Rendezvous As Soon As Possible

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 as soon as possible with her maximum speed.

Procedure to find Rendezvous Position

1. Find the course made good of targeted vessel;
2. Find the range and bearing of rendezvous vessel relative to targeted vessel;
3. Use plotting on radar plotting sheet or sin law of triangle calculations to determine the relative speed between two vessels and the course required by rendezvous vessel;
4. Divide the range between the two vessels by relative speed to find the time needed to rendezvous;
5. Apply the time needed to rendezvous to the speed of the targeted vessel to find distance from initial position to rendezvous position, and rendezvous position.

Procedure to plot on the plotting sheet to find relative speed and course

1. From the centre of the plotting sheet, which is considered as the position of targeted vessel, plot OA as the course and speed of targeted vessel;
2. From the centre of plotting sheet, plot the bearing of rendezvous vessel from targeted vessel;
3. From A, using compass that is adjusted to the maximum speed of rendezvous vessel on same scale as used for vessel A, mark point B on the bearing line;
4. Measure OB, which would be the relative speed between the two vessels. Check the direction of BA, which would be the required course for vessel B to rendezvous vessel A as soon as possible.

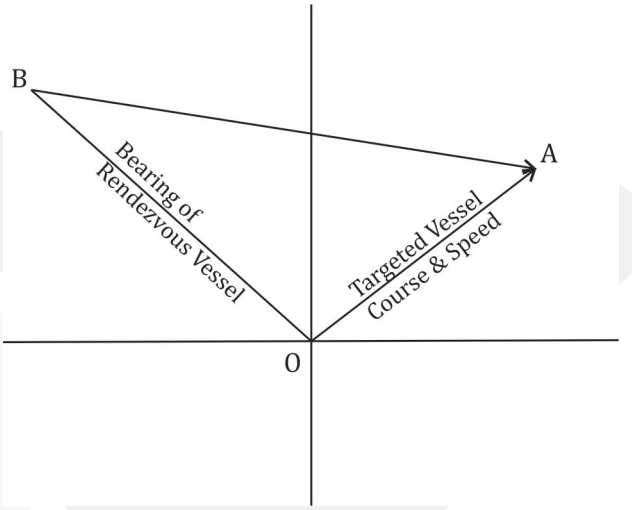
Procedure to find relative speed and course by using sin law

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

In triangle OAB, we know:

1. OA direction (Targeted Vessel's course);
2. OA magnitude (Targeted Vessel's speed);
3. OB direction (bearing of Rendezvous Vessel from Targeted Vessel);

4. BA magnitude (Speed of Rendezvous Vessel).



From (1) and (2); we can find the angle BOA, and with (2) and (4) we can use the sin law to obtain angle OBA. Angle OAB can be obtained by following formula:

$$\angle \mathrm{OAB} = 180° - \left(\angle \mathrm{OBA} + \angle \mathrm{BOA}\right)$$

By knowing angle OAB, we can use sin law to obtain the magnitude of OB, which is the relative speed between the two vessels. The direction of BA can also be found by subtracting the bearing from the angle OBA.

Example 1

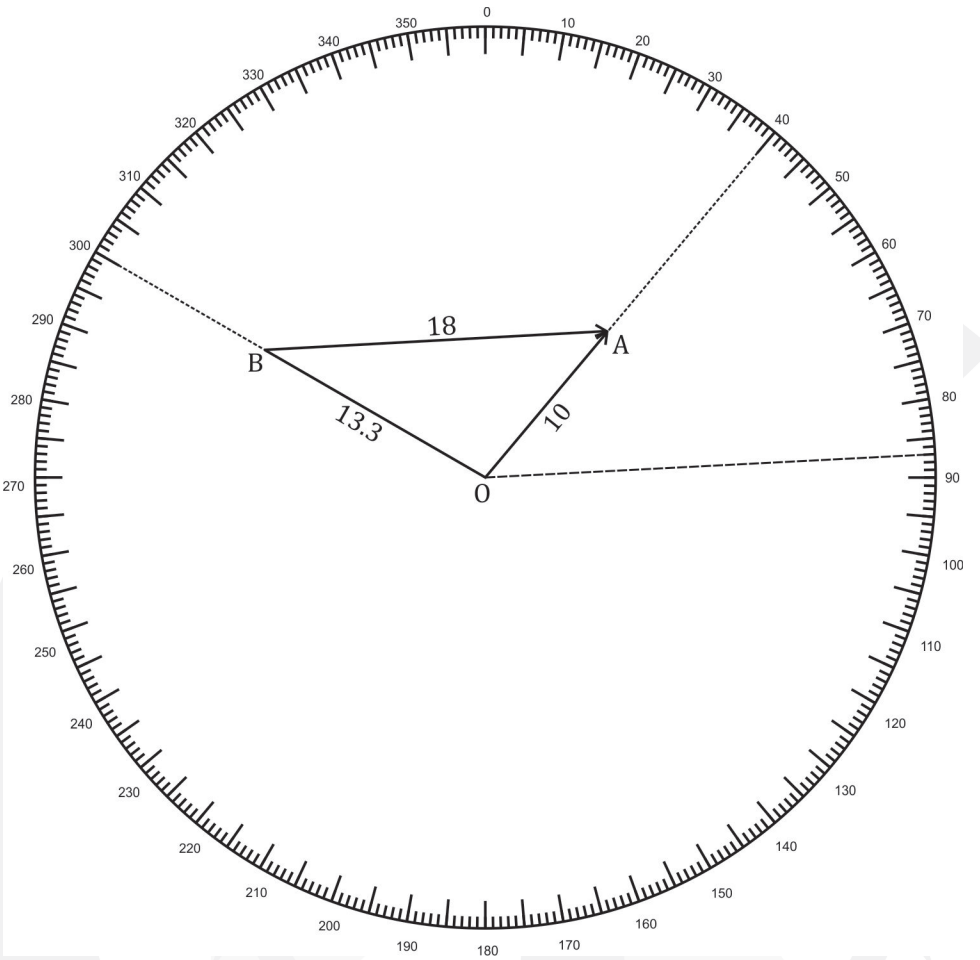
The Targeted Vessel is making a course of 040° T, speed 10 knots. Your vessel has a maximum speed of 18 knots and relative bearing of 300° T, 120 miles from Targeted Vessel. Find the course and time required for your vessel to rendezvous as soon as possible with Targeted Vessel.

Find relative speed and course for Rendezvous Vessel by plotting

As the diagram shows, the relative speed will be 13.4 knots; as the distance between the two vessels is 120 miles, the time needed to rendezvous is as follows:

$$\mathbf{Lat._V = \arccos\left(\sin A \cos Lat._A\right)}$$

The course required for vessel B to make is 087° T.



Find relative speed and course for Rendezvous Vessel by using sine law:

In triangle OBA:

Vector OA is represented course and speed of Targeted Vessel

Vector BA is represented course and speed of Rendezvous Vessel

Vector OB is represented relative bearing and speed between Targeted and Rendezvous Vessels.

Targeted Vessel's course: 40°T (1)

Rendezvous Vessel is bearing 300°T from Targeted Vessel (2)

From (1) and (2)AOB = 100°

Apply sin rule:

$$\frac{18}{\sin 100°} = \frac{10}{\sin OBA} \quad \therefore OBA = \arcsin\left(\frac{10 \times \sin 100°}{18}\right) = 33.2°$$

$$\therefore OAB = 180° - (100° + 33.2°) = 46.8°$$

Find relative speed

$$\frac{18}{\sin 100°} = \frac{OB}{\sin 46.8°} \quad \therefore OB = \frac{18 \times \sin 46.8°}{\sin 100°} = 13.3$$

Relative speed 13.3 kn, so time required for rendezvous:

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}} = \frac{120}{13.3} = 9^{h}01^{m}$$

Find Rendezvous Vessel's course

Transfer vertical and horizontal axis from O to B

$$\text{Bearing} = 300°\text{T} \quad \therefore \ \alpha = 30°$$
$$\text{Course} = 90° - (OBA - \alpha) = 90° - (33.2° - 30°) = 86.8° \approx 087°\text{T}$$

Example 2

At 0930 on 17th April 2008, vessel A departs from position 33°20.0′N 16°10.0′W to position 35°50.0′N 06°20.0′W at a speed of 8 knots. Vessel B is in position 35°10.0′N 17°10.0′W with maximum speed of 15 knots. Find the course required for vessel B to rendezvous as soon as possible with vessel A, and the rendezvous position:

Course made good of vessel A

Initial Position:	33°20′N	16°10′W	
Final Position:	35°50′N	06°20′W	
	150′(N)	590′(E)	Lat_m = 34°35′N

$$\text{Dep.} = \text{D. Long.} \times \cos(\text{Lat}_m)$$
$$= 590' \times \cos 34°35'$$
$$= 485.8'$$

$$\text{Course} = \arctan\left(\frac{\text{Dep.}}{\text{D. Lat.}}\right) = \arctan\left(\frac{485.8'}{150'}\right)$$
$$= \text{N}\,72.8°\,\text{E} = 072.8°\text{T}$$

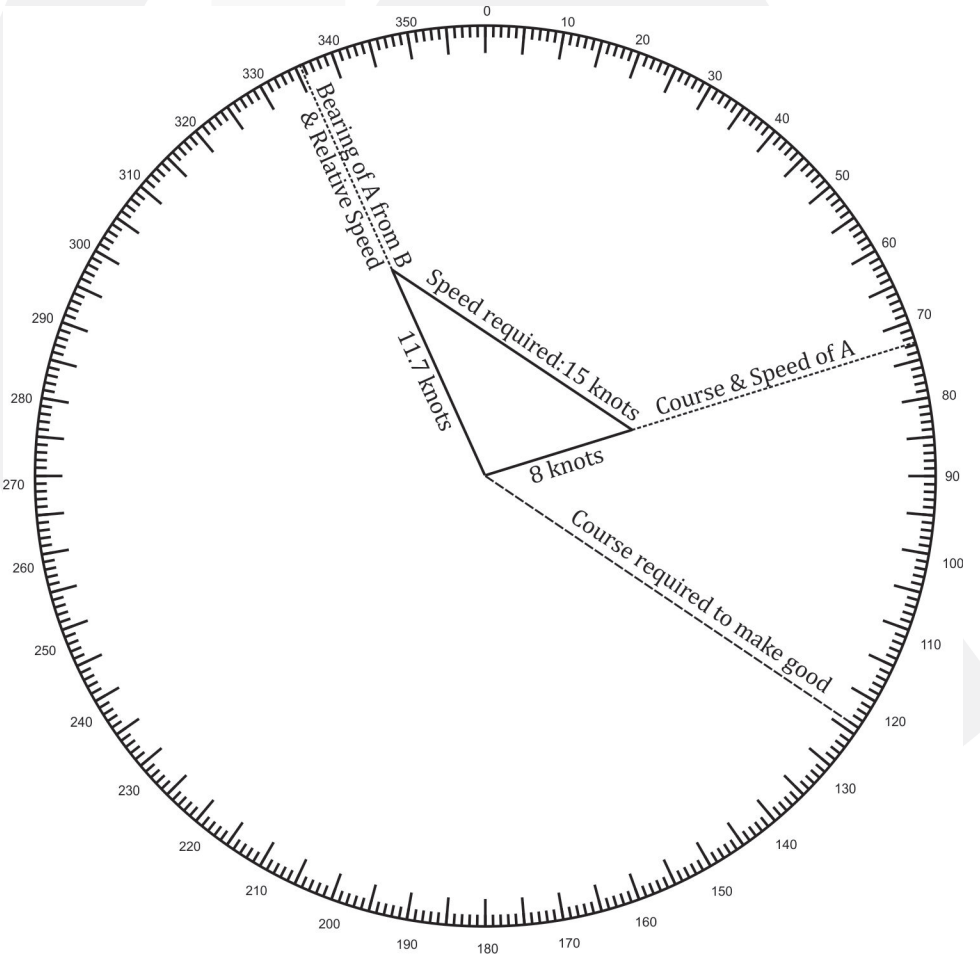
Range and Bearing of vessel B from vessel A

Vessel A Position:	33°20′N	16°10′W	
Vessel B Position:	35°10′N	17°10′W	
	110′(N)	60′(W)	Lat_m = 34°15′N

$$\text{Dep.} = \text{D. Long.} \times \cos\left(\text{Lat}_{\text{m}}\right)$$
$$= 60' \times \cos 34°15'$$
$$= 49.6'$$

$$\text{Bearing} = \arctan\left(\frac{\text{Dep.}}{\text{D. Lat.}}\right) = \arctan\left(\frac{49.6'}{110'}\right)$$
$$= \text{N}24.3°\text{W} = 335.7°\text{T}$$

$$\text{Distance} = \text{D. Lat.} \times \sec C_{\text{o}}$$
$$= 110' \times \sec 24.3°$$
$$= 120.7 \text{ miles}$$



By using plotting to determine the relative speed between two vessels and the course required for vessel B to make good in order to rendezvous vessel A as soon as possible:

Relative Speed: 11.7 knots
Course required to make good: 124°T

$$\text{Steaming time} = \frac{120.7}{11.7} = 10^{h}19^{m}$$

$$\text{Distance of vessel A travelled} = 10^{h}19^{m} \times 8\,\text{knots} = 82.5\,\text{miles}$$
$$\text{D.Lat.} = \text{Distance} \times \cos C = 82.5 \times \cos 72.8° = 24.4'$$
$$\text{Lat}_{m} = 33°32.2'$$
$$\text{Dep.} = \text{D.Lat.} \times \tan C = 24.4 \times \tan 72.8° = 78.8'$$
$$\text{D.Long.} = \text{Dep.} \times \sec \text{Lat}_{m} = 78.8 \times \sec 33°32.2' = 94.5' = 1°34.5'$$

Vessel A Position:		33°20.0′N		16°10.0′W
	D.Lat.	24.4′(N)	D.Long.	1°34.5′(E)
Rendezvous Position:		33°44.4′N		14°35.5′W

Example 3 At 1000 on 18th July 2008, vessel A departs from position 41°24.0′ N 06°30.0′ E for position 43°20.0′ N 05°30.0′ E at a speed of 8 knots. Vessel B is in position 42°16.0′ N 03°50.0′ E with maximum speed of 12 knots. Find the course required for vessel B to rendezvous as soon as possible with vessel A, and the rendezvous position:

Course made good of vessel A

Initial Position:	41°24′N	06°30′E	
Final Position:	43°20′N	05°30′E	
	116′(N)	120′(W)	Lat_{m} = 42°22′N

$$\text{Dep.} = \text{D. Long.} \times \cos\left(\text{Lat}_{m}\right)$$
$$= 120' \times \cos 42°22'$$
$$= 88.7'$$

$$\text{Course} = \arctan\left(\frac{\text{Dep.}}{\text{D.Lat.}}\right) = \arctan\left(\frac{88.7}{116}\right)$$
$$= \text{N}37.4°\text{W} = 322.6°\text{T}$$

Range and Bearing of vessel B from vessel A

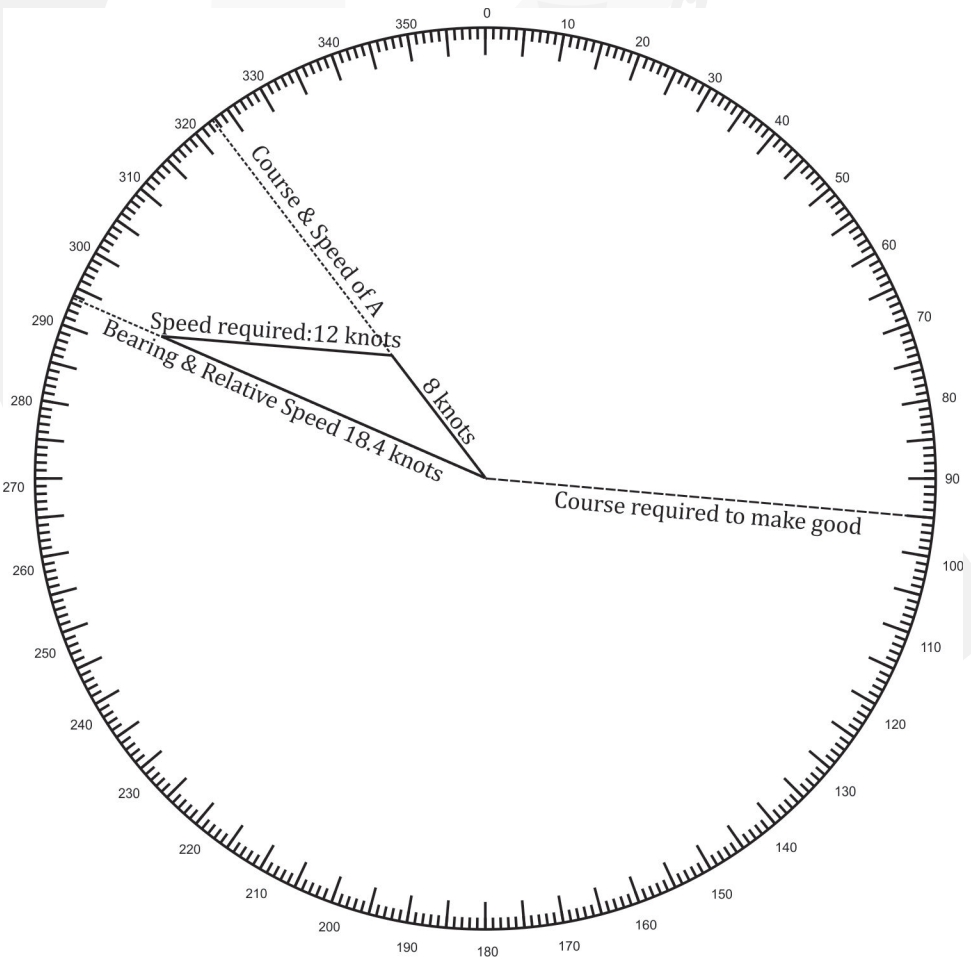
Vessel A Position:	41°24′N	06°30′E	
Vessel B Position:	42°16′N	03°50′E	
	52′(N)	160′(W)	Lat_{m} = 41°50′N

$$\text{Dep.} = \text{D. Long.} \times \cos\left(\text{Lat}_{\text{m}}\right)$$
$$= 160' \times \cos 41°50'$$
$$= 119.2'$$

$$\text{Course} = \arctan\left(\frac{\text{Dep.}}{\text{D. Lat.}}\right) = \arctan\left(\frac{119.2'}{52'}\right)$$
$$= \text{N}\,66.4°\,\text{W} = 293.6°\,\text{T}$$

$$\text{Distance} = \text{D. Lat.} \times \sec C_{\text{o}}$$
$$= 52' \times \sec 66.4°$$
$$= 129.9\,\text{miles}$$

By using plotting to determine the relative speed between two vessels and the course required for vessel B to make good in order to rendezvous vessel A as soon as possible:



Relative Speed: 18.4 knots

Course required to make good: 095°T

$$\text{Steaming time} = \frac{129.9}{18.4} = 7^{h}06^{m}$$

$\text{Distance of vessel A travelled} = 7^{h}06^{m} \times 8\,\text{knots} = 56.5\,\text{miles}$

$\text{D.Lat.} = \text{Distance} \times \cos C = 56.5 \times \cos 37.4° = 44.9'$

$\text{Lat}_{m} = 42°46.4'$

$\text{Dep.} = \text{D.Lat.} \times \tan C = 44.9' \times \tan 37.4° = 43.2'$

$\text{D.Long.} = \text{Dep.} \times \sec \text{Lat}_{m} = 43.2 \times \sec 41°46.4' = 94.5' = 57.9'$

Vessel A Position:		41°24.0′N		06°30.0′W
	D.Lat.	44.9′(N)	D.Long.	57.9′(W)
Rendezvous Position:		42°08.9°′N		07°27.9′W