Plane sailing with J Wylie

Flat Earth Navigation

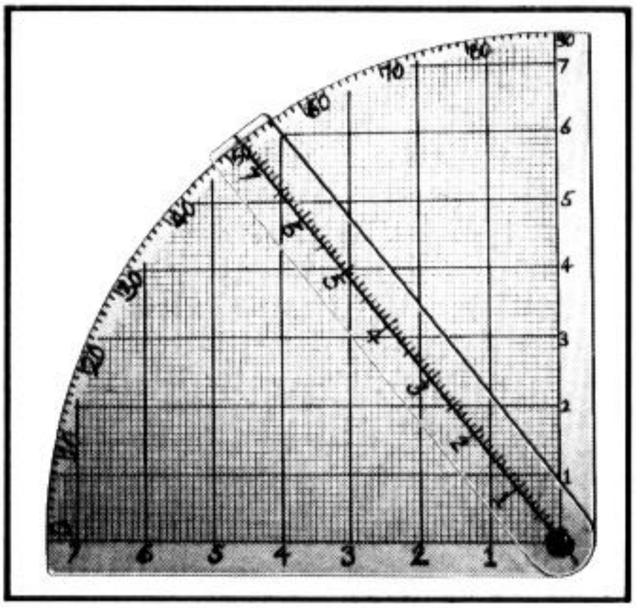
Plane (or plain) sailing is for flat-earth navigators. It's a method of calculating (1) a new position on the Earth's surface from a known position, after sailing a given course and distance, or (2) the course and distance from one position to another, on the assumption that the Earth is flat.

Since it isn't, plane sailing can only be used over distances of up to 600 nautical miles at most, to minimise errors.

It's based on the trigonometrical solution of a right-angled triangle. Most sailors don't care for trigonometry, so the professionals use Traverse Tables. Yachtsmen don't care for those either, especially when cold, wet, seasick and frightened.

A simple method, without calculation, is to draw right-angled triangles to scale, and measure the required sides of angle. But even drawing is avoidable if you take the trouble to make up a simple protractor using squared paper. A radial arm of the same material, marked in the same units, is pivoted at the base, and the arc it describes is marked out in degrees.

My own more permanent version (the *Wylie Traverse Protractor*) is made of Perspex, the lines being scribed with a steel point, and blackened with graduation filler.



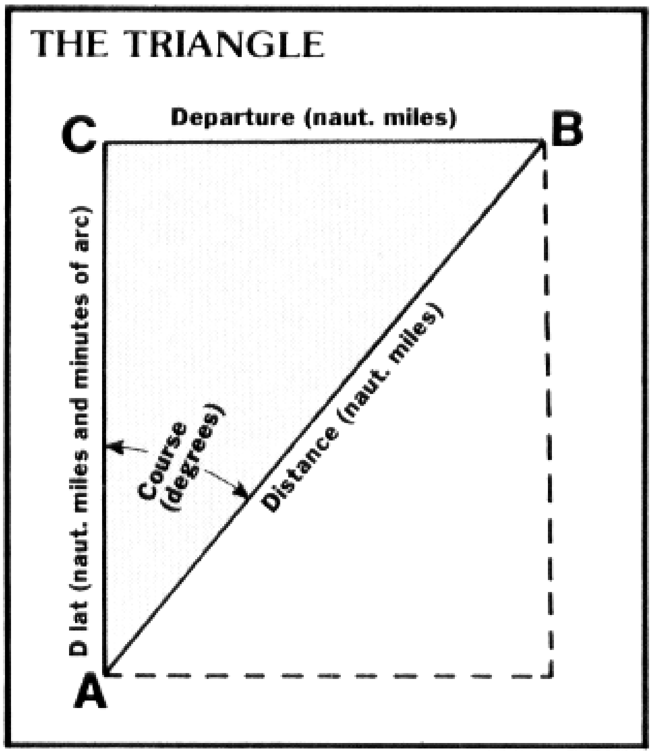
We need to remind ourselves of some definitions of terms in order to proceed.

D lat. = Difference of Latitude between the two positions, in minutes of arc (also nautical miles).

Mid-Latitude = Latitude midway between the latitudes of the two positions.

D long. = Difference of Longitude between the two positions, in minutes of arc.

Departure = East-West distance between the meridians of the two positions, along the Mid-Latitude, in nautical miles.



Trigonometrical Ratios from the Triangle

$$(1)\ \sin \text{Course} = \frac{\text{Departure}}{\text{Distance}}$$

$$(2)\ \cos \text{Course} = \frac{\text{D lat}}{\text{Distance}}$$

$$(3)\ \tan \text{Course} = \frac{\text{Departure}}{\text{D lat}}$$

We need to find Departure from D long and *vice versa*, since the minute of Longitude is only equal to the nautical mile at the Equator, and varies increasingly with Latitude. The relationship is

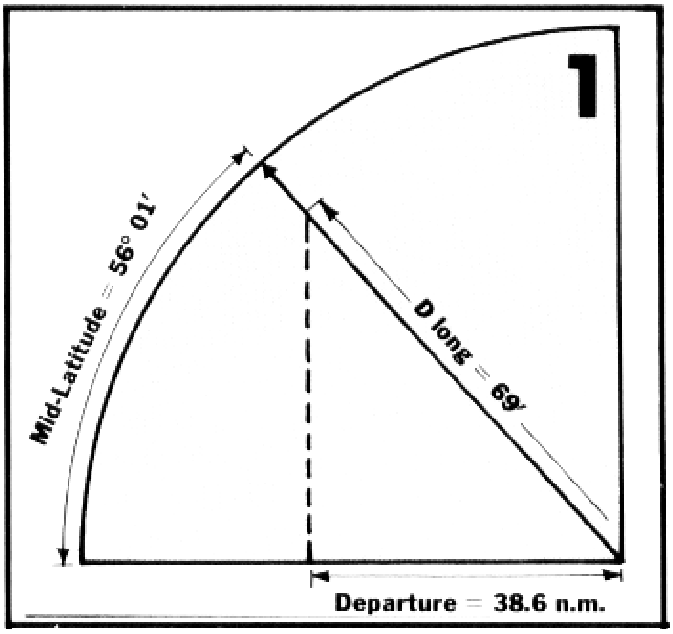
$$(4)\ \cos \text{Mid-Latitude} = \frac{\text{Departure}}{\text{D long}}$$

To solve a problem with these formulae means using (a) trigonometrical tables, (b) a mathematical calculator, or (c) traverse tables. The use of the Protractor gives the answer to the problem in less time than it takes to read about it.

To illustrate — find the course and distance to sail from position 55° 30′ N, 9° 19′ W, to position 56° 32′ N, 8° 10′ W.

By simple arithmetic, we find — D lat = 1° 02′N = 62′N; Mid-Latitude = 56° 01′N; D long = 1° 09′E = 69′E.

We first have to convert D long to Departure, the equivalent East-West distance in miles. Instead of using Equation (4), we set the protractor arm to the angle of the Mid-Latitude, measure off the D long along the radial arm, and drop to the base line to read off the Departure in nautical miles. (Fig.1).



Instead of using Equation (3) to find the Course, then either (1) or (2) to find the Distance, we get both in one operation with the Protractor. It helps to set it with its base line North-South, then the arm indicates the course directly. (Fig.2)

We have to sail 73 miles on Course 032°T to get from our first position to our second.

To illustrate the converse of the problem, suppose we sail 65 miles on Course 040°T from position 55° 30′N, 9° 19′W, what is our new position?

We set the protractor arm to Course 040° and read across from 65 on the arm to the vertical axis, where we find the D lat. D lat = 50′N (Fig.3). so New lat. = 55° 30′N + 50′N = 56° 20′N and Mid-lat. = 55° 55′N.

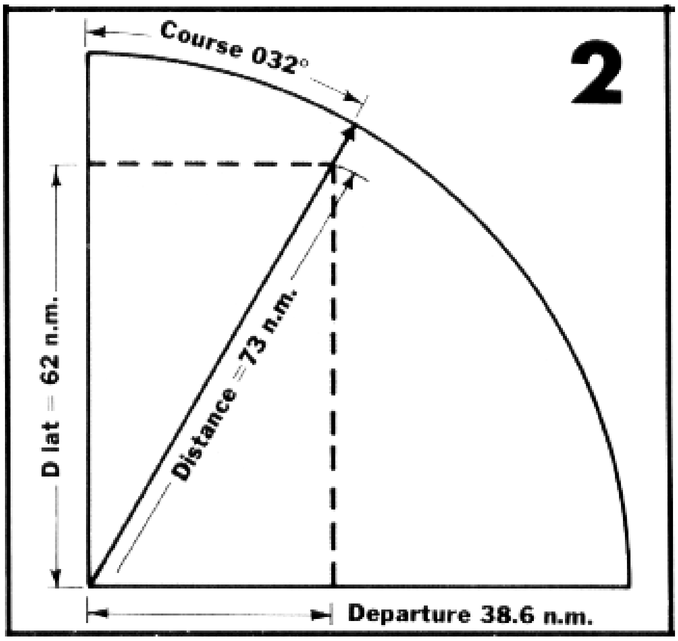
Reading down from 65 on the arm to the base axis, we find the Departure = 41.8n.m.

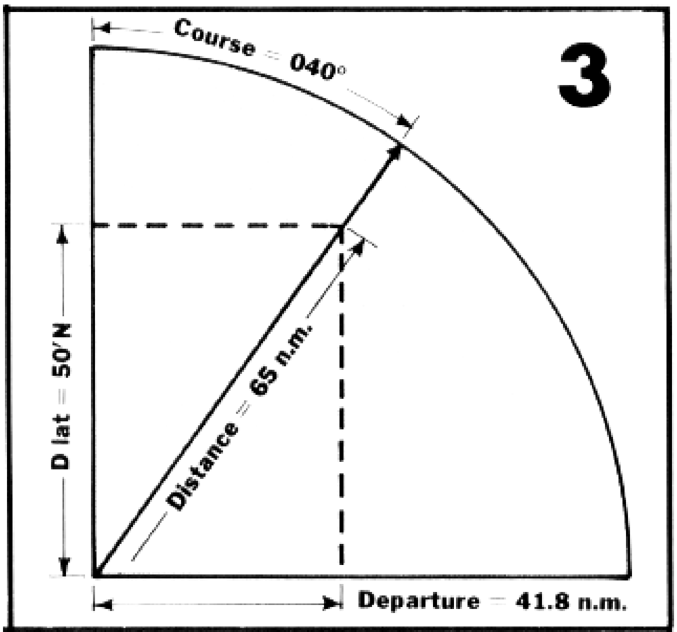
We now use the protractor instead of Equation (4) to convert the Departure to D long.

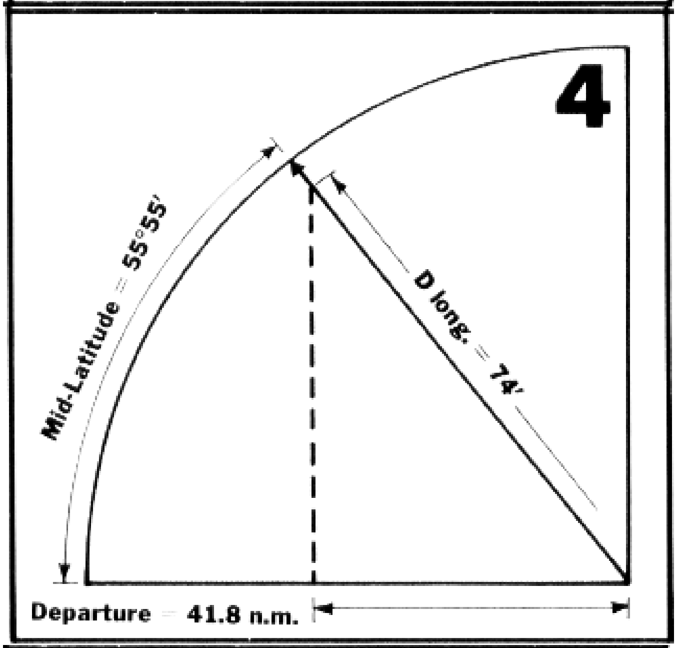
We set the protractor arm to the Mid-lat., find the Departure on the base and read up to find the D long. on the arm scale. (Fig.4). Departure = 41.8n.m; D long. = 74′E = 1° 14′E, so New Longitude = 9° 19′W-1° 14′ = 8° 05′W

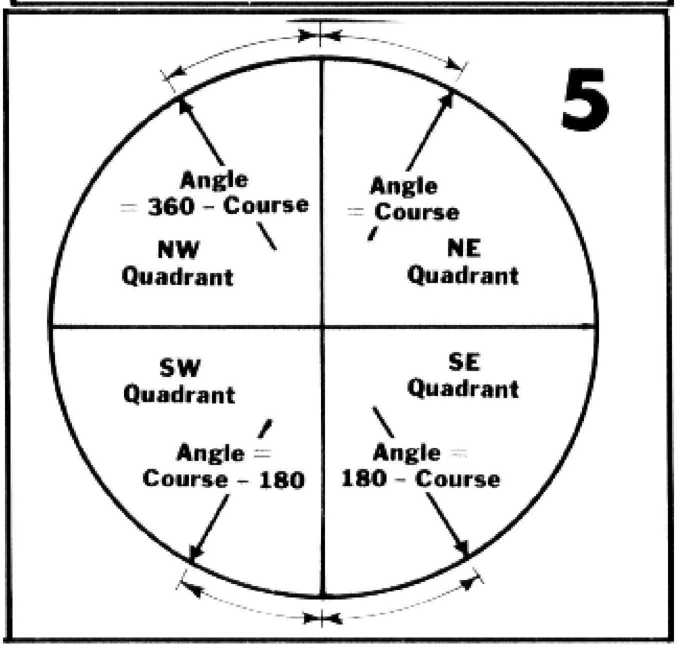
Whether to add or subtract the D lat and D long is a matter of commonsense observation, but for Courses other than in the NE quadrant a little thought is needed to decide what angle to set on the Protractor. A simple circle diagram like Fig.5 gives the answers.

After that, I suppose you might say it's simply plane sailing!

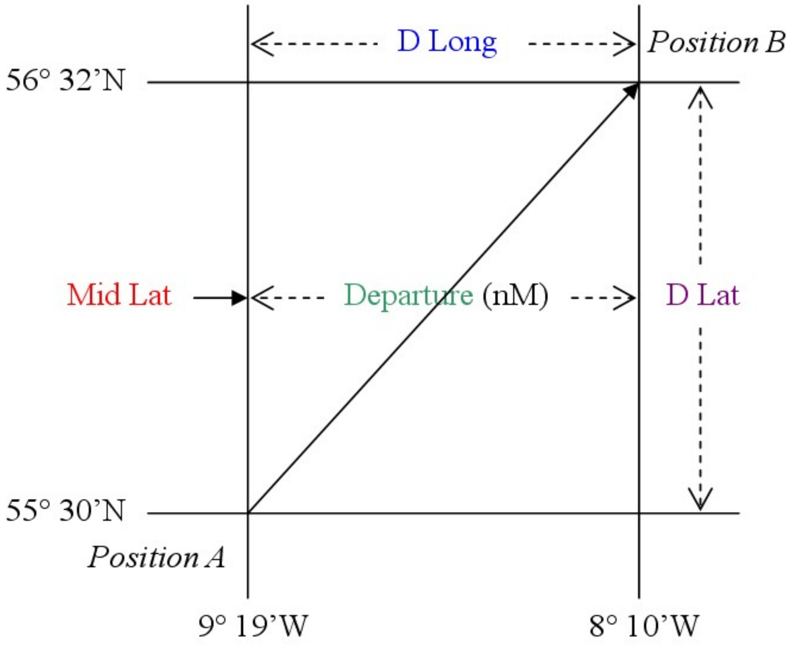








Example



To find Direction & Distance from *Position A* to *Position B*

Pos B 56° 32'N 8° 10'W

Pos A 55° 30'N 9° 19'W

D Lat = 62' D Long = 69'

Mid Lat = Pos A + $\frac{\text{D Lat}}{2}$

Mid Lat = 55° 30' + 31' = 56° 01'N

Departure = Cos Mid Lat x D Long

= Cos 56 $^{1}/_{60}$° x 69

Departure = 38.568 nM

tan Course = $\frac{\text{Departure}}{\text{D Lat}}$ = $\tan^{-1} \frac{38.568}{62}$

Course = 31.9°

Distance = $\frac{\text{Departure}}{\sin \text{Course}}$ = $\frac{38.568}{\sin 31.9°}$

Distance = 73.02 nM