The equator is blank latitude

When describing location, it is common to mention the city, state, or country as a location descriptor. It is also common to talk about landmarks that may be nearby. Another way to describe location is to use reference lines to describe coordinates, or absolute position, on the globe. Two types of imaginary reference lines are used to locate positions or points and to make accurate globes and maps. These lines are called parallels of latitude and meridians of longitude. Two of these imaginary reference lines, the equator and the prime meridian, are called primary reference lines because they are where we start the numbering system. Equator, Hemispheres, Axis, and Directions The earth rotates daily about its axis. The north and south poles are the two imaginary points where the axis would enter and exit from the earth if the axis were a pole or a line (see Fig. 1.9). The equatoris the imaginary primary reference line drawn around the earth halfway between the north and south poles. The half of the earth to the north of the equator is the northern hemisphere; the half to the south is the southern hemisphere (Fig. 1.9). (The prefix hemi- means "half"; thus, hemisphere means "half-sphere.") The poles determine north and south directions. Movement toward the North Pole is northerly in direction. Movement toward the South Pole is southerly in direction. Parallels of Latitude Latitude is measured in degrees (°)—from 0˚ to 90˚—north or south of the equator. Degrees of latitude are measured from an imaginary point at the center of the earth. If the earth was cut in half, this imaginary point would be intersected by a line drawn from the North Pole to the South Pole and by a line drawn from the equator on one side of the earth to the equator on the other (Fig. 1.10 A). A radius is a line drawn from the edge of a circle to its center. The angle between the radius lines drawn from the equator and from the north pole (or south pole) forms a right angle, which is 90°. The equator is at 0°, and both of the earth's poles are at 90° from the equator. Latitude is determined by the angle between a point on the earth's surface and the equator. To calculate the angle, draw a line from the point to the center of the earth and a line from the equator to the center of the earth (Fig. 1.10 A). Parallels of latitude are imaginary reference lines that form complete circles around the earth parallel to the equator and parallel to each other. Every point on a parallel of latitude is the same distance from the equator, and thus the angle formed between the equator and the latitude line is constant. This is shown in Fig. 1.10 B for the latitude lines 30° and 60° north. Parallels of latitude are circles of different sizes (see Fig. 1.11). The largest parallel is at the equator, and the parallels decrease in size towards the poles. Except for positions located right on the equator (0°), parallels of latitude are described by the number of degrees that they are north (N) or south (S) of the equator. The greater the distance from the equator, either north or south, the higher the latitude. Honolulu, Hawai'i, for example, is on the 21° N parallel. Sydney, Australia, is on the 34° S parallel. Meridians of Longitude Meridians of longitude are imaginary half-circles running from the North Pole to the South Pole. They are sometimes called lines of longitude. Unlike parallels of latitude that are different sizes, all lines of longitude are the same length. Since every meridian must cross the equator, and since the equator is a circle, the equatorial circle can be divided into 360°. These divisions of the equatorial circle are used to label the meridians. By international agreement, the 0˚ meridian (also called the prime meridian) is drawn through Greenwich, England. Meridians are numbered east and west from the prime meridian (Fig. 1.12 A). Longitude is the distance east or west of the prime meridian, and longitude is measured in degrees from 0˚ to 180˚ (Fig. 1.12 B). Places to the east of the prime meridian have east longitude. Rome, Italy, for example, is located on the 12˚ E meridian, whereas Washington DC, USA, is located on the 77˚ W meridian. East and west longitude meet at the 180˚ meridian, which runs through the Pacific ocean basin (Fig. 1.13). Therefore, most of the United States (including Hawai'i) lies in the western hemisphere. Only a small portion of Alaska (part of the Aleutian Islands) crosses the 180˚ meridian into the eastern hemisphere. The complete circle around the earth made by the prime meridian (0˚) and the 180˚ meridian divide the earth into eastern and western hemispheres (see Figs. 1.12 and 1.13). International Date Line The international date line is an imaginary line running mostly along the 180˚ meridian (see Fig. 1.14). The international date line determines where on earth the date changes. For example, at the same moment the time is 6:00 am on July 1st in Bangladesh, the time is 6:00 pm on June 30th in Mexico and midnight on June 30th in England (see Fig. 1.15 A). Places located immediately to the right and left of the date line are 24 hours apart. This means that on the left side of the international date line in Tonga, when the time is noon on Monday, July 1st, on the right side of the date line in Sāmoa, the time is noon on Sunday, June 30th (see Fig. 1.15 B). Travelers who cross the dateline heading west lose a day, but travelers who cross the dateline going east gain a day. When traveling east across the dateline, it is actually possible to arrive at your destination earlier than when you left! For practical purposes, the international date line has been adjusted to allow certain land areas to remain together in the same day and time zones. For example, the extreme eastern tip of Russia, which juts into the Bering Strait, was kept in the easternmost time zone, whereas the U.S.-owned Aleutian Islands were kept as part of the westernmost time zone (see Fig. 1.15 B). In another example, the country of Kiribati (pronounced KIRR-i-bas) drastically changed the date line in 1995 so that the entire country could be on the same day at the same time. Before this, the western part of Kiribati, where the capital lies, would be 22 hours ahead of the eastern portion of the county. Now eastern Kiribati and Hawai'i, which are located close to the same longitude, are a whole day apart (see Fig. 1.16). Location Lines of latitude and longitude form an imaginary global grid system, shown in Fig. 1.17. Any point on the globe can be located exactly by specifying its latitude and longitude. This system is essential for ships at sea that cannot locate their positions using landmarks or coastal navigational aids such as buoys or channel markers. This system is just as useful for people on land when hiking, driving, or surveying an environment. To locate a point on a globe exactly, degrees of latitude and longitude are further subdivided into minutes and seconds. In latitude and longitude measurements, minutes and seconds do not refer to time. Instead, they refer to parts of an angle. But, like with time, there are 60 minutes in a degree (just as there are 60 minutes in an hour). Similarly, there are 60 seconds in a minute of time and 60 seconds in a minute of longitude or latitude. 1 degree (1°) = 60 minutes (60') 1 minute (1') = 60 seconds (60") The latitude and longitude readings of a place are called its spherical coordinates. For example, the coordinates of the location of the USS Arizona Memorial in Pearl Harbor (Fig. 1.18) are "latitude 21 degrees, 21 minutes, and 54 seconds north; longitude 157 degrees, 57 minutes, and zero seconds west." This is written as "21° 21' 54" N, 157° 57' 0" W". Activity Make a globe marked with reference lines of latitude and longitude. Activity Make three maps of a globe: an orthographic-projection map, a cylindrical-projection map, and an equal-area map. Latitude and Longitude Use If the latitude and longitude coordinates of a location are known, it can be pinpointed on a map or globe. Knowing the spherical coordinates of a location is useful for people when hiking, diving, or surveying an environment. Sophisticated navigational aids use latitude and longitude to give directions when driving and flying. The spherical coordinate system is essential for ships at sea that cannot locate their positions using landmarks or coastal navigation aids like buoys or channel markers. Nautical Miles and Knots In addition to using latitude and longitude to specify location, marine and air navigators also use the nautical mile as their unit of length or distance. A nautical mile is approximately one minute of latitude along a line of longitude, a distance of 1.85 kilometers. Navigators describe the speed of ships and airplanes in knots. Meteorologists also describe wind speeds in knots. One knot is equal to one nautical mile per hour. 1 nautical mile = 1.85 km 1 knot = 1 nautical mile/hour Activity Complete a location scavenger hunt using a map of the South Pacific ocean basin. Any point on Earth can be defined by the intersection of its lines of latitude and longitude. is measured as the angle from the equator, to the Earth's center, to your position on the Earth's surface (Figure2.1.1). It is expressed as degrees north or south of the equator (0o), with the poles at a latitude of 90o. Thus the poles are referred to as high latitude, while the equatorial region is considered low latitude. Lines of equal latitude are always the same distance apart, and so they are called parallels of latitude; they never converge. However, the circles created by the parallels of latitude do get smaller as they approach the poles. Figure 2.1.1 The latitude of a point on the Earth's surface is determined by the angle (ø) between the point and the equator, passing through Earth's center (Peter Mercator [Public domain], via Wikimedia Commons). One degree of latitude is divided into 60 minutes ('). One minute of latitude equals one , which is equal to 1.15 land miles (1.85 km). Each minute of latitude is further divided into 60 seconds ("). So traditionally, positions have been expressed as degrees/minutes/seconds, e.g. 36o 15′ 32″ N. However, with modern digital technology, positions are increasingly expressed as decimals, such as 36o 15.53′ N, or 36.2589o N. (A useful tool for converting coordinates between these formats can be found at: . In the Northern Hemisphere, latitude can be determined by the angle of the North Star (Polaris) from the horizon. The North Star always sits over the North Pole. Here, if a person looks straight ahead towards the horizon, the star would be directly overhead, creating a 90o angle; thus the latitude at the North Pole is 90o N. At the equator looking north, the star is in the same direction as the horizon, so the angle between them is 0o, and thus the equatorial latitude is also 0o. At any other point in the Northern Hemisphere, the angle between the horizon and the star will give the latitude. Early mariners used an instrument called an astrolabe to calculate this angle. Later the sextant was developed, which allowed more accurate measurements (Fig. 2.1.2). Figure 2.1.2 An astrolabe (left) and sextant (right) (Public domain via Wikimedia Commons). There is no direct analogue to the North Star in the Southern Hemisphere that is useful for determining latitude. However, the Southern Cross and Centaurus constellations can be used to find the south celestial pole. If a line is drawn through the long axis of the Southern Cross, and another line is drawn between the two brightest stars in Centaurus, the two lines will intersect at the south celestial pole. measures the distance east or west of an imaginary reference point, the prime meridian (0o), which is now defined as the line passing through Greenwich, England (although throughout history the prime meridian has also been located in Rome, Copenhagen, Paris, Philadelphia, the Canary Islands, and Jerusalem; unlike the equator, the prime meridian's location is fairly arbitrary). Your longitude represents the angle east or west between your location, the center of the Earth, and the prime meridian (Fig. 2.1.3). Figure 2.1.3 Longitude is determined as the angle (λ) between the prime meridian and your position (Peter Mercator [Public domain], via Wikimedia Commons). As you move east and west from the prime meridian, eventually you reach 180o E and W on the opposite side of the globe from Greenwich. This point is the International Date Line. Lines of longitude are called meridians of longitude, or great circles. All circles of longitude are the same length, and are not parallel like lines of latitude; they converge as they near the poles. Therefore, while one minute of latitude always equals one , the length of one minute of longitude will decline from the equator to to poles, where it will ultimately decline to zero. Measuring longitude requires accurate time at your current location, and also the time at some distant point like a home port at the same instant. The time difference can be used to calculate longitude. This is because the Earth takes 24 hours for a complete 360o rotation. So in one hour, the Earth rotates through 1/24 of 360o, or 15o. Therefore, for each hour of time difference between two locations, there is a 15o difference in longitude. Accurate measurements of latitude using the North Star have been made since at least the third century B.C.E. Because longitude measurements required accurate timekeeping, it wasn't until the mid-18th century that longitude was easily and precisely measured at sea. Before then, sailors would often sail north or south to get to the desired latitude, then just head east or west until they reached the target longitude. Solving the longitude problem was so important that the British government passed the Longitude Act in 1714, offering a £20,000 prize to anyone who could devise a method of measuring longitude at sea to within half a degree. Many unsuccessful solutions were proposed, including astronomical observations, but it was a clock maker, John Harrison, who developed a series of clocks that eventually satisfied the criteria. The first version (the H1) weighed over 80 lbs, but his final timepieces, the H4 and H5, could be held in the palm of one hand. Ironically, even though his clocks satisfied the criteria, Harrison was never named as the winner of the longitude prize, and in fact no winner was ever officially determined. With accurate timepieces now available, a ship could have one clock set for Greenwich time (or some other home location), and another clock set to local time, which could be reset each day by observing the sun. The time difference between the two clocks could be used to calculate longitude. Today we use GPS (Global Positioning System) technology to determine latitude and longitude, and even the smallest smart phones and smart watches can use GPS to calculate position. GPS works through a system of orbiting satellites that constantly emit signals containing the time and their position. A GPS receiver receives these signals from multiple satellites, and triangulates the signals to calculate position. The system needs 24 satellites to be functional at one time; as of 2015, the system consisted of about 32 operational satellites, able to give a position with an accuracy of 9 meters (30 feet) or less. the distance north or south of the equator, measured as an angle from the equator (2.1) a distance equal to one minute of latitude; equivalent to 1.15 land miles or 1.85 km (2.1) measurement of distance east or west of the prime meridian, expressed as an angle (2.1)