Rendezvous at Sunrise

In this case, one vessel maintains her course and speed, which is considered “Targeted Vessel”, while another vessel, called “Rendezvous Vessel”, tries to rendezvous the targeted vessel at the next sunrise.

Procedures to find rendezvous position for next sunrise

1. Use DR position of targeted vessel to find time of sunrise;

2. Find the first approximate position of targeted vessel based on time of sunrise;

3. Use 1^{st} approximate position to find new time of sunrise;

4. Find the second approximate position based on new time of sunrise. For more accuracy, the third approximate position can be found, but in most cases this is unnecessary.

Example 1

On 24^{th} October 2008, at 0500 (UT), Vessel A is at position 38°10.0´ S 166°04.0´ E, steering 288° T, speed 22 knots. Vessel B is at position 38°05.0´S 160°15.0´E. Find the UT time of sunrise next day, course and speed required for vessel B to rendezvous with vessel A at sunrise, and rendezvous position:

Time of sunrise

$$\begin{array}{rll} \text{LMT}(35°\text{S}) & 25^{th} & 05^h05^m \\ \text{Correction}(3°10') & & \underline{\quad 4^m} \quad (\text{LMT of } 40°\text{S}: 04^h58^m) \\ \text{LMT}(38°10'\text{S}) & 25^{th} & 05^h01^m \\ \text{Longitude in time:} & & \underline{11^h04^m} \\ \text{UT:} & & 16^h05^m \end{array}$$

First Approximation

$$\text{Steaming time} = 16^h05^m - 05^h00^m = 11^h05^m$$
$$\text{Distance} = 11^h05^m \times 22\,\text{knots} = 243.8\,\text{miles}$$

Using plane sailing method or traverse tables to obtain D. Lat. and D. Long.

$$\text{D.Lat.} = \text{Distance} \times \cos C_o = 243.8 \times \cos 72° = 75.3' = 1°15.3'$$
$$\text{Departure} = \text{Distance} \times \sin C_o = 243.8 \times \sin 72° = 231.9'$$
$$\text{Mean Lat. } (\text{Lat}_m) = 38°10'\text{S} - (75.3' \div 2) = 37°32.4'\text{S}$$

$$\text{D.Long.} = \frac{\text{Departure}}{\cos \text{Lat}_m} = \frac{231.9'}{\cos 37°32.4'} = 292.5' = 4°52.5'$$

Initial Position:	Lat.	38°10.0′S	Long.	166°04.0′E
	D.Lat.	1°15.3′	D.Long.	4°52.5′
1st Approx. Position:	Lat.	36°54.7′S	Long.	161°11.5′E

Time of sunrise

LMT(35°S)	25th	05^h05^m	
Correction(1°54.7′)		3^m	(LMT of 40°S: 04^h58^m)
LMT(36°54.7′S)	25th	05^h02^m	
Longitude in time:		10^h45^m	
UT:		15^h47^m	

Second Approximation

Steaming time $= 15^h47^m - 05^h00^m = 10^h47^m$;

Distance $= 10^h47^m \times 22\text{knots} = 237.2\text{miles}$

$$\text{D.Lat.} = \text{Distance} \times \cos C_o = 237.2 \times \cos 72° = 73.3' = 1°13.3'$$

$$\text{Departure} = \text{Distance} \times \sin C_o = 237.2 \times \sin 72° = 225.6'$$

$$\text{Mean Lat. } (\text{Lat}_m) = 38°10'S - (73.3' \div 2) = 37°33.4'S$$

$$\text{D.Long.} = \frac{\text{Departure}}{\cos \text{Lat}_M} = \frac{225.6'}{\cos 37°33.4'} = 284.6' = 4°44.6'$$

Initial Position:	Lat.	38°10.0′S	Long.	166°04.0′E
	D.Lat.	1°13.3′	D.Long.	4°44.6′
2nd Approx. Position:	Lat.	36°56.7′S	Long.	161°19.4′E

Rendezvous Position: 36°56.7′S 161°19.4′E

Vessel B:	38°05.0′S		160°15.0′E		38°05.0′S
RV Pos.:	36°56.7′S		161°19.4′E	½D.Lat.	34.2′
D.Lat.	68.3′(N)	D.Long.	64.4′(E)	Mean Lat.	37°30.8′

$$\text{Dep.} = \text{D.Long.} \times \cos \text{Lat}_M = 64.4' \times \cos 37°30.8' = 51.1'$$

$$C_o = \tan^{-1}\left(\frac{\text{Dep.}}{\text{D.Lat.}}\right) = \tan^{-1}\left(\frac{51.1'}{68.3'}\right) = \text{N}36.8°\text{E}$$

$$\text{Distance} = \text{D.Lat.} \times \sec C_o = 68.3' \times \sec 36.8° = 85.3'$$

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} = \frac{85.3'}{10^h47^m} = 7.9\text{knots}$$

Sunrise: 15^h47^m (UT)

Rendezvous Position: 36°56.7′S 161°19.4′E

Course required for vessel B to rendezvous: 036.8°T

Speed required for vessel B to rendezvous: 7.9knots

Example 2

At 2230 on 15th April 2008, vessel A departs from position 29°45.0´N 65°12.0´W, course 260° T, speed 25 knots. Vessel B is in position 31°20.0´N 69°25.0´W. Find the UT time of sunrise next day, course and speed required for vessel B to rendezvous with vessel A, and rendezvous position:

Time of sunrise

LMT(20°N)	16^{th}	05^h41^m
Correction(9°45′)		9^m (LMT of 30°N: 05^h32^m)
LMT(29°42′N)	16^{th}	05^h32^m
Longitude in time:		4^h21^m
UT:	16^{th}	09^h53^m

First Approximation

$$\text{Steaming time} = 9^h53^m + 02^h00^m = 11^h53^m;$$

$$\text{Distance} = 11^h53^m \times 25\text{knots} = 297.1\text{miles}$$

$$\text{D.Lat.} = \text{Distance} \times \cos C_o = 297.1 \times \cos 80° = 51.6'$$

$$\text{Departure} = \text{Distance} \times \sin C_o = 297.1 \times \sin 80° = 292.6'$$

$$\text{Mean Lat. } (\text{Lat}_m) = 29°45'\text{N} - (51.6' \div 2) = 29°19.2'\text{N}$$

$$\text{D.Long.} = \frac{\text{Departure}}{\cos \text{Lat}_M} = \frac{292.6'}{\cos 29°19.2'} = 335.6' = 5°35.6'$$

Initial Position:	Lat:	29°45.0′N	Long.	65°12.0′W
	D.Lat.	51.6′	D.Long.	5°35.6′
1st Approx. Position:	Lat.	28°53.4′N	Long.	70°47.6′W

Time of sunrise

LMT(20°N)	16^{th}	05^h41^m
Correction(8°53.4′)		8^m (LMT of 30°N: 05^h32^m)
LMT(29°42′N)	16^{th}	05^h33^m
Longitude in time:		4^h43^m
UT:	16^{th}	10^h16^m

Second Approximation

$$\text{Steaming time} = 10^h16^m + 02^h00^m = 12^h16^m;$$

$$\text{Distance} = 12^h16^m \times 25\text{knots} = 306.7\text{miles}$$

$$\text{D.Lat.} = \text{Distance} \times \cos C_o = 306.7 \times \cos 80° = 53.3'$$

$$\text{Departure} = \text{Distance} \times \sin C_o = 306.7 \times \sin 80° = 302'$$

$$\text{Mean Lat. } (\text{Lat}_m) = 29°45'\text{N} - (53.3' \div 2) = 29°18.4'\text{N}$$

$$\text{D.Long.} = \frac{\text{Departure}}{\cos \text{Lat}_M} = \frac{302'}{\cos 29°18.4'} = 346.3' = 5°46.3'$$

Initial Position:	Lat: 29°45.0′N		Long.	65°12.0′W
	D.Lat.	53.3′	D.Long.	5°46.3′
2^{nd} Approx. Position:	Lat.	28°51.7′N	Long.	70°58.3′W

Rendezvous Position: 28°51.7′N 70°58.3′W

Course and Speed required for vessel B to rendezvous

Vessel B:	31°20.0′N		69°25.0′W		31°20.0′S
RV Pos.:	28°51.7′N		70°58.3′W	½D.Lat.	1°14.2′
D.Lat.	148.3′(S)	D.Long.	93.3′(W)	Lat_M	30°05.8′

$$\text{Dep.} = \text{D.Long.} \times \cos \text{Lat}_M = 93.3' \times \cos 30°05.8' = 80.7'$$

$$C_o = \tan^{-1}\left(\frac{\text{Dep.}}{\text{D.Lat.}}\right) = \tan^{-1}\left(\frac{80.7'}{148.3'}\right) = \text{S}28.6°\text{W}$$

$$\text{Distance} = \text{D.Lat.} \times \sec C_o = 148.3' \times \sec 28.6° = 168.9'$$

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}} = \frac{168.9'}{12^h 16^m} = 13.8 \text{ knots}$$

Course: 208.6°T

Speed: 13.8 knots