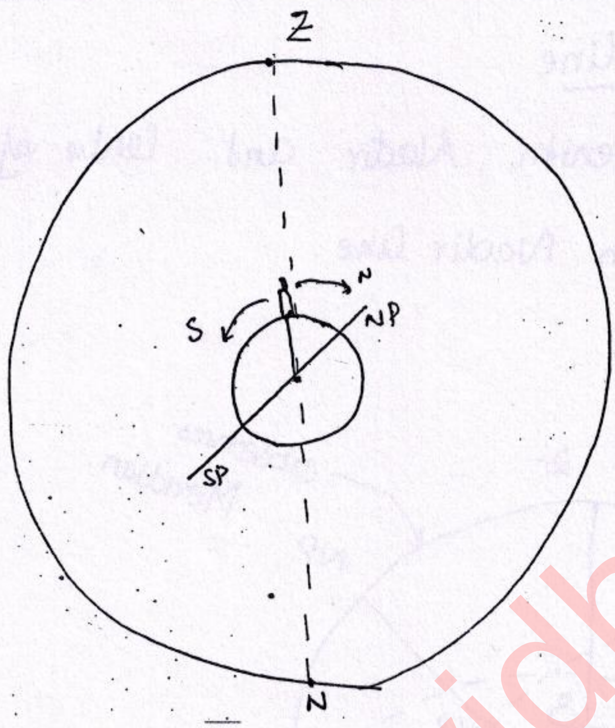
ASTRONOMY



1. Celestial Sphere

An Imaginary Sphere on which all heavenly bodies like Stars, Sun, moon etc are assumed to be projected in universe. The centre of celestial sphere will be Centre of earth.

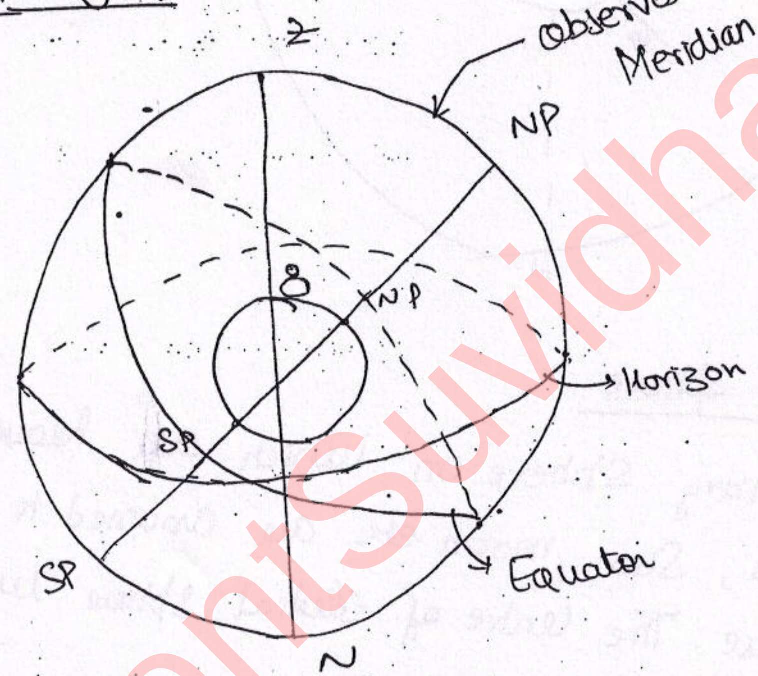
2. Zenith (Z) on celestial sphere
A point exactly above (opp. to centre of earth) an observer is called Zenith body

3. Nadir (N)
A point on Celestial Sphere exactly below the observer is called Nadir point.

i) <u>Zenith Nadir Line</u>

Line joining Zenith, Nadir and Centre of earth is called Zenith Nadir Line.

) <u>Celestial Horizon</u>



→ A <u>Great</u> Circle (a circle which has radius equal to Radius of sphere and centre as center of sphere is called Great circle)

→ Horizon is a Great Circle ⊥ to Zenith, Nadir Line.

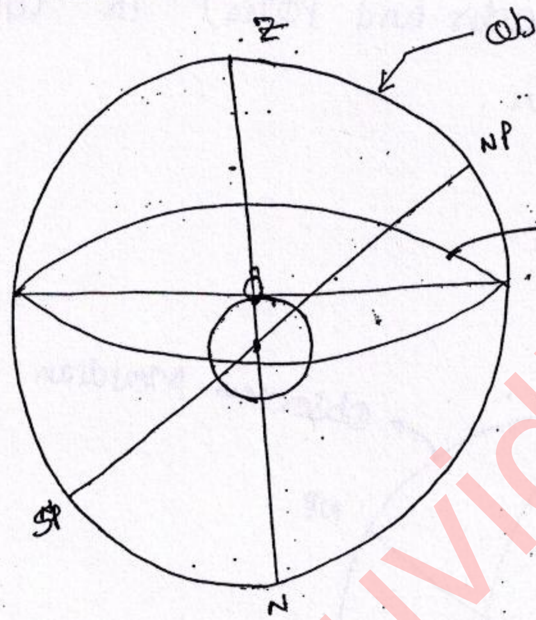
6) <u>POLES</u>

Intersection point of Axis of Rotation of rotation of earth with celestial sphere is called Poles

7. Celestial Equator

A Great Circle ⊥ to axis of Rotation of Earth on Celestial Sphere is Called celestial equator.

8. Sensible Horizon



A Circle on celestial Sphere Having Centre as observers point and parallel to Horizon is Called Sensible Horizon.

→ Distance b/w Horizon and Sensible Horizon is = R = Radius of Earth.

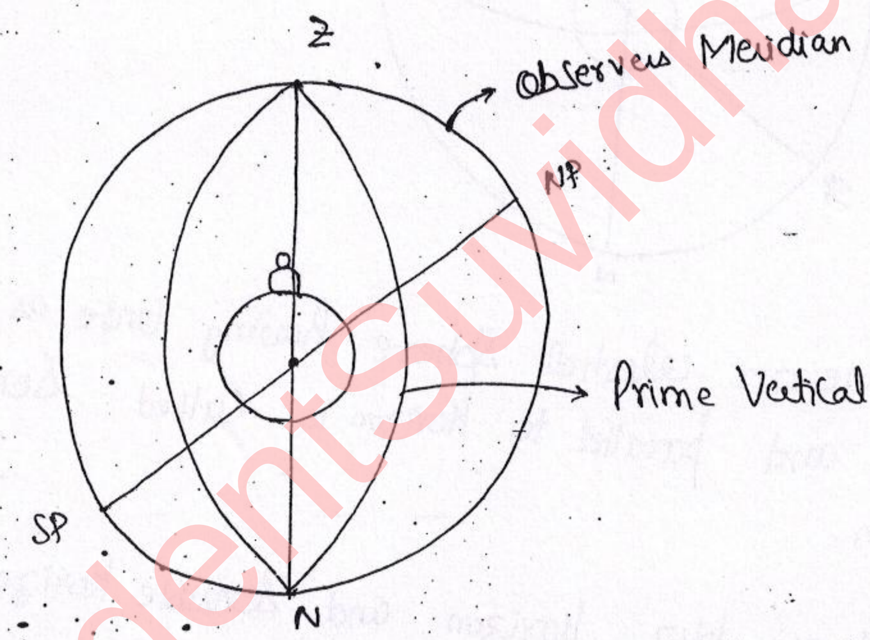
9. Vertical Circle

All Great Circles on Celestial Sphere passing from Zenith and Nadir Points are Called Vertical Circle.

10. <u>Observer's Meridian</u>

The Great Vertical Circle, also passing from poles (Zenith, Nadir and Poles) is called Observers Meridian.

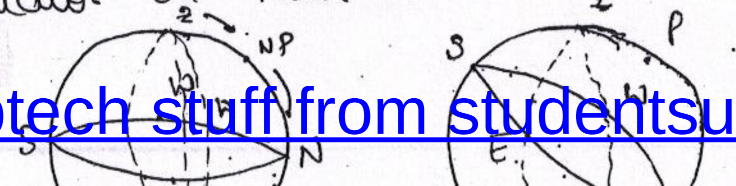
1. <u>Prime Vertical</u>

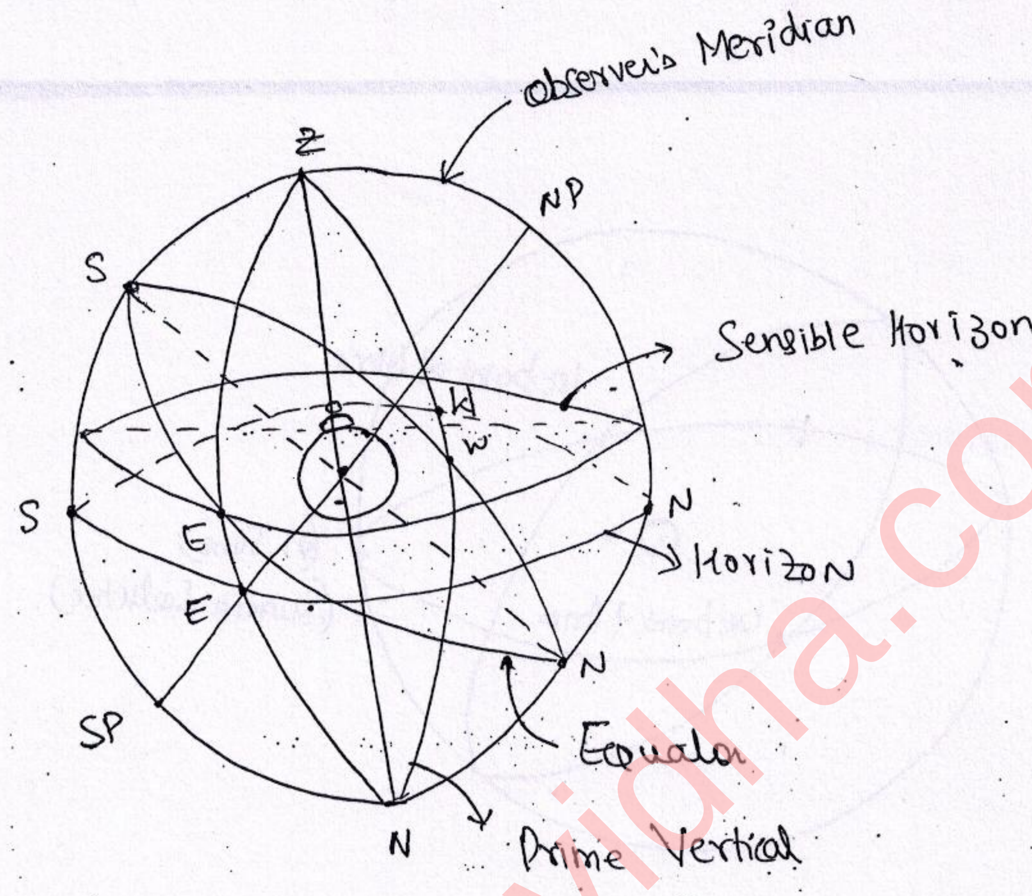


Prime Vertical is the Great Circle ⊥ to Observers Meridian and passing from Zenith & Nadir

1. <u>North & South Point (on Horizon)</u>

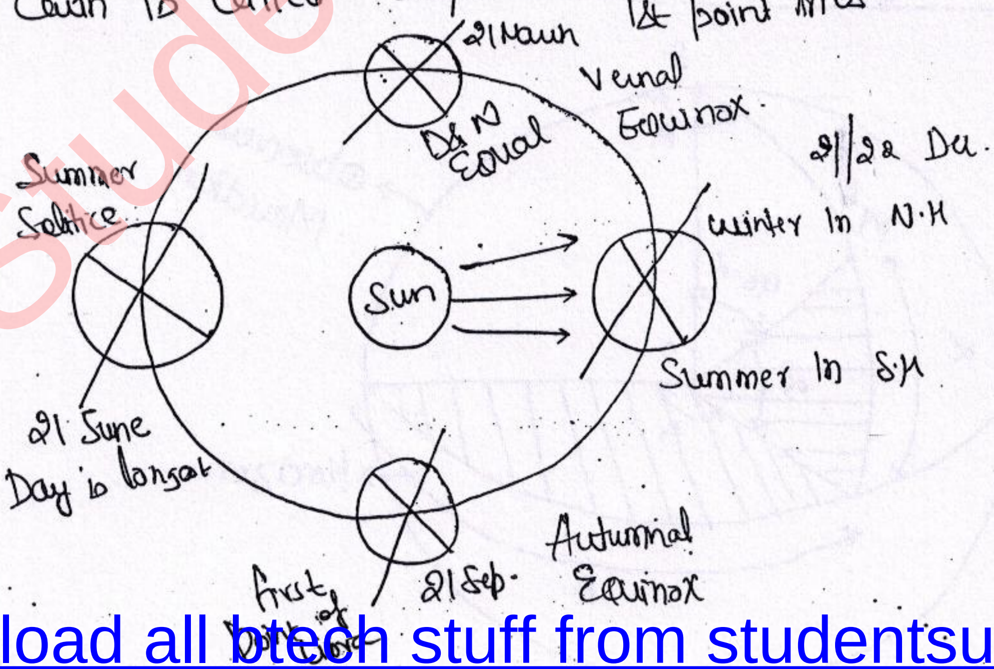
Intersection Point of observers Meridian with Horizon or Equator are North and South Point.

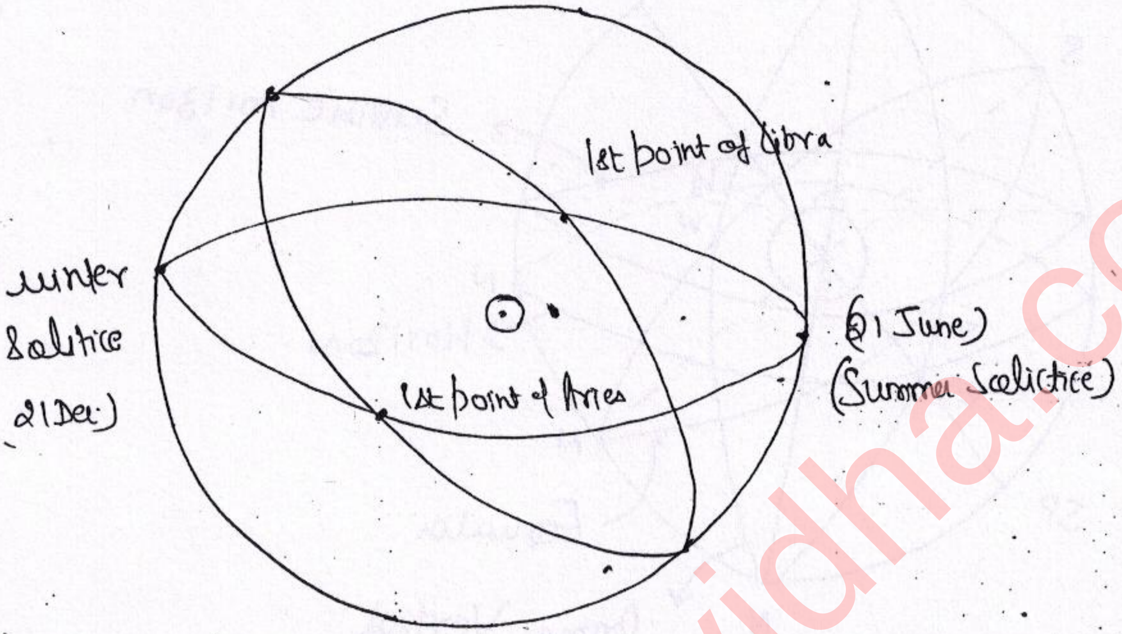




12. Ecliptic

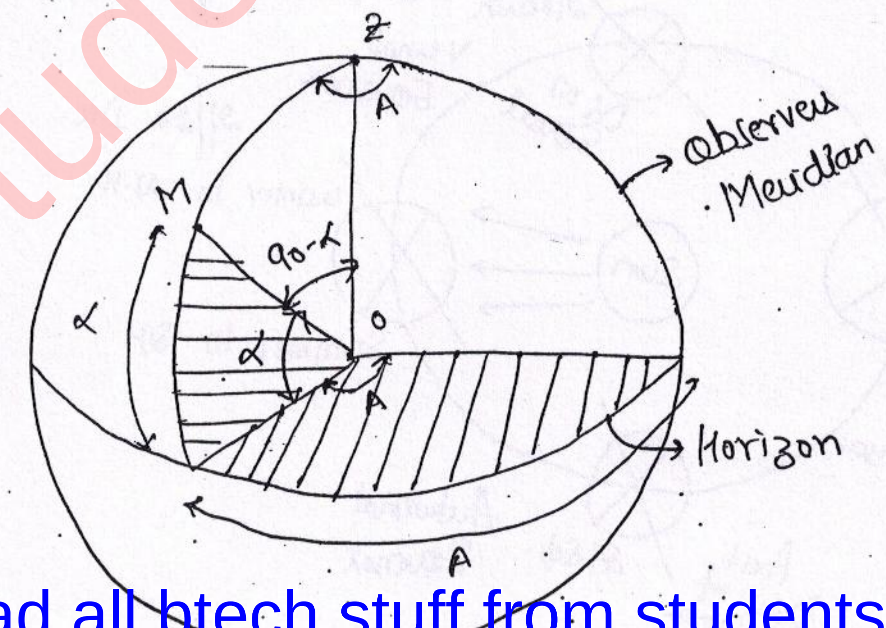
Relative path of Sun on celestial sphere as compared to Earth is called Ecliptic.





The Co-ordinate System

Horizon System / (Altitude & Azimuth System)



Refrence Points

1. Zenith
2. Horizon
3. Observers Meridian

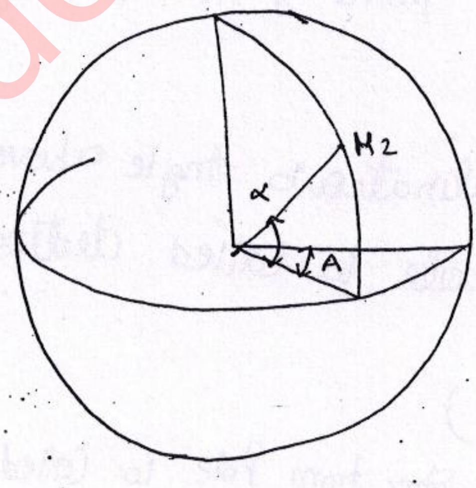
Angles Measured

1. Azimute: Measured from observers Meridian upto Star position on Horizon (at Zenith)

2. Altitude: Angle Above or Below (vertical angle) the horizon is called Altitude (α)

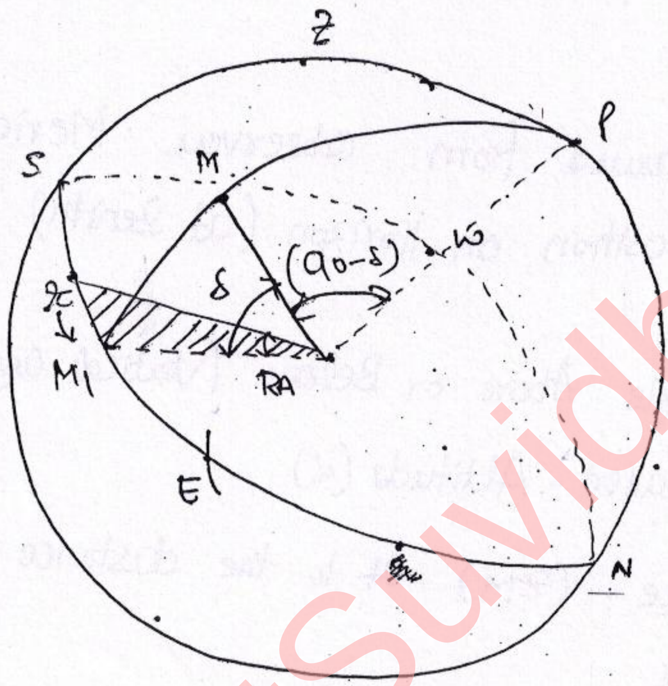
3. Zenith distance: (ZM) It is the distance b/w Zenith and Star.

$$\boxed{ZM = 90 - \alpha}$$



2nd System : Independent Equatorial System

(Right ascension & declination System)



1) <u>Right Ascension</u>: The Angle Measure Along equator Starting from first point of Aries, Going towards East.

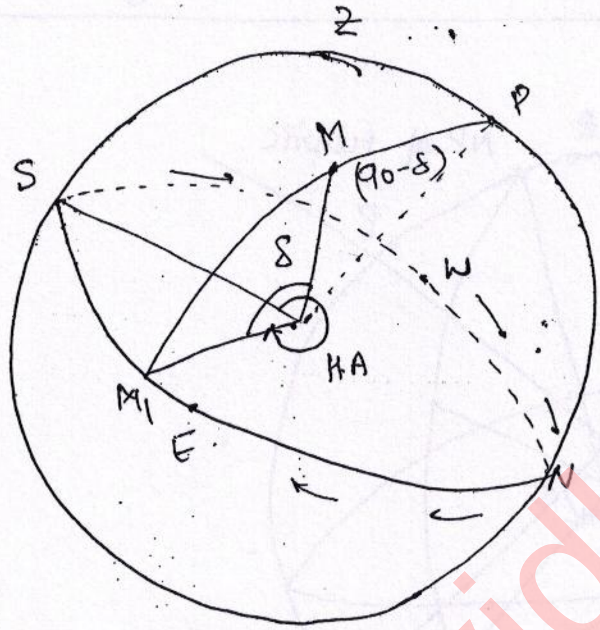
2) <u>Declination</u>: Declination is Angle above or below Equator towards pole is called declination.

3) <u>Polar Distance</u> (PM)
Angular Distance of Star from Pole is Called Polar Distance.

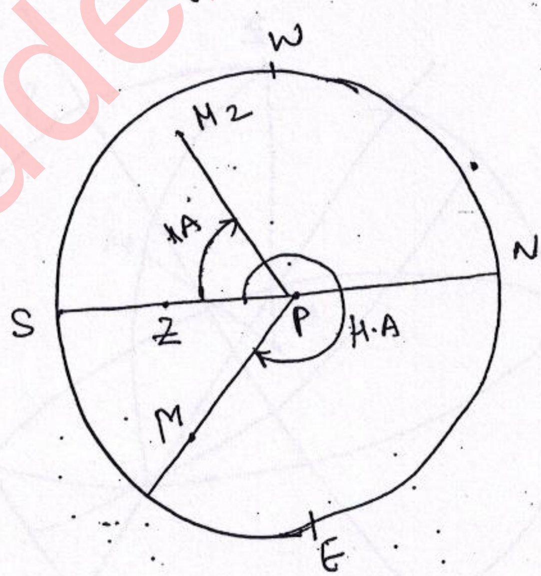
PM = 90 − δ

3rd System (Dependent Equatorial System)

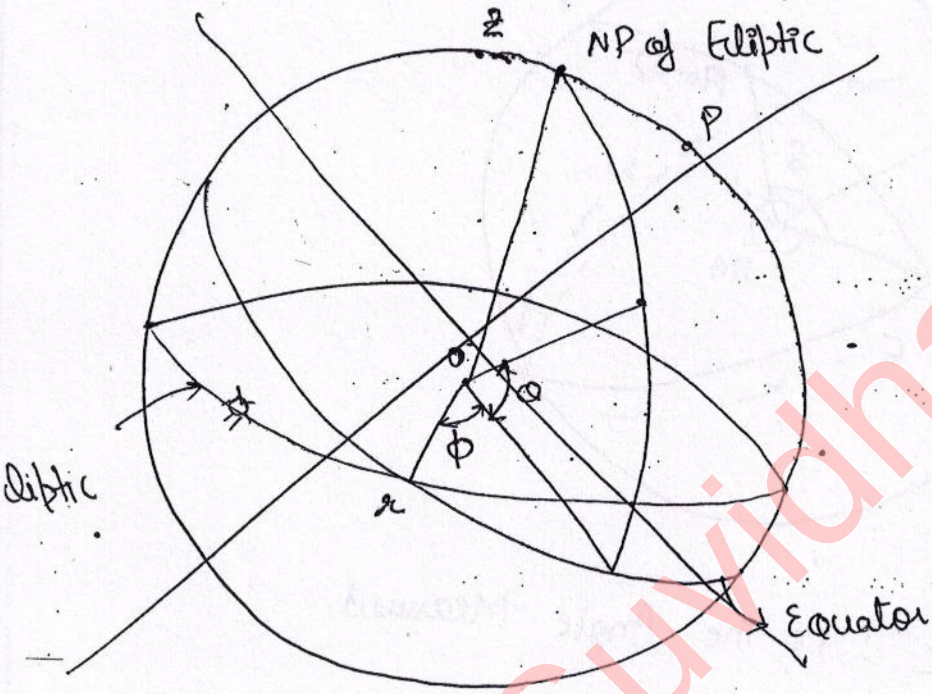
(Declination & hour angle)

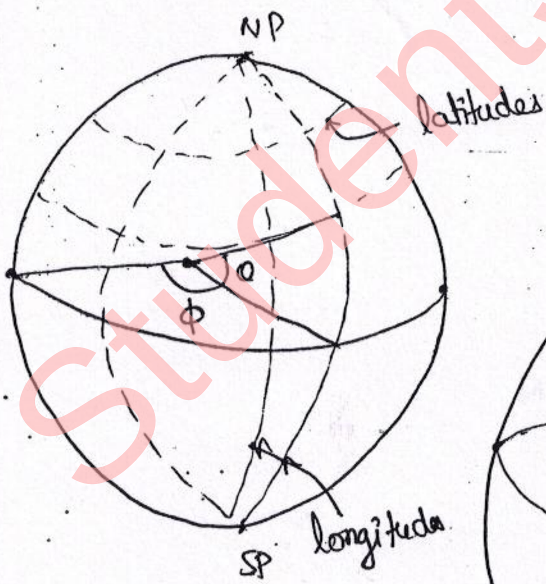


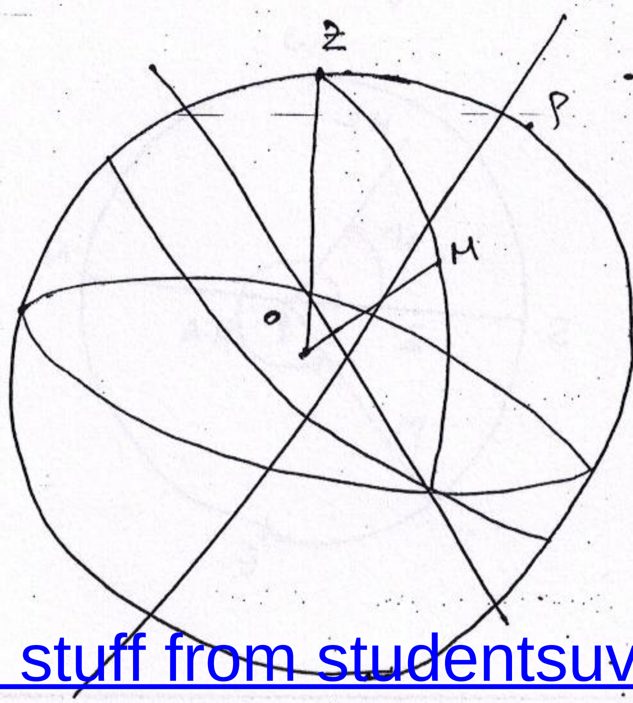
1. <u>Hour Angle</u> : Is the Angle Measured
   - along Equator
   - Starting from South
   - Going towards West

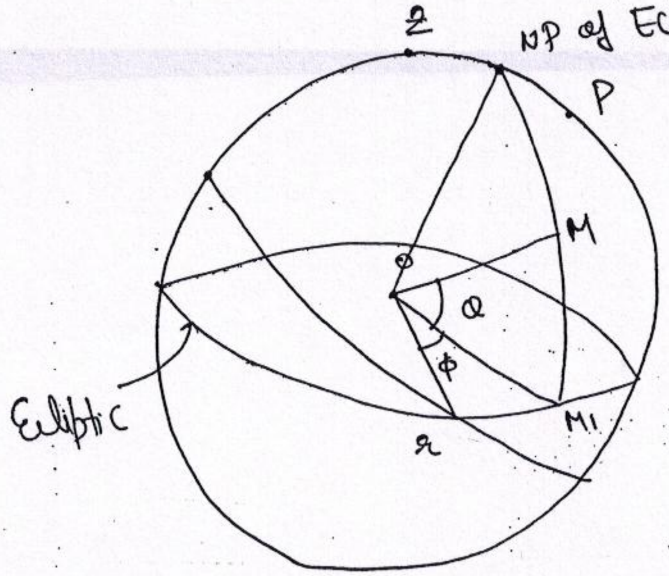


4) System : Celestial Latitude & Celestial Longitude System



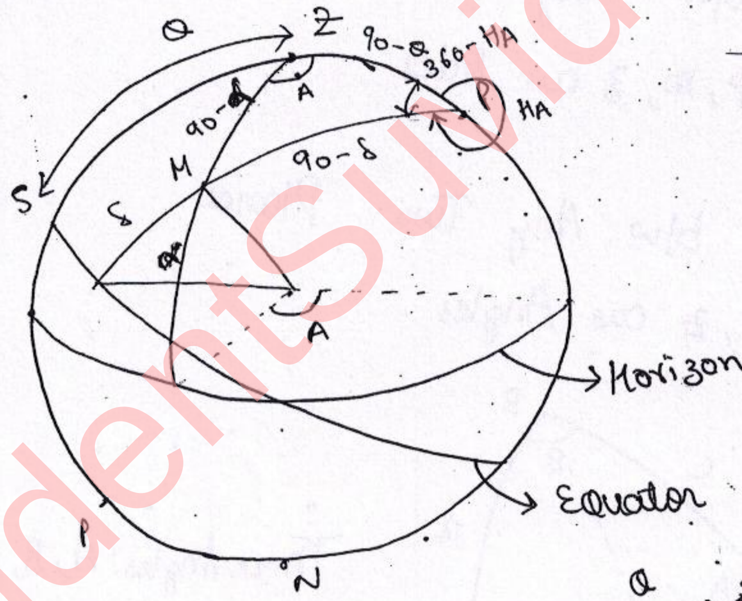


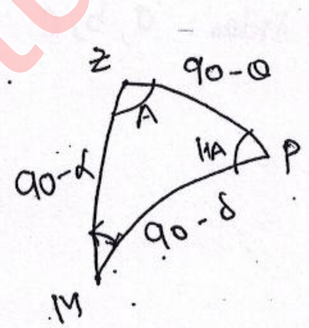


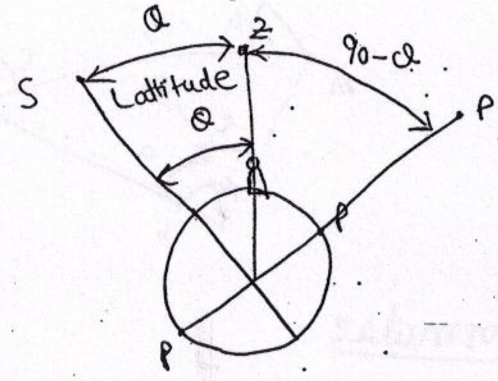


θ : Cel. latitude
ϕ : celest longitude

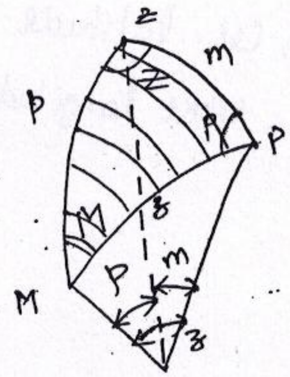
Astronomical Triangle





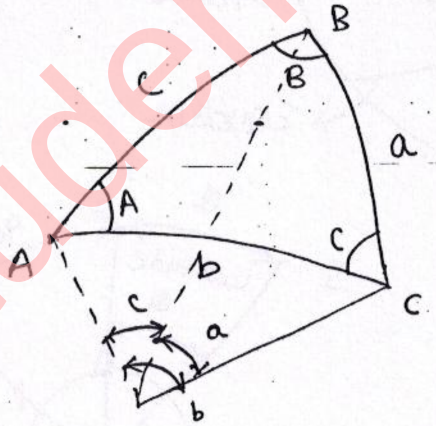


Spherical Triangle



Sides: Angle b/w any two edge.
p, m, z are Sides.

ngles: Angle b/w Any Two Planes
P, M, Z are Angles.



Three Angles: A, B, C

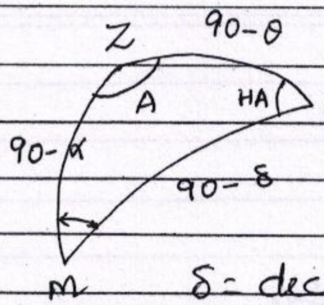
Three Sides: a, b, c

formulae

$$\frac{\sin a}{\sin A} = \frac{\sin b}{\sin B} = \frac{\sin c}{\sin C}$$

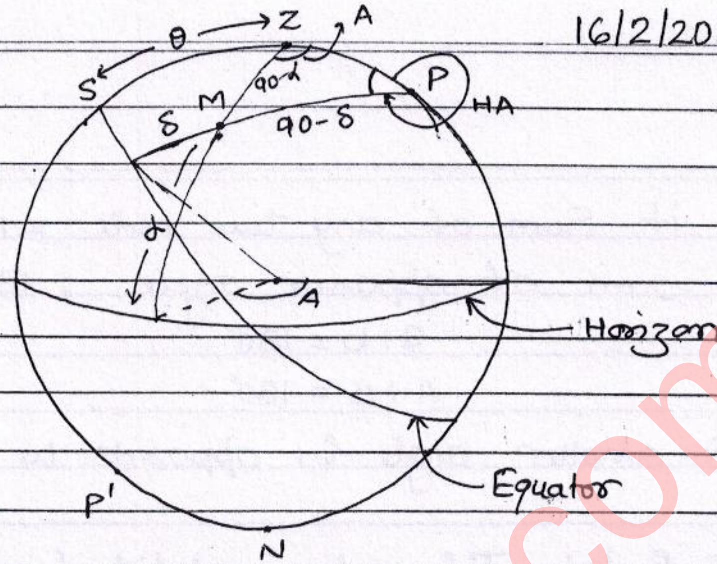
16/2/2013.

Astronomical triangle

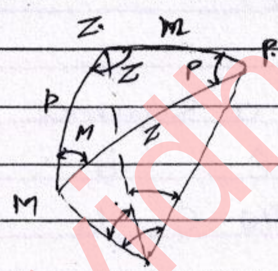


θ = latitude
A = Azimuth

δ = declination.
α = Altitude.

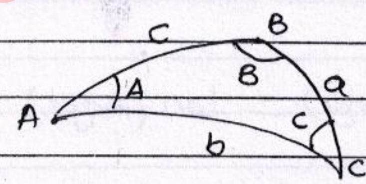


Spherical triangle:-



sides:-
Angle b/w any two edges.
p, m, z are sides.

formula



(i) $\dfrac{\sin a}{\sin A} = \dfrac{\sin b}{\sin B} = \dfrac{\sin c}{\sin C}$

(ii) Cos formula.

$\cos a = \dfrac{\cos A + \cos B \cos C}{\sin B \sin C}$ $\qquad \cos A = \dfrac{\cos a - \cos b \cos c}{\sin b \sin c}$.

properties of spherical triangles:-

1) Any angle $< 180°$
2) Sum of three angles

$180° < A+B+C < 540°$

spherical excess.

$E = (A+B+C) - 180°$

Area of spherical triangle $= \dfrac{\pi R^2}{180} \times E$.

3) Sum of any two side > third side

$a+b > c$

$b+c > a$

$c+a > b$

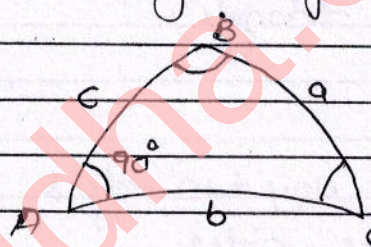
(4) if Sum of any two side = 180° then
sum of opposite angle = 180°.

$a+b = 180°$

$A+B = 180°$

5) A smaller angle is opposite to smaller side.

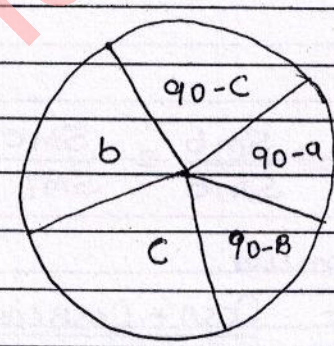
Napier Rule:- This rule is valid for a right angle spherical triangle (Not side)



1) write all angles in a sequence

c, B, a, C, b

c, 90-B, 90-a, 90-C, b.



Sin(Any) = tan(Adj1) tan(Adj2).

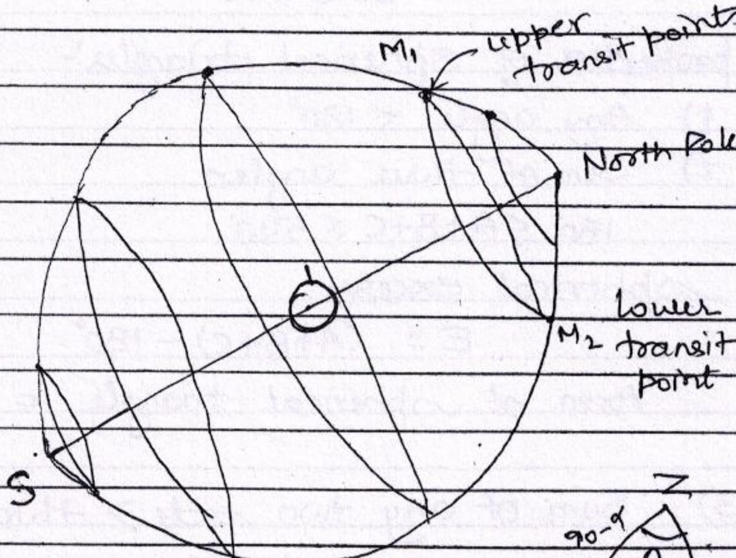
Sin(Any) = Cos(opp1) * Cos(opp2).

Sin(90-a) = tan(90-C) tan(90-B).

sin(90-a) = cos b cos c.

$$\boxed{\begin{array}{l} \cos a = \cot C . \cot B. \\ \cos a = \cos b \cos c \end{array}}$$

Earth rotate on its own axis and around the sun also.



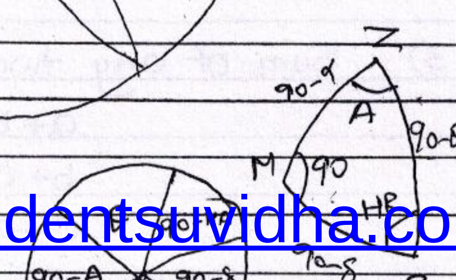
1) Star at elongation

at greatest distance from observer's meridian

angle at Z = max^m

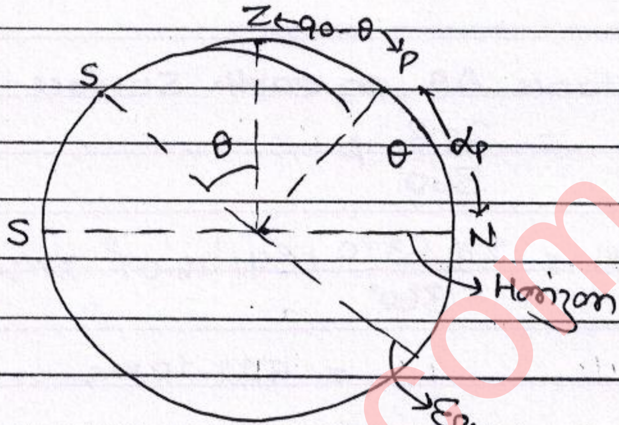
∠M = 90° (angle at star)

Napier rule can be applied



so 90 − α, 90 − A, θ, 90 − HA, 90 − δ.

$\theta = \alpha_p$
lattitude is equal
to altitude of pole
altitude is always from
Horizon and declination is
always from Equator.



for star M_1

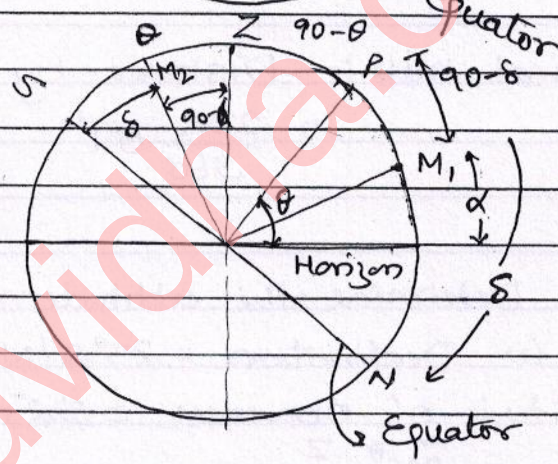
$\theta = (90-\delta)+\alpha$

$= P + \alpha$, P = polar distance

for star M_2

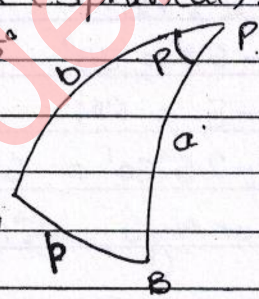
$\theta = \delta + (90-\alpha)$.

$\theta = \delta + Z$



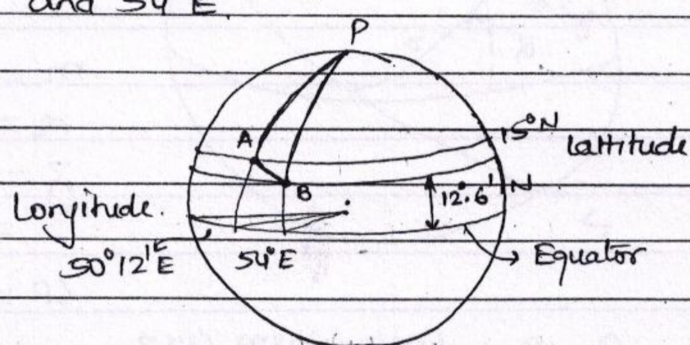
Ques 1). find the shortest distance between two points A and B given that the latitude of A and B are 15°N & 12°6'N and their longitudes are 50°12'E and 54°E.

Ans In triangle (spherical).



$b = PA = 90 - 15°$
$= 75°$

$a = PB = 90 - 12°6'$
$= 77°54'$



∠P = Angle b/w two planes
$= 54° - 50°12' = 3°48'$

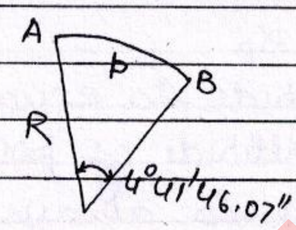
$$\cos P = \frac{\cos p - \cos a \cos b}{\sin a \sin b}$$

$$\cos 3°48' = \frac{\cos p - \cos 77°54' \cos 75°}{\sin 77°54' \sin 75°}$$

$p = 4°41'46.07''$

Distance AB on earth surface

$$= \frac{2\pi R}{360} p$$



$$AB = \frac{2\pi \, 6370}{360^\circ} \, 4^\circ 41' 46.07'' \text{ km}$$

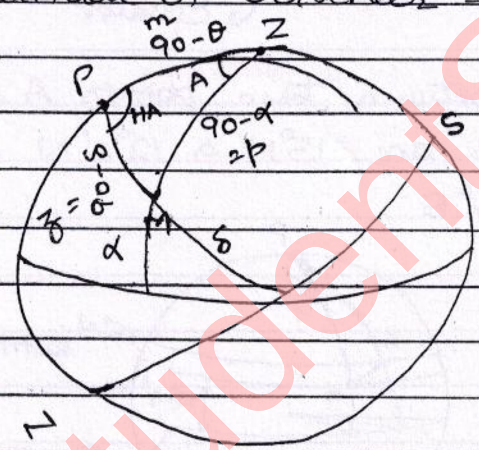
$$= 522.10 \text{ km}$$

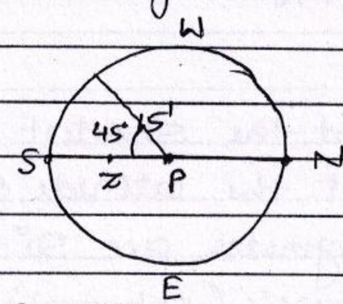
Nautical mile :- Distance by 1 minute angle

$$= \frac{2\pi R}{360^\circ} 0^\circ 1' = 1.853 \text{ km} = 1 \text{ Nautical mile}$$

Ques2. Determine the altitude and azimuth of a star which has (i) Declination = 25°30′N (ii) Hour Angle = 45°15′ and latitude of observer = 52°N.

Ans.





for Hour Angle

$$m = 90 - \theta = PZ$$

$$m = 90 - 52^\circ = 38^\circ$$

$$z = 90 - \delta = PM$$

$$= 90 - 25^\circ 30' = 64^\circ 30'$$

$$\angle P = \text{Hour Angle} = 45^\circ 15'$$

$$\cos P = \frac{\cos p - \cos m \cos z}{\sin m \sin z}$$

$$\cos 45^\circ 15' = \frac{\cos p - \cos 38^\circ \cos 64^\circ 30'}{\sin 38^\circ \sin 64^\circ 30'}$$

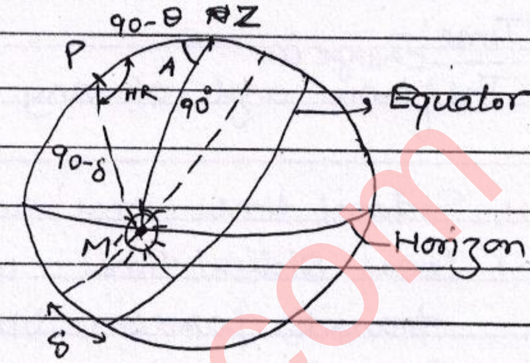
$$p = 43^\circ 4' 30.35'' = 90 - \alpha$$

$$\alpha = 90 - 43^\circ 4' 30.35''$$

$$= 46^\circ 55' 29.65'' = \text{Altitude}$$

$$\cos Z = \frac{\cos z - \cos p \cos m}{\ldots} = \frac{\cos 64^\circ 30' - \cos 43^\circ 4' 30.35'' \cos 38}{\ldots}$$

Ques 3. Calculate Sun azimuth and Hour angle at sunset at a place of latitude 42°30'N when its declination is 23°N.



$p = ZM = 90°$

$m = 90 - \theta = PZ$

$= 90 - 42°30' = 47°30'$

$z = 90 - \delta = PM$

$90 - 23° = 67°$

apply Cos formula $\cos P = \dfrac{\cos p - \cos m \cos z}{\sin m \sin z}$

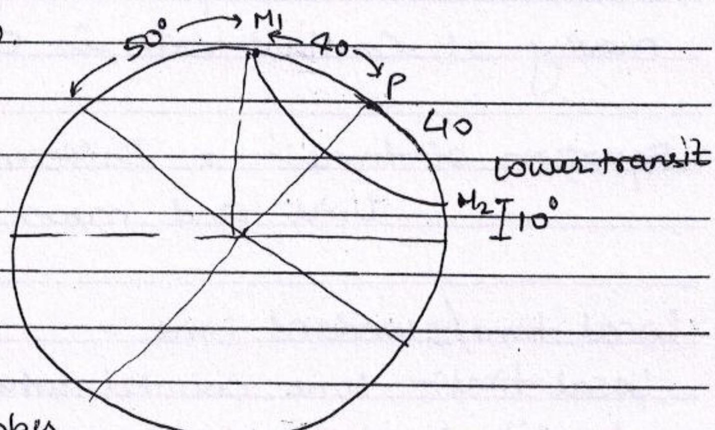
$= \dfrac{\cos 90° - \cos 47°30' \cos 67°}{\sin 47°30' \sin 67°}$

$P = 112°53'23.18''$

$\cos Z = \dfrac{\cos z - \cos p \cos m}{\sin p \sin m} = \dfrac{\cos 67° - \cos 90° \cos 47°30'}{\sin 90° \sin 47°30'}$

$Z = 57°59'48.89''$ Azimuth.

Ques 4) A star having declination of 50°N has its upper transit point in zenith. find out the altitude of star at its lower transit position.



At upper transit

declination of star = 50° = δ

(because the star is at Zenith)

$\angle PZ = 90 - 50° = 40° = PM_1$

polar distance of star at upper transit

At lower transit point M_2 polar distance $PM_2 = 40°$.

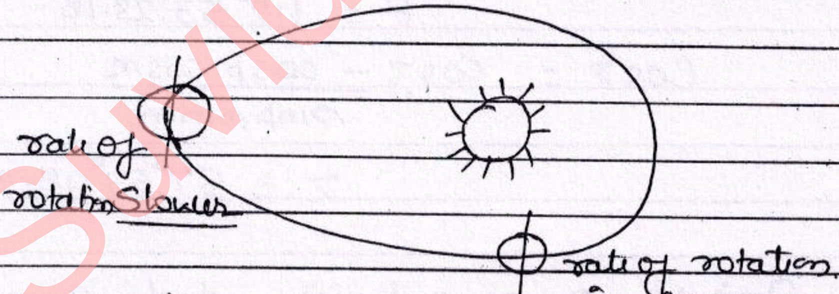
Altitude of star at lower transit will be

$HM_2 = HZ - PM_1 - PM_2$

$= 90 - 40 - 40 = 10$

Time:-
The change in hour angle of any fixed point is called time

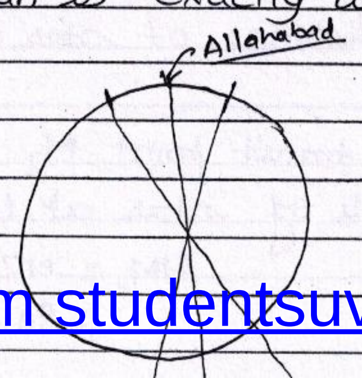
(i) Sideral time:- time measured with respect to 1st point of Aries
(ii) local sideral time:- when 1st point of Aries is at lower transit position, time 0 hour is considered.
(iii) Solar time:- time measured w. respect to Sun position
Apparent Solar time:- according to the actual movement of earth, time counted is called apparent Solar time.
Actual movement of earth is not constant - Rate of rotation is changing.



Mean Solar time:- ~~time~~ average time considered for convenient as per the movement of an imaginary Sun moving at constant rate is called mean solar time.

Equation of time:- = Difference between apparant solar time and mean solar time.

local time/standard time
local time:- time counted when Sun is exactly at lower transit position of place



Standard time:- local time standardized from a particular place

Relation:- time angle

24 hrs = 360°

1 hr = $\frac{360°}{24}$ = 15° degree.

1 hr = 15° degree

60 min = 15×60 minutes

time | Angle

$\boxed{1 \text{ min} = 15 \text{ minute}}$ $\boxed{1 \text{ sec} = 15 \text{ second}}$

Conversion.

(i) time to angle

14 hr 53 min 47 sec = ? Angle

= 223° 26' 45".

14 hr = 14×15 = 210° 0' 0"

53 min = 53×15 = 13° 15' 0"

47 sec = 47×15 = 0° 11' 45"

223° 26' 45"

Photogrammetry

1) Types

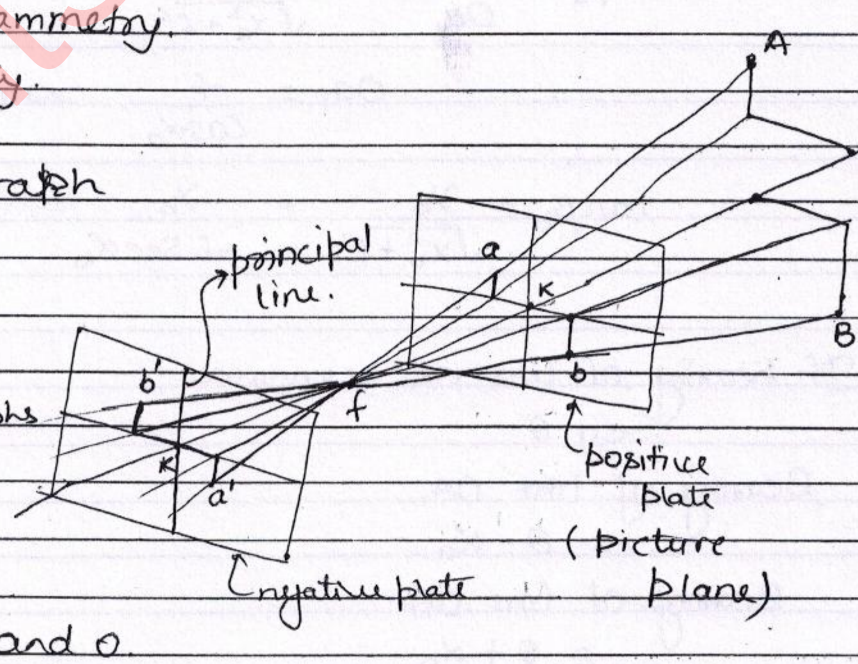
a) Terrestrial photogrammetry

b) Arial Photogrammetry.

a) Terrestrial

(1) Horizontal photograph

Imp definition



(i) principle points:-

K and K' on photographs

Intersection of x-y axis.

(ii) Camera axis

Line joining K, K' and O.

(iii) principal plane:- in which Camera axis and principal line exist.

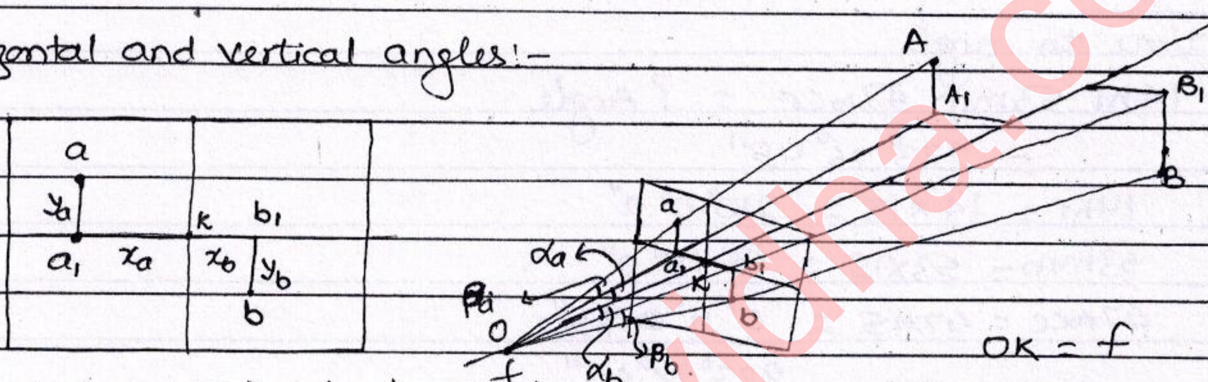
4) principal line :- Vertical Y axis from K on photograph.

5) oblique photograph (tilted photograph)

a) low oblique photograph :- if horizon (sky) is not visible.

b) High oblique photograph :- Horizon or sky is visible.

Horizontal and vertical angles :-



a_1, K, b_1 are in horizontal plane. (Fig 2)

$$\tan\alpha_a = \frac{x_a}{f} \qquad \tan\alpha_b = \frac{x_b}{f}$$

$$\tan\beta_a = \frac{y_a}{Oa_1} = \frac{y_a}{\sqrt{x_a^2+f^2}} \qquad \cos\alpha_a = \frac{f}{Oa_1}$$

$$Oa_1 = \frac{f}{\cos\alpha_a} \quad \text{so} \quad \tan\beta_a = \frac{y_a}{f\sec\alpha_a}$$

$$\tan\beta_b = \frac{y_b}{\sqrt{x_b^2+f^2}} = \frac{y_b}{f\sec\alpha_b}$$

If bearing of line OK is known

Say θ.

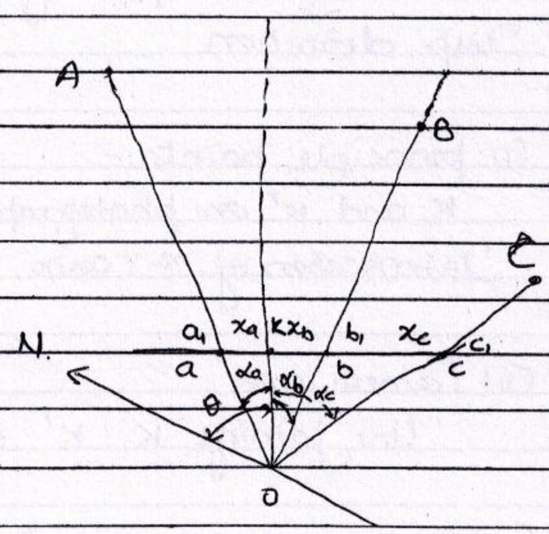
Bearing of line OA

$= \theta - \alpha_a$

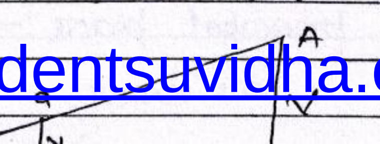
Bearing of line OB

$= \theta + \alpha_b$

Bearing of line OC $= \theta + \alpha_c$



From (fig 2) Elevation of point A.



$$\frac{y_a}{f\sec\alpha_a} = \frac{V}{D}$$

so elevation of point $A = D\left(\frac{y_a}{f\sec\alpha_a}\right)$.

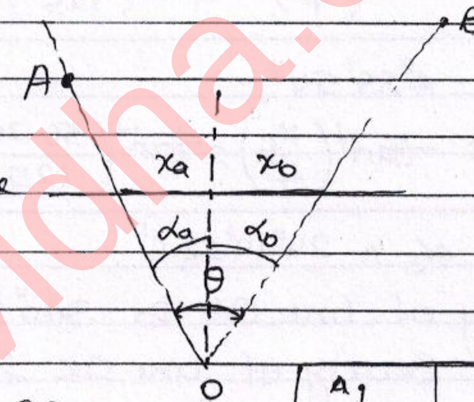
or

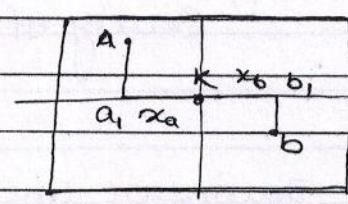
$$V = D\left(\frac{y_a}{\sqrt{f^2+x_a^2}}\right).$$

RL of A = RL of O + V.

Determination of focal length:-

1. Choose two points A and B on the ground.
2. from the location of Camera (say O) using a theodolite measure angle between A and B $\angle AOB$. (say θ.)
3. take a photograph from O. measure value of x_a and x_b on the photograph.





$$\tan\alpha_a = \frac{x_a}{f} \qquad \tan\alpha_b = \frac{x_b}{f}.$$

$$\tan\theta = \tan(\alpha_a+\alpha_b) = \frac{\tan\alpha_a + \tan\alpha_b}{1-\tan\alpha_a\tan\alpha_b}$$

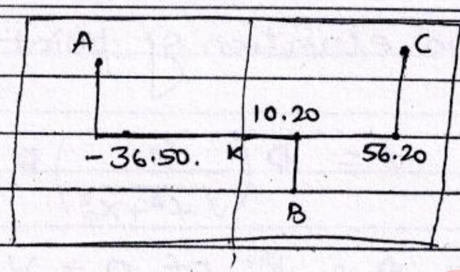
$$\tan\theta = \left(\frac{\frac{x_a}{f}+\frac{x_b}{f}}{1-\frac{x_a x_b}{f^2}}\right) \text{ solve for } f.$$

Ques 1) Three points A, B and C were photographed and their coordinates on photographs are

Points	x (mm)	y (mm)
A	−36.50	+25.5
B	+10.20	−18.60
C	+56.50	+40.20

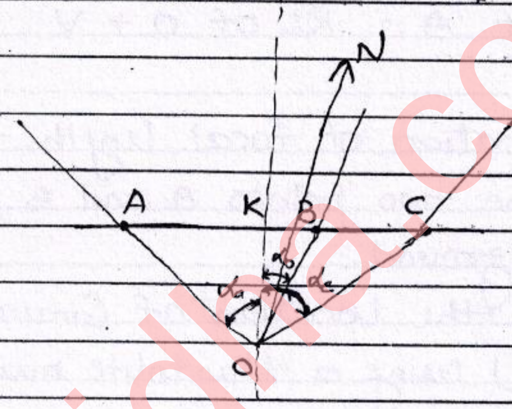
focal length of camera is 125mm. Determine the azimuth of line OB and OC if the azimuth (bearing) of line OA is 340°30'. the axis of camera is horizontal at the time of exposure.

Ans. For Bearing only horizontal angles are required.



$$\alpha_a = \tan^{-1}\left(\frac{x_a}{f}\right) = \tan^{-1}\left(\frac{36.50}{125}\right)$$

$$\alpha_a = 16^\circ 16' 40''$$



$$\alpha_b = \tan^{-1}\left(\frac{x_b}{f}\right) = \tan^{-1}\left(\frac{10.20}{125}\right)$$

$$\alpha_b = 4^\circ 39' 54''$$

$$\alpha_c = \tan^{-1}\left(\frac{x_c}{f}\right) = \tan^{-1}\left(\frac{56.20}{125}\right)$$

$$\alpha_c = 24^\circ 19' 22.6''$$

Bearing of line OA is $340^\circ 30'$.

Bearing of line OK is = Bearing of line OA + α_a

$= 340^\circ 30' + 16^\circ 16' 40''$

$= 356^\circ 46' 40''$

Bearing of line OB is = Bearing of line OK + α_b

$= 356^\circ 46' 40'' + 4^\circ 39' 54'' - 360^\circ$

$= 1^\circ 26' 34''$

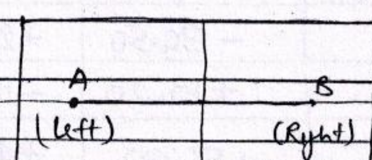
Bearing of OC is = Bearing of line OK + α_c

$= 356^\circ 46' 40'' + 24^\circ 19' 22.6'' - 360^\circ$

$= 21^\circ 6' 2.6''$

Ques 2) Distance measured on a photograph of two points A and B are 60.50mm (left) and 72.60mm (Right). Angles measured between the two points using a theodolite is $45^\circ 30'$. Calculate the focal length of the camera.

Ans. $\theta = 45^\circ 30'$



$x_a = 60.5$ mm $\quad x_b = 72.6$ mm

$\tan\alpha_a = \frac{60.5}{f} \quad \tan\alpha_b = \frac{72.6}{f}$

A 60.5 | 72.60 B

$$\tan 45^\circ 30' = \left(\frac{\frac{x_a}{f} + \frac{x_b}{f}}{1 - \frac{x_a}{f}\cdot\frac{x_b}{f}}\right) = \frac{f(x_a + x_b)}{f^2 - x_a x_b}$$

$$(f^2 - 60.5 \times 72.6) - f\left(\frac{60.5 + 72.6}{\tan 45^\circ 30'}\right) = 0$$

$$\boxed{f = 158.5\,mm}$$

Arial Photogrammetry

Important definitions:-

(i) N = Nadir point at Ground

(ii) GN = Ground Nadir point.

(iii) i = isocentre

mid point of N and K.

(iv) t = tilt = ∠NOK

= OHK.

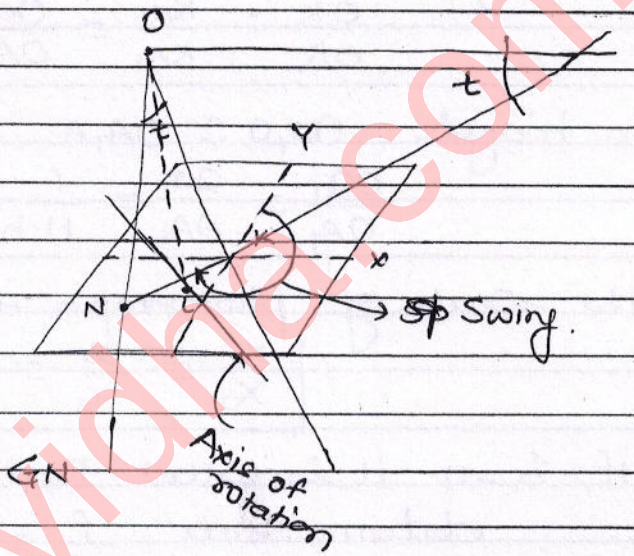
(v) principal plane

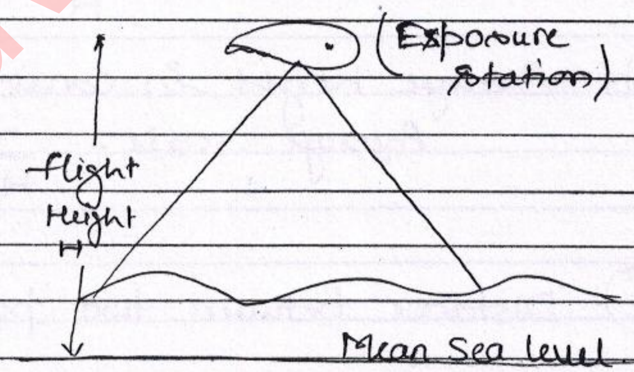
is OKN.

NK is principal line.

[Angle of NK line from Y axis:

= Swing]



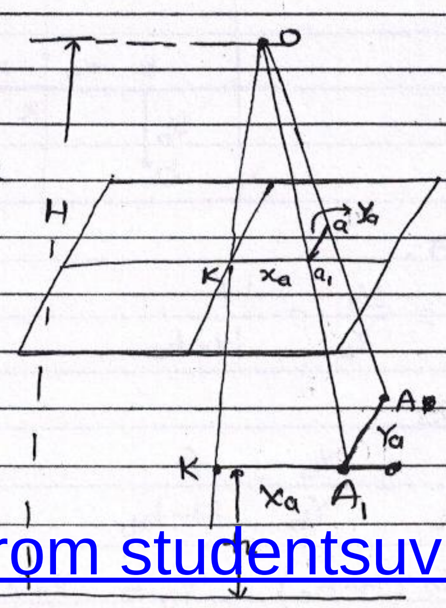


Vertical photograph:-

Scale of a vertical photograph.

K, A, and A are on same plane

with Height h from MSL



Scale of a photograph =

$$\frac{\text{Map distance}}{\text{Ground distance}}$$

$$= \frac{Ka_1}{KA_1} = \frac{aa_1}{AA_1}$$

$$\text{Scale} = \frac{Ka_1}{KA_1} = \frac{OK}{OK} = \frac{f}{H-h}$$

In triangle $OKa_1 \simeq OKA_1$.

$$\frac{OK}{OK} = \frac{Ka_1}{KA_1} = \frac{Oa_1}{OA_1} = \frac{f}{H-h}$$

In triangle $Oa_1a \simeq OA_1A$.

$$\frac{Oa_1}{OA_1} = \frac{aa_1}{AA_1} = \frac{f}{H-h} = \frac{y_a}{Y_a}$$

the scale of photograph is

$$\boxed{\frac{x_a}{X_a} = \frac{y_a}{Y_a} = \frac{f}{H-h}}$$

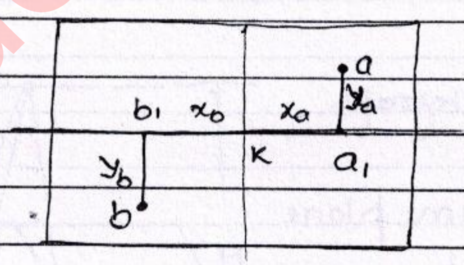
if $h=0$ it is called Datum Scale. (At MSL)

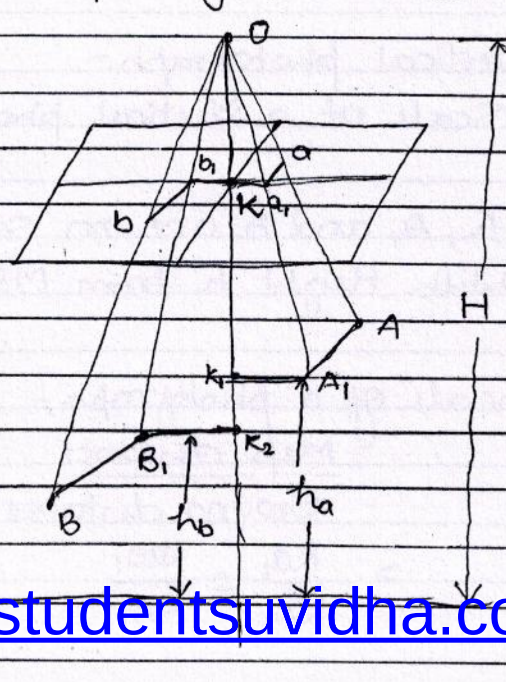
$$\text{datum Scale} \quad \frac{f}{H} = \frac{x_a}{X_a} = \frac{y_a}{Y_a}$$

if Average height is considered h_a.

$$\text{Average Scale} = \frac{f}{H-h_a}$$

Distance between two points on a photograph. (Horizontal)





for point A.

$$\frac{x_a}{X_a} = \frac{y_a}{Y_a} = \frac{f}{H-h_a}$$

for point B

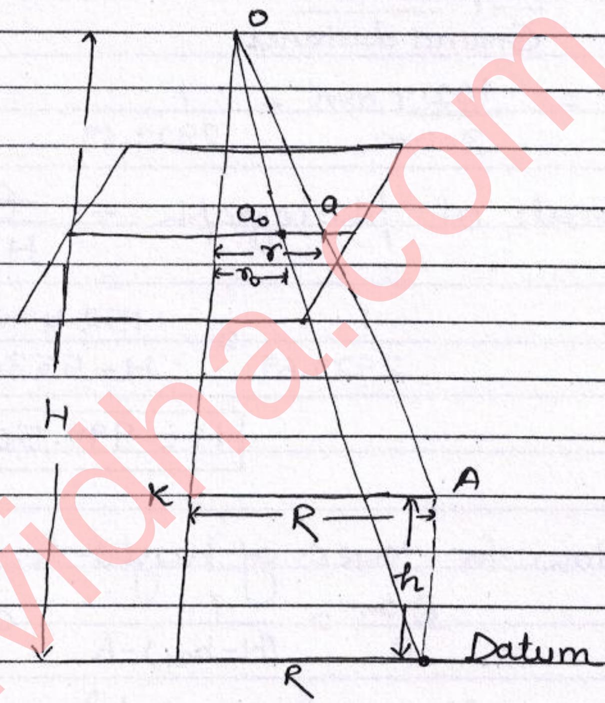
$$\frac{x_b}{X_b} = \frac{y_b}{Y_b} = \frac{f}{H-h_b}$$

$$X_a = \frac{x_a}{f}(H-h_a) \qquad Y_a = \frac{y_a}{f}(H-h_a)$$

General formula for Distance b/w AB is.

$$AB = \sqrt{(X_a - X_b)^2 + (Y_a - Y_b)^2}$$ where X_b and Y_b is negative.

Relief Displacement :-



$aa_0 = d$ relief displacement.

If a point A is taken to datum the change in image on the photograph is called relief displacement.

$$\frac{r_0}{R} = \frac{f}{H} \Rightarrow r_0 = \frac{Rf}{H} \quad \text{— (1)}$$

$$\frac{r}{R} = \frac{f}{H-h} \Rightarrow r = \frac{fR}{H-h} \quad \text{— (2)}$$

relief displacement

$$r - r_0 = aa_0 = \frac{fR}{H-h} - \frac{fR}{H}$$

$$aa_0 = fR\left[\frac{H - H + h}{(H-h)H}\right] = \frac{fRh}{H(H-h)} = \frac{h}{H}\left(\frac{fR}{H-h}\right)$$

$$d = \boxed{aa_0 = \frac{h}{H} r}$$ relief displacement.

height of an object (at datum)

$$\boxed{h = \frac{dH}{r}}$$

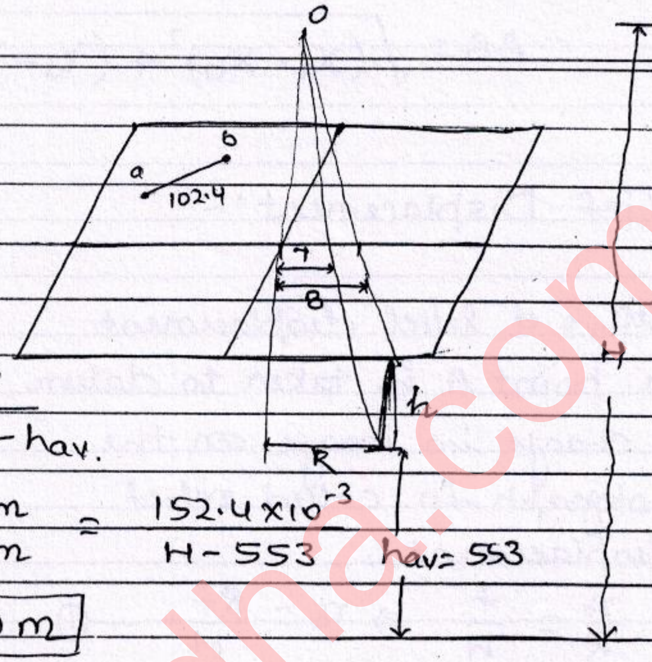
ES 2001

Que 1 A Section line AB 300m long on a flat terrain measures 102.4 mm on a vertical photograph. A radio tower also appears on the photograph. The distance measu[red] from principal points to the image of bottom and top of the radio tower found to be 7cm and 8cm respectively. The average elevation of terrain is 553m. Determine the height of tower. f = 152.4 mm.

Scale of the photograph

$= \dfrac{\text{map distance}}{\text{Ground distance}}$

$= \dfrac{102.4\ mm}{300m} = \dfrac{1}{2929.69}$



Scale of photograph $= \dfrac{f}{H - h_{av}}$

$\dfrac{1}{2929.691} = \dfrac{152.4\ mm}{H - 553m} = \dfrac{152.4 \times 10^{-3}}{H - 553}$

$\boxed{H = 999.50\,m}$

Now for tower of height h.

$\dfrac{8\ cm}{R} = \dfrac{f}{(H - h_{av}) - h}$ and $\dfrac{7\ cm}{R} = \dfrac{f}{(H - h_{av})}$

$fR = 8[(H - h_{av}) - h]$ and $fR = 7(H - h_{av})$

$8[(H - h_{av}) - h] = 7(H - h_{av})$

$8[999.5 - 553 - h] = 7[999.5 - 553]$

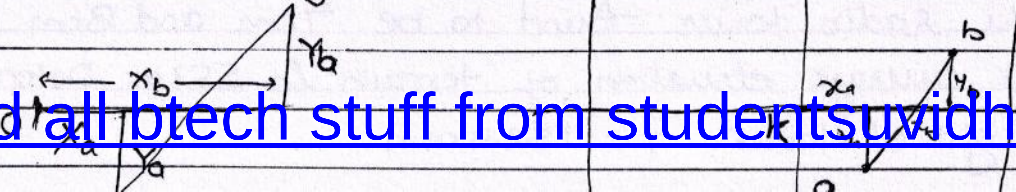
$h = \dfrac{(8-7)[999.5 - 553]}{8} = 55.81\,m$

ES1997

Ques 2:- A Vertical photograph was taken from a height of 3200m above MSL, with a Camera of focal length 120mm. It contained two points a and b Calculate the horizontal length AB, and average scale along line ab.

Photo points	Elevation above MSL	Photo coordinates X (mm)	Y (mm)
a	640m	+19.50	−14.60
b	780m	+26.70	+10.80

Ans



Ans $H = 3200m$. $x_a = +19.50mm$, $y_a = -14.60mm$

$f = 120mm$. $x_b = +26.7mm$ $y_b = +10.80mm$.

$h_a = 640m$, $h_b = 780m$.

$$\frac{x_a}{X_a} = \frac{y_a}{Y_a} = \frac{f}{H-h_a}.$$

$$X_a = \frac{19.50}{120}(H-h_a) \text{ and } Y_a = \frac{-14.60}{120}(H-h_a).$$

$$X_a = \frac{19.5}{120}(3200-640), \text{ and } Y_a = -\frac{14.60}{120}(3200-640)$$

$$X_a = 416m \qquad Y_a = -311.47m$$

and $$\frac{x_b}{X_b} = \frac{y_b}{Y_b} = \frac{f}{H-h_b}$$

$$X_b = \frac{26.7}{120}(H-h_b) \text{ and } Y_b = \frac{10.8}{120}(H-h_b).$$

$$X_b = \frac{26.7}{120}(3200-780) \text{ and } Y_b = \frac{10.8}{120}(3200-780)$$

$$X_b = +538.45m \qquad Y_b = 217.80m$$

Now $AB = \sqrt{(X_a - X_b)^2 + (Y_a - Y_b)^2}$

Horizontal distance $= \sqrt{(538.45-416)^2 + (217.8+311.47)^2} =$

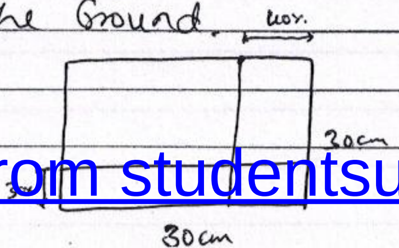
$AB = 543.25m$.

Average height $= \frac{640+780}{2} = 710m. = h_{av}$

Average Scale $= \frac{f}{H-h_{av}} = \frac{120\,mm}{(3200-710)mm \times 1000} = \frac{1}{20750}$

Ques the Scale of a arial photograph is 1cm = 200m. Size of one photograph is 30cm x 30cm, if longitudinal and side lap is to be provided 40% and 30% in each photograph Calculate total number of photograph required to cover an area of 800 km² on the Ground.

Ans



Effective length $= 30 \times 0.6$

$= 18cm$

Effective width = $30 \times 0.7 = 21$ cm.

Net area = $21 \times 18 = 378\ cm^2$

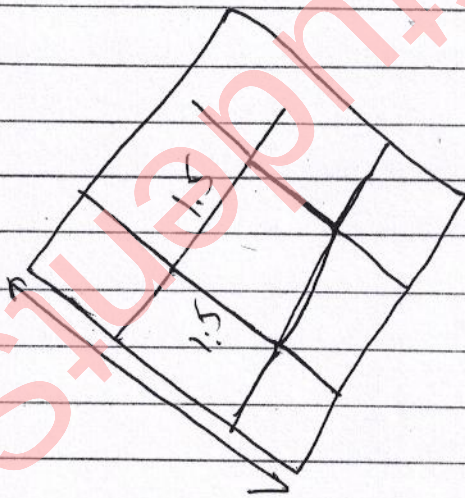
on Ground $1\ cm^2 = (200)^2$

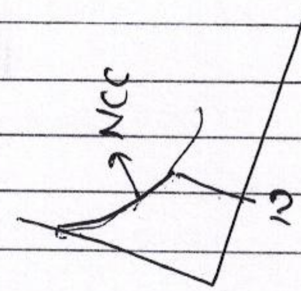
$378\ cm^2 = 4 \times 10^4 \times 378\ m^2$

one photograph will cover $15.12\ km^2$.

Number of photos $= \frac{800}{15.12} \simeq 53$ photos.

Date-Sept	Project	Autocad		
622 A	53 P	69 P	14576	10
623 P	54 P	70 A	14984	10
24 A	55 P	71 ~~A~~	14574	10
25 P	56 P	72 P	14584	10.
26 P	57 P	73 A	14540	10
27 P	58 P	74 ~~A~~	14558	15.
28 P	59 A	75 P		
29 P	60 P	76 P		
30 A	61 P	77 P		
31 P	62 A	78 A		
32 P	63 A	79 P		
33 P	64 P	80 A		
34 P	65 P	81 P		
35 P	66 A	82 A		
36 A	67 P	83 P		
37 A	68 P	84 P		
38 ~~A~~	69 P	85 P		
39 P	70 P	86 A		
40 P	71 P	87 P	990 P	
41 P	72 P	88 ~~A~~	981 A	
42 P	971 P	89 P		
43 P	976 P	90 P		
44 P	977 P	91 P		
45 ~~A~~		92 A		
46 A		~~92~~ 981 A		
47 P		982 P		
48 A		983 P		
49 P		984 A		
50 P		985 P		
51 P		986 A		
52 A		987 P		
		988 A		
		989 P		

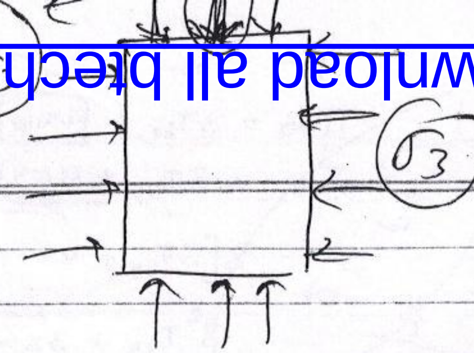




Tacheometer - 137
Plain table Surveying - 145

Undrained
drained

σ_{total}



undisturbed $V = 105 cm^3$.

$m = 200 gm$.

$m_s = 170 gm$.

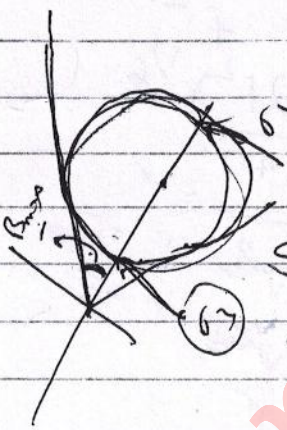
Water Content $= \frac{\cancel{170}}{\cancel{200}} = \frac{30}{170} = 0.176 = 17.6\%$.

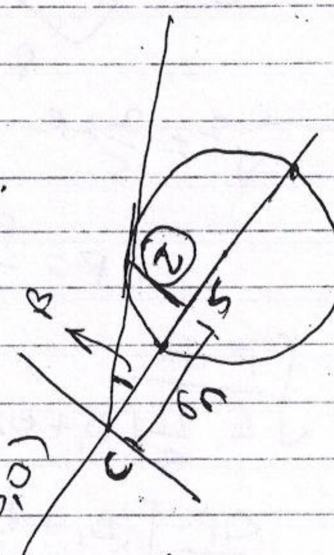
Void ratio. $Se = wG$. $\boxed{e = \frac{V_v}{V_s}}$

Now $\gamma_b = \left(\frac{G+Se}{1+e}\right)\gamma_w = \frac{G(1+w)}{1+e}\gamma_w$ and $\gamma_b = \frac{mass}{Volume} \times g$

$\left(\frac{200}{105}\right) = \frac{G(1+w)}{1+e} \times 1$.

$1+e = \frac{105}{200} \times 2.7(1+0.176)$.





$e = 0.67$.

$n = \frac{e}{1+e} = \frac{0.67}{1.67} = 0.4$.

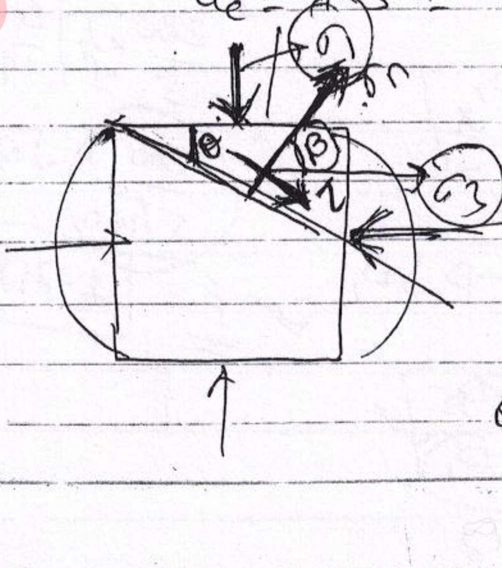
$Se = wG_s$

$S = \frac{0.176 \times 2.7}{0.67} = 0.709$

and air content

$a_c + S = 1$

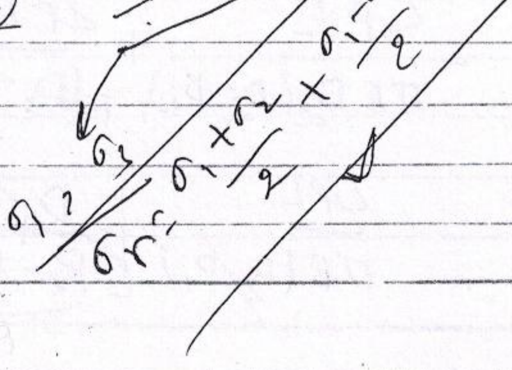
$a_c = 1 - S = 0.29$.



$\sigma_1 = \sigma_3 \tan^2(45 + \phi/2)$

$2C \tan(45 + \phi/2)$

$\frac{\sigma_1 + \sigma_3}{2} \times \frac{\sigma_1 - \sigma_3}{2} \times \cos^2$



$T_{100} = 3T_{99} + \boxed{4\times 100} - 6$ $\quad 3^2 T_{98}$

$= 3T_{98} + 4\times 99 - 6$ $\quad 3^{99}T_1 \quad 3^{99} + 200$

$3[3T_{98} + 4\times 99 - 6] + 4\times 100 - 6.$

$3^2 T_{98} + 3\times 4\times 99 - 6\times 3 + 4\times 100 - 6.$

$Q = AV \qquad V = \frac{Q}{A}$

$Q = A \cdot \frac{1}{n} R^{2/3} S^{1/2}$

$Af^2 = 140V^5 \qquad Af^2 = 140V^5$

$V = \sqrt{\frac{2}{5} fR} \qquad \frac{Af^2}{140} = V^5$

10%

$P - P/g - R = 0 \qquad \boxed{R = P/g}$

$V^2 = \frac{2}{5} fR \qquad Q = AV \quad \frac{140V^6}{f^2}$

$R = \left(\frac{5V^2}{2f}\right)$

$V = \left(\frac{Qf^2}{140}\right)^{1/6}$

$V^2 = \frac{2}{5} fR$

$P = R = \frac{A}{P} \qquad \frac{A}{\frac{5}{2}\frac{V^2}{f}}$

$P = \frac{A}{R}$

$\frac{140 V^5 V^2}{f^2 \times \frac{5}{2} \times f}$

It is method of superposition

$\int \frac{P\,dx}{E \frac{\pi}{4}(D_1 + bx)^2}$

$\frac{4P}{\pi E}\left[\frac{(D_1 + bx)^{-2+1}}{(-2+1)b}\right]_0^L$

$P = \frac{280}{5}\frac{V^3}{f}$

$-\frac{4P}{\pi E}\left[\frac{1}{\left(\frac{D_2 - D_1}{L}\right)\left(D_1 + \frac{D_2 - D_1}{L}x\right)}\right]$

$\frac{280}{5} \times \frac{1}{f}\left[\frac{Qf^2}{140}\right]^{1/2}$

$\frac{280 \times \sqrt{Q}}{5\sqrt{140}}$

$-\frac{4PL}{\pi E D_2(D_2 - D_1)} + \frac{4PL}{\pi E (D_2 - D_1) D_1}$

$P = \boxed{4.75\sqrt{Q}}$

$\frac{4PL}{\pi E (D_2 - D_1)} \left[\frac{-D_1 + D_2}{D_2 \, D_1}\right]$

Bohemia

Admit Card

I Card

Flow net - 38

Boussinesque 56

Westerguard - 57

Principle of chaining