Lab 01c: navigation: celestial navigation overview

https://en.wikipedia.org/wiki/Celestial_navigation

Main points:

An astrolabe is a device for measuring altitude of objects, or the angles of stars or planets for navigation. You can make your own using a protractor, a straw, some tape, dental floss and a rock or weight (see below):

http://www.hmdt.org.uk/STEM_lesson_plans/2%20Physics/2%20Hypatia/3%20Make%20an%20Astrolabe%20Worksheet.pdf

https://www.nps.gov/teachers/classrooms/make-your-own-astrolabe.htm

Astrolabe for altitude:

45 degree method:

- find your "eye height" by looking at a ruler on the wall, write this down
- set your astrolabe for 45°,
- walk towards the object (pole, building, tree) until it shows up in your sight
- measure the distance to the object
- add your eye height to this distance
- this is the height of the object (isosceles triangle)
- use this method to find the height of the elab, a flagpole, and several objects of your choice

Tangent method:

- measure a distance from the object (huge tape measure can be useful here)
- measure the degrees you see in your astrolabe to the top of the object
- use the tangent calculator on your phone: tan = opposite (height)/adjacent (distance)
- you could also use: distance x tangent θ = height
- make sure to add your eye height
- use this method to determine the altitude of the same objects

- try to calculate the altitude of Mauna Kea by looking up the distance, knowing the elab is at 800 meters altitude (confirm this with the GPS on your phone)
- using google earth, look up the distance between several peaks on your map and make a scale ruler for your map
- use this scale ruler to find the distance to other peaks
- repeat the tangent method to find the height of each peak you can see: Hokuula, La'e La'e, Mauna loa...

Challenge: how could you use your astrolabe sideways to find your location?

Calculating latitude (latitude= "ladders")

First you have to understand the seasons...

- map out the orbit of the earth around the sun on your big piece of paper (we know it is not a circle, ok for now), using a loop of dental floss
- label out the seasons on your paper, including the tilt angle of the earth at each transition, March 21, June 21, September 21, December 21, with June 21 at the top of your paper
- at the equinoxes ("equal night") determine the tilt of the earth
- what would the angle of a shadow look like in Waimea at noon on this date?
- compare with Alaska, Spain, Brazil, Germany and a few others
- repeat this at the solstices for these locations-what do you notice?
- if we lived on the tropic of cancer (north) or tropic of capricorn (south) what would the sun angle be on the solstices?
- what about on the equinoxes?
- why are they named this way? (look this up)
- what would be the lowest angle the noon sun should be in Waimea, and on what date?
- what would be the highest angle the sun should be at noon in Waimea, and on what date?
- what are the longest and shortest days where you are from?

ok, now that we know the extremes, imagine we are in between one of these extremes:

- mark where we would be on your season map based on the date
- what degree should ours be between?
- measure the angle of the sun at around noon (noon is best, but close will be ok for now)
- using your angle, look up on a navigation almanac what our latitude should be
- how close are you?

Calculating longitude ("long lines")

First we have to understand a bit about astronomy, and why there is a famous telescope at a place called Greenwich near London...

- on a globe, find London
- notice the longitude of London
- find the longitude of where you are from and record this
- if every 15° of latitude is one hour, calculate how many degrees away from London your home is exactly

- the telescope at Greenwich near London calculated noon exactly. If you had a clock with you, wherever you were on the planet, if you knew what time "local noon" was, you could calculate your latitude.
- there are a set of radio stations around the world that now broadcast this time signal on the radio, so ships and lost students can determine their latitude if they know local noon.
- on a radio, listen for WWV or WWVH (Hawaii version) on 10 MHz shortwave
- notice that when the chirps make a long beep, your phone, your computer and any device changes the minute-EXACTLY
- why do you care? if your computer or phone is on the wrong time even by a few minutes your web browser, email and everything on the internet will not work-why?
- Since our class does not meet at exactly noon, you can look up local noon on the web for this location
- calculate our longitude from this number
- since you can look on your super-fancy big island map, label our latitude and longitude if you have not already
- how many hours and minutes should we be from GMT (Greenwich Mean Time)?
- China has one time zone-how does this impact life there?

Putting it all together:
You now know how to find your latitude using an astrolabe, and your longitude using an astrolabe and a good clock
Look up how to do this with your hands if you are lost in the wilderness or at sea...

Next: Polynesian navigation-using the stars to find home

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