LESSON 7: HOW LONG IS A DAY?

While it seems obvious that a day is twenty-four hours long, it is not necessarily that simple. There are four different ways to define a day: by the apparent motion of the sun at any given time (called the solar day), by the apparent motion of the sun averaged over the year (called the mean solar day), by the length of time it takes for the earth to turn 360 degrees on its axis (called the sidereal day), and using the scientific definitions of the units of time (called the standard day).

GRADES K-2

An excellent introduction to chronology (the measurement of time), is the book *A Second Is a Hiccup* by Hazel Hutchins. The author compares each of unit of time to an activity such as a hiccup taking about a second, a minute is 60 hops, an hour is enough time to build a sand castle, etc. The rhyming text and references to familiar activities keep the topic from overwhelming young students.

You might read the book with your class and then brainstorm a list of other events or actions that would fit into each time segment that is mentioned. You could also try some of the examples from the book or your list and see if they can actually be completed in the specified time. For more of a challenge, you might measure the distance walked in a minute, and then multiply that by the number of minutes in a day to see how far you would have traveled if you kept going.

GRADES 3-5

One full day is twenty-four hours long. Of the twenty-four hours, on average about half are daytime, when the sun is above the horizon, and the other half are nighttime, when the sun is below the horizon. The word "day" can mean either the full twenty-four hour day or just the part when the sun is above the horizon; this can be very confusing if we are not careful.

During the summertime, the part of the day when the sun is above the horizon is more than half the full day while the nighttime is less than half the full day. During the wintertime, these are reversed: the nighttime is more than half the full day and the daytime is less than half the full day.

GRADES 3-5 (CONTINUED)

It would be an interesting exercise to look at the times of sunrise and sunset in different places on the earth and compare them to how far north and south the places are and the time of year. One web site which gives this information is http://www.sunrisesunset.com/

Another research idea is to search for statistics related to a 24-hour period. For example, lightning strikes the Earth 8 million times a day and 7 million pizzas are eaten in America every day. What other cool facts could your students discover? A book to begin your
search with is *The World in One Day* by Russell Ash.

GRADES 6-8

Standard time is the time that one reads off of one's watch or from a clock. It is set by the International Earth Rotation and Reference Systems Service (IERS), which is a worldwide group of laboratories which monitor the rotation of the earth. One standard day is 86,400 seconds long (86,400 = 60 x 60 x 24).

Local solar time is the time of day measured by the position of the sun. Solar noon is the time at which the sun is directly south (or directly north, if in the Southern Hemisphere) of the zenith. Other solar times are measured relative to solar noon. Solar time varies with longitude by four minutes of time for every degree of longitude. Solar time also varies with the time of year because of the ellipticity of the earth's orbit around the sun.

Local mean solar time is the time of day measured by the position of the sun, but averaged out over the course of the year. It varies with longitude but not with the time of year.

One sidereal day is the amount of time required for the earth to rotate 360 degrees on its axis. This is significantly less than one standard day (in fact, it is 23 hours, 56 minutes, and 4.1 seconds). The difference is caused by the fact that in one solar day, the earth has moved about a degree farther along in its orbit around the sun. For the sun to be directly overhead the same point on the earth two days in a row, the earth needs to have turned 361 degrees: 360 degrees for a full rotation plus one extra degree to account for its progress in its orbit.

If you do the mathematics, you find that the ratio of one sidereal day to one standard day is equal to 365.2425 to 366.2425. The number 365.2425 is the number of days in a year, accounting for leap years.

GRADES 9-12

The difference between local solar time and local mean solar time is shown by a graph called the *"equation of time."* Confusingly, it is neither an equation nor applicable to time in general, being restricted to the earth's rotation. It looks like this:

Equation of Time
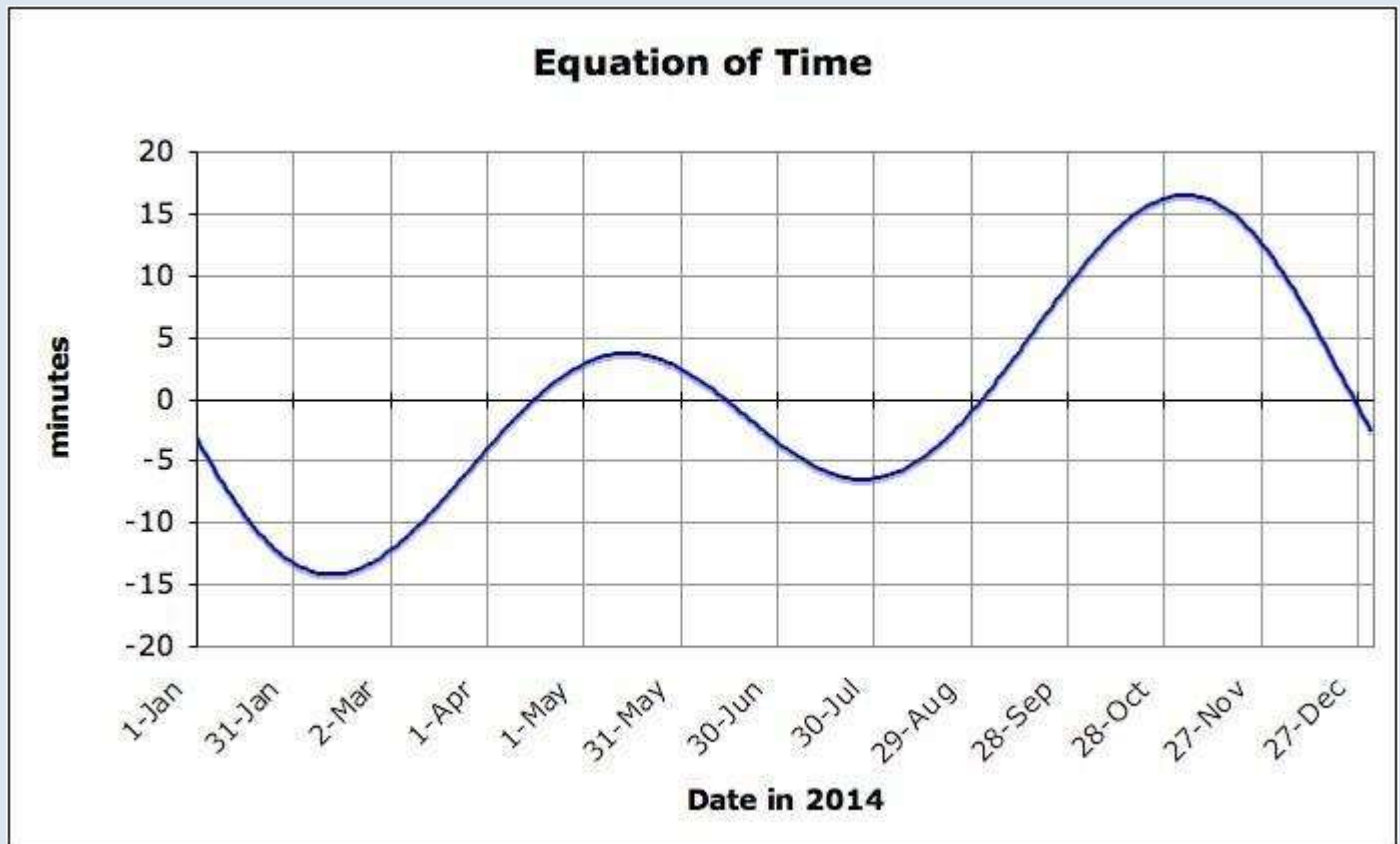
The graph shows the local solar time minus the local mean solar time. When it is negative, the sun lags "behind" a fictitious "average sun" and noon local solar time comes later than noon local mean solar time. This is incredibly difficult to visualize and it is extremely easy to confuse the meanings of the plus and minus signs.

If the equation of time is plotted versus the latitude of the point on the earth's surface directly underneath the sun, the result is a curve called the *"analemma."*

One can usually find an analemma drawn on globes of the earth. Wikipedia has an excellent article on it: https://en.wikipedia.org/wiki/Analemma