AST 142 Pset 1 Solns E. Blackman Sp 2012

(problems from Ryden & Peterson)

1-1) Festivals would be held twice per year as at latitudes $-23.5 < \ell \leq 23.5$ sun passes directly overhead twice per year at noon.

- latitude of Tahiti is $-17°37'$. The sun passes this declination in early Februray (Feb 1) and Early Nov (Nov 2).
- latitude of Oahu is $21°28'$ Sun pases this latitude at end of May (May 29) and mid July (July 15)

use Fig 1.13 for approximate time of year. No need to get exact dates.

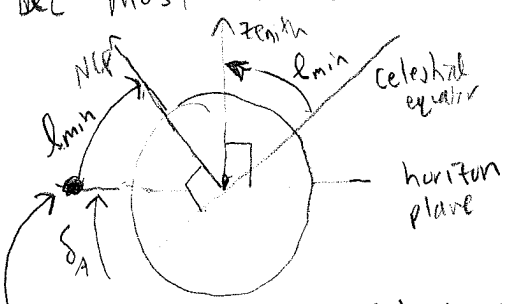
(P.

1.2)

Star	RA	dec, δ
Alkaid	$13^h 48^m$	$+49°19' = \delta_A$
Mizar	$13^h 24^m$	$+54°56'$
Alioth	$12^h 54^m$	$+55° 58'$
Megrez	$12^h 15^m$	$57° 02'$
Phecda	$11^h 54^m$	$53\ 42'$
Merak	$11^h 02^m$	$56° 23'$
Dubhe	$11^h 04^m$	$61° 45' = \delta_D$

a) For all stars to be circumpolar the star of lowest dec must be above the horizon at lower transit. That star is Alkaid.

(note that in 24 hr, a star incurs both upper transit and lower transit.) see figure 1.4



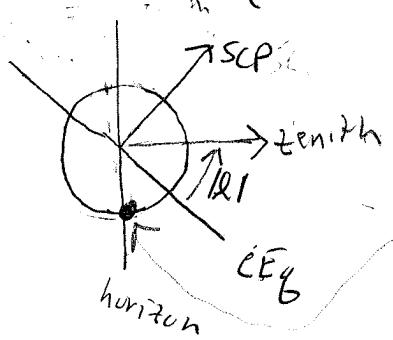
put Alkaid (of dec δ_A) at horizon to obtain minimum lattitude l_{min} at which it is circumpolar

$\Rightarrow$ for an observer with $l > l_{min} = 90 - \delta_A$

$= 90° - 49°19' = 40°41'$

$= l_{min}$

b) southernmost lattitude at which all stars of big dipper can be seen is determined by the lattitude at which northernmost star Dubhe, passes at its upper transit (not essential for this part that it cant be seen at lower transit)



put Dubhe of dec δ_D here at horizon for its upper transit

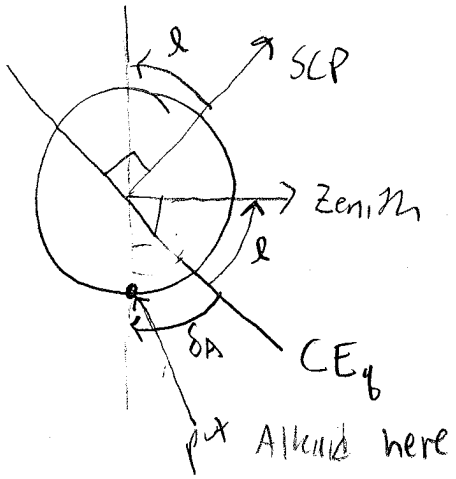
$\Rightarrow |l| < 90 - \delta_D \Rightarrow$

$|l| < 90° - 61°45'$

$= 28'15'$

Since $l < 0$ in southern hemisphere l must be $> -28'15'$; All latitudes farther south cannot see all of the big dipper.

c) Range of lattitudes for which no stars of big dipper are above horizon is that for which the southernmost star at upper transit cannot be seen.
This range of lattitudes must be in the southern hemisphere



so for

$$|\ell| < 90 - \delta_A = 90 - 49°19'$$
$$= 40°41'$$

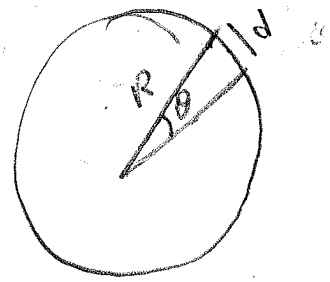
or $\boxed{\ell < -40°41'}$ where no stars of big dipper can be seen.

1.4) last week of september sun is in front of constellation virgo at right ascention $\alpha = 13^h$ and pisces is at 0^{hr} (vernal equinox, set as 0 point for r.a.)
Autumnal equinox occurs in 3rd week of september and must be near $\alpha = 12^h$ $(= 1/2 \times 24^{hr})$.
The sun moves $\frac{360°}{52 \text{ weeks}} \simeq 7°/\text{week} \simeq \frac{7°}{360°} 24^h = 0.46 \frac{hr}{week}$

so its only about 0.5h on sky from star in virgo so one has to look in broad daylight! Much better to look toward Pisces at r.a. = 0. The star in pisces would be observable at

1-6) two points on Earth surface separated by 1 arc sec

a)



$$R\theta \simeq d$$

$$R = R_e = 6378 \text{ km}$$

$$\theta = 1'' = \frac{1^\circ}{3600} \cdot \frac{2\pi}{360^\circ} \text{ rad} = \frac{1}{206265} \text{ rad}$$

$$\Rightarrow d = \frac{(6378)}{206265} \text{ km} = 0.031 \text{ km}$$

$\boxed{\text{or } 31 \text{ meters}}$

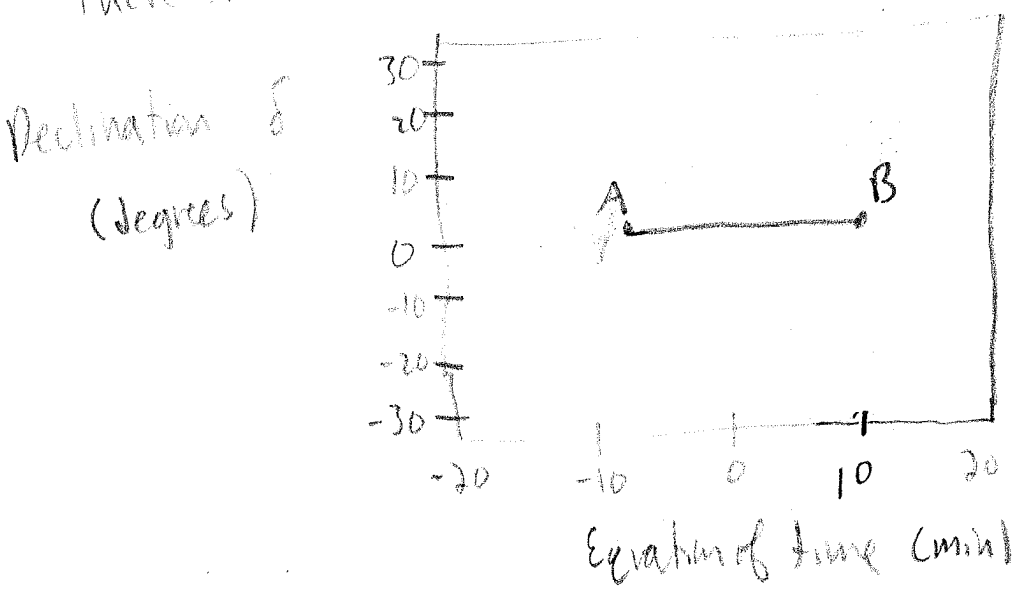
b) physical distance for $\theta = 1$ sec of time:

$$= 1 \text{ sec} \left(\frac{1 \text{ hr}}{3600 \text{ sec}}\right) \cdot \left(\frac{2\pi \text{ rad}}{24 \text{ hr}}\right) = 7.3 \times 10^{-5} \text{ rad}$$

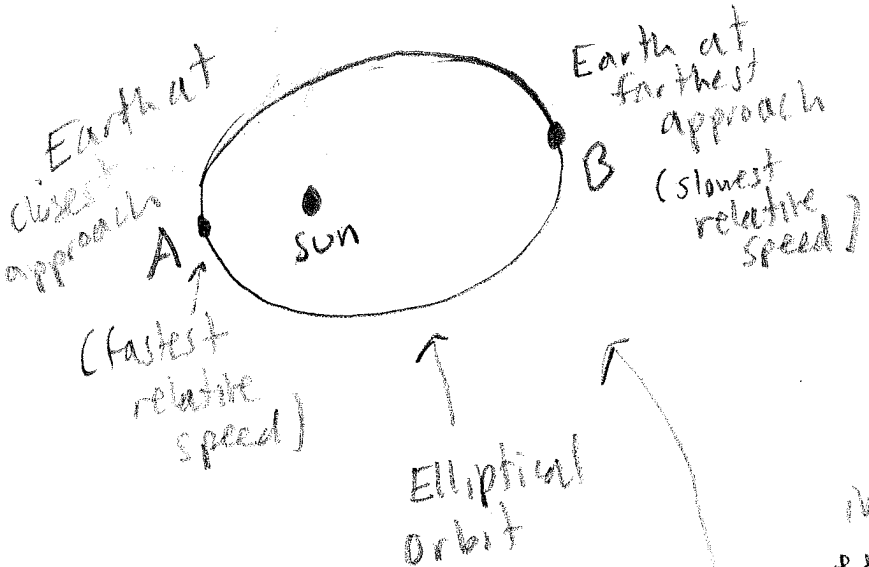
$$\Rightarrow d = R_e\theta = (6378 \text{ km})(7.3 \times 10^{-5} \text{ rad})$$

$$= 0.464 \text{ km} = \boxed{464 \text{ m}}$$

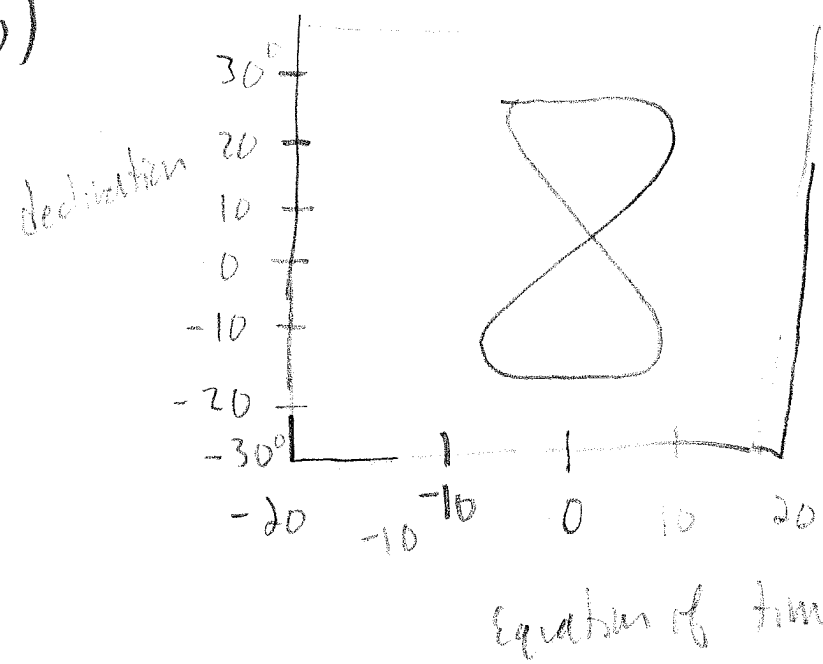
1.8) a) in this case, the declination remains fixed at 0°
There is still deviation around mean solar time because of the elliptical orbit.



The analemma is a straight line in this case. The sun traverses this line as seen from Earth, since Earth moves in elliptical orbit around sun. At the closest approach the apparent time lags behind the mean time. When sun moves slowest in its orbit, apparent time exceeds mean time
See fig 1-11 and note



b) if orbit is a perfect circle then analemma is a symmetric figure 8. Use dotted line in figure 1.12 to determine approximate width of this curve)



c) from the figure of Mars' analemma we can infer that the tilt of mars' spin axis to its orbital plane is about 25°.