SIMULTANEOUS OBSERVATION

No. 117 Date 15.04.2025

Chapter 32

Worked example 1 - two long by chrons

Obs long 1 : 146° 13.4' W
Az : 046° (T)
LOP : 136° - 316°

Obs long 2 : 146° 19.3' W
Az : 130° (T)
LOP : 040° - 220°

d'long = 5.9' W

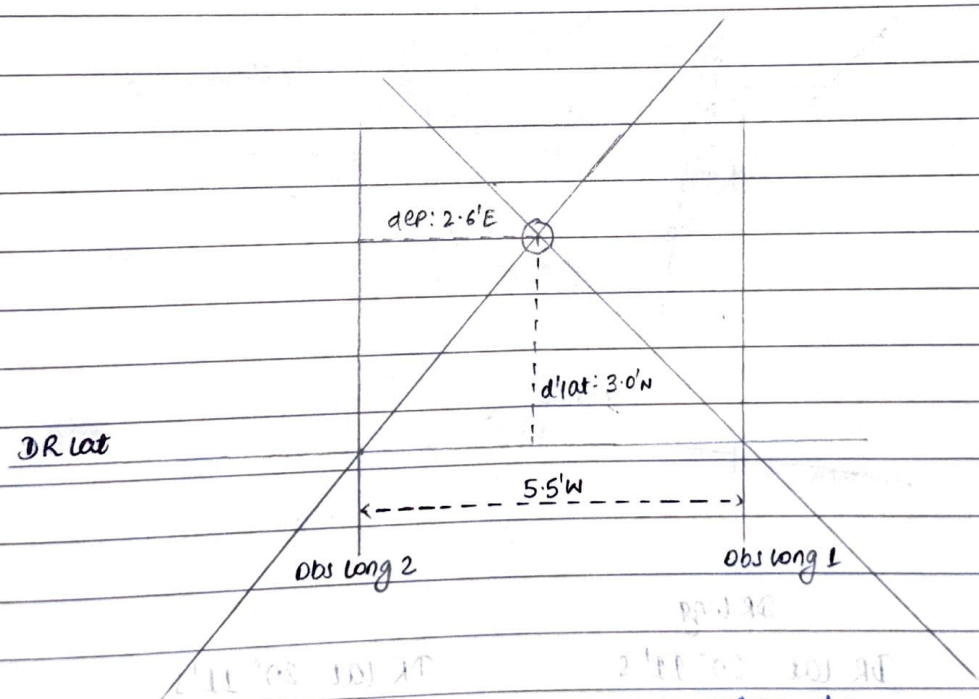
same name - diff name +
W to more W is west

Parallel sailing formula,

cos lat = dep / d'long

cos 20°36' = dep / 5.9'

dep = 5.5' W



DR lat : 20° 36.0' N
d'lat : 3.0' N
Fix lat : 20° 39.0' N

DR lat: 20° 36.0' N
Fix lat: 20° 39.0' N
M'lat: 20° 37.5' N

Plane sailing formula

cos m'lat = dep / d'long

cos 20° 37.5' = 2.6' / d'long

d'long = 2.8' E

Obs long 2 : 146° 19.3' W
d'long : 2.8' E
Fix long : 146° 16.5' W

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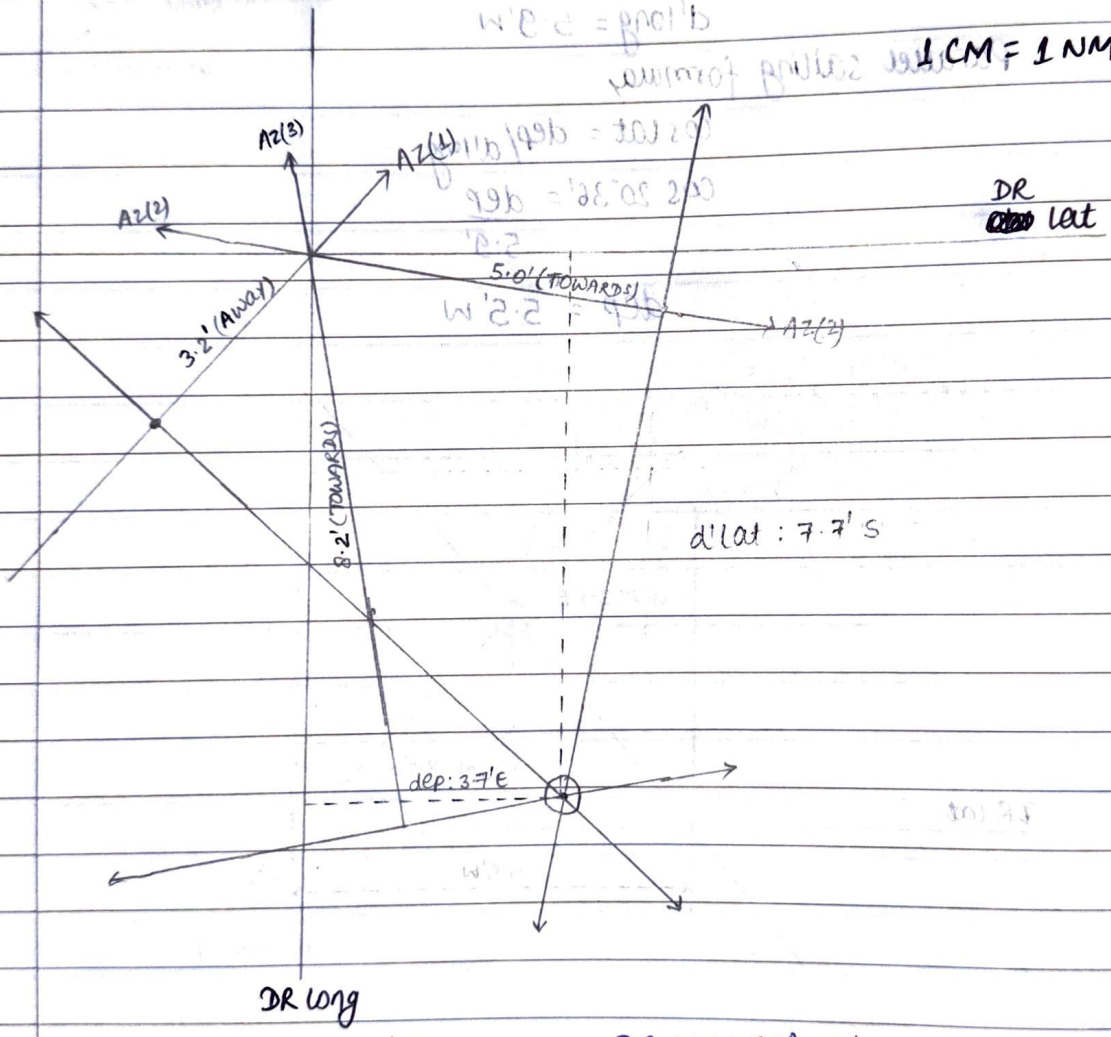
Worked example 2 - three intercepts

DR Lat: 20° 11's DR Long: 140° 36'E

Intercept	Name	Azimuth
3.2M	Away from	042°(T)
5.0M	Towards	100°(T)
8.2M	Towards	170°(T)



DR Lat: 20° 11'S
d'lat: 7.7'S
Fix Lat: 20° 18.7'S

DR Lat: 20° 11'S
Fix Lat: 20° 18.7'S
m'lat: 20° 14.9'S

Plane sailing formula,

cos m'lat = dep/d'long
cos 20° 14.9' = 3.7/d'long
d'long = 3.9'E

DR Long: 140° 36'E
d'long: 3.9'E
Fix long: 140° 39.9'E

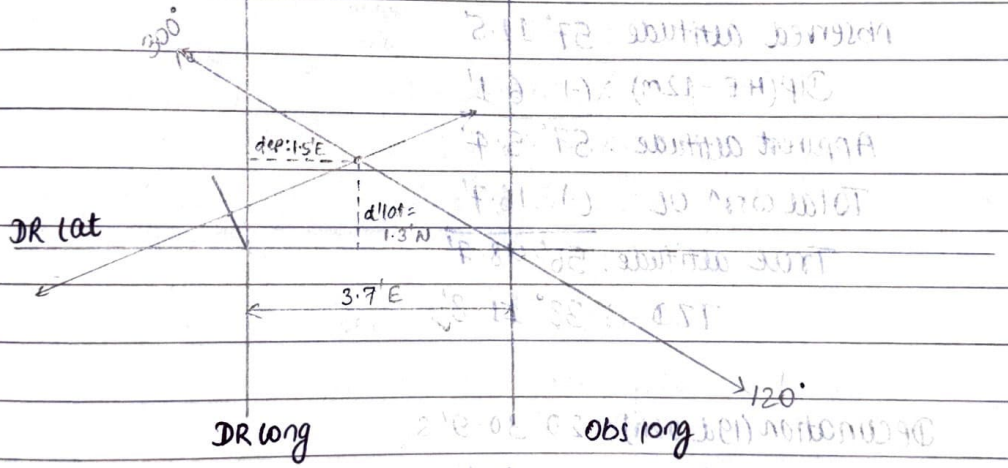
Worked example 3: one intercept & one long by chron

DR Lat: 48° 24'N DR long: 179° 59'E

Intercept: 0·5' (Towards) Az - 335°(T)

Obs Long: 179° 55·4'W Az - 030°(T)

LOP = 120° - 300°



DR long: 179° 59'E

Obs long: 179° 55·4'W same name -

d'long: 5·6'E diff name +

Parallel sailing:

$$\cos lat = \frac{dep}{d'long}$$

$\cos 48° 24' = dep/5·6'$

$dep = 3·7'$

DR lat: 48° 24'N

d'lat: 1·3'N

Fix lat: 48° 25·3'N

DR lat: 48° 24'

Fix lat: 48° 25·3'

m'lat: 48° 24·65'

$\cos m'lat = dep/d'long$

$\cos 48° 24·6' = 1·5/d'long$

$d'long = 2·3'E$

DR long: 179° 59'E
d'long: 2·3'E
Fix long: 179° 58·7'W

Ques) JULY 21 JULY 18 In DR 20°S, 175°E on 19th Jan 1992 on a ship, the sextant altitude of SUN's UL west of the meridian was 57° 10' when GMT was 19th Jan 02h 52m 24s i.e. was 1·5' off the arc & H.E was 12m. Calculate intercept and direction of PL

Soln:-

Sextant altitude: 57° 10'
IE (off): (+) 1·5'
Observed altitude: 57° 11·5'
Dip (H.E - 12m): (-) 6·1'
Apparent altitude: 57° 5·4'
Total corn UL: (-) 16·7'
True altitude: 56° 48·7'
TZD: 33° 11·3'

ON -
OFF +

Declination (19d 02h): 20° 30·9' S
d(0·5): (-) 0·4'
Declination SUN: 20° 30·5' S

GHA SUN (19d 02h): 207° 23·4'
Increment (52m 24s): 13° 06·0'
GHA SUN: 220° 29·4'
Long (E): (+) 175° 00·0'
LHA SUN: 35° 29·4'

P = LHA (bcz west of meridian)
P = 35° 29·4'

lat & dec, same name +

cos CZD = cos P · cos lat · cos dec ± sin lat · sin dec
cos CZD = cos 35° 29·4' × cos 20° × cos 20° 30·5' + sin 20° × sin 20° 30·5'
cos CZD = 0·836
CZD = 33° 14·0'

CZD: 33° 14.0'

TZD: 33° 11.3'

Tom greater, away

Intercept: 2.7' (Towards)

To find direction of PL

$A = \frac{\text{Tan lat}}{\text{Tan P}}$ $B = \frac{\text{Tan dec}}{\text{sin P}}$

$A = \frac{\text{Tan } 20°}{\text{Tan } 35°29.4'}$ $B = \frac{\text{Tan } 20°30.5'}{\text{sin } 35°29.4'}$

A = 0.510 (N) → Opp to lat B = 0.644 (S) → same as dec

except LHA is 090° to 270°

C = A ± B

C = 0.644 − 0.510

C = 0.134 S

Tan Az = 1/C x cos lat

Tan Az = 1/0.134 x cos 20°

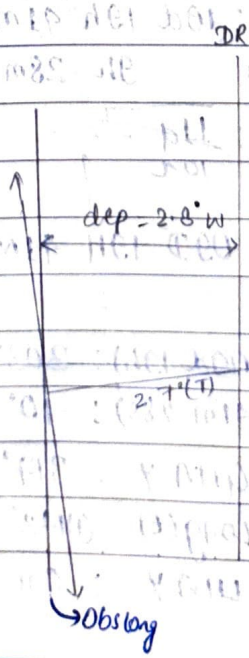
Az = (S) 82.8° (W)

↓ same as C ↓ LHA is 0° to 180°

T Az = 262.8° (T)

PL = 172.8° − 352.8°

b) Without working out the sight, Find what longitude will an observer get if the above sight was calculated using long by chron method.



dep = 2.8'W

$\cos lat = \frac{dep}{d'long}$

$\cos 20^\circ = \frac{2.8}{d'long}$

$d'long = 2.98'W / 3.0'W$

DR long : 175°E

d'long : 3.0'W

Fix long : 174° 57.0'E

② JAN-2018 JAN-2019 OCT 2024

On 10th OCT 1992 at ship in DR long 142° 10'E, sextant altitude of polaries was 41° 10' at GMT 19h 41m 28s. At the same time, sextant altitude of star denebola was 16° 36'. H.E : 20m I.E : NIL. Find position of observer.

Sol^n:- ~~POLARIES~~

~~Sextant altitude : 41° 10'~~

~~IE (NIL) : 0.0'~~

~~Observed altitude : 41° 10.0'~~

~~Dip (HE - 20m) : (-) 7.9'~~

~~Apparent altitude : 41° 2.1'~~

~~Total corr^n : (-) 1.1~~

~~True altitude : 41° 1.0'~~

First verify the GMT

if GMT : ~~10~~ 09d 19h 41m 28s

LIT(E) : 9h 28m 40s — Long E, GMT least

LMT : ~~11~~ 10d 05h 10m 08s

∴ GMT : 09D 19H 41M 28S

GHA ♈ (09d 19h) : 303° 38.6'

Increment (41m 28s) : 10° 23.7'

GHA ♈ : 314° 02.3'

Long (E) : (+) 142° 10.0' — Long E, GHA least

LHA ♈ : 096° 12.3'

only for a_0, a_1, a_2 value

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POLARIS:

Sextant altitude: 41° 10'
IE (NIL): 0.0'
Observed altitude: 41° 10.0'
Dip (HE-20m): (-) 7.9'
Apparent altitude: 41° 2.1'
Total corrn: (-) 1.1'
True altitude: 41° 1.0'
a0: (+) 36.1'
a_1: (+) 0.5 (use T.alt for this)
a_2: (+) 0.3
SUM: 41° 37.9'
Minus 1°: 1° 00.0'
Obs Lat: 40° 37.9' N (Always N as polaris is not visible in south Hemisphere)

Az: 359.1° (T)
LOP: 089.1° – 269.1°

Denebola (long by chron)

GHA ♈ (09d 19h): 303° 38.6'
Increment (41m 28s): 10° 23.7'
GHA ♈: 314° 02.3'
Long (E): (+) 142° 10.0'
LHA ♈: 096° 12.3'
SHA ☆: 182° 49.7'
Approx. LHA ☆: 279° 02.0' → only used for name of azimuth
Dec denebola: 14° 36.7' N

GHA ♈: 314° 02.3'
SHA ☆: 182° 49.7'
GHA ☆: 136° 52.0'

Sextant Altitude: 16° 36.0'
IE (NIL): 0.0'
Observed altitude: 16° 36.0'
Dip (HE-20m): (-) 7.9'
Apparent altitude: 16° 28.1'
Total corrn: (-) 3.2'
True altitude: 16° 24.9'

By long by chron formula

$$\cos P = \frac{\sin T \cdot alt \mp \sin lat \cdot \sin dec}{\cos lat \cdot \cos dec}$$

lat & dec, same name −

$$\cos P = \frac{\sin 16°24.9' - \sin 40°37.9' \sin 14°36.7'}{\cos 40°37.9' \cdot \cos 14°36.7'}$$

$\cos P = 0.1611$

$P = 80°43.7'$

Sight is taken before LMT mer. pass

So, LHA = 360° − P

LHA : 279° 16.3'

GHA : 138° 52.0'

Obs long : 142° 24.3' E

$$A = \frac{\tan lat}{\tan P} \qquad B = \frac{\tan dec}{\sin P}$$

$$A = \frac{\tan 40°37.9'}{\tan 80°43.7'} \qquad B = \frac{\tan 14°36.7'}{\sin 80°43.7'}$$

A = 0.140 (S) → opp to lat except when LHA is b/w 090° to 270°

B = 0.264 (N) → same asc

C = A ± B

C = 0.264 − 0.140

C = 0.124 N

Tan Az = 1/C x cos lat

Tan Az = 1/0.124 x cos 40°37.9'

Az = (N) 84.6° (E) → LHA 180° to 360°

(N) same as C

T Az = 84.6°

LOP = 174.6° − 354.6°

DR long : 142° 10.0' E

Obs long : 142° 24.3' E

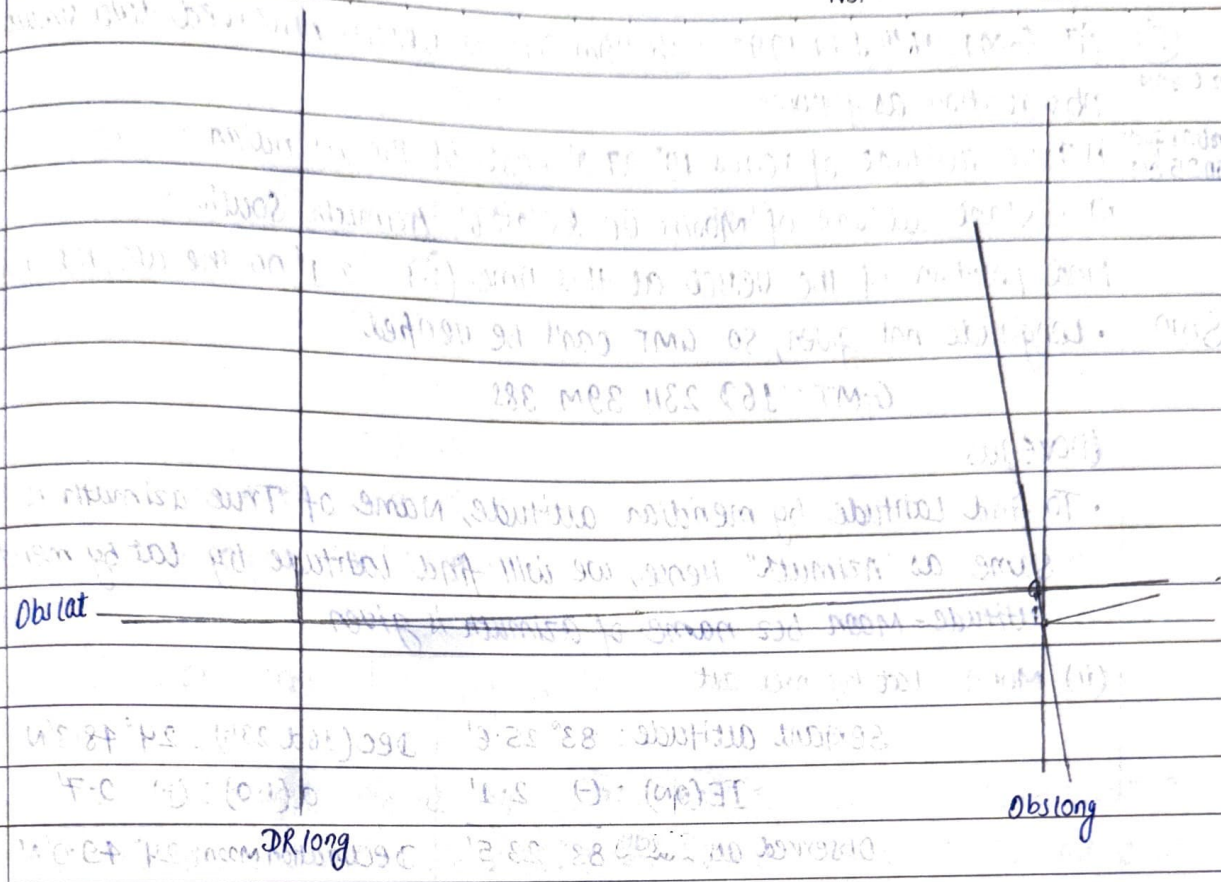
d'long : 14.3' E

cos lat = dep/d'long

cos 40°37.9' = dep/14.3'

dep = 10.8' E

No. Date



Obs lat : 40° 37·9' N
d'lat : 0·5' N
Fix lat : 40° 38·4' N

Obs lat : 40° 37·9'
Fix lat : 40° 38·4'
m'lat : 40° 38·1'

dep = 0·1° W

cos m'lat = dep/d'long
cos 40° 38·1' = 0·1/d'long
d'long = 0·1° W

Obs long : 142° 24·3' E
d'long : 0·1' W
Fix long : 142° 24·2' E

Posn of observer: Lat : 40° 38·4' N
Long : 142° 24·2' E

(3) DEC 2014 Similar ques: JAN 25 AM

AT GMT 16th JAN 1992 23h 39m 38s, a vessel observed two simultaneous observation as follows:-

i) True altitude of venus 19° 37.8' east of the meridian. → Long by chron

ii) Sextant altitude of Moon's UL 83° 25.6', Azimuth South → Lat by mer. alt

Find position of the vessel at this time (I.E - 2.1' on the arc, H.E: 12m)

Soln:- • Longitude not given, so GMT can't be verified

GMT: 16D 23H 39M 38S

Note:-

• To find Latitude by meridian altitude, Name of True azimuth is same as "Azimuth". Hence, we will find latitude by Lat by meridian altitude - Moon bcz name of azimuth is given.

(ii) Moon - Lat by mer. alt

Sextant altitude	83° 25.6'	Dec(16d 23h)	24° 48.3'N
IE(ON)	(-) 2.1'	d(1.0)	(+) 0.7'
Observed altitude	83° 23.5'	Declination Moon	24° 49.0'N
DIP(HE-12m)	(-) 6.1'		
Apparent altitude	83° 17.4'		
(always add) Main corn	(+) 17.3'		
HP(60.1) UL	(+) 3.3'		
Substract 30'	30.0'		
True altitude	83° 08.0'S		
MZD	06° 52.0'N	} same name add	
Dec	24° 49.0'N		
Latitude	31° 41.0'N		

(i) Venus - Long by chron (Planet)

GHA (16d 23h)	201° 36.5'		
Increment (39m 38s)	9° 54.5'		
v(-0.8)	0.5'	True altitude	19° 37.8'
GHA venus	211° 30.5'		
Dec (16d 23h)	21° 30.0'S	Latitude	31° 41.0'N
d(0.3)	(+) 0.2'		
Dec venus	21° 30.2'S		

$\cos P = \frac{\sin T.alt \mp \sin Lat \cdot \sin dec}{\cos Lat \cdot \cos dec}$ Lat & dec, diff name add

$\cos P = \frac{\sin 19°37.8' + \sin 31°41.0' \cdot \sin 21°30.2'}{\cos 31°41.0' \cdot \cos 21°30.2'}$

$\cos P = 0.6675$

$P = 48°07.6'$

$LHA = 360° - P$

$LHA = 311°52.4'$

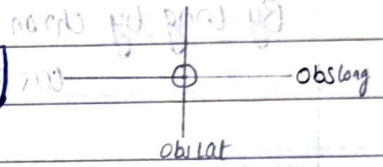
$GHA = 211°30.5'$

$Obs\ long = 100°21.9'E$

LHA 0° to 180° = body west of meridian
P = LHA
LHA 180° to 360° = body east of meridian
LHA = 360° − P

LHA − GHA = Obs long E

Answer:- Posn :- Lat: 31°41.0'N 100°21.9'E



④ JULY 2012 ON 6th March 1992 PM at ship, in DR longitude 070° 45'W. The following simultaneous observation were made, first observation: sextant meridian altitude of star vega north of the observer was found to be 51° 11.2', H.E: 15m, I.E: 0.4' OFF the arc. → Lat by mer. alt - star. Second observation: sextant altitude of Moon's LL using same sextant was 17° 48' at GMT 23h 10m 30s. Find the position of the vessel. → Long by chron Moon

SOLN:-

- Longitude W, GMT best

So, LMT less & Question says PM at ship. So GMT is correct

(i) Vega - Lat by mer. alt (star)

Sextant Altitude: 51° 11.2'	Declination Vega: 38° 46.3'N
IF (OFF): (+) 0.4'	
Observed altitude: 51° 11.6'	
DIP (HE - 15m): (-) 6.9'	
Apparent altitude: 51° 4.7'	
Total correction: (-) 0.8'	
True altitude: 51° 3.9' (N) → given in ques - same as Azimuth	
MZD: 38° 56.1' (S) → opposite to T. alt.	
Dec: 38° 46.3'N → diff name	
Latitude: 00° 9.8' (S) → name of larger one	
LOP: E-W	

(ii) Moon - long by chron

GHA(0Gd 23h) : 138° 58.4'	Sextant altitude : 17° 48'
Increment(1om 30s) : 2° 30.3'	IE(OFF) : (+) 0.4'
v(14.0) : 2.5'	Observed altitude : 17° 48.4'
GHA MOON : 141° 31.2'	Dip(HE : 15M) : (-) 6.9'
Long (W) : (+)070° 45 (W) - GHA 6eor	Apparent altitude : 17° 41.5'
LHA MOON : 70° 46.2'	Main corr^{n} : (+) 62.6'
Declination(0Gd 23h) : 10° 08.1'N	HP(55.7' LL) : (+) 2.5'
d(12.0) : (+) 2.1'	True altitude : 18° 46.6'
Decination MOON : 10° 10.2'N	Latitude : 0° 9.8'S

By long by chron formula,

$$\cos P = \frac{\sin T \cdot \text{alt} \mp \sin \text{Lat} \cdot \sin \text{dec}}{\cos \text{Lat} \cdot \cos \text{dec}}$$ (diff name add)

$$\cos P = \frac{\sin 18° 46.6' + \sin 0° 9.8' \cdot \sin 10° 10.2'}{\cos 0° 9.8' \times \cos 10° 10.2'}$$

$\cos P = 0.3275$

$P = 70° 52.85'$

$P = LHA$ (LHA 0° to 180° west of meridian)

$LHA = P$

$LHA = 70° 52.85'$

$GHA = 141° 31.2'$

Obs long = 70° 38.4' W (GHA - LHA = Obs long W)

Answer :- Position: Lat : 0° 9.8'S Long : 070° 38.4'W

(5) JAN 2015 ON GMT 22D 16H 25M 13S, sept'92, a vessel near international date line took two simultaneous observation, I.E : 1.2' OFF THE ARC, H.E : 19m,

I) MOON, UL, SEXTANT ALTITUDE 32° 13.3' → long by chron

II) VENUS, SEXTANT ALTITUDE 48° 00.7', AZ : 180°(T) → means LOP : E-W that means Lat by mer alt.

Find position of the vessel this time.

Soln :- GMT: SEPT 22D 16H 25M 13S

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(11) VENUS - Lat by mer. alt (Planets)

Sextant altitude: 48° 00.7'	Declination (22d 16h): 10° 06.1' S
IF (OFF): (+) 1.2'	d (1.2): (+) 0.5'
Observed altitude: 48° 1.9'	Declination venus: 10° 06.6' S
Dip (HE-19m): (-) 7.7'	
Apparent altitude: 47° 54.2'	
Total corr^n: (+) 0.9' (-) 0.9'	
True altitude: 47° 53.4' (S) → same as MZ	
MZD: 42° 06.6' N	
Dec: 10° 06.6' S	
Obs Latitude: 32° 00.0' N	

(1) MOON - Long by chron (MOON)

GHA (22d 16h): 113° 10.0'	Sextant altitude: 32° 13.3'
Increment (125m 13s): 06° 01.0'	IF (OFF): (+) 1.2'
v (7.5'): (+) 3.2'	Observed altitude: 32° 14.5'
GHA Moon: 119° 14.2'	Dip (HE-19m): (-) 7.7'
	Apparent altitude: 32° 6.8'
	Main corr^n: (+) 57.9'
Declination (22d 16h): 15° 17.7' N	HP (60.1) UL: (+) 5.0' (-) 30.0' Substract 30'
d (11.4'): (+) 4.8'	True altitude: 32° 39.7'
Declination Moon: 15° 12.9' N	Latitude: 32° 00.0' N

By long by chron method,

$$\cos P = \frac{\sin T.alt \mp \sin Lat \cdot \sin dec}{\cos Lat \cdot \cos dec}$$ same name substract

$$\cos P = \frac{\sin 32°39.7' - \sin 32°00.0' \cdot \sin 15°12.9'}{\cos 32°00.0' \cdot \cos 15°12.9'}$$

$\cos P = 0.4895$

$P = 60°41.4'$

Case 1

P = LHA

LHA = 60° 06'

GHA = 119° 14.2'

Long = 059° 8.2' W ✗ wrong

bcz question says vessel near IDL

LHA = 360° − P

LHA = 299° 18.6'

GHA = 119° 14.2'

Obs Long = 179° 55.6' W GHA − LHA = Obs long W

Answer:-

Latitude: 32° 00' N 179° 55.6' W

Ex-meridian

⑥ On 2ND MAY 1992, at ship in DR 44° 11's, 102° 40'E, the sextant altitude of the star POLLUX near the meridian was 17° 14.6' at GMT 02D 10H 54M 20S, same time sextant altitude of JUPITER was observed to be 28° 32.0'. If IE was 3.6' off the arc and HE was 12m. Find the position of the vessel if the second observation was calculated using DR Latitude

Soln:- • LONG 'E, GMT least

So LMT will be more. Since LT is 06h 50.7 min. If we add in GMT, still it will come on same day.

GMT: MAY 02D 10H 54M 20S

(i) POLLUX (near the meridian) : Ex-meridian stars.

GHAY (02d 10h) : 10° 34.2'	Sextant altitude: 17° 14.6'
Increment (54m 20s) : 13° 37.2'	IE(OFF) : (+) 3.6'
GHAY : 24° 11.4'	Observed altitude : 17° 18.2'
Long (E) : 102° 40.0'	HE(12.0m) : (-) 6.1'
Long E, GHA least — LHAY : 126° 51.4'	Apparent altitude : 17° 12.1'
Always add — SHA Pollux : 243° 47.1'	Total corrn : (-) 3.1'
LHA Pollux : 10° 38.5'	True altitude : 17° 09.0'N
LHA = P bcz LHA is 0° to 180° — P : 10° 38.5'	TZD : 72° 51.0'S
Declination Pollux : 28° 02.7'N	Latitude : 44° 11'S

dec, lat

$\cos MZD = \cos TZD + [(1-\cos P) \cdot \cos DR\ lat \cdot \cos dec]$

$\cos MZD = \cos 72°51.0' + [(1-\cos 10°38.5') \cdot \cos 44°11' \cdot \cos 28°02.7']$

$\cos MZD = 0.3058$

MZD = 72° 11.8' (S) → same as TZD

Dec = 28° 02.7'N

Obs Lat = 44° 09.1' (S) → Larger name

$A = \frac{\tan Lat}{\tan P}$ $\quad B = \frac{\tan dec}{\sin P}$

$A = \frac{\tan 44°09.1'}{\tan 10°38.5'}$ $\quad B = \frac{\tan 28°02.7'}{\sin 10°38.5'}$

A = 5.167 N $\quad$ B = 2.885 N

C = A ± B same name add

C = 5·167 + 2·885

C = 8·052 N

Tan Az = 1/C x cos lat

Tan Az = 1/8·052 x cos 44° 09·1

Tan Az = 0·173

Az = N 9·8 W

T Az = 350·2° (T)

LOP = 080·2° - 260·2°

(ii) Jupiter (Ques say calculate using DR Latitude) : Long by chron

GHA (02d 10h)	: 213° 35·9'	Sextant altitude	: 28° 32·0'
Increment (54m 20s)	: 13° 35·0'	IE (OFF)	: (+) 3·6'
GHA Jupiter	: 227° 10·9'	Observed altitude	: 28° 35·6'
Long (E) (LONG E, GHA least)	: 102° 40·0'	HE (12·0m)	: (-) 6·1'
LHA Jupiter	: 329° 50·9'	Apparent altitude	: 28° 29·5'
Declination (02d 10h)	: 11° 00·4' N	Total correction	: (-) 1·8'
d (0·0)	: (-) 0·0'	True altitude	: 28° 27·7'
Declination Jupiter	: 11° 00·4' N	DR Latitude	: 44° 11's

By Long by chron formula,

$$\cos P = \frac{\sin T \cdot Alt \mp \sin Lat \cdot \sin dec}{\cos Lat \cdot \cos dec}$$

different name add

$$\cos P = \frac{\sin 28° 27.7' + \sin 44° 11' \cdot \sin 11° 00.4'}{\cos 44° 11' \cdot \cos 11° 00.4'}$$

Cos P = 0·856

P = 29° 59·8'

LHA = 360° - P

LHA = 330° 0·2

GHA = 227° 10·9'

Obs long = 102° 49·3' E

$A = \frac{\text{Tan lat}}{\text{Tan P}}$ $B = \frac{\text{Tan dec}}{\text{sin P}}$

$A = \frac{\text{Tan } 44°11'}{\text{Tan } 29°59.8'}$ $B = \frac{\text{Tan } 11°00.4'}{\text{sin } 29°59.8'}$

$A = 1.683$ (N) → to lat except LHA is 090°-270° $B = 0.389$ N

$C = A \pm B$

$C = 1.683 + 0.389$

$C = 2.072$ N

$\text{Tan Az} = 1/C \times \cos \text{lat}$

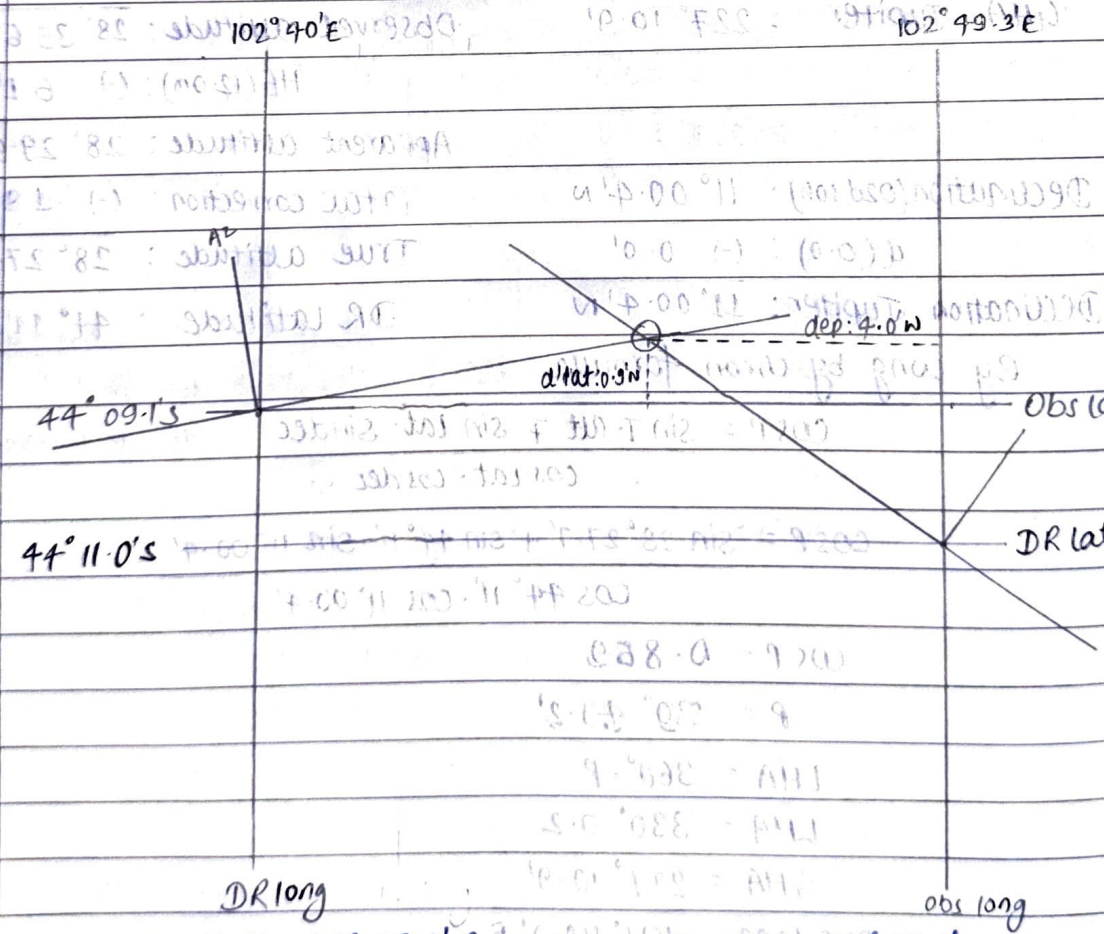
$\text{Tan Az} = 1/2.072 \times \cos 44°11'$

$\text{Tan Az} = 0.673$

$Az = N\ 33°56.45'\ E$

$T\ Az = 33.9\ (T)$

$LOP = 123.9° - 303.9°$



Obs lat: 44° 09.1' S

d'lat: 0.9' N

Fix lat: 44° 8.2' S

Obs lat: 44° 09.1' S

Fix lat: 44° 8.2' S

m'lat: 44° 08.6' S

cos m'lat = dep/d'long

cos 44° 08·6' = 4·0/d'long

d'long = 5·6' W

Obs long : 102° 49·3' E

d'long : 5·6' W

Fix long : 102° 43·7' E

Fix position: 44° 08·2' S 102° 43·7' E

SIMULTANEOUS OBSERVATION (COCKED HAT)

No. 138 Date 25.04.2025

① IN DR position 17°15'N 087°12'E, Three observation of three stars gave the following intercepts:

STAR 'X' --- AZ = 058°(T) X INT 2.0'(T) — smaall

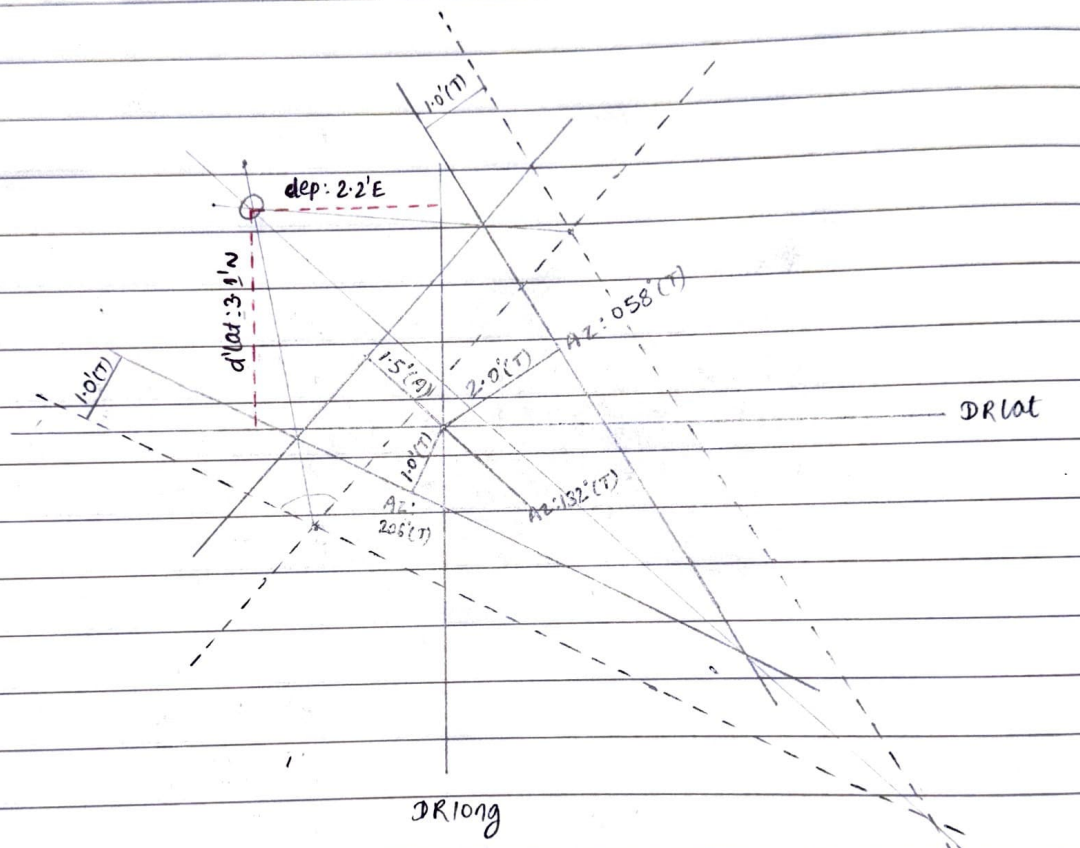
STAR 'Y' --- AZ = 132°(T) X INT 1.5'(A)

STAR 'Z' --- AZ = 206°(T) X INT 1.0'(T) — Largest

diff: 206°-58° = 148°

If less than 180°, then outside

Find the position of vessel.



- Shift all 3 PL 1.0' TOWARDS
- Bisect the angle
- Where it meets, we get the posn.

d'lat: 3.1'N dep: 2.2'E

DR Lat: 17° 15' N
d'lat: 3.1' N
Fix Lat: 17° 18.1' N

DR Lat: 17°15' N
Fix Lat: 17° 18.1' N
m'Lat: 17° 16.55' N

cos m'lat = dep/d'long

d'long = 2.2'/cos 17° 16.55' N

No. 139 Date 25.04.25

d'long : 2·3'W

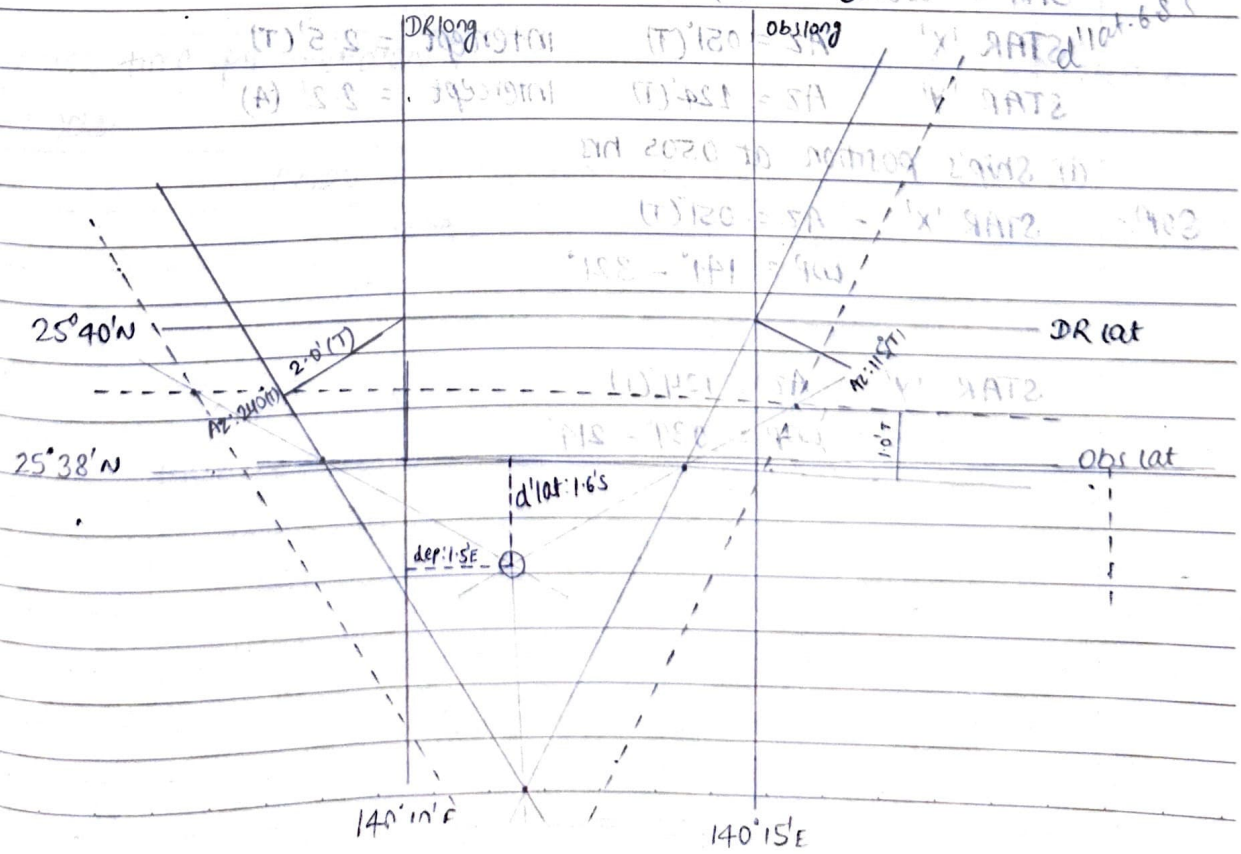
DR long : 087° 12' E
d'long : 2·3'W
Fix long : 087° 9·7'E

(2) The following simultaneous observation were calculated using DR 25°40'N 140° 10'E. STAR 'X' - OBS LONG 140° 15'E AZ 115°(T)
STAR 'Y' - AZ : 240°(T), INT: 2'(T)
STAR 'Z' (POLARIES) : AZ:- 001°(T) X OBS LAT 25° 38'N(T)
Find vessel's position.

Sol:-
STAR 'X' : Az : 115°(T) — DR lat
PL : 025°-205° — Obs long

STAR 'Y' : Az : 240°(T)
PL : 150°-330° — DR lat
Int : 2'(TOW) — DR long

STAR 'Z' : Az : 001°(T) — Obs lat
PL : 091°-271° — DR long



d'lat: 1.6'S dep: 1.5'E

Obs lat: 25° 38'N
d'lat: 1.6'S
Fix lat: 25° 36.4'

Obs lat: 25° 38'N
Fix lat: 25° 36.4'N
m'lat: 25° 37.2'N

cos m'lat = dep/d'long
d'long = 1.5/cos 25° 37.2'
d'long = 1.67'E

DR long: 140° 10'E
d'long: 1.67'E
Fix long: 140° 11.67'E

Final answer:- 25° 36.4'N 140° 11.67'E

③ On 2ND SEPT 1992 at ship in DR 20°N, 179° 30'E observed two stars as given below at ship's time 0505 HRS (ship's time = GMT +12 hours)
Ship's course 132°(T) AT 25 kts.

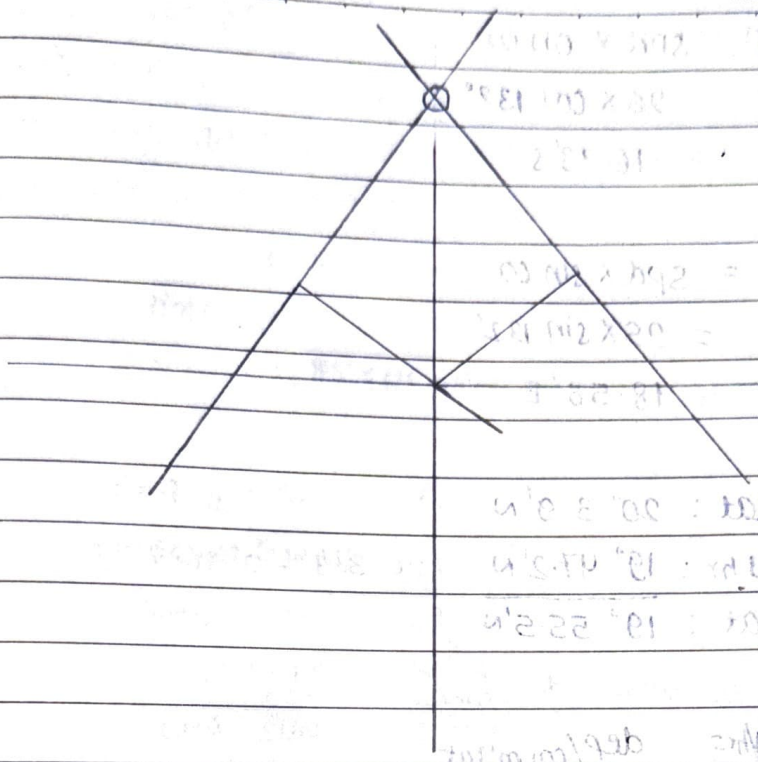
STAR 'X' Az = 051°(T) Intercept = 2.5'(T)
STAR 'Y' Az = 124°(T) Intercept = 2.2' (A)

(i) Ship's position at 0505 hrs.

SOL:- STAR 'X' - Az = 051°(T)
LOP = 141° - 321°

STAR 'Y' Az = 124°(T)
LOP = 034° - 214°

8°46')
'14'



dlat: 3.9'N
dep: 0.0

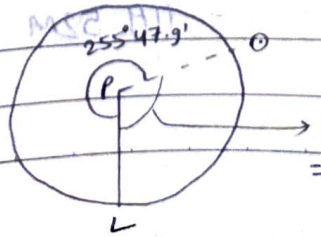
DR lat: 20° 00' N
dlat: 3.9'N
Fix lat: 20° 3.9'N

DR long: 179° 30'E
dlong: 0.0
Fix long: 179° 30'E

(ii) Ship's time for meridian passage of sun if the ship did not alter her clocks.

Ship's time: 02D 05H 05M
zone time: (-) 12H 00M
GMT: 01D 17H 05M

GHA (01d 17h): 75° 02.8'
Increment (05m 00s): 01° 15.0'
GHA SUN: 76° 17.8'
Long (E): 179° 30.0'
LHA SUN: 255° 47.9'

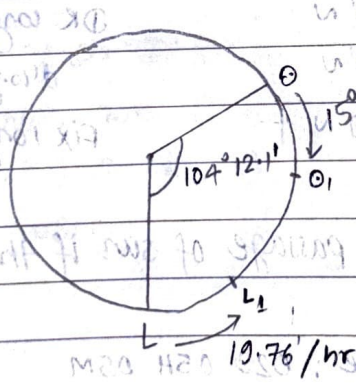


D'lat/hr = spd × cos co
= 25 × cos 132° (S 48°E)
= 16.73'S

Dep/hr = spd × sin co
= 25 × sin 132°
= 18.58'E

Fix lat : 20° 3.9'N
D'lat after 1 hr : 19° 47.2'N (20° 3.9' − 0° 16.73')
m'lat : 19° 55.5'N

cos m'lat = dep/d'long
D'long/hr = dep/cos m'lat
= 18.58/cos 19°55.5'
= 19.76'E

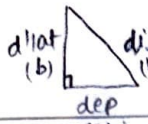


When both observer & sun together, ♈ will be on meridian

104° 12.1'
15° + 0° 19.76'

⇒ 104° 12.1' / 15° 19.76' = 6H 47M 51S

Ship's time mer. pass :-
05H 05M + 06H 47M 51S
= 11H 52M 50S



P b p
h h b
s c t

STAGGERED PROBLEMS

No. 146 Date 02·05·25

Q. 1) At 0830 hrs in DR position 48° 30'N, 024° 20' W, an observation of sun gave an intercept of 4'(T) on an azimuth of 100°(T). Ship then steered a course of 250°(T) at 14 Kts. At 1130 hrs a second observation of the sun gave an intercept of 3'(A), Azimuth 175°(T), having run up the DR position for this intercept calculation. Find the ship's position at 1130 hrs and at noon.

Soln:-

Total time run: 1130 - 0830

= 034 00M

Spd = 14 Kts

Distance = 42 NM

CO = 250°(T) S 70° W

$\cos CO = \frac{d'lat}{dist}$

$\cos 70° = \frac{d'lat}{42}$

d'lat = 14.4'S

$\sin CO = \frac{dep}{dist}$

$\sin 70° = \frac{dep}{42}$

dep = 39.5'W

$\cos lat = \frac{dep}{d'long}$

$\cos 48°30' = \frac{39.5}{d'long}$

d'long = 59.6'W

59.5

0830 DR lat : 48° 30'N

d'lat : 14.4'S

1130 DR Lat : 48° 15.6'N

m'lat : 48° 22.8'N

0830 DR long : 024° 20'W

d'long : 59.5 W

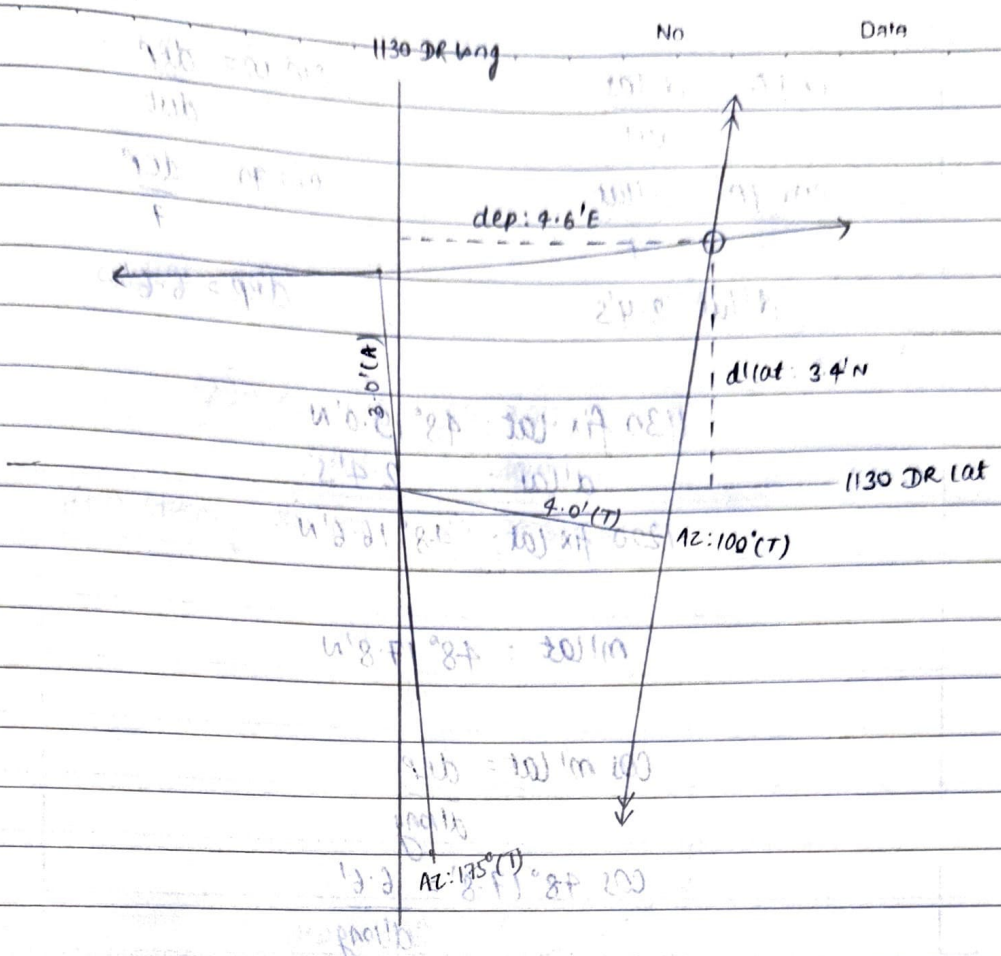
1130 DR long : 025° 19.5'W

0830 Intercept : 4'(T), AZ : 100°(T)

PL : 010° - 090°

1130 Intercept : 3'(A), AZ : 175°(T)

PL : 85° - 265°



1130 DR lat : 48°15.6'N

dlat : 3.4'N m'lat : 48°17.3'N

1130 fix lat : 48°19.0'N

$\cos m'lat = \frac{dep}{dlong}$

$\cos 48°17.3' = \frac{4.6'}{d'long}$

$d'long = 6.9'E$

1130 DR long : 025°19.5'W

d'long : 6.9'E

1130 fix long : 025°12.6'W

Ship position at 1130 HRS: 48°19.0'N 025°12.6'W

Apply run for 30 mins

CO : 250°(T) / S 70°W

dist : 7 NM

$\cos co = \frac{d'lat}{dist}$ $\quad \sin co = \frac{dep}{dist}$

$\cos 70° = \frac{d'lat}{7}$ $\quad \sin 70° = \frac{dep}{7}$

$d'lat = 2·4's$ $\quad dep = 6·6'w$

1130 fix Lat: 48° 19·0'N
d'Lat: 2·4'S
1200 fix Lat: 48° 16·6'N

m'lat: 48° 17·8'N

$\cos m'lat = \frac{dep}{d'long}$

$\cos 48° 17·8' = \frac{6·6'}{d'long}$

$d'long = 9·9'w$

1130 fix long: 025° 12·6'W
d'long: 9·9'W
1200 fix long: 025° 22·5'W

1200 Fix position: 48° 16·6'N 025° 22·5'W

② At 1200 hrs Latitude by meridian altitude of sun was found to be 20° 30's, vessel then sailed on a course 210°(T) x distance 30 N·M On completion of steaming an intercept of sun was observed Az 330°(T) x 4'A, DR position of the ship Lat: 21° 00'S long: 20° 30'W was used for intercept calculation. Find vessel initial and final position.

Soln:-

Co: 210°(T)
S 30°W
Dist: 30 N·M

$\cos co = \frac{d'lat}{dist}$ $\sin co = \frac{dep}{dist}$

$\cos 30° = \frac{d'lat}{30}$ $\sin 30° = \frac{dep}{30}$

d'lat : 26's dep : 15'W

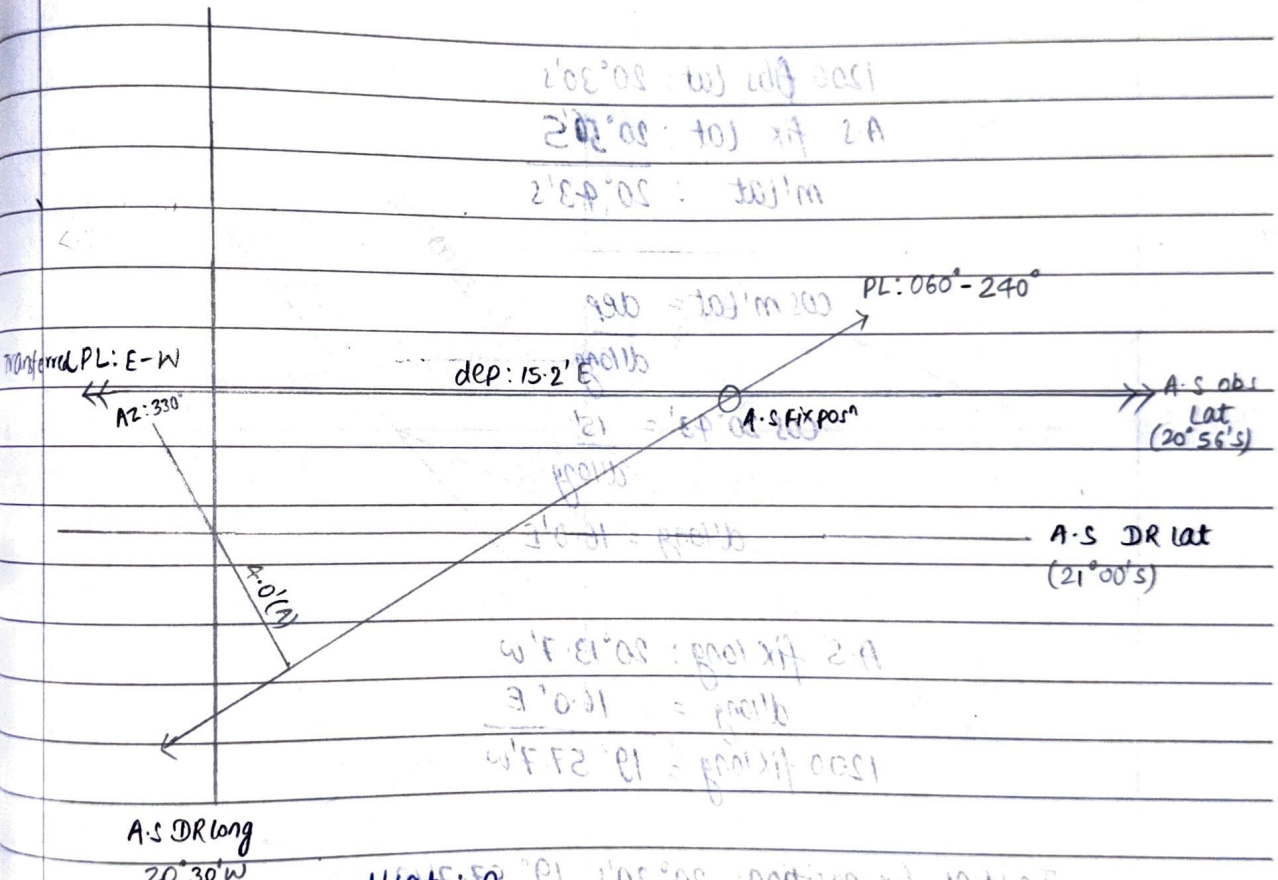
↓

15'E (in reverse)

1200 obs lat : 20° 30's

d'lat : ~~30's~~ 26's

After steaming obs lat : ~~20° 00's~~ 56's



d'lat: 0

So, Final Lat: 20°56's

dep: 15·2'E

$\cos lat = \frac{dep}{d'long}$

$\cos 20°56' = \frac{15·2'}{d'long}$

d'long = 16·3'E

A·S DR long: 20° 30'W
d'long : 16·3'E
Final fix long: 20°13·7'W

Final fix position: 20° 56'S 20°13·7'W

Since we don't have Initial DR long, we have to workout in reverse from Final OBS long.

Hence dep = 15'E

1200 Obs Lat: 20°30'S
A·S fix Lat : 20°56'S
m'Lat : 20°43'S

$$\cos m'Lat = \frac{dep}{d'long}$$

$$\cos 20°43' = \frac{15'}{d'long}$$

$$d'long = 16·0'E$$

A·S fix long: 20°13·7'W
d'long = 16·0'E
1200 fix long = 19° 57·7'W

Initial fix position: 20°30'S 19° 57·7'W

③ OCT 2016 At 1800 hrs on a certain day DR position of a vessel was 22°37'N 028°47'W. At 1750 hrs STAR 'A' gave an intercept 5·1'(T) and azimuth 129°(T). At 1813 hrs STAR 'B' gave an intercept 2·1'(A) azimuth 048°(T). Both the sight were worked using 1800 hrs DR posn. Find the position of the vessel at 1800 hrs if the vessel was steaming on a course 293°(T) at a speed of 22Kts.

Sol:-

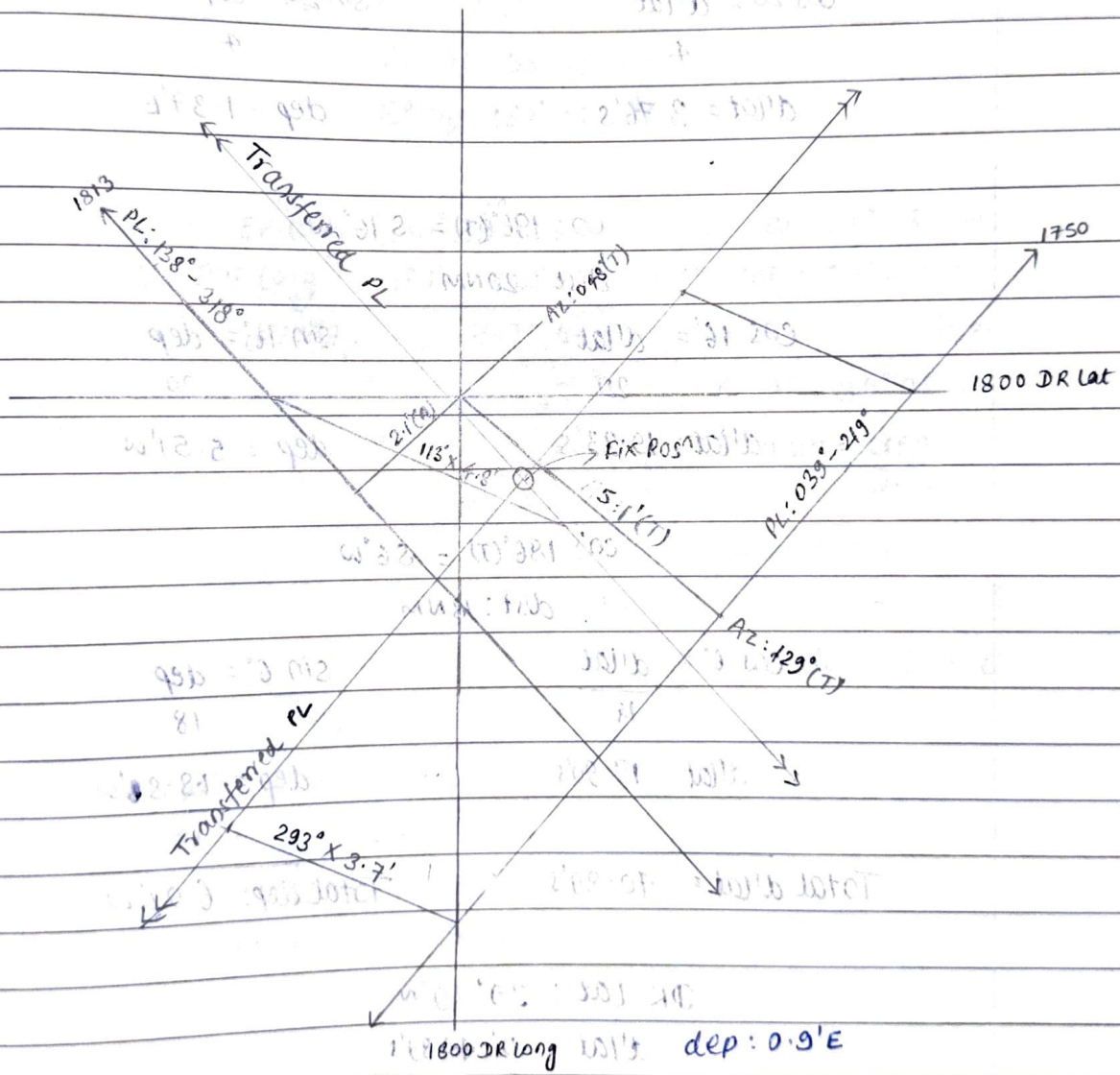
1800 DR Posn: 22° 37'N
028° 47'W

Intercept At 1750: 5·1'(T)
Az: 129°(T)

Forward Run: CO: 293°(T)
dist: $\frac{22}{60} \times 10 = 3.7$

Intercept At 1813: 2·1'(A)
Az: 048°(T)

Reverse Run: CO: 113°(T) (293-180)
dist: $\frac{22}{60} \times 13 = 4.8$ NM



dep: 0·9'E

d'lat: 1·2'S

1800 DR Lat: 22°37'N
1800 fix lat: 22° 35·8'N
m'lat: 22° 36·4'N

cos m'lat = dep/d'long
cos 22°36·4' = 0·9/d'long
d'long = 1·0'E

1800 DR long = 028°47'W
1800 Fix long = 028°46'W

1800 fix position: 22° 35·8'N 028° 46'W

④ SEP 2021 In DR position 39°39'N, 130°47'E, an observation of the sun gave an intercept 4 n.m towards, bearing 160°(T). A second observation using Latitude 39°09'N gave a longitude of 130°47'E, bearing 200°(T). Find the ship's position at the time of second observation, if during this interval the ship travelled 196°(T) × 20 miles and 186°(T) × 18 miles.

Soln:-

CO : 160°(T) = S 20°E

Dist : 4 NM

$\cos CO = \frac{d'lat}{dist}$ $\sin CO = \frac{dep}{dist}$

$\cos 20° = \frac{d'lat}{4}$ $\sin 20° = \frac{dep}{4}$

d'lat = 3·76's dep = 1·37'E

CO : 196°(T) = S 16°W

dist : 20 NM

$\cos 16° = \frac{d'lat}{20}$ $\sin 16° = \frac{dep}{20}$

d'lat = 19·23's dep = 5·51'W

CO : 186°(T) = S 6°W

dist : 18 NM

$\cos 6° = \frac{d'lat}{18}$ $\sin 6° = \frac{dep}{18}$

d'lat = 17·90's dep = 1·8·8·2'W

Total d'lat = 40·89's Total dep: 6·02'W

DR Lat : 39°39'N

d'lat : 0° 40·89's

EP Lat : 38° 58·11' N

m'Lat : 39° 18·5'N

$\cos m'Lat = \frac{dep}{d'long}$

$\cos 39^\circ 18.5' = \frac{6.02}{d'long}$

$d'long = 7.78'W$

DR long : 130° 47' E
d long : 7.78' W
EP long : 130° 39.22' E

Intercept: Azimuth : 160° (T)

① PL : 070° - 250°
EP Lat : 38° 58.11' N
EP long : 130° 39.22' E

EP long : 130° 39.22' E
2nd Obs long : 130° 47.00' E
d'long : 7.78' E

EP lat : 38° 58.11' N
2nd DR Lat : 39° 09' N
d'lat : 10.89' N
m'lat : 39° 03.5'

$\cos m'lat = \frac{dep}{d'long}$

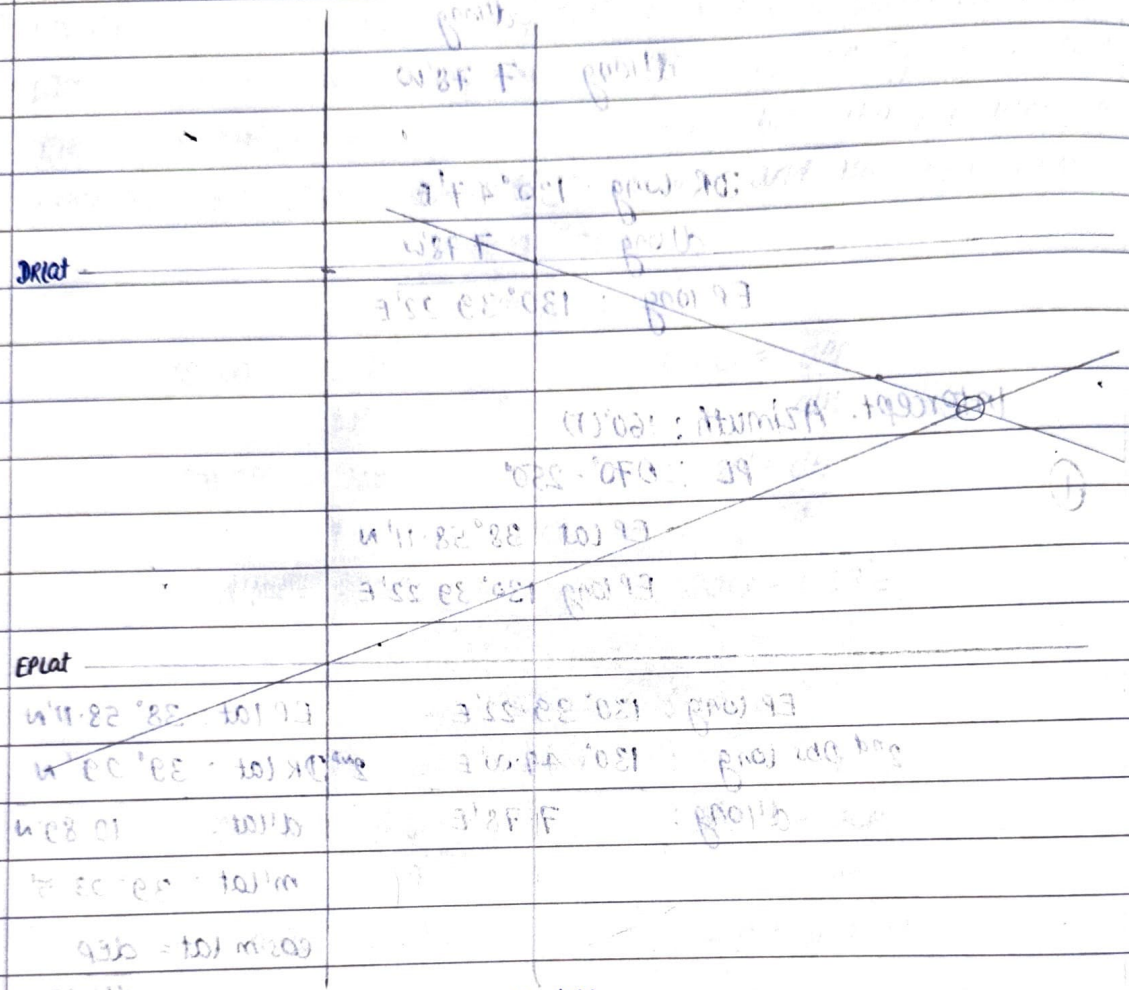
$\cos 39^\circ 03.5' = \frac{dep}{7.78'}$

$dep = 6.04' E$

② Azimuth : 200° (T)
PL : 110° - 290°
DR Lat : 39° 09' N
Obs long : 130° 47' E

PLOTTING AT NEXT PAGE

No. Date



d'lat: 4.6'S dep: 12.6'E

DR lat: 39° 09'N

d'lat: 4.6'S

Fix lat: 39° 4.4'N

m'lat: 39° 06.7'

cos m'lat = dep / d'long

cos 39° 06.7' = 12.6' / d'long

d'long = 16.24'E

Obs long: 130° 47'E

16.24'E

130° 3.24'

No. 155 Date 07-05-25

(5) At 1500 hrs, a point of land in position 50°20'N, 007°18'W, bore 072°(C), while steering a course 292°(C), deviation 2°E, variation 4°W at 18 Kts, through a current setting 010°(T) at 3 Kts. At 1800 hrs, a star sight then gave a bearing 245°(T), intercept 3·0'(T). DR position 50°44'N 008°34'W. was used for intercept calculation. Find ship's position at 1800 hrs

Soln:-

CO : 292°(C)

C.E : 2°W

T.CO : 290°(T) : N 70°W

dist : 18 Kts × 3 hrs = 54 NM

$\cos CO = \frac{d'lat}{dist}$ $\sin CO = \frac{dep}{dist}$

$\cos 70° = \frac{d'lat}{54}$ $\sin 70° = \frac{dep}{54}$

d'Lat : 18·47'N dep = 50·77'W

current : 010°(T) : N 10°E

dist : 3 Kts × 3 hr = 9 NM

$\cos 10° = \frac{d'lat}{9}$ $\sin 10° = \frac{dep}{9}$

d'lat = 8·86'N dep = 1·56'E

Total d'lat : 27·33'N Total dep = 49·18'W

1500 land lat : 50° 20'N

d'lat : 27·33'N

1800 land lat (transferred) : 50°47·33'N

m'lat : 50° 33·6'N

$\cos m'lat = \frac{dep}{d'long}$

$\cos 50°33·6' = \frac{49·18'}{d'long}$

d'long = 1° 17·4'W

1500 land long : 007° 18'W

d'long : 001° 17·4'W

1800 transferred land long : 008° 35·4'W.

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1800 transferred land pos^n : 50° 47·33'N
008° 35·40'W

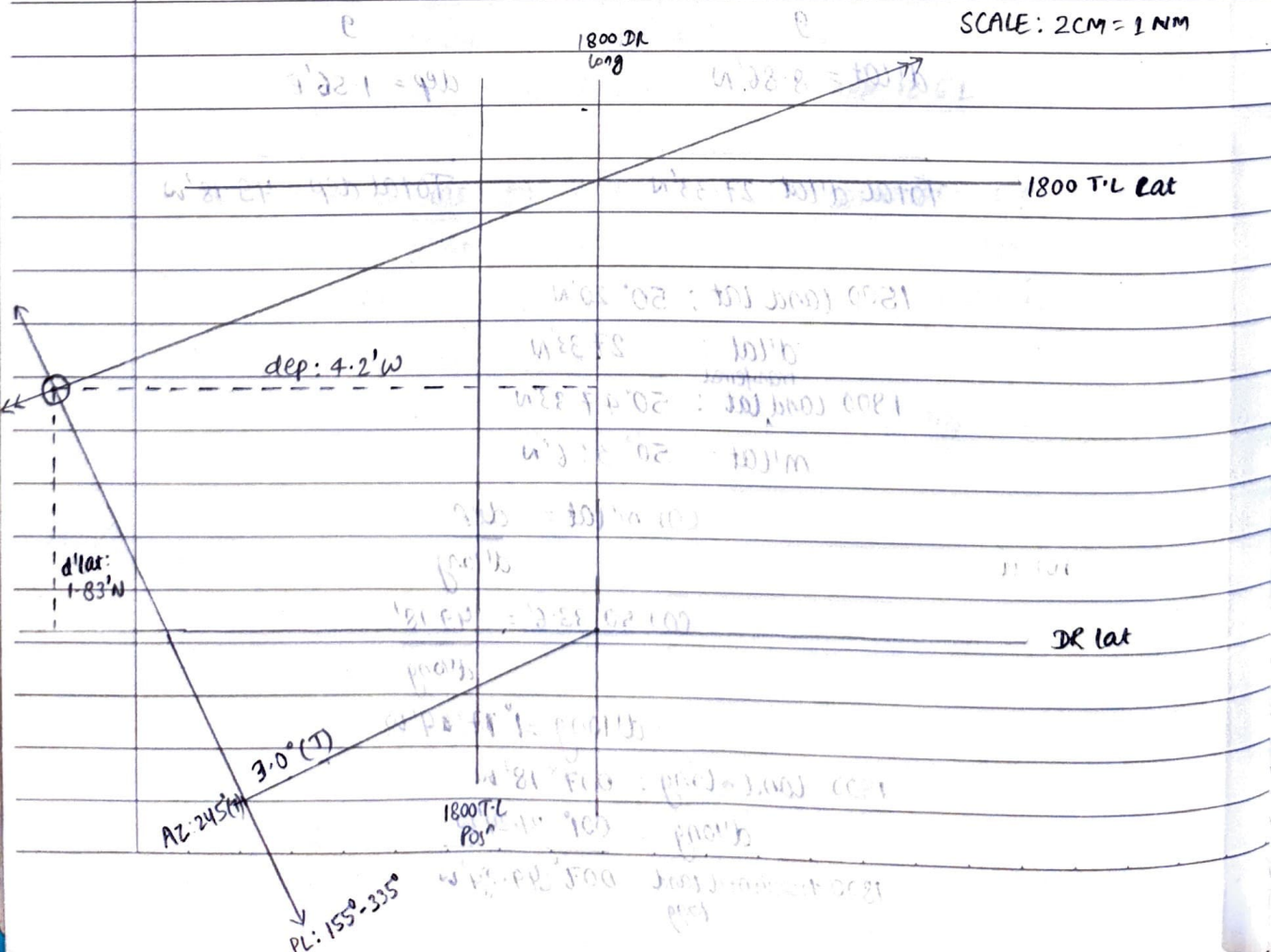
Brg : 072°(C)
CE : 2°W
Brg : 070°(T) ↳ this is terrestrial brg

1800 DR lat : 50° 44'N
DR long : 008° 34'W
Intercept : 3·0°(T)
Brg 245°(T) = 155° - 335°

50° 47·33'N	008° 35·4'W
50° 44' N	008° 34' W
d'lat : 3·33' S	d'long : 1·4' E

m'lat : 50° 45·67'

cos m'lat = dep/d'long
cos 50° 45·67' = dep/1·4
dep = 0·89'E



1800 DR Lat : 50° 44'N
d'lat : 1·83'N
1800 fix Lat : 50° 45·83'N
m'lat : 50° 44·92'N

cos m'lat = dep / d'long

cos 50° 44·92' = 4.2 / d'long

d'long = 6·64'W

1800 DR long : 008° 34'W
d'long : 6·64'W
1800 fix long : 008° 40·64'W

1800 Fix position : 50° 45·83'N 008° 40·64'W

(6) On 29th November 1992 at GMT 06H 16M 00S, The true attitude of SUN was 89° 26'. The vessel was on course of 270°(T) at a speed of 22·5 Kts. Exactly four minutes Later, the true attitude of sun was again 89° 26'. Find the position of the vessel at the time of second observation if the sun passed south of the observer at the time of meridian passage.

GMT : 29D 06H 16M 00S

1st observation :-

GHA (29d 06h) : 272° 54·6'
Increment (16m 00s) : 4° 00·0'
GHA SUN : 276° 54·6'
Long : 083° 05·4'E (If 180° to 360°, substract from 360° & name E)

Declination (29d 06h) : 21° 31·5'S
d(0·4) : (+) 0·1'
Declination, SUN : 21° 31·6'S i.e. Latitude

T. alt of SUN : 89° 26'
TZD : 34'

~~2ND OBS: After 4 minutes~~

1ST Obs Lat: 21° 31·6' S

1st Obs. Long: 083° 05·4' E

↓ After 4 minutes 270°(T) × 22·5 Kts

CO: 270°

dist: $\frac{22.5}{60} \times 4 = 1.5$ NM

(Bcz Parallel Sailing CO:270) dist = dep = 1·5 NM

$\cos lat = \frac{dep}{dlong}$

$\cos 21°31.6' = \frac{1.5}{dlong}$

dlong = 1·61' W

1st obs. long: 083° 05·4' E

d'long: 1·61' W

After 4 min 1st obs long: 083° 3·79' E

After 4 min 1st obs Lat: 21° 31·6' S } TZD: 34'

long: 083° 3·79' E

2ND OBS: For 1hr = 60 min is 15°

1 min is 15/60

4 min is 15/60 × 4 = 1°

1st Obs GHA: 276° 54·6'

After 4 min: 1° 00·0'

2nd obs GHA: 277° 54·6'

Long: 82° 5·4' E

Since d correction is very less for 1 hr

So for 4 min it is negligible

Lat: 21° 31·6' S

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2nd Obs Lat: 21° 31·6'S
long: 82° 5·4'E } TZD = 34'

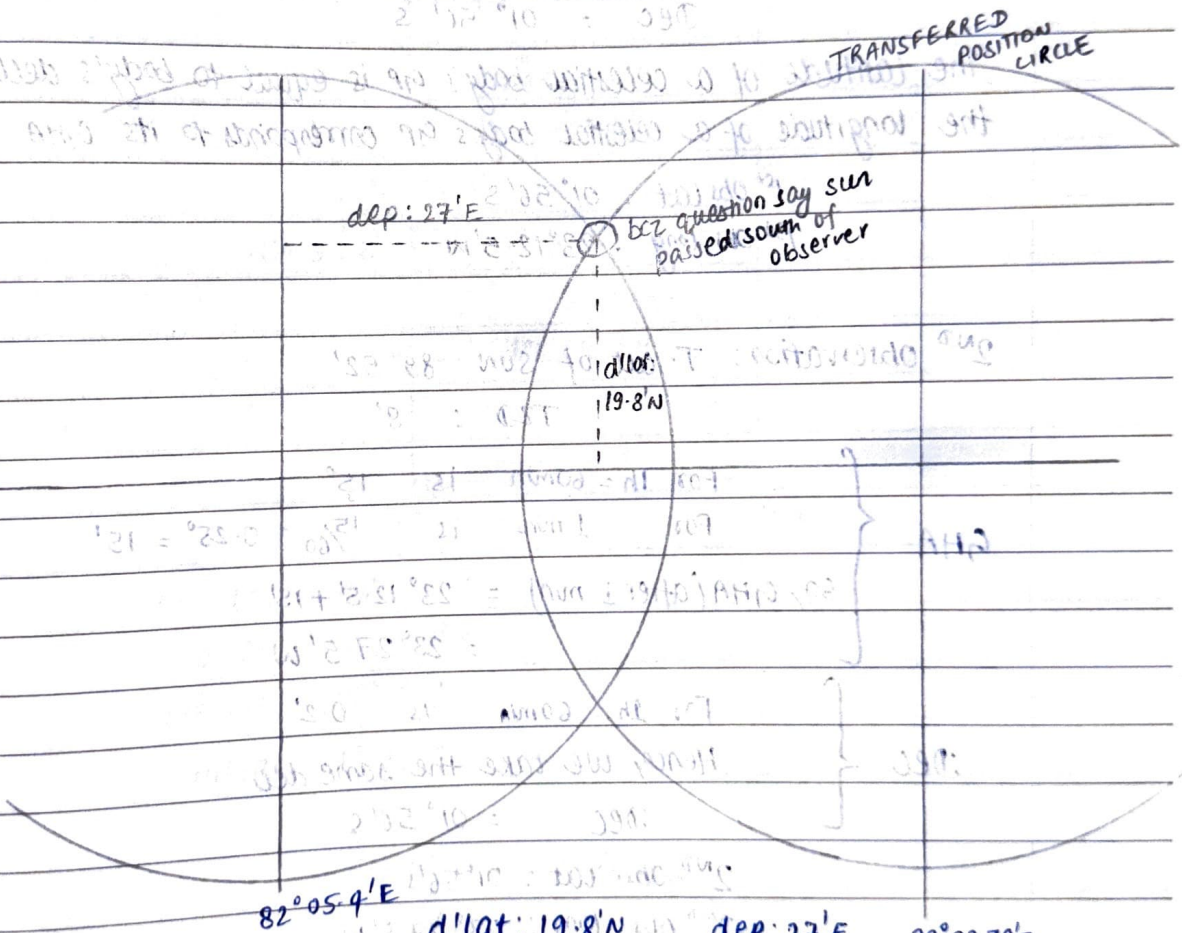
d'long = 58·4'W

cos m'Lat = dep/d'long

cos 21° 31·6' = dep/58·4'

dep = 54·3'W

54·3' = 9·05 CM ÷6



Obs Lat: 21° 31·6'S

d'lat: 19·8'N

Fix Lat: 21° 11·8'S

m'Lat: 21° 21·7'

cos m'Lat = dep/d'long

cos 21° 21·7' = 27/d'long

d'long = 29·0'E

2nd long: 82° 05·4'E

d'long: 29·0'E

Fix long: 82° 34·4'E

Vessel pos^{n}:- 21° 11·8'S 082° 34·4'E ANS

(7) An observer on an anchored vessel, obtained the true altitude of SUN as 89°46', when SUN's GHA was 23°12.5' and declination was 01°56'S. The true altitude of the sun obtained exactly 1 minute later was 89°52'. If during the interval, the sun crossed the observer's meridian to his north, Find the ship's position by plotting.

Soln:-

1st observation: T. alt of SUN = 89°46'

TZD = 90° - 89°46'

= 14'

GHA = 23°12.5' (W) 0° to 180°, Long W

Dec = 01°56' S

the Latitude of a celestial body's GP is equal to body's declination

the longitude of a celestial body's GP corresponds to its GHA

1st Obs Lat : 01°56'S

1st Obs. long : 23°12.5'W

2ND observation: T. alt of SUN : 89°52'

TZD : 8'

GHA

For 1h = 60min is 15°

For 1 min is 15/60 = 0.25° = 15'

So, GHA (after 1 min) = 23°12.5' + 15'

= 23°27.5'W

Dec

For 1h = 60min is 0.2'

Hence, we take the same dec

Dec = 01°56'S

2ND Obs. Lat : 01°56'S

2ND Obs. long : 23°27.5'W

$$\cos m'\text{Lat} = \frac{\text{dep}}{\text{d'long}}$$

$$\cos 01°56' = \frac{\text{dep}}{15'}$$

dep = 14.99'W

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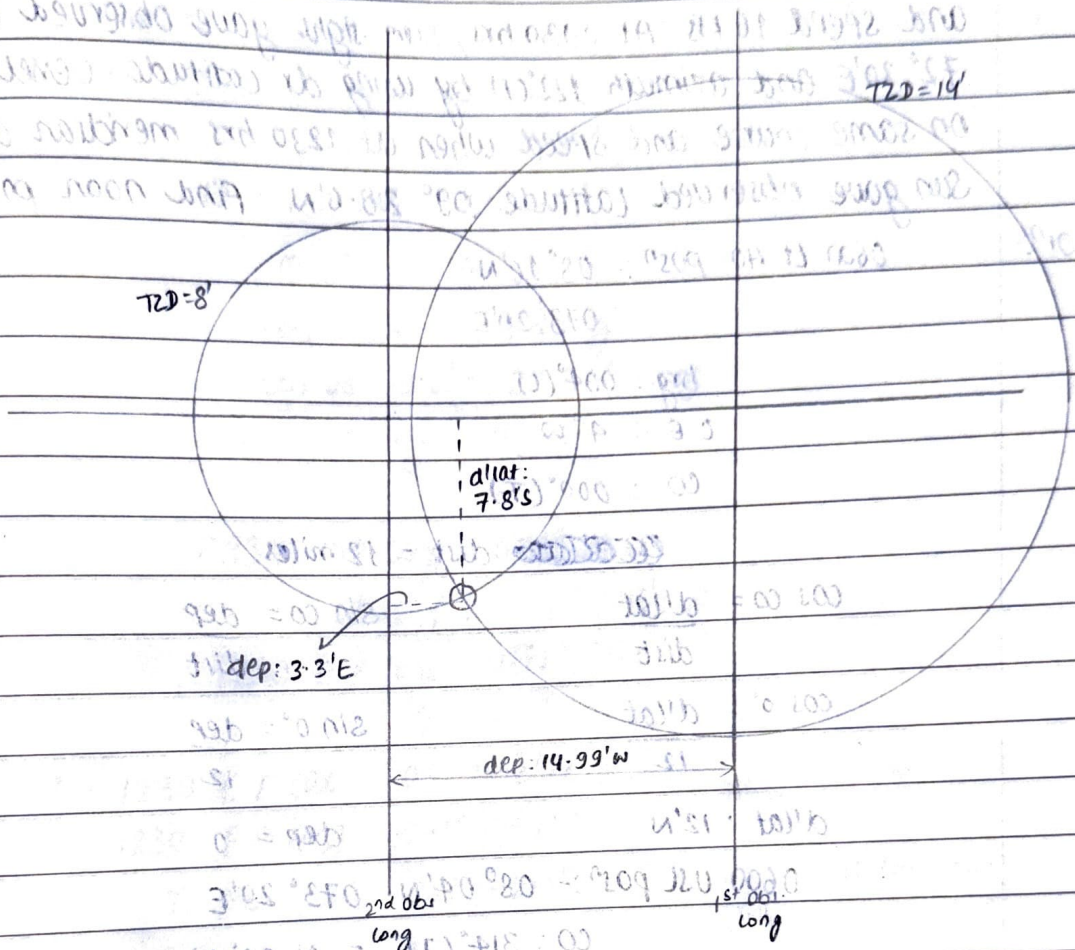
3CM = 1NM (3)



Obs Lat : 01° 56'S

d'lat : 7·8'S

Fix Lat : 02° 3·8'S

m'lat : 1° 59·8'

5cm = 15'

cos m'Lat = dep/d'long

cos 1° 59·8' = 3·3/d'long

d'long = 3·30'E

2nd obs long : 23° 27·5'W

d'long 3·3'E

Fix long : 23° 24·2'W

Ship's position : 02° 3·8'S 23° 24·2'W

Ans

(B) At 0600 hrs MINICOY ISLAND LT HO (08°16'N, 73°20'E) bore 004°(C), C.E: 4°W, distance 12 miles. Course was then altered to 314°(T) and speed 16 Kts. At 0930 hrs, sun sight gave observed longitude 72°30'E and azimuth 122°(T) by using dr latitude. Vessel continued on same course and speed when at 1230 hrs meridian altitude of sun gave observed latitude 09°28.6'N. Find noon position.

Soln:-

0600 Lt HO posn :- 08°16'N
073°20'E

brg : 004°(C)
C.E : 4°W
CO : 000°(T)
dist = 12 miles

$\cos CO = \frac{d'lat}{dist}$ $\sin CO = \frac{dep}{dist}$

$\cos 0° = \frac{d'lat}{12}$ $\sin 0° = \frac{dep}{12}$

d'lat : 12'N dep = 0

0600 USL posn :- 08°04'N 073°20'E

CO : 314°(T) = N 46°W

dist : 16 Kts × 3.5 hrs = 56 NM

$\cos 46° = \frac{d'lat}{56}$ ~~$\sin 46° = \frac{dep}{56}$~~

d'lat = 38.9'N ~~dep = 40.25W~~

0600 lat : 08°04'N ~~Total dep = 40.25W~~
d'lat : 38.9'N
0930 lat : 08°42.9'N 0930 Obs long : 072°30'E

0930 USL posn :- 08°42.9'N 072°30'E
Az : 122°(T)
PL : 032° – 212°

Again vessel continue on same CO & spd
CO : 314°(T) = N 46°W
dist : 16 Kts × 3 hrs = 48 NM

$\cos 46 = \frac{d'lat}{48}$ $\sin 46° = \frac{dep}{48}$

d'lat = 33.34'N dep = 34.53' W

0930 E.P Lat : 08° 42.9'N

d'lat : 33.34'N

1230 E.P Lat : 09° 16.2'N

m'Lat : 08° 59.6'

cos m'Lat = dep/d'long

cos 08° 59.6' = 34.53/d'long

d'long = 34.96' W

0930 E.P long : 072° 30'E

d'long : 34.96' W

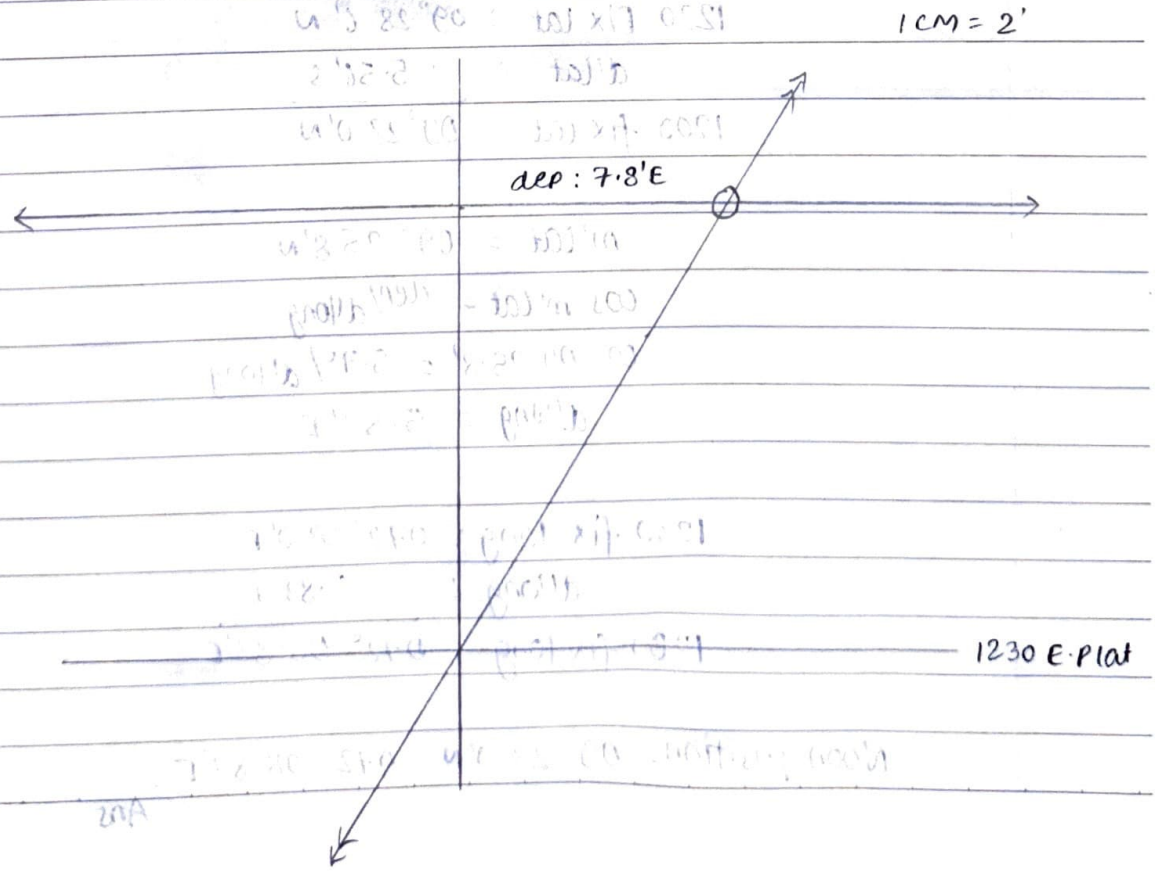
1230 E.P long : 071° 55.1'E

1230 E.P Lat : 09° 16.2'N

1230 E.P long : 071° 55.1'E

8 T. PL : 032° - 212° d'lat : 12.4'

1230 Obs Lat : 09° 28.6'N



1230 Fix lat: 09° 28·6'N

cos Lat = dep/d'long

cos 09°28·6' = 7·8/d'long

d'long = 7·9'E

1230 E·P long: 071° 55·1'E

d'long: 7·9'E

1230 fix long: 072° 03·0'E

1230 Fix long: 072° 03·0'E

Reverse run: (1230 to 1200)

CO: 134°(T) = S46°E CO: 314°

dist: 16 Kts x 0·5 = 8 NM

$\cos co = \frac{d'lat}{dist}$ $\sin co = \frac{dep}{dist}$

$\cos 46° = \frac{d'lat}{8}$ $\sin 46° = \frac{dep}{8}$

d'lat = 5·56'S dep = 5·75'E

1230 Fix lat: 09° 28·6'N

d'lat: 5·56'S

1200 fix lat: 09° 23·0'N

m'Lat = 09° 25·8'N

cos m'Lat = dep/d'long

cos 09°25·8' = 5·75/d'long

d'long = 5·83'E

1230 fix long: 072° 03·0'E

d'long: 5·83'E

1200 fix long: 072° 08·83'E

Noon position: 09° 23·0'N 072° 08·83'E

// Ans

No. 165 Date 09.05.2025

⑨ While steering a course 090°(T) x 20 Kts, the following celestial observation were obtained and worked out using a DR position 19° 56'N, 045° 41'E and following results were obtained:

1809 HRS : VENUS --- INTERCEPT 0.6'(T) --- Azimuth - 239°(T)

1805 HRS : ALTAIR --- INTERCEPT 5.4'(T) --- Azimuth - 270°(T)

1822 HRS : DENEB --- INTERCEPT 4.4'(T) --- Azimuth 315°(T)

Find the position of the vessel at 1815 hrs

60 min = 20 Kts

∴ $\frac{20}{60}$ x

Soln:-

(i) VENUS at 1809 hrs

CO: 090°

dist: 20 Kts x 6 min = 2 NM

Fwd run: 090° x 2 NM

(ii) Altair @ 1805 hrs

CO: 090°

dist: 20 Kts x 10 min = 3.33 NM

Fwd run = 090° x 3.33 NM

(iii) Deneb @ 1822 hrs

CO: 270° (reverse)

dist: 20 Kts x 7 min = 2.33 NM

Reverse run = 270° x 2.33 NM

No. Date