Navigation Quiz Answers

You & four friends (Tom, Bob, Don & Rick) are on a cruise ship. Each of you brought along your marine sextants, 2018 Nautical Almanacs, Texas Instruments Voyage 200 calculators and plotting materials to practice your celestial navigation skills. On August 17th 2018 just before sun set you spot a small island to the North West of your position. At 19:20:00 GMT using your sextant to measure the altitude of the Moon's lower limb, you find the sextant altitude to be 75° 18.5'. At the same time Tom measures the altitude for Antares and gets a sextant altitude of 71° 22.4', Bob obtains a sextant altitude for Rigel Kentarus of 35° 22.7', Don obtains a sextant altitude for Altar of 31° 37.9' & Rick obtains a sextant altitude for Arcturus of 51° 25.2'. Previously you had determined the upper observation deck of the cruise ship to be 88 feet above the water line. Your sextant's index correction, IC= -1.6', Tom's IC= -1.8', Bob's IC= -0.3', Don's IC= -0.4' & Rick's IC= -2.1'. The air temperature is 31°C & the pressure is 1005mb**.**

Nautical Almanac **data for August 17th 2018 for GMT = 19:00:00**

Moon GHA =23° 32.8' *v*=12.2 Dec 12° 24.1' S *d*=9.2 HP=56.3' Moon's declination is increasing with time

Aries GHA=251° 06.2'

Altar	SHA=062° 04.5'	Dec=08° 55.3' N
Antares	SHA=112° 21.9'	Dec=26° 28.2' S
Arcturus	SHA=145° 52.7'	Dec=19° 05.5' N
Rigel Kentarus	SHA=139° 47.1'	Dec=60° 54.7' S

For the Moon what is Total GHA _28° 23.3'_ , Dec _12° 27.2' S_, Ho_75° 37.4'_

For the Altar what is Total GHA_318° 11.5'_ , Dec _8° 55.3' N _ , Ho_31° 26.9'_

For the Antares what is Total GHA_ 8° 28.9'_ , Dec _26° 28.2' S_, Ho_71° 11.2'_

For the Arcturus what is Total GHA_41° 59.7'_ , Dec _19° 5.5' N_, Ho_51° 13.3'_

For the Rigel Kentarus what is Total GHA_35° 54.1'_ , Dec _60° 54.7' S_, Ho_35° 12.0_

Which bodies provide the best 2 body fix? _Moon_, _Antares_

Which bodies provide the best 3 body fix? _Altar_, _Arcturus_, _Rigel Kentarus _

What was your latitude & longitude @ 19:20:00 GMT for the 2 body fix? _8° 29.7' S_, _14° 19.6' W_

What was your latitude & longitude @ 19:20:00 GMT for the 3 body fix? _8° 29.9' S_, _14° 19.7' W_

What was your latitude & longitude @ 19:20:00 GMT for a 5 body fix using the method for determining position from intercept and azimuth by calculation? _8° 29.7' S_, _14° 19.7' W _

(See Nautical Almanac Page 282 paragraph 11)

What island did you spot to the North West just prior to sun set? _ Ascension _

Note: The 2 body & 3 body fix was found using the intersections of Circles of Equal Altitude

Worksheet for checking data on the front of USPS SR 96a & SR 96b Forms

Data From "Nav Bodies" Worksheet

© Use "Nav Bodies" Worksheet to specify DR Position, Date & Time

Date & MeanTime @ Greenwich		Date & Zone Time @ DR Position	
17-Aug-18	19:20:00	17-Aug-18	18:20:00

Enter SHA, GHA, *v*, DEC & *d* for the Body from the *Nautical Almanac* for the Greenwich Date shown in cell D2 and GMT shown in Cell E2 above.

GMT	19 hr.	20 min.	0 sec.		
SHA of Star		deg.		min.	
19 hr. → GHA	23	deg.	32.8	min.	19 hr.
	4	deg.	46.3	min.	
20 min.	0 sec.				
v	12.2	v corr	4.2	min.	
Total GHA	28	deg.	23.3	min.	
DR Lo	14	deg.	20.0	min.	W
LHA	14	deg.	3.3	min.	

Results shown in the turquoise cells for Ho, Hc, EP L & EP Lo are not valid until *Nautical Almanac* values of GHA , *v*, DEC, *d* & SHA for the body are entered for the Date, Time & Position specified in the "Nav Bodies" Worksheet & shown in the purple cells above.

Nautical Almanac GHA Increments

	20 min.	0 sec.	
SUN & Planets	5 deg.	0.0 min.	
ARIES	5 deg.	0.8 min.	
MOON	4 deg.	46.3 min.	

& corrections

v corr 4.2 min. d corr 3.1 min.

Sun SD Option	Average SD		Include OB correction for Moon	No	
Body	MOON	Limb	LL	Sight No.	Me
DR L	8 deg.	30.0 min.		S	
DR Lo	14 deg.	20.0 min.		W	
DEC	12 deg.	24.1 min.		S	
d	9.2	d corr	3.1 min.		
DEC	12 deg.	27.2 min.		S	
LHA	14.05447 deg.	DEC	12.45406 deg.		
Hc	75.62935 deg.	Lat	8.50000 deg.		
		Z	S 72.83	W	
EP Lat	8 deg.	29.89 min.		S	
EP Lon	14 deg.	19.65 min.		W	

Enter data into yellow cells. To Clear User Data Cells, Click On This Box

Use the "Sight Reduction" worksheet for checking the Diagram on the Plane of the Observer's Celestial Meridian, the Time Diagram & data on the back of ED SR 96a "Sight Reduction by NASR Method" & ED SR 96b "Sight Reduction Tables for Marine Navigation H.O. PUB. NO. 229"

Height of eye	88.0 ft.		
hs	75 deg.	18.5 min.	
	(+)	(-)	
IC	min.	1.6 min.	
Dip		9.1 min.	
(±) Totals	0.0 min.	10.7 min.	
Corr	-10.7 min		
Ha	75 deg.	7.8 min	
Moon's HP		56.3 min	
	(+)	(-)	
Main	25.3 min.	0.0 min.	
Add'l M, Pl	4.3 min.	0.0 min.	
If Body is UL of Moon	-30.0'	0.0 min.	
Add'l Ref.	0.0 min.	0.0 min.	
(±) Totals	29.6 min.	0.0 min.	
Corr	29.6 min		
Ho	75 deg.	37.4 min.	
Hc	75 deg.	37.8 min.	
a	0.4 n. mi.	Away	
Zn	253 deg.		

Click on this box to save the data needed for plotting the LOP on a CLS 98 Form

Selcet Method for Calculating Dip Short	USPS	Height of eye	88	Feet	
Horizon	Natural	Distance to Visible Horizon	22230	Yards	
For sight taken on a natural horizon: Dip =	9.10 min	Dip	9.10	min.	
Dip Short Distance		Yards			
Atmospheric Pressure	1005 mb	Add'l Ref. Correction (R_0 -R) =	0.0	min.	
Air Temperature	31 ° C				

Increment Main Correction by 0.0 min.

Increment Add'l M, Pl Correction by 0.0 min.

Use $Ha_{Avg.}$ for calculating Additional LL & UL correction for Moon No

Body MOON data shown in this box was calculated by the "Nav Bodies" worksheet.

Hc 75 deg. 37.87 min.

Total GHA 28 deg. 23.22 min.

Note: Check the value of Hc shown in Cells T25 & V25 with the value of

Worksheet for checking data on the front of USPS SR 96a & SR 96b Forms

Use "Nav Bodies" Worksheet to specify DR Position, Date & Time

Date & MeanTime @ Greenwich		Date & Zone Time @ DR Position	
17-Aug-18	19:20:00	17-Aug-18	18:20:00

Enter SHA, GHA, *v*, DEC & *d* for the Body from the *Nautical Almanac* for the Greenwich Date shown in cell D2 and GMT shown in Cell E2 above.

GMT	19	hr.	20	min.	0 sec.
SHA of Star	62	deg.	4.5	min.	
19 hr. → GHA	251	deg.	6.2	min.	19 hr.
	5	deg.	0.8	min.	
20 min. 0 sec.					
v	0.0	v corr	0.0	min.	
Total GHA	318	deg.	11.5	min.	
DR Lo	14	deg.	20.0	min.	W
LHA	303	deg.	51.5	min.	

Results shown in the turquoise cells for Ho, Hc, EP L & EP Lo are not valid until *Nautical Almanac* values of GHA , *v*, DEC, *d* & SHA for the body are entered for the Date, Time & Position specified in the "Nav Bodies" Worksheet & shown in the purple cells above.

Nautical Almanac GHA Increments

	20	min.	0	sec.
SUN & Planets	5	deg.	0.0	min.
ARIES	5	deg.	0.8	min.
MOON	4	deg.	46.3	min.

& corrections

v corr 0.0 min. d corr 0.0 min.

Data From "Nav Bodies" Worksheet

Sun SD Option	Average SD		Include OB correction for Moon	No	
Body	ALTAIR	Limb		Sight No.	Don
DR L	8	deg.	30.0	min.	S
DR Lo	14	deg.	20.0	min.	W
DEC	8	deg.	55.3	min.	N
d	0.0	d corr	0.0	min.	
DEC	8	deg.	55.3	min.	N
LHA	303.85833	deg.	DEC	-8.92167	deg.
Hc	31.42836	deg.	Lat	8.50000	deg.
			Z	S 105.97	E
EP Lat	8	deg.	29.67	min.	S
EP Lon	14	deg.	18.84	min.	W

Enter data into yellow cells. To Clear User Data Cells, Click On This Box

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Height of eye	88.0	ft.		
hs	31	deg.	37.9	min.
	(+)		(-)	
IC		min.	0.4	min.
Dip			9.1	min.
(±) Totals	0.0	min.	9.5	min.
Corr	-9.5	min		
Ha	31	deg.	28.4	min
Moon's HP				min
	(+)		(-)	
Main	0.0	min.	1.6	min.
Add'l M, Pl	0.0	min.	0.0	min.
If Body is UL of Moon -30.0'			0.0	min.
Add'l Ref.	0.1	min.	0.0	min.
(±) Totals	0.1	min.	1.6	min.
Corr	-1.5	min		
Ho	31	deg.	26.9	min.
Hc	31	deg.	25.7	min.
a	1.2	n. mi.	Toward	
Zn	74	deg.		

Selcet Method for Calculating Dip Short	USPS		Height of eye	88	Feet
Horizon	Natural		Distance to Visible Horizon	22230	Yards
For sight taken on a natural horizon: Dip =	9.10	min	Dip	9.10	min.
Dip Short Distance		Yards			
Atmospheric Pressure	1005	mb	Add'l Ref. Correction (R_0 -R) =	0.1	min.
Air Temperature	31	° C			

Click on this box to save the data needed for plotting the LOP on a CLS 98 Form

Increment Main Correction by 0.0 min.

Increment Add'l M, Pl Correction by 0.0 min.

Use $Ha_{Avg.}$ for calculating Additional LL & UL correction for Moon: No

Body	ALTAIR	data shown in this box was calculated by the "Nav Bodies" worksheet.	Hc	31 deg.	25.77 min.
			Total GHA	318 deg.	11.56 min.

Note: Check the value of Hc shown in Cells T25 & V25 with the value of

Worksheet for checking data on the front of USPS SR 96a & SR 96b Forms

Data From "Nav Bodies" Worksheet

Use "Nav Bodies" Worksheet to specify DR Position, Date & Time

Date & MeanTime @ Greenwich		Date & Zone Time @ DR Position	
17-Aug-18	19:20:00	17-Aug-18	18:20:00

Enter SHA, GHA, *v*, DEC & *d* for the Body from the *Nautical Almanac* for the Greenwich Date shown in cell D2 and GMT shown in Cell E2 above.

GMT	19	hr.	20	min.	0 sec.
SHA of Star	112	deg.	21.9	min.	
19 hr. → GHA	251	deg.	6.2	min.	19 hr.
	5	deg.	0.8	min.	
20 min. 0 sec. *v*	0.0	v corr	0.0	min.	
Total GHA	8	deg.	28.9	min.	
DR Lo	14	deg.	20.0	min.	W
LHA	354	deg.	8.9	min.	

Results shown in the turquoise cells for Ho, Hc, EP L & EP Lo are not valid until *Nautical Almanac* values of GHA , *v*, DEC, *d* & SHA for the body are entered for the Date, Time & Position specified in the "Nav Bodies" Worksheet & shown in the purple cells above.

Nautical Almanac GHA Increments

	20	min.	0	sec.
SUN & Planets	5	deg.	0.0	min.
ARIES	5	deg.	0.8	min.
MOON	4	deg.	46.3	min.

& corrections

v corr 0.0 min. d corr 0.0 min.

Sun SD Option	Average SD		Include OB correction for Moon	No	
Body	ANTARES	Limb		Sight No.	Tom
DR L	8	deg.	30.0	min.	S
DR Lo	14	deg.	20.0	min.	W
DEC	26	deg.	28.2	min.	S
d	0.0	d corr	0.0	min.	
DEC	26	deg.	28.2	min.	S
LHA	354.14833	deg.	DEC	26.47000	deg.
Hc	71.19211	deg.	Lat	8.50000	deg.
			Z	S 16.44	E
EP Lat	8	deg.	29.69	min.	S
EP Lon	14	deg.	20.09	min.	W

Enter data into yellow cells. To Clear User Data Cells, Click On This Box

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Height of eye	88.0	ft.	
hs	71 deg.	22.4	min.
	(+)	(-)	
IC		1.8	min.
Dip		9.1	min.
(±) Totals	0.0 min.	10.9	min.
Corr	-10.9	min	
Ha	71 deg.	11.5	min
Moon's HP		min	
	(+)	(-)	
Main	0.0 min.	0.3	min.
Add'l M, Pl	0.0 min.	0.0	min.
If Body is UL of Moon	-30.0'	0.0	min.
Add'l Ref.	0.0 min.	0.0	min.
(±) Totals	0.0 min.	0.3	min.
Corr	-0.3	min	
Ho	71 deg.	11.2	min.
Hc	71 deg.	11.5	min.
a	0.3 n. mi.	Away	
Zn	164	deg.	

Click on this box to save the data needed for plotting the LOP on a CLS 98 Form

Selcet Method for Calculating Dip Short	USPS	Height of eye	88	Feet	
Horizon	Natural	Distance to Visible Horizon	22230	Yards	
For sight taken on a natural horizon: Dip =	9.10	min	Dip	9.10	min.
Dip Short Distance		Yards			
Atmospheric Pressure	1005	mb	Add'l Ref. Correction (R_0 -R) =	0.0	min.
Air Temperature	31	° C			

Increment Main Correction by 0.0 min.

Increment Add'l M, Pl Correction by 0.0 min.

Use $Ha_{Avg.}$ for calculating Additional LL & UL correction for Moon: No

Body	ANTARES	data shown in this box was calculated by the "Nav Bodies" worksheet.	Hc	71 deg.	11.49 min.
			Total GHA	8 deg.	28.89 min.

Note: Check the value of Hc shown in Cells T25 & V25 with the value of

Worksheet for checking data on the front of USPS SR 96a & SR 96b Forms

Data From "Nav Bodies" Worksheet

© Use "Nav Bodies" Worksheet to specify DR Position, Date & Time

Date & MeanTime @ Greenwich		Date & Zone Time @ DR Position	
17-Aug-18	19:20:00	17-Aug-18	18:20:00

Enter SHA, GHA, *v*, DEC & *d* for the Body from the *Nautical Almanac* for the Greenwich Date shown in cell D2 and GMT shown in Cell E2 above.

GMT	19	hr.	20	min.	0 sec.
SHA of Star	145	deg.	52.7	min.	
19 hr. → GHA	251	deg.	6.2	min.	19 hr.
	5	deg.	0.8	min.	
20 min. 0 sec.					
v	0.0	v corr	0.0	min.	
Total GHA	41	deg.	59.7	min.	
DR Lo	14	deg.	20.0	min.	W
LHA	27	deg.	39.7	min.	

Results shown in the turquoise cells for Ho, Hc, EP L & EP Lo are not valid until *Nautical Almanac* values of GHA , *v*, DEC, *d* & SHA for the body are entered for the Date, Time & Position specified in the "Nav Bodies" Worksheet & shown in the purple cells above.

Nautical Almanac GHA Increments

	20	min.	0	sec.
SUN & Planets	5	deg.	0.0	min.
ARIES	5	deg.	0.8	min.
MOON	4	deg.	46.3	min.

& corrections

v corr 0.0 min. d corr 0.0 min.

Sun SD Option	Average SD		Include OB correction for Moon	No	
Body	ARCTURUS	Limb		Sight No.	Rick
DR L	8	deg.	30.0	min.	S
DR Lo	14	deg.	20.0	min.	W
DEC	19	deg.	5.5	min.	N
d	0.0	d corr	0.0	min.	
DEC	19	deg.	5.5	min.	N
LHA	27.66167	deg.	DEC	-19.09167	deg.
Hc	51.21010	deg.	Lat	8.50000	deg.
			Z	S 135.55	W
EP Lat	8	deg.	29.50	min.	S
EP Lon	14	deg.	20.49	min.	W

Enter data into yellow cells. To Clear User Data Cells, Click On This Box

Use the "Sight Reduction" worksheet for checking the Diagram on the Plane of the Observer's Celestial Meridian, the Time Diagram & data on the back of ED SR 96a "Sight Reduction by NASR Method" & ED SR 96b "Sight Reduction Tables for Marine Navigation H.O. PUB. NO. 229"

Height of eye	88.0	ft.	
hs	51 deg.	25.2	min.
	(+)	(-)	
IC		2.1	min.
Dip		9.1	min.
(±) Totals	0.0 min.	11.2	min.
Corr	-11.2	min	
Ha	51 deg.	14.0	min
Moon's HP		min	
	(+)	(-)	
Main	0.0 min.	0.8	min.
Add'l M, Pl	0.0 min.	0.0	min.
If Body is UL of Moon	-30.0'	0.0	min.
Add'l Ref.	0.1 min.	0.0	min.
(±) Totals	0.1 min.	0.8	min.
Corr	-0.7	min	
Ho	51 deg.	13.3	min.
Hc	51 deg.	12.6	min.
a	0.7 n. mi.	Toward	
Zn	316	deg.	

Selcet Method for Calculating Dip Short	USPS		Height of eye	88	Feet
Horizon	Natural		Distance to Visible Horizon	22230	Yards
For sight taken on a natural horizon: Dip =	9.10	min	Dip	9.10	min.
Dip Short Distance		Yards			
Atmospheric Pressure	1005	mb	Add'l Ref. Correction (R_0 -R) =	0.1	min.
Air Temperature	31	° C			

Click on this box to save the data needed for plotting the LOP on a CLS 98 Form

Increment Main Correction by 0.0 min.

Increment Add'l M, Pl Correction by 0.0 min.

Use $Ha_{Avg.}$ for calculating Additional LL & UL correction for Moon: No

Body	ARCTURUS	data shown in this box was calculated by the "Nav Bodies" worksheet.	Hc	51 deg.	12.62 min.
			Total GHA	41 deg.	59.70 min.

Note: Check the value of Hc shown in Cells T25 & V25 with the value of

Worksheet for checking data on the front of USPS SR 96a & SR 96b Forms

Data From "Nav Bodies" Worksheet

© Use "Nav Bodies" Worksheet to specify DR Position, Date & Time

Date & MeanTime @ Greenwich		Date & Zone Time @ DR Position	
17-Aug-18	19:20:00	17-Aug-18	18:20:00

Enter SHA, GHA, *v*, DEC & *d* for the Body from the *Nautical Almanac* for the Greenwich Date shown in cell D2 and GMT shown in Cell E2 above.

GMT	19	hr.	20	min.	0 sec.
SHA of Star	139	deg.	47.1	min.	
19 hr. → GHA	251	deg.	6.2	min.	19 hr.
	5	deg.	0.8	min.	
20 min. 0 sec.					
v	0.0	v corr	0.0	min.	
Total GHA	35	deg.	54.1	min.	
DR Lo	14	deg.	20.0	min.	W
LHA	21	deg.	34.1	min.	

Results shown in the turquoise cells for Ho, Hc, EP L & EP Lo are not valid until *Nautical Almanac* values of GHA , *v*, DEC, *d* & SHA for the body are entered for the Date, Time & Position specified in the "Nav Bodies" Worksheet & shown in the purple cells above.

Nautical Almanac GHA Increments

	20	min.	0	sec.
SUN & Planets	5	deg.	0.0	min.
ARIES	5	deg.	0.8	min.
MOON	4	deg.	46.3	min.

& corrections

v corr 0.0 min. d corr 0.0 min.

Sun SD Option	Average SD		Include OB correction for Moon	No	
Body	RIGIL KENTAURUS	Limb		Sight No.	BOB
DR L	8	deg.	30.0	min.	S
DR Lo	14	deg.	20.0	min.	W
DEC	60	deg.	54.7	min.	S
d	0.0	d corr	0.0	min.	
DEC	60	deg.	54.7	min.	S
LHA	21.56833	deg.	DEC	60.91167	deg.
Hc	35.19191	deg.	Lat	8.50000	deg.
			Z	S 12.63	W
EP Lat	8	deg.	30.47	min.	S
EP Lon	14	deg.	20.11	min.	W

Enter data into yellow cells. To Clear User Data Cells, Click On This Box

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Height of eye	88.0	ft.		
hs	35	deg.	22.7	min.
	(+)		(-)	
IC		min.	0.3	min.
Dip			9.1	min.
(±) Totals	0.0	min.	9.4	min.
Corr	-9.4	min		
Ha	35	deg.	13.3	min
Moon's HP				min
	(+)		(-)	
Main	0.0	min.	1.4	min.
Add'l M, Pl	0.0	min.	0.0	min.
If Body is UL of Moon	-30.0'		0.0	min.
Add'l Ref.	0.1	min.	0.0	min.
(±) Totals	0.1	min.	1.4	min.
Corr	-1.3	min		
Ho	35	deg.	12.0	min.
Hc	35	deg.	11.5	min.
a	0.5	n. mi.	Toward	
Zn	193	deg.		

Selcet Method for Calculating Dip Short	USPS		Height of eye	88	Feet
Horizon	Natural		Distance to Visible Horizon	22230	Yards
For sight taken on a natural horizon: Dip =	9.10	min	Dip	9.10	min.
Dip Short Distance		Yards			
Atmospheric Pressure	1005	mb	Add'l Ref. Correction (R_0 -R) =	0.1	min.
Air Temperature	31	° C			

Click on this box to save the data needed for plotting the LOP on a CLS 98 Form

Increment Main Correction by 0.0 min.

Increment Add'l M, Pl Correction by 0.0 min.

Use $Ha_{Avg.}$ for calculating Additional LL & UL correction for Moon No

Body RIGIL KENTAURUS data shown in this box was calculated by the "Nav Bodies" worksheet.

Hc	35	deg.	11.47 min.
Total GHA	35	deg.	54.10 min.

Note: Check the value of Hc shown in Cells T25 & V25 with the value of

After selecting Body$_1$ visualize that you are standing at the center of a 12 hour clock face and the vertical circle from your zenith passing through Body$_1$ intersects the horizon at the 12 o'clock position. Select Body$_2$ from a vertical circle that intersects the horizon at or near either the 3 o'clock or 9 o'clock position, this will produce the optimum crossing angle of about 90° at the intersection of the 2 circles.

Two Body Fix Using Intersections of Circles of Equal Altitude

Enter data into yellow cells

	Day	Month	Year
Date @ Greenwich	17	Aug.	2018

Body$_1$	MOON	Limb	LL	GMT$_1$	19:20:00

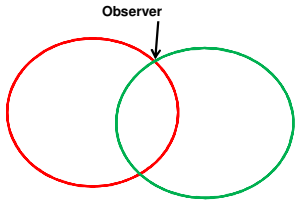
GHA$_1$	28 deg.	23.2 min		
Dec$_1$	12 deg.	27 min.	S	
Ho$_1$	75 deg.	37.4 min		
Body$_1$ is	WSW	of the observer		
Radius of the Circle of Equal Altitude	863 n. mi.			

Body$_2$	ANTARES	Limb		GMT$_2$	19:20:00

GHA$_2$	8 deg.	28.9 min	
Dec$_2$	26 deg.	28.4 min.	S
Ho$_2$	71 deg.	11.2 min	
Body$_2$ is	SSW	of the observer	
Radius of the Circle of Equal Altitude	1129 n. mi.		

Click to view 3 Body Fix Using Intersections of Circles of Equal Altitude

This worksheet assumes all sights were taken from the same geographic position.



A Circle of Equal Altitude

A Circle of Equal Altitude is centered at the Geographic Position(**GP**) of a Body. The Latitude of the body's **GP** is defined by the body's Declination(**Dec**). The Longitude of the body's **GP** can be determined from the body's Greenwich Hour Angle **(GHA**). The radius of a Circle of Equal Altitude in nautical miles is **60x(90° - Ho).** When two bodies are observed, the two Circles of Equal Altitude will have two intersections.

Observer's position determined from the intersections of Circles of Equal Altitude

Observer's Latitude	8 deg.	29.7 min	S	
Observer's Longitude	14 deg.	19.6 min	W	

If the sights were "accurate" one of the intersections listed below will be at or near the observer's geographic position.

Intersection 1

Use intersection 1 as Fix: Yes

Body$_1$ & Body$_2$				
Lat	8 deg.	29.73 min	S	
Lon	14 deg.	19.57 min	W	

Intersection 2

Use intersection 2 as Fix: No

Body$_1$ & Body$_2$				
Lat	26 deg.	47.11 min	S	
Lon	27 deg.	13.48 min	W	

After selecting $Body_1$ visualize that you are standing at the center of a 12 hour clock face and the vertical circle from your zenith passing through $Body_1$ intersects the horizon at the 12 o'clock position. Select $Body_2$ from a vertical circle that intersects the horizon at or near the 8 o'clock position and $Body_3$ from a vertical circle that intersects the horizon at or near the 4 o'clock position, this will produce the optimum crossing angles at the intersection of the 3 circles

Three Body Fix Using Intersections of Circles of Equal Altitude

Enter data into yellow cells

	Day	Month	Year
Date @ Greenwich	17	Aug.	2018

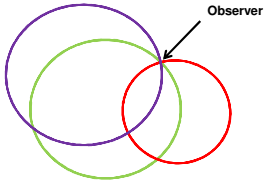
	$Body_1$	$Body_2$	$Body_3$
	ARCTURUS	RIGIL KENTAURUS	ALTAIR
Limb			
GMT_n	19:20:00	19:20:00	19:20:00
GHA_n	41 deg. 59.7 min	35 deg. 54.1 min	318 deg. 11.6 min
Dec_n	19 deg. 5.5 min. N	60 deg. 54.8 min. S	8 deg. 55.3 min. N
Ho_n	51 deg. 13.3 min	35 deg. 12 min	31 deg. 26.9 min
$Body_n$ is	NNW of the observer	SSW of the observer	NNE of the observer
Radius of the Circle of Equal Altitude	2327 n. mi.	3288 n. mi.	3513 n. mi.

A Circle of Equal Altitude

A Circle of Equal Altitude is centered at the Geographic Position(**GP**) of a Body. The Latitude of the body's **GP** is defined by the body's Declination(**Dec**). The Longitude of the body's **GP** can be determined from the body's Greenwich Hour Angle **(GHA**). The radius of a Circle of Equal Altitude in nautical miles is **60x(90° - Ho).** When three bodies are observed, the three Circles of Equal Altitude will have six intersections.

Observer's position determined from the intersections of Circles of Equal Altitude

Observer's Latitude	8 deg.	29.9 min	S
Observer's Longitude	14 deg.	19.7 min	W



Click to view 2 Body Fix Using Intersections of Circles of Equal Altitude

This worksheet assumes all sights were taken from the same geographic position.

Select Intersections to Use in Calculating Fix

If the sights were "accurate", three of the intersections listed below will be at or near the observer's geographic position.

	Intersection 1	Intersection 2	Intersection 3	Intersection 4	Intersection 5	Intersection 6
Use Intersection in Calculating Fix	Yes	No	No	Yes	Yes	No
	$Body_1$ & $Body_2$	$Body_1$ & $Body_2$	$Body_1$ & $Body_3$	$Body_1$ & $Body_3$	$Body_2$ & $Body_3$	$Body_2$ & $Body_3$
Lat	8 deg. 30.30 min S	11 deg. 0.80 min S	48 deg. 6.91 min N	8 deg. 28.36 min S	8 deg. 30.90 min S	46 deg. 17.89 min S
Lon	14 deg. 21.31 min W	17 deg. 11.81 min W	10 deg. 10.23 min W	14 deg. 19.31 min W	14 deg. 18.58 min W	63 deg. 34.89 min E

Position from intercept and azimuth by calculation ~ See Nautical Almanac page 282 paragraph 11

DR Lat	8	deg.	30.0	min.	S	Date @ DR Position	17-Aug-18
DR Lo	14	deg.	20.0	min.	W	Zone Time	18:20:00
Previous Fix Lat	8	deg.	0.0	min.	S		
Previous Fix Lo	14	deg.	0.0	min.	W		

Δ Time Since Previous Fix: 2:00:00

Daylight Saving Time? No

Fix Lat	8	deg.	29.7	min.	S		
Fix Lo	14	deg.	19.7	min.	W		
Set	47.1	deg.				Drift	0.22 kn
Distance Between Fixes	35.51	n. mi.				Distance Between DR & Fix	0.44 n. mi.

Use "Nav Bodies" Worksheet to specify DR Position, Previous Fix, Date & Time

Distance from Previous Fix to DR: 35.9 n. mi.

track and speed made good through a current

Track Made Good (TMG)	213.2 deg.	Speed Made Good (SMG)	17.8 kn.
Course (C) from Previous Fix to DR	213.4 deg.	Speed Of Advance (SOA)	18.0 kn.
Drift Angle	0.2 deg. to Port	Were sights taken from a fixed shore position ?	Yes

Enter Data Into Yellow Cells

ψ 7E-13 n. mi.

course to steer at a given speed through the water to make good a given course through a current

Course To Steer	261.0 deg.	Speed Through Water	7 kn.
Course	260 deg.	Drift Angle	1.0 deg. to Port
		My Sigma	min.

1 Include Body 1 Data in Fix Calculation ? Yes

Body 1		deg.	min.
MOON	Hc	75	37.74
Time of Observation	Zn	252.8	deg.
18:20:00	Intercept (p)	0.3	n. mi. Away

Ho	75 deg.	37.4 min.	
Total GHA	28 deg.	23.3 min.	
Declination	12 deg.	27.2 min.	S

2 Include Body 2 Data in Fix Calculation ? Yes

Body 2		deg.	min.
ALTAIR	Hc	31	25.70
Time of Observation	Zn	74.0	deg.
18:20:00	Intercept (p)	1.2	n. mi. Toward

Ho	31 deg.	26.9 min.	
Total GHA	318 deg.	11.5 min.	
Declination	8 deg.	55.3 min.	N

3 Include Body 3 Data in Fix Calculation ? Yes

Body 3		deg.	min.
ANTARES	Hc	71	11.53
Time of Observation	Zn	163.6	deg.
18:20:00	Intercept (p)	0.3	n. mi. Away

Ho	71 deg.	11.2 min.	
Total GHA	8 deg.	28.9 min.	
Declination	26 deg.	28.2 min.	S

To clear data for a given body, click on the yellow square above the name of the body.

σ 0.77 min.

Error Ellipse (95%)

Major Axis 1.20 n. mi.

Minor Axis 1.18 n. mi.

Zn of Major Axis 353.0 deg.

4 Include Body 4 Data in Fix Calculation ? Yes

Body 4		deg.	min.
ARCTURUS	Hc	51	12.61
Time of Observation	Zn	315.5	deg.
18:20:00	Intercept (p)	0.7	n. mi. Toward

Ho	51 deg.	13.3 min.	
Total GHA	41 deg.	59.7 min.	
Declination	19 deg.	5.5 min.	N

5 Include Body 5 Data in Fix Calculation ? Yes

Body 5		deg.	min.
RIGIL KENTAURUS	Hc	35	11.51
Time of Observation	Zn	192.6	deg.
18:20:00	Intercept (p)	0.5	n. mi. Toward

Ho	35 deg.	12.0 min.	
Total GHA	35 deg.	54.1 min.	
Declination	60 deg.	54.7 min.	S

6 Include Body 6 Data in Fix Calculation ? No

Body 6		deg.	min.
	Hc	73	22.88
Time of Observation	Zn	60.0	deg.
	Intercept (p)	4402.9	n. mi. Away

Ho	deg.	min.	
Total GHA	deg.	min.	
Declination	deg.	min.	