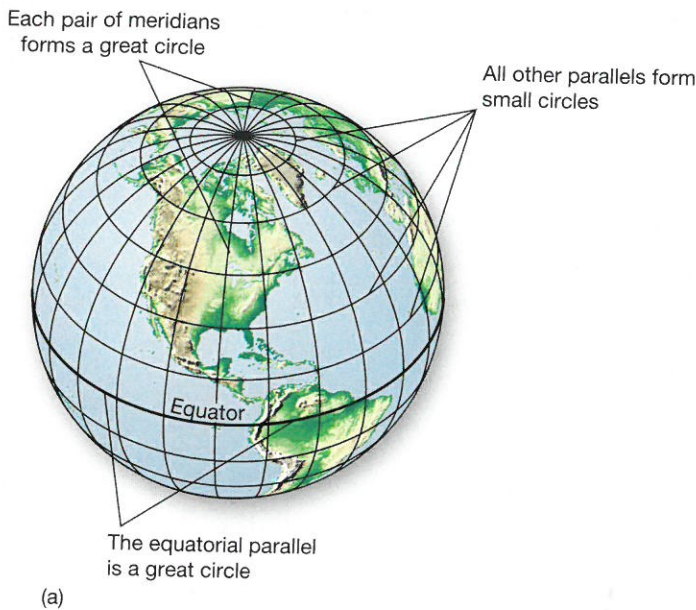
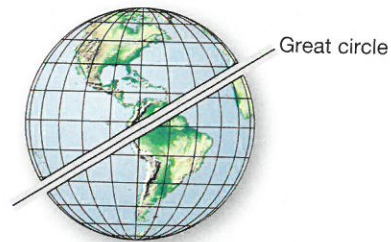
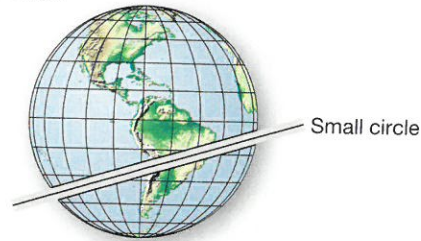




▲Figure 1.14 Great circles and small circles.



(b) A plane intersecting the globe along a great circle divides the globe into equal halves and passes through its center.



(c) A plane that intersects the globe along a small circle splits the globe into unequal sections—this plane does not pass through the center of the globe.

is based on longitude, the prime meridian, and the fact that Earth rotates on its own axis, revolving 360° every 24 hours, or 15° per hour ($360^\circ \div 24 = 15^\circ$).

In 1884 at the International Meridian Conference in Washington, DC, a prime meridian was set as the official standard for the world time zone system—**Greenwich Mean Time (GMT)** (see <http://www.greenwichmeantime.com/>). This standard time system established 24 standard meridians around the globe at equal intervals from the prime meridian, with a time zone of 1 hour spanning 7.5° on either side of each of these *central meridians*. Before this universal system, time zones were problematic, especially in large countries. In 1870, railroad travelers going from Maine to San Francisco made 22 adjustments to their watches to stay consistent with local time! Today, only three adjustments are needed in the continental United States—from Eastern Standard Time to Central, Mountain, and Pacific—and four changes across Canada (Figure 1.15).

Using the international time zones in Figure 1.15, you can determine that when it is 9:00 P.M. in Greenwich, then it is 4:00 P.M. in New York (−5 hr), 3:00 P.M. in Chicago (−6 hr), 2:00 P.M. in Denver (−7 hr), 1:00 P.M. in Seattle and Los Angeles (−8 hr), noon in Anchorage (−9 hr), and 11:00 A.M. in Honolulu (−10 hr). To the east, it is midnight in Riyadh, Saudi Arabia (+3 hr). The designation A.M. is for *ante meridiem*, “before noon,” whereas P.M. is for *post meridiem*, “after noon.” A 24-hour clock avoids the use of these designations: 3 A.M. is 3:00 hours; 3 P.M. is 15:00 hours.

Figure 1.15 also shows that national or state boundaries and political considerations distort time boundaries. For example, China spans four time zones, but its

government decided to keep the entire country operating at the same time. Thus, in some parts of China clocks are several hours off from what the Sun is doing. In the United States, parts of Florida and west Texas are in the same time zone.

Coordinated Universal Time For decades, GMT was determined using the Royal Observatory’s astronomical clocks and was the world’s standard for accuracy. However, Earth rotation, on which those clocks were based, varies slightly over time, making it unreliable as a basis for timekeeping. For example, 150 million years ago, a “day” was 22 hours long, and, 150 million years in the future, a “day” will be approaching 27 hours in length.

The invention of a quartz clock in 1939 and atomic clocks in the early 1950s improved the accuracy of measuring time. In 1972, the **Coordinated Universal Time (UTC)** time-signal system replaced GMT and became the legal reference for official time in all countries. UTC is based on average time calculations from atomic clocks collected worldwide. You might still see official UTC referred to as GMT or Zulu time.

International Date Line An important corollary of the prime meridian is the 180° meridian on the opposite side of the planet. This meridian is the **International Date Line (IDL)**, which marks the place where each day

UTC is in use because agreement was not reached on whether to use the English word order, CUT, or the French order, TUC. UTC was the compromise and is recommended for all timekeeping applications; use of the term GMT is discouraged.