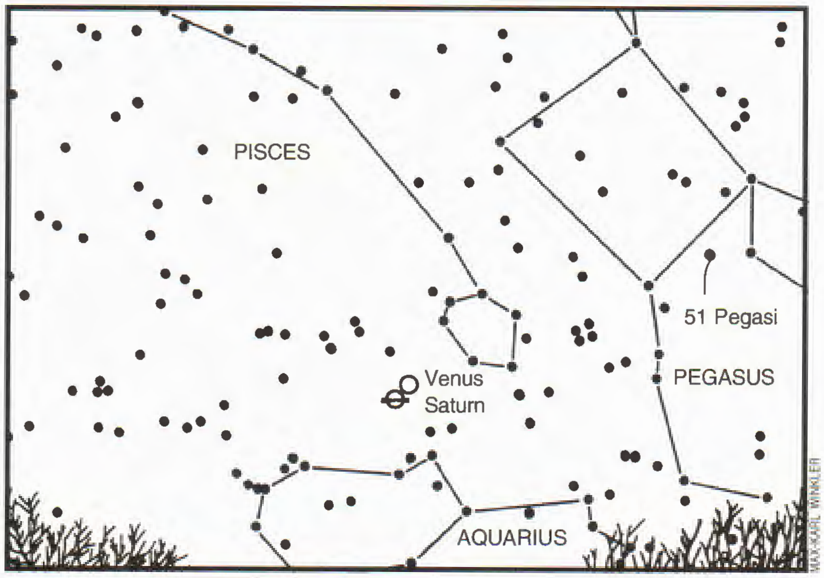
A year divisible by four



LOOKING SOUTH-SOUTHWEST ON FEBRUARY 2, 1995.

This is a leap year, and as is the tradition, the month of February is lengthened by adding a day. A leap year is necessary because the Earth orbits the Sun in an uneven number of days. Based on the Sun's apparent motion due to Earth revolution, it takes 365.242 days for the Sun, starting from its March equinox point, to return to the same equinox point, giving us the tropical year. For convenience, we think of this time interval as the calendar year, lasting exactly 365 days. However, the extra quarter of a day per year adds up and needs to be accounted for eventually, and this is the purpose of the leap year. By agreement, a leap year is any year divisible by 4 that is not a century, or any century divisible by 400. This year is a leap year and so we add an extra day.

It's been a long day

The basis for our time measurement system, one of the most obvious systems, comes from the position of the Sun over the horizon and the interval it takes for the Sun to return to that same position. The sundial, the oldest known time-measurement device, measures this way. The sundial's gnomon, or upright portion, casts a shadow on the base, which is calibrated for time measurement. Throughout the day, as the Earth rotates and the Sun's apparent sky position changes, the gnomon's shadow position also changes. A sundial measures solar time, or local apparent time, which is of limited everyday use because the time is local only to other locations with the same longitude. When the Sun is due south for an observer (on the meridian—an extension of the observer's meridian of longitude onto the sky), it is noon solar time, or local apparent time, only along that longitude. When the Sun is due south, or on meridian, in St. Louis (90°W), a sundial will show the time to be noon (see first half of Figure 1). At the same time, a sundial in Kansas City will show a time of 11:44 a.m. because the Earth rotates at a rate of 1° every four minutes (see second half of Figure 1).

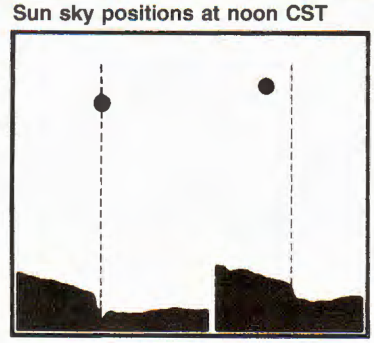
Keeping time by the Sun's position using a sundial is further complicated because the length of an apparent solar day varies slightly during the year because the Earth follows a slightly elliptical path around the Sun. Because of its elliptical orbital shape, as Kepler explained in his laws of planetary motion, the Earth moves faster when it is nearest the Sun (at perihelion) than when farthest away (at aphelion). Furthermore, the Earth travels 360° around the Sun in approximately 365 days, causing the Sun to appear to move east with respect to the background stars, at an average rate of about 1° per day.

During perihelion, when the Earth is moving fastest, the Sun's apparent eastward motion is also greatest. Consequently, the daily apparent motion of the Sun from revolution varies, but the daily apparent motion of the Sun from rotation does not vary. Therefore, at noon local apparent time, the Sun does not always appear due south every day. In other words, the Sun is either "behind" or "ahead of" noon solar time. To compensate for this, a mean (average) solar day of exactly 24 hours was adopted along with a system of standard time zones, in which the time across a single time zone is the same everywhere within the time zone regardless of longitude, latitude, and Sun position.

The difference between mean solar time and apparent solar time is

FIGURE 1.

Sun sky positions at noon CST



known as the equation of time. Using the background stars as a point of reference for the Sun's daily position, it can be seen that the daily difference is approximately 1° or the equivalent of four minutes of Earth rotation time. During perihelion, the Earth has to rotate up to nearly an additional 15 minutes before the Sun is on meridian for the observer. In contrast, during aphelion at noontime, the Sun has already passed the meridian nearly 15 minutes earlier. In fact, only on four days of the year (April 15, June 13, September 1, December 24) is the Sun on meridian at local noon apparent time. On February 12, the equation of time reaches a minimum of -14.28 minutes, indicating apparent solar time lags behind mean solar time by 14.28 minutes.

Special planet watch

During the latter half of January and early February, Venus will close in on Saturn and pass closest to it on February 2 (see sky chart). At that time, the two planets will be less than 1° apart (about the width of one finger held at arm's length). Because Venus is an inner planet, its motion from night to night will be considerably more noticeable than that of an outer planet such as Saturn. Each night Venus is nearly 1° farther east, while Saturn moves considerably slower, at a rate of about that much each month.

Evening planets

Venus: Over the southwestern horizon, sets two to three hours after sunset. Venus is the only evening planet visible during the spring.

Saturn: Over the southwestern horizon, sets two to three hours after sunset. Toward the end of February, falls behind horizon before sunset.

Moon phases

February
Full Moon - February 4
Third Quarter - February 12
New Moon - February 18
First Quarter - February 25

March
Full Moon - March 5
Third Quarter - March 12
New Moon - March 19
First Quarter - March 26

Bob Riddle is the planetarium director of the Kansas City School District at Southwest Math & Science Magnet High School.