Radio Astronomy

Assignment 1

Q1. The Altitude of polaris ≃ altitude of north celestial pole which is equal to 38° (observer's latitude).

The altitude of the south celestial pole = −(observers latitude)

$= -38°$

As, Observer's latitude = 38°

then ~~alt~~ altitude of celestial equator = $90° - 38° = 52°$ off the southern horizon

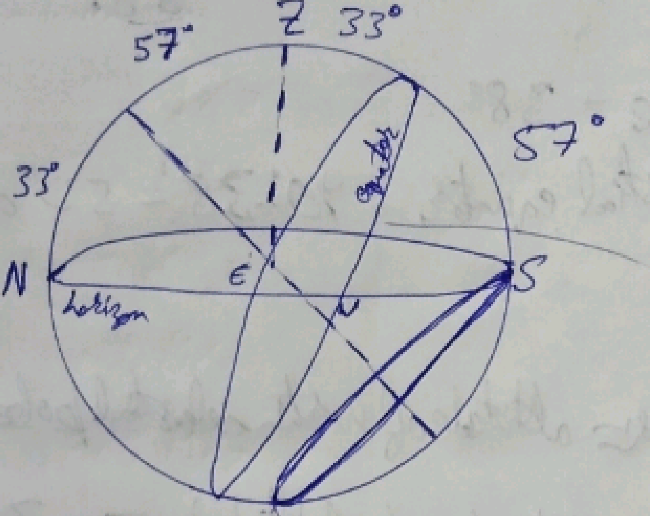
Q2. Altitude of polaris ≃ altitude of north celestial pole which is equal to −(observer's latitude) $= -38°$

Altitude of ~~South~~ North celestial pole = 38°

the Altitude of celestial equator is = 52°

For the people observing from southern Hemisphere, the celestial equator crosses the northern sky.

Q3.



The star is at S, just at the horizon, 57° from equator.

⇒ from equator to zenith = 33°

from zenith to north celestial pole = 57°

from pole to northern horizon = 33°

⇒ Any observer north of latitude 33° N will not be able to see it.

i.e. just visible at 33° N.

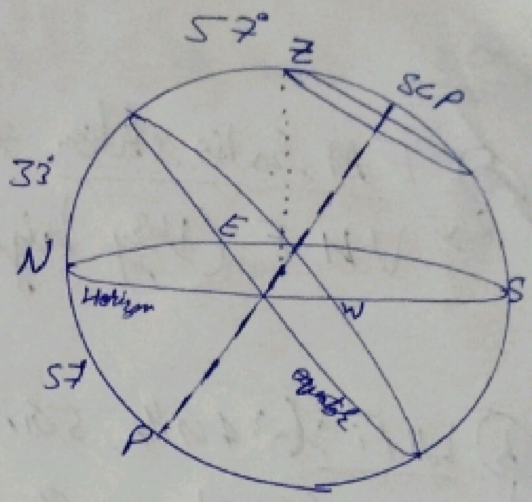
Passoverhead-

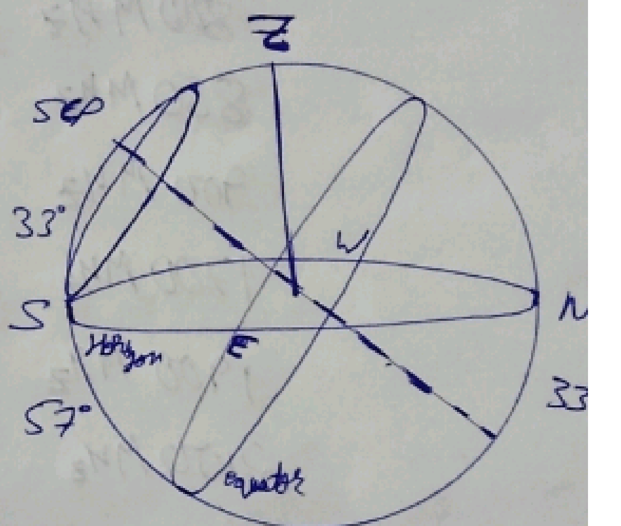
The star is at zenith Z.

from Z to equator = 57°

from equator to horizon = 33°

P = 57° below north horizon = $\boxed{57°S}$





Never set at latitudes-

Let us say that star it at S.

It is 57° from S to equator.

33° from S to southern celestial pole

As SCP is 33° above southern horizon

⇒ NCP is 33° below northern horizon

Latitude here is −33° or 33°S

The star will never set for any observer south of 33°S

Q4. $RA = 05h\ 55m\ 10.3sec = 88.79292$ degrees.

$Dec = 07°24'25'' = 7.4069$ degrees.

Time = 2100

$Lat = 22.7196°N = 22.7196$ deg

$Long = 75.8577°E = 75.8577$ deg

$LST = 4.93$ hours $= 73.95$ deg.

$HA = LST - RA = 73.95 - 88.79292 = \underline{-14.84292}$

Now, we will have to look for Betelgeuse at $= 7.4069 - 22.7196$

$= -15.3127°N$

$= 15.3127$ S of zenith.

$\Rightarrow$ ~~Alt of Betelgeuse = 90 - 15.3127 = 74.68873°~~

Now, $$\cos(Az) = \frac{\sin(dec) - \sin(Alt) * \sin(lat)}{\cos(Alt) * \cos(lat)}$$

$\cos(Az) = -0.7008$

$Az = \cos^{-1}(-0.7008) = \underline{134.5 \text{ deg}}$

$$\sin(Alt) = \sin(Dec) * \sin(LAT) + \cos(Dec) * \cos(LAT) * \cos(HA)$$

$$= 0.934$$

$$\Rightarrow \underline{Alt = 69.07^\circ}$$

$$\boxed{\begin{aligned} Alt &= 69.07^\circ \\ Az &= 134.5^\circ \end{aligned}}$$

Q5:

(a) FM radio station ⇒ (~ 90 MHz to 110 MHz)
↳ VHF (Very high frequency)

(b) WiFi ⇒ (2.4 GHz, 5 GHz)
↳ S (Shortwave Band), C band

(c) Cellular communication

800 MHz
850 MHz
900 MHz
1700 MHz
1900 MHz
2100 MHz

] VHF (very high frequency)

(d) NavIC satellite communication (2492.02 MHz)
↳ S band

(e) Medical RF wireless devices (402 MHz to 405 MHz)
↳ UHF (Ultra high freq. Band)

(f) RFID (865 MHz to 867 MHz)
↳ UHF (Ultra high freq. Band)

Q6.

(a) Ka Band - 27 to 40 GHz Kurtz above

(b) Ku Band - 12-18 GHz Kurtz under

(c) W Band - 75-110 GHz

(d) V Band - 40-75 GHz

(e) X Band - 8-12 GHz

Q8. Universal time in decimal hours = UT = 23.166667

d = Days from J2000

To find d, ① divide number of minutes by 60 to obtain fraction of an hour, here 10/60 = 0.166667

② add this to hours then divide by 24 hours to obtain decimal fraction of the day $= \frac{23.166667}{24} = 0.9652778$

③ No. of days from beginning of year to August = 212.

④ No. of days to the date = 10.

⑤ Days since J2000.0 to the beginning of the year = -731.5

$d = 0.9652778 + 212 + 10 - 731.5 = -508.53472$

Longitude = -1.9166667 (west is negative)

$LST = 100.46 + 0.985647 \times d + \text{longitude} + 15 \times UT$

$= 100.46 + 0.985647 \times (-508.53472) + (-1.9166667) + 15 \times (23.166667)$

$= -55.19238$ degrees

$= 304.80762$ degrees.

Q7. Lat = 22.7196°N

Long = 75.8577°E

Date = Jan 7, 2022.

RA = 02h 20m 55.1 sec

Dec = 23°26'11.4"

Aries will be 2h 20min 55.1s behind sun on march 21

On 7th Jan 2022 Aries will be nearly 75° or 5 hrs more behind

⇒ 7 hrs 20 min 55.1 sec behind the sun.

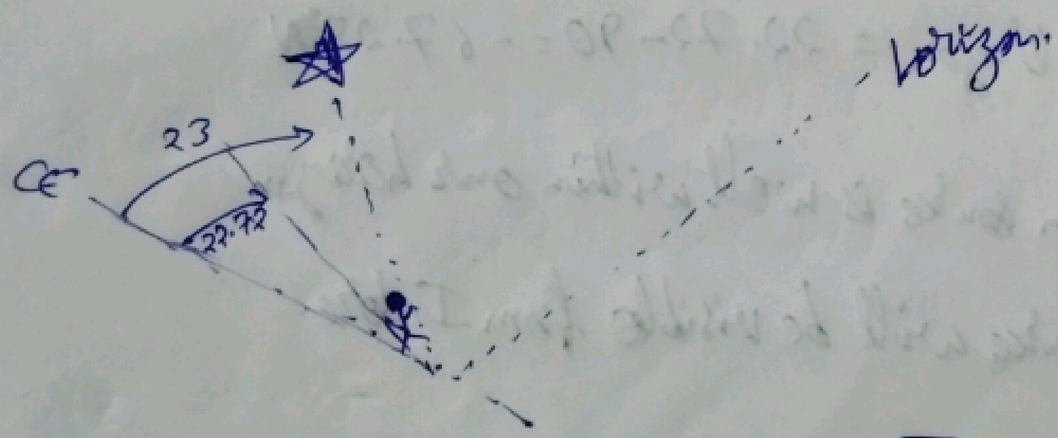
Now at meridian LMA = 0

LST = RA aries (2h 20min 55.1 sec).

when aries is on the meridian, then the Sun is 7 hrs 20 min 55.1 sec towards the west.

So, if the Sun was on the meridian at noon, the time is 7:20:55 pm

or, 19 hrs 20 min 55.1 sec



The Altitude is $90° - [23.4365° - 22.7196°] = 89.2831$ above the north.

Its rising $\Rightarrow$ its $LHA = -90° = -6\,hr\ 0\,min\ 0\,sec$

$RA = 2\,hr\ 20\,min\ 55.1\,sec$

$LST = RA + LHA = -4\,hr\ 40\,min$

$= 20\,hrs\ 20\,min\ 55.1\,sec$

its 7 hr 20 min 55.1 sec behind the sun when its rising.

Q9. Lat $= 22.7196°N$

α, $RA = 2hr\,20min\,55.1s = 88.79°$

δ, Dec $= 7°24'25'' = 7.4069$

$\alpha_g = 192.25°$, $\delta_g = 27.4°$, $l_g = 33°$

$$\cot(l - l_g) = \frac{\tan\delta \cos\delta_g - \cos(\alpha - \alpha_g)\sin\delta}{\sin(\alpha - \alpha_g)\cos\delta} = +0.2288$$

$$l = \cot^{-1}(-0.2288) + l_g = 199.786$$

$$\sin b = \cos\delta \cos\delta_g \times \cos(\alpha - \alpha_g) + \sin\delta \cdot \sin\delta_g$$

$$= -0.1456$$

$$\Rightarrow b = \sin^{-1}(-0.1456) = -8.372°$$

Q10. lat, $b = 7^\circ 32' 48.63'' = 7.547^\circ$

long, $l = 241^\circ 12' 40.40'' = 241.211^\circ$

$\alpha_g = 192.25^\circ$, $\delta_g = 27.4^\circ$, $l_g = 33^\circ$

$$\tan(\alpha - \alpha_g) = \frac{\cos(l - l_g)}{\tan b \cos\delta_g - \sin\delta_g \sin(l - l_g)} = \quad -0.873$$

$$\alpha - \alpha_g = \tan^{-1}(-0.873) =$$

$$\alpha = \quad 133.6513^\circ$$

$$\sin\delta = \cos b \cos\delta_g * \sin(l - l_g) + \sin b \cdot \sin\delta_g$$

$$= \quad -20.98^\circ$$

$$\delta = \sin^{-1}(-0.219) \Rightarrow \delta = -12.65^\circ N \text{ (towards SCP)}$$

For Indore, Lat $= 22.72^\circ N$

$\Rightarrow$ South Horizon $= 22.72 - 90 = -67.28^\circ N$

$\Rightarrow$ The given source is well within our horizon

$\Rightarrow$ The source will be visible from Indore.