Thus, set 66 on index to 19 on B, then opposite 60.6 on index is lound semi-tangent of half the difference of the naknown angles 17.5 on B: if 17.5 be now taken on the line of somi-tangents, viz., the perpendicular of 30 and the index set to it, the quadr at will be cut by the index at 30' 11', half the difference of the unknown angles. Then,

 $63^{\circ} 40 + 30^{\circ} 11' = 93^{\circ} 51'$ greater augle C. $63^{\circ} 40 - 30^{\circ} 11' = 33^{\circ} 22'$ less augle B.

B C is readily found by first case.

Or, set the index to the given angle 520 40 on quadrant ; take 47 on index and 85 on side A, imagine a right line drawn from 47 on index to 85 on side A, and the triangle is complete. The perpendicular from 17 $\frac{8e_0}{12}$ on index to side A is 37.5, and divides the bass into two segments, 28.5 and 56.5, and the triangle into two right-angled triungles. Il the perpendicular of 56.5, segment D B, adjacent to the required augle, taken on A, and the parallel of 37.5 takea on B, be traced till they intersect, and the index set to the point of intersection, this point shows on index the side B C 67.7, and the intersection of index with the are of the quadrant, shows on the quadrant angle B 33° 29.

The same worked with the aid of the assisting index. RULE .- Set the attached index F to the given angle 52-40' on the quadrant, and while in this position, set the centre of the assisting index II to 47 on F: bring the graduated edge in contact with the other given side 85 on A : then the eircular part will indicate the angle at meeting of indices to be 93 51', and the side sought to be 67.7. Two angles being known, the third can easily be found by note to Art. 52, or thus : reverse the assisting index by placing its centre on 85 taken on A, and its graduated edge on 47 taken on attached index, the circular part will indicate the angle to be 33º 29', and the side 67.7.

54. CASE IV .- Given the three sides to find the angles. RULE .- Draw a perpendicular from one of the angles upou the opposite side or this side produced ; then calling this side base, say as base is to the sam of the other two sides, so is the difference of these sides to the difference of the segments of the base.

Then half this difference added to half the sum gives the greater segment, and subtracted from half the sum-that is half the base-gives the less. Then the triangle will be divided into two right-angled triangles, the angles of which cau be found by Art. 46.

Ex .-- Given the side A B 157, the side B C 110 and the side A C 88, to find the angles A B and C. figure 14. A B + A C 16 B A C 16 (A)

-AB	:	$\Lambda C+C$	В.	- i	AC > C	в	:	A D , D	B
157	:	198	-	-	22		:	27.74	C

or 78.5: 99 = 22 : 27.74Set 99 on index to 78.5 on B; then opposite 22 on B is found on index 27.74 difference of the segments of the base Theu 27.74

13.87 half difference of the segments.

78.5 half the sum or half the base.

92.37 sum gives greater segment D B.

64.63 diff. gives less segment A D.

Set side A C 88 taken on index to its adjacent segment A D 64.63 taken on A; the index will shew on quadrant the nugle $\Lambda 42^{\circ} 44^{\circ}$.

Again set side C B 110 taken on index, to its adjacent segment D B 92.37 taken on A; the index will show on quadrant, in like manner the uugle B 32° 53'.

The same worked with the aid of the detached index II. First take the halves of the sides, namely 78.5, 44 and 55. On the attached index F take 44, and to it set the centre of the detached index. Move the indices till you get 55 on detached index in contact with 78.5 on side A; the attached index will be found to intersect the quadrant at 42° 44' angle A, and the circular part will indicate the angle at the meeting of the indices to be 104° 23' ungle C.

EXAMPLES FOR EXERCISE.

1. Given one side 129, an adjacent angle 56° 30' and the opposite nugle 81° 36': required the third angle and the reumining sides.

Aus .- The third angle is 41° 54', and the remaining sides are 108.7 and 87.08,

2. Given one side 110, another side 102, and the coutained angle 413° 36': required the remaining angles and the third side.

Ans .- The remaining angles are 34° 37' and 31° 47', and the third side is 177.5.

3. Given the three sides respectively 120,6, 125.5, and 146.7 : required the augles.

Ans .- The angles are 51° 53', 54° 58', and 73° 9'.

PLANE SAILING.

55. In plane sailing, the earth is supposed to be an extended plane, and the meridians are, therefore, considered as being purallel to each other, the parallels of latitude at right angles to the meridians, and the length of a degree on the meridian, equator, and parallels of latitude every where equal.

56. The course is the nugle which the ship's truck nukes with the meridian ..

The distance is the number of miles, &c., between any two places, reckoned on the rhumb line of the course.

57. The difference of latitude is the distance which a ship makes North or South of the place sailed from, and is reckoned on a meridian.

58. The departure is the distance which a ship makes East or West, and is reckoned on a parallel of latitude.

Note .- As the course is generally taken on the arc of the quadrant, the operator will find it more convenient to take the difference of latitude on side A and the departure on side B.

Ex. 1.-A ship from latitude 48° 40 N., sails N.

See figure 15, E. by N. 296 miles, required her present lutitude, and the departure made good.

Then, by Trigonometry :

Rudius : Dist. 296 = Cosine con. 3 pts. : diff lat. Sine course 3 pts. : dep.

By the Seale :

Set radius 60 on index to 296 on B, then opposite cosine 3 pts 49.9 on index is diff. lat. 246.1 on B and opposite sine 3 pts. 33.2 on index is dep. 164.4 on B. Or, set the index to the course 3 pts, then the distance 296 on index will cat the perpendicular of the difference of latitude 246.4 on side A, and at the same time will ent the parallel of the departure 164.4 on side B. Then the proportion will be-

As radius 60 on F is to cosine 3 pts 49.9 on A, so is distance 296 or 29.6 ou F to 24.64 or 246.4 on A; and so is distance 296 or 29.6 on F to departure 16.44 or 164.4 on A.

59. The operator cannot fail to see that all the exercises in Navigation can be solved by the scale in various ways; but as a work of this kind must necessarily be short, we will after this coufine ourselves to the cusiest methods; and for she made? this purpose we must reserve the usual position of the figure, by drawing the difference of latitude across the page, and the departure in a direction from top to bottom.

Ex. 2.—A ship sails S. E. $\frac{1}{2}$ E. from St. Helena, in latitude 45° 55' S., until by observation she is figure 16. in latitude 18° 49' S., require her distance run and departure mado good.

Latitude St. Heleua Latitude come to	${15^{\circ}}{55'} {18^{\circ}}{49}$
Difference lutitude	$\begin{array}{ccc} 2^\circ & 51 \\ 60 \end{array}$
In miles	17.1

the difference of latitude 174 on A will uppeur the distance be placed in the north column, if the course be northerly, and

274.3 on index, and the parallel traced from this point on index to side B, will show on B the departure 212. Ex. 3.—A ship from latitade 3° 16' N., sails S.

W. by W. 1 W. until she hus made 356 miles of de- agure 17. parture : required her present latitude and distance sailed.

RULE .- Set the index to the course 51 points, then opposite the departure 356 on B will appear the distance 415.1 on index, and the perpendicular traced from this point to side A, will show on A the difference of latitude 213.4. Lat. left 3º 16' N.

Diff. lut. 213 miler or 3º 33' S.

Lat in

0º 17' S. Ex. 4 .- A ship from Cape St. Vincent in lufitude 37° 3' N., suils between the North and West figure 18. 430 miles, until her ditlerence of latitude is 214 miles : rcquired her course steered and departure made good.

RULE .- Set the distance 430 on index to the perpendicular of the latitude 214 on A, then opposite 430 on index is departure 373 on B, and the latersection of index with the ure of the quadrant shows on the are the course 60° 9'.

Ex. 5 .- A ship from latitude 1° 32' S., sails between the North and East 250 miles, and flads she figure 18. has made 126 miles departure : required the course steered and her lutitude in.

RULE .- Set the distance 250 on index to the departure 126 on side B, then opposite 250 on index is lound the difference of latitude 215.9 on side A, and the intersection of index with the arc of the quadrant shows ou the arc the course 30' 16'.

Lat. Diff.	left . lat.	216	miles,	or	 1° 32' S. 3° 36' N.
Lat.	in .		••••••		 2' 4' N.

Ex. 6.—A ship from Funchal, in Madeira, in See hatitude 32° 38' N., sails u direct conrese between figure 19. the south and west until she is in latitude 31° 13' N., by observation, having made 72 miles of departure ; required her course steered and distance run.

Lat. in, by observation 31° 13' N. Difference of lat. 4º 25

-60

In miles 85

RULE .- Trace the perpendicular of the latitude 85 tuken on A, till it will intersect the parallel of the departure 72 taken on B; set the index to the point of intersection, and this point will show on index the distance 111.4, and the index will show on quadrant the course 40° 16'.

EXAMPLES FOR EXERCISE.

1. A ship from latitude 36° 30 N, sails SW, by W, 420 ailes : what is her present latitude, and what departure has

Ans,-Latitude in 32° 37 N., and departure 349.3 miles. 2. A ship from latitude 3° 54 S, has sailed NW. 3 W, till she arrives at latitude 2º 14 N. : required her distance run,

and departure made good ? Ans.-Distance 617.8, and departure 496.2 miles.

3.- A ship sails between the north and west 170 leagues. from a port in latitude 38° 42 N., uatil her departure is 98 leagues : required her course and latitude in ? Ans.-Course N. 35" 12 W., and latitude in 15" 31 N.

TRAVERSE SAILING.

60. RULE .- Find by the scale the difference of latitude and departure corresponding to each course and distance, as in phase sailing; set these down opposite the distance in the RULE.-Set the index to the course 41 pts., then opposite proper column, observing that the difference of latitude must in the south departure n ensterly, an the columns set down th between the whole diffe with the gr east and we the same an

With this the direct c suiling. Ex.-Su

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