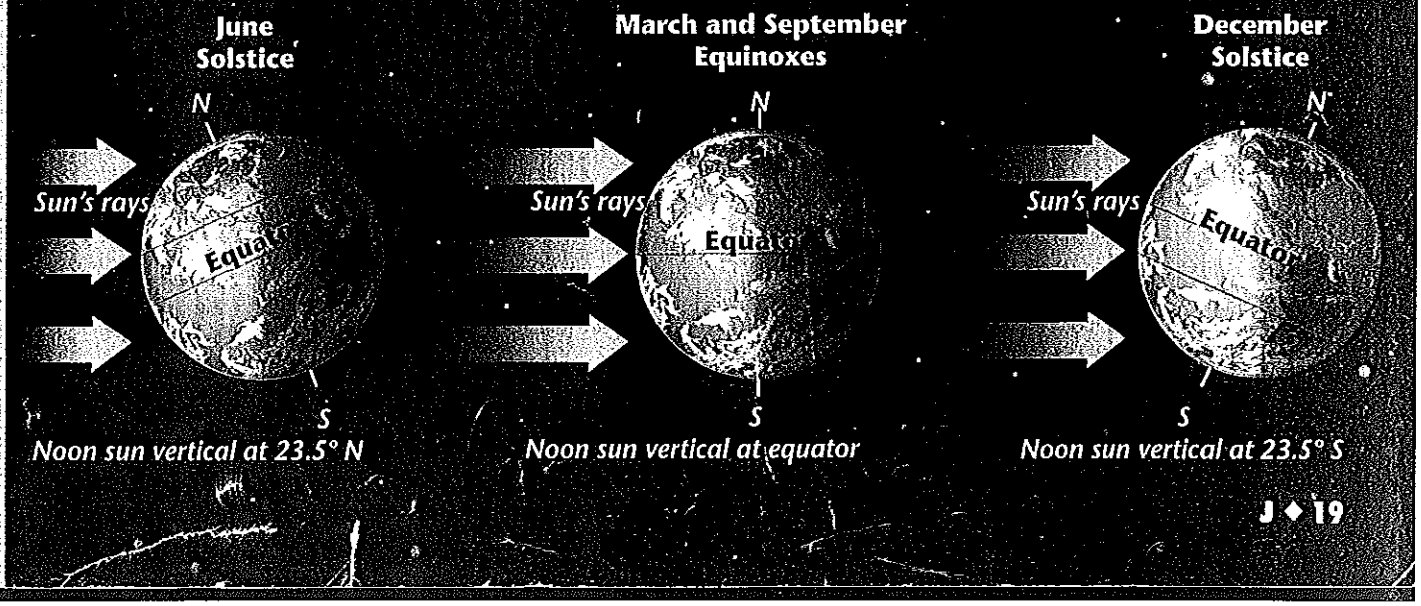
The yearly cycle of the seasons is caused by the tilt of Earth's axis as it revolves around the sun.



Late December—Solstice
The south end of Earth's axis is tilted toward the sun. It is summer in the Southern Hemisphere and winter in the Northern Hemisphere.

Late June—Solstice
The north end of Earth's axis is tilted toward the sun. It is summer in the Northern Hemisphere and winter in the Southern Hemisphere.

Late March and Late September—Equinoxes
Neither end of Earth's axis is tilted toward the sun. Both hemispheres receive the same amount of energy.



Earth in June In June, the north end of Earth's axis is tilted toward the sun. The noon sun is directly overhead at 23.5° north latitude. **Latitude** is a measurement of distance from the equator, expressed in degrees north or south. (The equator has latitude 0° and the North Pole has latitude 90° north.)

The hemisphere that is tilted toward the sun also has more hours of daylight than the hemisphere that is tilted away from the sun. The combination of direct rays and more hours of sunlight heats the surface more than at any other time of the year. It is summer in the Northern Hemisphere.

At the same time, for any place on Earth south of the equator, the sun's energy is spread over a large area. There are also fewer hours of daylight. The combination of indirect rays and fewer hours of sunlight heats Earth's surface less than at any other time of the year. It is winter in the Southern Hemisphere.

Earth in December Look again at *Exploring the Seasons.* Around December 21, the noon sun is overhead at 23.5° south latitude. People in the Southern Hemisphere receive the most direct sunlight, so it is summer there. At the same time, the sun's rays in the Northern Hemisphere are indirect and there are fewer hours of daylight. So it is winter in the Northern Hemisphere.

Both June and December On two days each year, the noon sun is overhead at either 23.5° south or 23.5° north. Each of these days is known as a **solstice** (SAHL stis). The day when the noon sun is overhead at 23.5° south is the winter solstice in the Northern Hemisphere. It is the summer solstice in the Southern Hemisphere. This solstice occurs around December 21 each year, and is the shortest day of the year in the Northern Hemisphere. At

Figure 3 Spring is the season between the vernal equinox and the summer solstice. The warming temperatures of spring make it the best time to plant flowers like these pansies.

the same time, it is the longest day of the year in the Southern Hemisphere.

Similarly, around June 21, the noon sun is overhead at 23.5° north. This is the summer solstice in the Northern Hemisphere and the winter solstice in the Southern Hemisphere.

Earth in March and September Halfway between the solstices, neither hemisphere is tilted toward or away from the sun. This situation only occurs on two days of the year. On these days, the noon sun is directly overhead at the equator.

Each of these days is known as an **equinox,** which means "equal night." During an equinox, the lengths of nighttime and daytime are about the same. The **vernal equinox,** or spring equinox, occurs around March 21, and marks the beginning of spring in the Northern Hemisphere. The **autumnal equinox** occurs around September 23. It marks the beginning of fall in the Northern Hemisphere.

Integrating Life Science In much of the United States, seasonal changes affect living things. In spring and summer, the sun shines for more hours each day and is higher in the sky. The warmer days allow many plants to begin growing leaves and flowers. Because plants grow more, animals that feed on the plants, from tiny insects to large deer, get more food.

In the fall, the nights get longer, signaling the plants to stop growing and some plants to lose their leaves. With less food available, black bears and some other animals go into a dormant state in which they use very little energy. Others, like many songbirds and waterfowl, travel to warmer climates where food is still available.

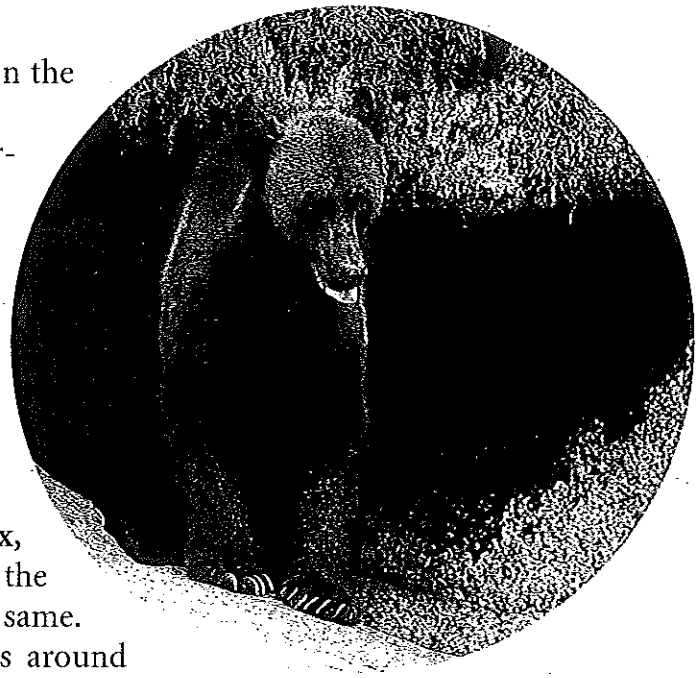


Figure 4 This hungry bear has spent the long winter in a dormant state in a cave in Alaska.
Applying Concepts Why didn't this bear remain active all winter?

Section 1 Review

1. Explain the process that causes day and night.
2. What two factors cause the cycle of the seasons?
3. Compare rotation and revolution.
4. What do the words *solstice* and *equinox* mean? How are they related to the position of Earth's axis?
5. **Thinking Critically Relating Cause and Effect** Are changes in the distance between Earth and the sun important in causing the cycle of the seasons? Explain.

Check Your Progress

CHAPTER PROJECT 1

Begin recording your daily observations of the moon. Sketch a map of the site from which you will be making observations. Which way is north? East? South? West? Each night, observe and record the moon's direction. You should also estimate the moon's altitude, or height in degrees from the horizon. You can do this by making a fist and holding it at arm's length. One fist above the horizon is 10°, two fists are 20°, and so on.