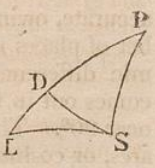
Of the traverse table.

with every logarithmic sine, cosine, &c, used in the work; the sum of all the logarithms (abating one or two radii or tens in the index, according as 2 or 3 logarithmic sines, &c are used in the part of the work in question) will be the logarithmic sine, cosine, tangent, or cotangent required.

Ex. 1. To find the log. sine of 34° 17′ 24″
Here log. sine of 34° 17′ - - 9·7507287
And as 60 : 24 or as 10 : 4 : : 1853 : - 741
9·7508028

Ex. 2. To find the log. cos. of 55° 42′ 36″
Log. cos. of 55° 43′ - - - 9·7507287
60 : 24 (60—36), or 10 : 4 : : 1853 : - 741
9·7508028

Ex. 3. In the triangle PLS, given
P = 20° 30′ 48″
PS = 85 3 40
PL = 89 10 0
to find LS by prop. 23; SD being perp. PL.



P	20°	31′	″	cos.	-	9·9715404		
	.	.—12		- - - - - -		95		
PS	85	3	.	tan.		11·0624350	cos. found by taking tang. from sine	8·9349686
	.	.	40	- - - - -		9814		
PD	84	43	43	tan.		11·0349663	- - - - - - -	11·0349663
PL	89	10	0				cosec. PD 84° 44′ ″ -	10·0018374
LD	4	26	17				— 17 -	33
							cosin. LD 4 27 . -	9·9986888
							— 43 -	70
							cosin. LS 20 53 24 -	9·9704714

Here to avoid the trouble of finding the proportional part for the large logarithm difference of the cosine of PS, that cosine is found by subtracting the tangent of it (already found) from the sine, which is easily found, because the differences are small: And, for the same reason, the sum of the tangent and cosecant of PD, are used instead of its secant.

N. B. The perpendicular should always be let fall from the end of the side, PS or PL, which differs most from 90°, over or under."

OF THE TRAVERSE TABLE.

THIS traverse table, or table of difference of latitude and departure, in page 338 and 339, is so contrived, as to have the whole in one view, and is so plainly titled as to want little or no explanation.

The distances 1, 2, 3, &c, at the top and bottom, may be accounted 10, 20, 30, &c, and the 10 as 100, if the minutes of latitude and departure answering to the course be increased in the same proportion; so that if the distance consists of two significant figures, the difference of latitude, and the departure, is each to be taken out at twice; and if of three figures, at thrice.

The chief design of this table, is for the ready and exact working of traverses; but it may also be applied to the solution of the several cases of plain sailing, and to some other uses.

Prop. I. *Having the course and distance, to find the difference of latitude and departure.*

Seek the course on the left hand of both pages downwards, if less than four points, or 45 degrees; or if greater, on the right hand upwards; and even with it in the double column, signed at the top and bottom with the distance, is found both the difference of latitude and the departure.

Example 1. A ship sails ssw ¾ w 37 miles; the difference of latitude and the departure are required.

Find the course 2¾ points on the left-hand side of each page, and even with it in the double columns signed 3, and 7, the two figures of the distance, the difference of latitude for 30 is 25·732, and for 7 is 6·004, the sum is 31·736 for the whole difference of latitude; and the departure for 30 is 15·423, and for 7 is 3·599, the sum is 19·022 for the whole departure.

Thus, *Dist.*	*Diff. Lat.*	*Dep.*
30 - -	25·732 -	15·423
7 - -	6·004 -	3·599
37 miles	31·736 -	19·022

Example 2. A ship sails SE 49° 148 miles; the difference of latitude and the departure are required.

Find the course 49 degrees on the right-hand side of each page, and even with it in the double columns signed 10, 4, and 8, the difference of latitude at 100 miles is 65·606, at 40 is 26.242. and at 8 is 5·248; the sum is 97·096 for the whole difference of latitude. And the departure at 100 miles is 75·471, at 40 is 30·188, and at 8 is 6·038; the sum is 111·697 for the whole departure. Thus,

Dist.	*Diff. Lat.*	*Depart.*
100 - - -	65.606 -	75·471
40 - - -	26·242 -	30·188
8 - - -	5·248 -	6·038
148 miles	97·096 -	111·697

Prop. II. *Having several courses and distances; to find the difference of latitude and the departure.*

Make a table in the following manner, and put therein each course and distance; then find the difference of latitude and departure to each course by the preceding, and place them in the proper column; the difference of the sums of the northings and southings, is the whole difference of latitude; and the difference of the sums of the eastings and westings, is the whole departure.

Example. A ship from the latitude of 50° north, sails according to the courses and distances set in the traverse table; the differences of latitude, and the departure, are found at the bottom.

THE TRAVERSE TABLE.

Courses.	Dist.	Diff. of Lat.		Departure.	
	Miles.	North.	South.	East.	West.
SSE ¼ E	79		69·671	37·241	
SE ½ E	86		54·557	65·479	
S bW ¾ W	108		101·697		36·384
S 48° W	112		74·942		83·231
N 58° W	70	6·101			59·734
S 40° W	84		64·348		53·994
Diff. la. 359·104		6·101	365·205	102·720	243·343
			6·101		102·720
				Depart.	139·623

This proposition may be applied in the surveying of large tracts of land, as a county, &c. and was made use of by Mr. Norwood in measuring the distance from York to London, as the road led him, observing the several bearings by his circumferentor, and finding by such a table his several differences of latitude, and departure, by which he obtained the distance between the parallels of London and York, pretty near the truth, so long ago as the year 1635; as may be seen in his Seaman's Practice.

Also in plotting the survey of a county thus taken, the circuit station-lines, though consisting of many hundreds, may be reduced to a few for the first closing, and the like for the intermediates of each line first plotted, by which every station may perhaps be more truly placed than by any other method: the distances in the table may be chains of 66, or 100 feet, as well as miles, or any other measure that the differences of latitude and departure would be had in.

Prop. III. *Having the difference of latitude, and the departure; to find the course and distance.*

Seek the given difference of latitude and departure, taken together, in their columns, or the nearest numbers to them; and the course is even therewith at the side, and the distance at the top and bottom: but if the given difference of latitude and departure cannot be found nearly, take $\frac{1}{2}$, $\frac{1}{3}$, &c. part, or any equal multiple of them that can be found; then the course is even with them at the side, and such a part of the distance, as was taken of the difference of latitude and departure, at the top and bottom.

Example 1. Given the difference of latitude 59 miles S, and the departure 68 miles W; the course and distance are required.

In the double column over 9, even with 49° at the right-hand side, is found together the given difference of latitude and departure; therefore the course is 49° SW, and the distance 90 miles.

Example 2. Given the difference of latitude 30 miles N, and the departure 18 miles E; the course and distance are required.

Here the given difference of latitude and departure, or any numbers near them, are not to be found together in the table; therefore taking $\frac{1}{6}$ or the double of each, the course is found to be 31° NE, and the distance 35 miles.

Note. A table computed to every mile in the distance up to 100 miles would more readily solve this example.

Prop. IV. *Having the departure and middle latitude; to find the difference of longitude, according to the method used by* W. Jones, Esq. F. R. S.

Seek the given departure, or the next less number in the columns signed lat. even with the middle given latitude found among the courses, and at the top and bottom (signed dist.) is the difference of longitude sought; which, if not found directly at once, may be taken out at twice or thrice.

Example 1. Being yesterday noon in the latitude of 37° 17′ N, and this day noon in 38° 43′ N, and by the table the departure is found 70·921 E; the difference of longitude is required.

In the column signed lat. under 9, even with 38°, the middle latitude is found 7·0921; therefore 90 miles is the difference of longitude sought.

Example 2. Being yesterday noon in latitude 46° 25′ N, and this day at noon in 47° 35′ N, so that the middle latitude is 47° N, and the departure is found 112·53 miles W; required the difference of longitude.

In the column signed lat. over 10 at the bottom, even with 47 at the

right-hand side, is 6·8200; therefore subducting 68·200 from 112·53, the remainder is 44·33; then over 6 is 4·0920, and 40·92 subducted from 44·33 leaves 3·41, which is found over 5; therefore the difference of longitude is 165 miles west.

If the middle latitude be not an even degree, but have odd minutes; find the difference of longitude, for the even degrees next less and greater, and add a proportional part of the difference between the two results to the lesser; the sum will be the difference of longitude sought.

Suppose the middle latitude in the last example had been 47° 20′ N, then, after finding the difference of longitude as before for 47°, find it also for 48°, which is 168 miles; then $\frac{1}{3}$ of the difference being added to the former, gives the difference of longitude 166 miles west.

Note. Though this method is not in all cases near the truth, yet when the miles are geographical, it is sufficiently near for daily practice in any voyage, as well as easy, and very expeditious.

Prop. V. *Having the latitudes and the longitudes of two places, to find the bearing and distance.*

Seek the complement of the middle latitude among the degrees, and the difference of longitude in minutes among the distances, the departure answering is found in its proper column; then with the difference of latitude and departure, find their bearing or course and distance by the third.

Example. Let the Lizard be given in the latitude of 49° 50′ N, and 5° 21′ w longitude, and Cape Ortegal in the latitude of 44° 10′ N, and 70° 43′ w longitude; to find the bearing and distance.

The difference of longitude is 142′; and in the columns signed dep. under 10, 4, and 2, even with 43° the co-middle latitude, are found 6·8200, 2·7280, and 1·3640; then increasing the two former as before shown, their sum is 96·844 miles w, for the departure; and the bearing, or course, answering to 340 miles difference of latitude, with 96·844 departure, is found about 16° sw: and the distance about 354 miles.

OF MERCATOR'S SAILING.

THE uses of the table of meridional parts are fully supplied by the table of logarithmic tangents, as is demonstrated in N° 219 of the Philosophical Transactions. It is there proved, 1st, That the meridional line, or scale of Mercator's Chart, is a scale of the log. tangents of the half-complements of the latitude. 2dly, That such log. tangents of Mr. Briggs's form, are a scale of the differences of longitude, on the rumb which makes an angle of 51° 38′ 9″ with the meridian. And 3dly, That the differences of longitude on different rumbs, are to one another as the tangents of the angles of those rumbs with the meridian.

Hence it follows, that the difference of the log. tangents of the half complements of the latitudes, is to the difference of longitude a ship makes in sailing on any rumb from the one latitude to the other, as the tangent of 51° 38′ 9″ (whose logarithm is 10·1015104) to the tangent of the angle of the rumb or course with the meridian; so that:

I. If two latitudes, and the difference of longitude, be given, the course and distance are readily determined by this rule.