Discovering the Universe for Yourself (Chapter 2): Years, Seasons, and Months: The Motions of Sun, Earth, and Moon

Positions of objects in the sky can be given by their altitude in degrees above the horizon and their direction (north, south-east, etc). The zenith point is directly overhead and has an altitude of 90 degrees. The meridian line goes from looking north on the horizon, through zenith, to looking south on the horizon.

The rotation of Earth on its axis causes the Sun to move across the sky once each day. The orbit of Earth around the Sun causes the Sun's position in the sky at a fixed time during the day to move around over one year. This occurs because Earth's axis is tilted. The north pole points slightly towards the Sun during northern summer, slightly away from the Sun during northern winter, and neither towards nor away from the Sun during fall and spring. The true seasonal cycle is the change in the length of the day and the change in the Sun's position in the sky. When the northern hemisphere gets less solar heating than average due to the Earth's axial tilt, it becomes colder (winter). When it gets more, it becomes hotter (summer). The hottest time of the year is one or two months after the sunniest time of the year due to the time it takes Earth's climate to respond to the change in sunshine.

The Moon's phase changes on a 29.5 day cycle, a "moonth". Half the Moon is illuminated by the Sun at any time, and half is not. From Earth, we see different proportions of illuminated/shaded regions during each "moon"th. Unlike Earth, the Moon's "day" (rotational period) and "year" (orbital period) are the same length, 29.5 days, which is why we always see the same face of the Moon.

Lunar eclipses occur when the Moon is within the shadow of Earth. Earth is between the Sun and the Moon, so lunar eclipses can only occur at Full Moon. Lunar eclipses can be seen from anywhere on the darkside of Earth. Solar eclipses occur when the Moon's shadow falls on part of Earth's surface. The Moon is between the Sun and Earth, so solar eclipses can only occur at New Moon. Solar eclipses can only be seen from a small fraction of Earth's dayside. Eclipses do not occur every month because the plane of the Moon's orbit around Earth is not the same as the plane of Earth's orbit around the Sun.

The angular size of an object is the same fraction of 360^{o} as its physical size is of the circle's circumference (see diagram)

Specifying a distance, time, speed, mass, or just about anything needs both a number and a unit (eg 3 km, not just 3). If your answer to a question about speed has units of kilograms, then your answer is wrong. Units can be changed by careful multiplication (see example).

The rotation and orbit of the Earth control the patterns we see in the night sky. These patterns do not change from one year to the next because the distant stars move a very small fraction of their distance from Earth each year. Your latitude on Earth's surface affects what stars you can see at night.