



TEACHER GUIDE

EARTH'S ORBIT AND ROTATION GRADES 3-5

COMMON MISCONCEPTIONS

- **The sun and stars travel across the sky.**
Although from Earth it *appears* that the sun and stars move across the sky, it is actually the earth that is rotating.
- **The sun orbits around the Earth.**
For a long time, humans had a geocentric view of the Earth - meaning they believed that the Sun orbited around the Earth. Although it is difficult to determine through observation, humans did eventually figure out that the Earth orbits the Sun based on stellar parallax (explained below).

MOTION OF PLANETS

Earth, as well as the other planets in our solar system, rotate on their axes (spin), and they also move around the sun in an elliptical orbit. Different planets rotate and orbit at different rates. Earth rotates once every 24 hours, and orbits the sun every 365.25 days. Approximate rotation rates (length of a day) and orbit rates (length of a year) for each of the planets in our solar system are listed in the following table. They are all based on hours, days, and years on Earth.

Planet	Day length (one rotation)	Year length (one orbit)
Mercury	59 days	87 days
Venus	243 days	225 days
Earth	24 hours	365.25 days
Mars	25 hours	687 days
Jupiter	10 hours	12 years
Saturn	10 hours	29 years
Uranus	18 hours	84 years
Neptune	18 hours	165 years

As Earth spins, the portion facing the sun experiences day, while the portion facing away from the sun experiences night. From our perspective on Earth, the sun appears to be moving from East to West across the sky, when in reality it is actually the Earth that is spinning. The same principles that cause day and night are also responsible for the length and direction of shadows.

MODELING THE UNIVERSE

Due to its vast scale, it is impossible within the confines of a video to show the relative distances and sizes of the Earth, moon, sun, and stars to scale in a single model. The models used in this video show relative motion, but students should understand that in reality sizes and distances are different. Scale models are impractical since if the sun was the size of a baseball, earth would need to be width of a pen's tip (2 mm) and about 100 feet away from the baseball!

GEOCENTRIC VS. HELIOCENTRIC VIEW

For a long time, humans believed that Earth was orbiting the sun, based on the motion they observed. This is called a “geocentric” or Earth-centered view of the universe. From the surface of Earth the rate of rotation cannot be felt, but it can be detected. Evidence for a heliocentric (sun-centered) universe can be observed using a pendulum devised by Leon Foucault in the mid-1800s. The pendulum swings back and forth, but a record of its motion is kept as it traces a line in sand. If the Earth were not turning, the swing recorded would be a straight line. However, over many hours a pattern develops in the sand as the rotation of the Earth causes the sand beneath the swinging pendulum to move. Further evidence for a heliocentric view of the universe is called stellar parallax, which causes our view of the stars to shift relative to their backdrop from Earth over time. This could not be explained unless the Earth is orbiting the sun.

CHANGING CONSTELLATIONS

If the night sky is observed throughout a year, the stars that can be seen change slowly over time. Although night is due to Earth's rotation, the changing patterns of stars seen from Earth are due to the orbit of the Earth around the sun. The view from the Earth towards the universe changes as Earth changes positions around the sun over time. Which planets are visible from Earth also changes over time, as both Earth and the other planets are all orbiting at different rates and distances from the sun.

KEEPING TRACK OF TIME

Our concept of time has a lot to do with the motion of the Earth. Since ancient times, people have used the repeating pattern of stars visible at certain times of year to keep track of time and to create calendars. Early calendars fell out of sync with the seasons because they used a year composed of 365 days. Today we know that a year is actually 365 days, 5 hours, 48 minutes, and 46 seconds so we introduce a leap year every 4 years to correct for the difference.

TIME ZONES

Because the Earth is spherical, and different locations on its surface may be in any part of the 24 hour rotation at a given time, it was necessary for humans to construct time zones so that daylight hours fall during the day and night time hours fall during the night in each location. Humans have named 24 time zones across the planet.



KEEPING TIME

The motion of the Earth, and apparent motion of the sun, led to the development of the earliest watches—sundials. By using the shadows produced due to the apparent motion of the sun across the sky (caused by the rotation of the Earth), humans were able to keep track of hours throughout the day. Sundials may appear to be simple but calibrating them correctly takes into account where the sundial is located longitudinally (where it is within a time zone), its latitude (North or South Hemisphere) and the time of year.

