

Earth's shape and size by surveys and mathematical calculations. But in that year, Sir Isaac Newton postulated that Earth, along with the other planets, could not be perfectly spherical. Newton reasoned that the more rapid rotational speed at the equator—the part of the planet farthest from the central axis and therefore the fastest moving—produces an equatorial bulge as centrifugal force pulls Earth's surface outward. He was convinced that Earth is slightly misshapen into an *oblate spheroid*, or, more correctly, an *oblate ellipsoid* (*oblate* means “flattened”), with the oblateness occurring at the poles.

Earth's equatorial bulge and its polar oblateness are today universally accepted and confirmed with tremendous precision by satellite observations. The unique, irregular shape of Earth's surface, coinciding with mean sea level and perpendicular to the direction of gravity, is described as a **geoid**. Imagine Earth's geoid as a constant sea-level surface that extends worldwide, beneath the continents. Both heights on land and depths in the oceans measure from this hypothetical surface. Think of the geoid surface as a balance among the gravitational attraction of Earth's mass, the distribution of water and ice upon its surface, and the outward centrifugal pull caused by Earth's rotation. **Figure 1.9** gives Earth's polar and equatorial circumferences and diameters.

To determine location on our not-quite-spherical planet, we use a coordinated grid system that is internationally accepted. The terms *latitude* and *longitude* for the lines of this grid were in use on maps as early as the first century A.D., with the concepts themselves dating to earlier times.

The geographer, astronomer, and mathematician Ptolemy (ca. A.D. 90–168) contributed greatly to the development of modern maps, and many of his terms are still used today. Ptolemy divided the circle into 360 degrees (360°), with each degree having 60 minutes (60') and each minute having 60 seconds (60") in a manner adapted from

the ancient Babylonians. He located places using these degrees, minutes, and seconds. However, the precise length of a degree of latitude and a degree of longitude remained unresolved for the next 17 centuries.

Latitude

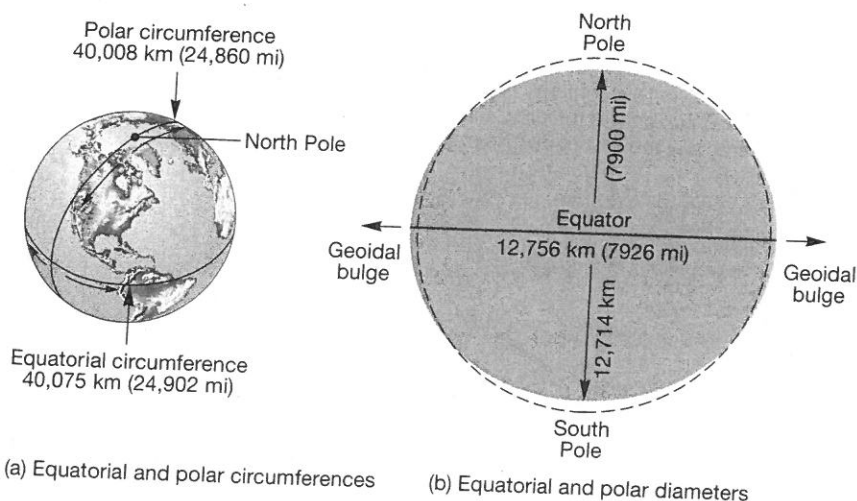
Latitude is an angular distance north or south of the equator, measured from the center of Earth (**Figure 1.10a**). On a map or globe, the lines designating these angles of latitude run east and west, parallel to the equator (**Figure 1.10b**). Because Earth's equator divides the distance between the North Pole and the South Pole exactly in half, it is assigned the value of 0° latitude. Thus, latitude increases from the equator northward to the North Pole, at 90° north latitude, and southward to the South Pole, at 90° south latitude.

A line connecting all points along the same latitudinal angle is a **parallel**. In **Figure 1.10**, an angle of 49° north latitude is measured, and, by connecting all points at this latitude, we have the 49th parallel. Thus, *latitude* is the name of the angle (49° north latitude), *parallel* names the line (49th parallel), and both indicate distance north of the equator.

To pinpoint location more precisely, we divide degrees into 60 minutes and minutes into 60 seconds. For example, Mount Cook, South Island, New Zealand, in **Figure 1.1** sits at 43 degrees, 35 minutes, 42 seconds (43° 35' 42") south latitude. Alternatively, many geographic information systems and Earth visualization programs such as Google Earth™ use decimal notation for latitude and longitude degrees (an online conversion is at <http://www.csgnetwork.com/gpscoordconv.html>). In decimal units, Mount Cook is at -43.5950° latitude—the negative sign is for south latitude; a positive sign indicates north latitude.

“Lower latitudes” are those nearer the equator, whereas “higher latitudes” are those nearer the poles. You may be familiar with other general names describing regions related to latitude, such as “the tropics” and “the Arctic.” Such terms refer to natural environments that differ dramatically from the equator to the poles. These differences result from the amount of solar energy received, which varies by latitude and season of the year.

Figure 1.11 displays the names and locations of the *latitudinal geographic zones* used by geographers: *equatorial* and *tropical*, *subtropical*, *midlatitude*, *subarctic* or *subantarctic*, and *arctic* or *antarctic*. These generalized latitudinal zones are useful for reference and comparison, but they do not have rigid boundaries; rather, think of them as transitioning one to another. We discuss specific lines of latitude, such as



▲**Figure 1.9** Earth's dimensions. The dashed line is a perfect circle for comparison to Earth's geoid.