

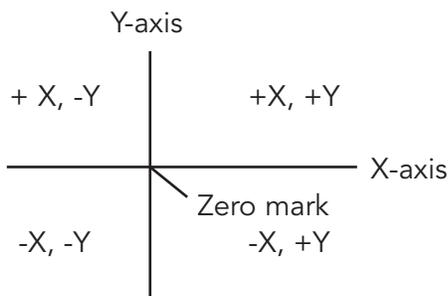
## Science Lectures

### Science lecture #1: The Cartesian Coordinate System

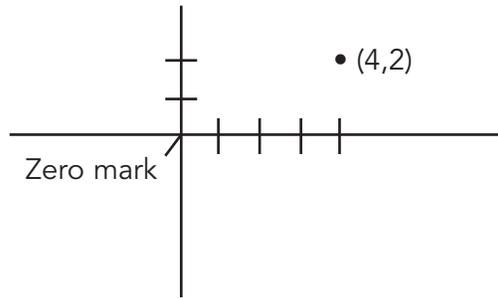
Maps and globes are drawings of the surface of *Kahonua* (the earth) as seen from above. The Hawaiian word for “map” is *palapala`āina* and the Hawaiian word for “globe” is *pa`a poepoe*. Maps are two-dimensional, meaning they are usually prepared or drawn on a flat piece of paper, whereas globes are three-dimensional and observed as a sphere or large, round ball. Maps and globes are primarily used as informational resources providing its viewer with accurate distances, a location of something specific, or differences in elevation from one area to the next. Some maps even show the differences in ground cover from one area to the next; that is, whether it is a forest area, a desert, a grassland, or even a sea or lake.

One of the oldest methods used in trying to locate something specific on a map or globe is with the use of the Cartesian Coordinate System, more commonly known as the **Cartesian Grid System**. Devised by French scientist and philosopher Rene Descartes in the 1600’s, it covers the entire surface of *Kahonua* and allows any individual to communicate a specific location to another person. By drawing a series of horizontal rings around the globe which are parallel to the equator (*pō`ai waena honua*), and a series of vertical rings which are spaced evenly apart at the equator but then converge at the poles (like orange slices), a network of reference lines or grid lines divides the entire surface of *Kahonua* into manageable sections which aid in pinpointing something or someplace specific.

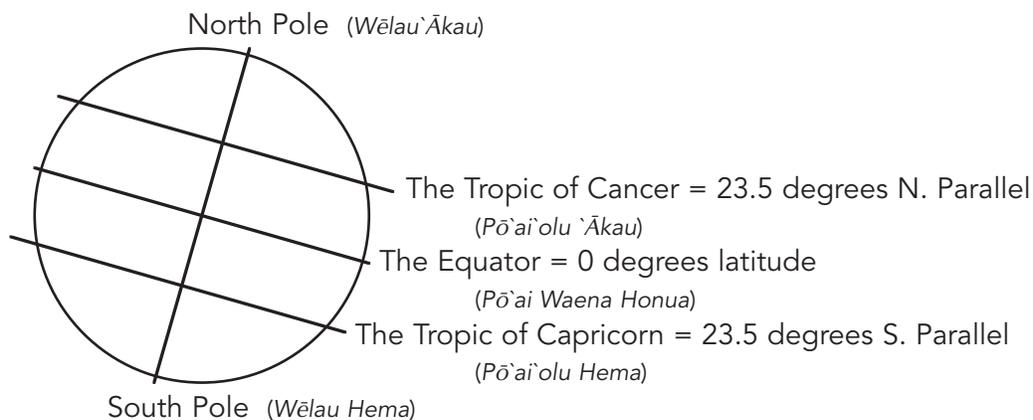
Descartes devised a method which uses coordinates, or pairs of numbers, which help to pinpoint the position of something specific. Mathematics teaches about the *X and Y grid system* where the *X-axis* is a horizontal line and the *Y-axis* is a vertical line, and where those 2 lines cross each other that intersecting point is known as the *Zero mark*.



Any **point** drawn on this kind of grid system will always have 2 numbers to determine its location, and is written like this:  $(\_,\_)$ . This is called the point’s **coordinates**. The first number dictates where this point is in reference to the *X-axis*, or the horizontal line; the second number dictates where the point is in reference to the *Y-axis*, or vertical line. For example, if a point’s coordinates read  $(4,2)$  this means the point is 4 units to the right of the *Zero mark* on the *X-axis*, and 2 units above the *Zero mark* on the *Y-axis*. It would look like this:



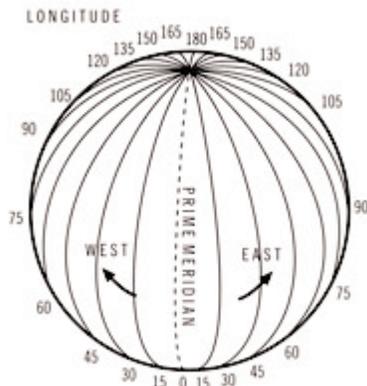
As mentioned earlier, the most commonly-used system for maps and globes today is the Cartesian Grid System. It uses lines of **latitude** (*lakikū*) and **longitude** (*lonikū*) which helped early ocean navigators locate themselves. This was important so they could navigate safely and find their way across vast oceans. *Lakikū* lines are the horizontal lines on a map going from left to right. It is a way to help measure specific distances above or below the **equator** (*pō`ai waena honua*); the equator is the imaginary "latitude" line found at the midway point on *Kahonua*, exactly half-way between the North and South Poles. This imaginary latitude line bears the coordinate: 0 degrees latitude ( $0^\circ$ ). All *lakikū* lines are parallel to the equator and parallel to each other, and are spaced at 15 degree intervals starting at the equator and ending at the poles; they are also known as "Parallels of Latitude" or simply **Parallels**, as in "the 45th Parallel." Every *lakikū* line above the equator can also be called a "North Parallel" or North latitude line, and every *lakikū* line below the equator can be called a "South Parallel" or South latitude line. The North Pole is at 90 degrees North ( $90^\circ\text{N}$ ) and the South Pole is at 90 degrees South ( $90^\circ\text{S}$ ). Since Hawai`i is situated above the equator, it has coordinates which read "21° 19' North latitude." Other "common" *lakikū* lines are: 1) the **Tropic of Cancer** (*Pō`ai`olu `Ākau*), at  $23.5^\circ$  North Parallel, and 2) the **Tropic of Capricorn** (*Pō`ai`olu Hema*), at  $23.5^\circ$  South Parallel. These 2 *lakikū* lines mark the northernmost regions and the southernmost regions of the "tropical" area known as the "Tropical Belt."



A second series of lines which run in an up and down direction are known as "Meridians of Longitude" or simply **longitude** (*lonikū*). They are vertical lines which begin and end at each Pole and actually converge, or touch each other at the ends. These vertical lines can also be called **meridians**. *Lonikū* lines aid in measuring distances to the east or to the west. The starting point is the **Prime Meridian**, which runs directly through the city of Greenwich, England. (The Greenwich Observatory was established in 1675 by King Charles II, and eventually became the Prime Meridian in 1884 when a group of delegates from several countries met at an

“International Meridian Conference,” to adopt Greenwich as the Prime Meridian location.) It bears the coordinate: 0 degrees longitude ( $0^\circ$ ). From there, there are 24 *lonikū* lines spaced evenly apart all the way around Kahonua and ends up back at Greenwich. The 24 *lonikū* lines coincide with our time clocks and represent each hour of the 24-hour day. Exactly half-way around *Kahonua* from the Prime Meridian is another “popular” meridian known as the **International Date Line**. This is important to know because it marks the end of one day and the beginning of the next.

In order to find locations on a map or globe and be able to communicate that information to someone else, it is critical that you give them as much detailed information as possible. For that matter, mapmakers have divided *Kahonua* using the mathematical principle of a complete circle, which is 360 degrees ( $360^\circ$ ). Knowing that  $360^\circ$  will take you all the way around *Kahonua* along the equator, and knowing that *Kahonua* makes one complete rotation every 24 hours, mapmakers have placed each *lonikū* line  $15^\circ$  apart from each other all the way around (at the equator). This can be seen in the diagram below:



However, to simplify the process of reading a map, mapmakers have chosen to go from  $0^\circ$  longitude at the Prime Meridian out to  $180^\circ$  longitude (half-way around *Kahonua*) in both directions, east and west. Therefore, since Hawai'i is closer to the Prime Meridian by traveling in a westward direction, Hawai'i's longitudinal coordinate is  $157^\circ 50'$  West longitude.

Any place on *Kahonua* can be located by seeing where a *lakikū* line and a *lonikū* line cross each other. However, many places do not lie exactly on these lines. So, smaller units have been used in-between the lines of latitude and longitude to give a more detailed location. Each degree then, can be broken down into 60 smaller units, called **minutes**, and each minute can be broken down into 60 smaller units, called **seconds**. Can you now find Hawai'i on the globe? What are its coordinates? If you said  $21^\circ 19' N$ ,  $157^\circ 50' W$  (21 degrees 19 minutes North, and 157 degrees 50 minutes West) you would be correct.

(Note that the *lakikū* measurement is always written first, followed by the *lonikū* measurement. This is the correct way to write it.)