Solution to HW 1

1.1 Tahiti 17.6667°S Oahu 21.4667°N.

Use the hint, look at Figure 11.13 (page 21 of textbook.) For Tahiti, it's at South, so declination is -17.6667°. Draw a straight line across the analemma, approximate 18°. February and November is where the Sun is right above the inhabitants.

For Oahu, +21.4667° (North = positive declination) ⇒ June July Mid July

End of May.

1.2. Definition of circumpolar: Stars (or any object in the sky) does not set or rise.

- Let's look at the lowest and highest declination of Big Dipper
- Mark that down like this:

![Diagram of declination angles]

We know that the rest of the stars are between these.

We also know "horizon" is where sun sets and rise. So let's draw a horizon.

We placed the "horizon" at latitude 49°19' because that's the minimum boundary. (If we put at latitude 61°45', we'll lose 49°19'!!)

In another...

An observer will have to be at 90° to that horizon to have a horizon.

To find what latitude the observer must be at (∂),

\[ \alpha = 180 - 90 - 49.19' = 40°41' \]
Again, to be able to see any stars at all, the horizon is the limit. Anything below our horizon is considered unseen. The question asked for which "Southwest" latitude we must be on. So we draw a horizon and placed ourselves at south.

\[ \alpha = 180 \, \degrees - 90 \, \degrees - 61.45' \]
\[ = -28.15' \] (we put a negative sign to say it's at negative declination/south.)

We know that from part i) we found at 40\,\degrees 41', all stars are circumpolar. Thus, at -40\,\degrees 41', we should not be able to see any stars.
We want to find **Virgo and Pisces** on last week of September.

See figure 1-6.

Last week of September = autumnal equinox. 2 information can be found at page 12 & 13.

Virgo is where autumnal equinox is located.

Pisces is where vernal equinox is located.

At autumnal equinox, where the sun is located 12 hours above the horizon and 12 hours below the horizon. You wouldn't have enough time to observe Virgo since it will behave like the sun. You, however, have plenty of time to observe Pisces since vernal equinox is exactly 180° away from autumnal equinox.

1.6. Find the physical distance between two points.

\[ S = \text{radius} \times \text{angle (rad)}, \quad \text{radius of earth} = 6378 \text{km}. \]

Angle of 1 arc second (change to radians.)

\[ 1^\circ = \frac{1}{360} \text{ of a circle}. \]

\[ 1' \text{ (one minute of an arc)} = \frac{1}{60} 1^\circ = \frac{1}{60} \times \frac{1}{360} \text{ of a circle}. \]

\[ 1'' \text{ (one second of an arc)} = \frac{1}{60} 1' = \frac{1}{60} \times \frac{1}{360} \text{ of a circle}. \]

We also know \[ 1^\circ = \frac{\pi}{180} \text{ radians}. \]

So \[ 1'' = \frac{1}{60} \times \frac{1}{60} \times 1^\circ = \frac{1}{60} \times \frac{1}{60} \times \frac{\pi}{180} \text{ radians}. \]

\[ = \frac{\pi}{648,1000} \text{ radians}. \]

\[ S = \frac{\pi}{648,1000} \times 6378 \text{ km} \approx 0.039 \text{ km}. \]
1.7 "How long" \( \equiv \) time it takes for Mintaka to travel 1°

From classical mechanics, velocity = \( \frac{\text{distance}}{\text{time}} \).

Like sine, angular velocity = \( \frac{\text{angle}}{\text{time}} \).

We know earth rotate 15° every hour. So angular velocity, \( \omega \), of earth is 15°/hr. To find 1°

\[
\frac{15°}{\text{hr}} = \frac{1°}{t}
\]

\[
t = \frac{\text{hr} \times 1°}{15°} = 0.0667 \text{ hour} = 4 \text{ minutes}.
\]

1.9 Square degrees on a sphere.

We know \( \frac{\Pi}{\Pi} = 180° \)

\( \therefore 1° = \frac{180°}{180} \).

\( \times \) we square this \( \left(\frac{\Pi}{180}\right)^2 \).

\( \times \) we are asked to find on a sphere. (Surface of sphere = 4\( \Pi \))

So the total degree on a sphere is \( \left(\frac{\Pi}{180}\right)^2 \times 4\Pi = 41253 \text{ sq deg} \).

2.1 Perihelion = point closest to the sun.

We know the earth travels faster at the perihelion from Kepler's law.

So we know on June it's at the aphelion, where it travels slowest.
And on June it's the summer solstice. So the north pole has more daylight.
the question tell no difference between opposition and conjunction is 17 minutes. This 17 minutes is attributed by the extra distance light must travel.

to find how far earth is from Jupiter when it’s at opposition,

\[ 5.203\text{AU} - 1\text{AU} = 4.203\text{AU}. \]

to find how far earth is from Jupiter when it’s at conjunction,

\[ 5.203\text{AU} + 1\text{AU} = 6.203\text{AU}. \]

the difference in their distance is \[ 6.203\text{AU} - 4.203\text{AU} = 2\text{AU}. \]

Speed of light is therefore \[ \frac{\text{distance}}{\text{time}} = \frac{2\text{AU}}{17\text{min}}. \]

Change to S.I. \[ 1\text{AU} = 149,597,870.7\text{ km}. \]

\[ 1\text{min} = 60\text{ seconds}. \]

\[ \therefore \frac{2 \times 10^{12} \text{m}}{17 \times 60 \text{ seconds}} = 2.9 \times 10^8 \text{ m/s} \]

(speed of light is \[ 2.998 \times 10^8 \text{ m/s} \])
24. Annual parallax definition can be found on page 24. In short, parallax refers to shift of position when seen from two different locations.

At equator, parallax will be biggest because the rotation of Earth contains greatest at equator by conservation of angular momentum.

"To find the amapade" is another way to say "find the angle of aberration."

Let's do an approximation calculation. We know light travel in straight line will cap a value of \( \approx 3 \times 10^8 \text{ m/s} \). Now, when Earth is rotating, there'll be \( \nu \) perpendicular.

1. Speed of light \( C \)
2. Stationary Earth
3. Rotating Earth
4. Combine 1 and 2

Assume \( \Phi \) is so far away it looks like this:

\[ \tan \theta = \frac{\nu}{C} \]

\[ \theta \sim \frac{\nu}{C} \quad \text{(since it's so far away)} \]
to find \( V \) of rotating earth.

\[
V = \frac{2\pi \text{ Earth}}{\text{Period}} = \frac{2\pi \times 6378 \text{ km}}{1 \text{ day}} = \frac{2\pi \times 6378 \times 10^3 \text{ m}}{86400 \text{ s}}
\]

\( = 463.82 \text{ m/s} \).

\[
\Theta = \frac{463.82 \text{ m/s}}{3 \times 10^8 \text{ m/s}} = 1.547 \times 10^{-6} \text{ radians}
\]

let's change this to \( \text{radians} \):

\[
1.547 \times 10^{-6} \times \frac{\pi}{180} = 8.8365 \times 10^{-5} \text{ }^\circ
\]

let's change this to \( \text{arc seconds} \) just to make it pretty:

\( 1^\circ = 3600 \text{ arc seconds} \).

\[
8.8365 \times 10^{-5} \times 3600 = 0.32 \text{ arc sec}.
\]