

ASTRONOMY 100, Section 1, Fall 2001

Study Guide

Chapter 2. Earth, Sun, and Sky

- Scientific Method – observe, theorize, predict, test, modify.
- The shape of the earth can be evidenced by
 - “hull down” disappearance of a ship at horizon
 - circular outline of the earth’s shadow on the moon during lunar eclipses
 - circum-navigation
 - photos taken from space-crafts.
- The size of the earth was first determined by measuring the difference in the sun’s direction between two cities, Syene and Alextrandria. The average diameter of the earth is 12,736 km. The earth is slightly flattened; this shape is called an *oblate spheroid*.
- The earth rotates, and its rotation can be remembered using the “right hand/fist rule” – point the thumb to the north pole, and the other fingers would point out the direction of the earth’s rotation.
- Coordinate systems:
 - on the Earth’s surface: longitude and latitude
 - on the celestial sphere: right ascension and declination
 - the equatorial plane of the celestial sphere = the equatorial plane of the earth
 - the celestial poles = the earth’s poles
 - *right ascension* is the celestial equivalent of *longitude* (east-west), and *declination* is the celestial equivalent of *latitude* (north-south).
- Motions in the Sky:

As a result of the earth’s spin (or rotation), stars in the sky trace out their *daily paths* that are parallel to the celestial equator. Stars near a celestial pole appear to trace circles around the pole. *Circumpolar stars* never set below the horizon.
- The earth revolves around the Sun in the same direction as its rotation. (Use the “right hand/fist rule”.) The orbit is slightly elliptical. The distances from the earth to the Sun at perihelion (closest) and aphelion (farthest) are different by only 3.4%.
- Interesting comparison among velocities:

Speed of car at 65 miles/hours	0.03 km/s
Speed of earth’s spin at the equator	0.46 km/s
Speed of earth’s orbiting around the sun	29.8 km/s
Speed of solar system’s orbiting around the Galactic center	250 km/s

- The apparent annual path of the Sun is a great circle on the celestial sphere called the *ecliptic*. The orbit of the earth around the Sun is in this ecliptic plane. The 12 constellations in the ecliptic are collectively called the *zodiac*.
- The spin axis of the earth is tipped by 23.5° with respect to the earth's orbital axis, which points to the north and south ecliptic poles. As a result of this tilt, the Sun's apparent position moves from 23.5° north of the celestial equator at the summer solstice (June 21) to 23.5° south of the celestial equator at the winter solstice (December 22).
- The direction of the Sun determines how the earth's surface gets heated, which gives the seasons. When the Sun is directly overhead, the heating is most efficient. At latitudes higher than 23.5° north of the equator, the most efficient solar heating occurs at the summer solstice. However, the hottest summer days come much later because the earth's surface takes time to adjust temperature.
- Because of the tilt of the earth's spin axis, the Sun can be directly overhead only from 23.5° north to 23.5° south of the equator. These two boundaries are called the *tropic of Cancer* and the *tropic of Capricorn*. Because of the tilt, near the polar regions (within 23.5° from the poles) of the earth, the Sun is continuously in the sky during the summer, and continuously below the horizon during the winter. The boundaries of these regions are called the *arctic circle* and *antarctic circle*.
- The period of the earth's orbit around the sun is 365.2422 days, slightly longer than the 365 days in a calendar year. Therefore, every four years one day is added in February. *Leap Year*. To make the "average" calendar year as close to the earth's orbital period as possible, a leap year is skipped every 100 year, but kept in the 400th year. For example, 1996 and 2000 are leap years, but 1700, 1800, 1900, and 2100 are not.
- The earth's spin can be demonstrated by *Foucault pendulums*. The earth's orbiting around the Sun can be evidenced by the *aberration of starlight*.
- The earth is slightly flattened with the equator bulging out. The Sun and the moon on the ecliptic exert a gravitational pull on the equator bulge, causing the earth's spin axis to wobble. The north celestial pole traces a circle of radius 23.5° around the north ecliptic pole in every $\sim 26,000$ years. This *precession* makes the vernal equinox shift to a new zodiacal constellation every 2,000 years.