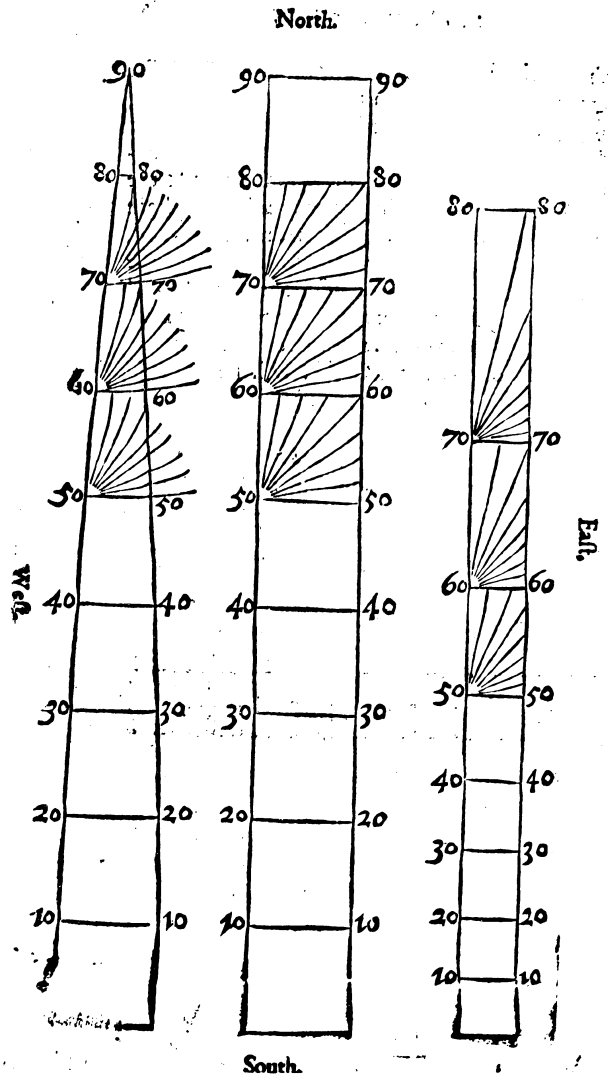


The vſe of this Planiſphære. Chap. 5.

IF the vſe of this Planiſphere much more mought be written then now I haue leyſure or cauſe to ſette downe, a great parte hereof being in ſuch ſort to be performed, as hath beene heretofore accuſtomed in the common ſea Chart, ſauing that this nauticall Planiſphære generally bringeth you to more certaine trueth in concluſion, then the ordinary Chart hitherto hath done, or poſsibly can do. Somet hing notwithſtanding, (for the better ſatiſfaction of the reader) I thought meete at this time to adde to the former treatiſe (eſpecially in thoſe poynts which may be moſt ſeruiceable for ſea men, and wherein the vſe of this nauticall Planiſphere differeth from the vſe of the common ſea Chart, heretofore ordinarily practiſed.

To knowe vppon what point of the compaſſe one place in this Chart lyeth from another, trye with your compaſſes from what rumbe both places haue equall diſtance, which may be found truly inough, for the marriners vſe for the moſt part by eſtimation onely. But if you would be preciſe, do thus, Draw a ſtraight line by both places, for a line paralell to it from the center of the next roſe or fly (as it is called) is the rumbe of thoſe two places, ſhewing vppon what poynt of the compaſſe you muſt go from the one to the other.

Or thus, (if you liſt not draw any lines vpon your Chart) lay the edge of a long ruler (reaching ouerthwart the Chart) to both places: take with your compaſſes the diſtance of the center of the next flie from the edge of the ruler, then guiding and caryng one foote along by the edge of the ruler, leade the other foote parallel-wiſe (that is, keeping it always equally at that diſtance from the ruler) for ſo it ſheweth you how thoſe places lie one from another.

To finde the diſtaunce of places.

The diſtance of twoo places (as the marriners commonly take it, and meaſure it in their Charts, is the ſegment or part of the rumbe intercepted betweene them, which howe much it is in the ordinary meaſure of leagues ſhall truely be found out by this Planiſphære, thus.

If both places haue one latitude.

If both places haue the ſame latitude, take with your compaſſes the length of a degree of the meridian at that latitude (take halfe the degree aboue, and halfe beneath that latitude) for ſo oft as you ſhall finde that length betweene the two places, ſo many ſcore leaues are there betwixt them. If the diſtance be great, for the more expedition you may take fiue times the length of that degree, and counting it for an hundreth leagues, proceede as before.

If both places haue the ſame longitude.

If both places haue not the ſame latitude, the æquinoctiall alſo not comming betweene them, ſubtract the leſſer latitude out of the greater, but if the æquinoctiall come betwixt them, adde both latitudes together, ſo haue you the difference of latitude betweene both places.

Now

Now if both places haue the ſame longitude, ſo many degrees as there is in the difference of latitude, ſo many ſcore leagues is the diſtaunce.

If both places differ both in longitude and latitude.

But if they differ alſo in longitude as well as in latitude, looke howe many degrees the difference of latitude containeth, ſo many degrees of the æquinoctiall take with your compaſſes, and leading one foote in the æquinoctiall, mooue forwardes the other alſo parallel-wiſe, keeping alwaies that diſtance, till it croſſe the rumbe of thoſe two places, in ſuch ſort, that one foote reſting in that croſſing, the other carried about, may but onely touch the æquinoctiall. Then hauing taken with your compaſſes the ſegment or parte of that rumbe betweene that croſsing and the æquinoctiall, ſet both feete in the æquinoctiall, and ſee howe many degrees are contained betwixt them, for ſo many ſcore leagues is the diſtance of thoſe two places.

Or if that ſegment of the ſayd rumbe be greater then wel can bee taken with the compaſſes, take the length of fiue degrees of the æquinoctiall, betweene the feete of your Compaſſes, and looke how oft you can finde that length in the ſegment aforeſaide of the rumbe, for ſo many hundreth leagues is the diſtance of thoſe two places.

The demonſtration hereof cannot be obſcure to him that well conſidereth the geometricall reaſon of the proiection, and making of this nauticall Planiſphere before ſette downe in the ſecond Chapter, from whence it foloweth, that bicauſe the ſphæricall ſuperficies (whereof this Planiſphære is conceiued to be geometrically made) extendeth it ſelf

euerie

euerie way equally, at euerie poynt of latitude betwixt the æquinoctiall and Pole, till it applie and ioyne it ſelfe round about to the concauitie of the circumſcribed cylinder; therefore the ſegments of the meridian, and of any other rumbe intercepted betwixt any the ſame two parallels, muſt needs increaſe in one and the ſame proportion.

And conſequently, as often as the ſegment of a meridian between any two parallels, is contained in the ſegment of any rumbe intercepted, betwixt theſame parallels in the Globe, ſo often is the like ſegment of a meridian contained in the ſegment of the ſame rumbe intercepted betweene the parallels correſpondent in this Planiſphere. Therfore (ſuppoſing the ſaide ſegment of the meridian in this Planiſphære to be diuided into ſo many equall parts as it containeth degrees) it followeth that ſo often as one of theſe partes is contained in the ſegment of the rumbe aforeſaide in this Planiſphere, ſo many ſcore leagues is the diſtance of the two places ſet at the endes of that ſegment.

Now it is manifeſt that by theſe three ſegments, that is, the ſegment of the rumbe betweene the two places, the ſegment of the meridian betwixt one of the places, and the parallel of the other) that is, the difference of latitude) and the ſegment of the parallel intercepted betwixt one of theſe places, and the meridian of the other, (which is the difference of longitude. I ſay it is manifeſt that by theſe three ſegments a right angled triangle is made, becauſe the ſegments of the meridian and parallel (which are two ſides of this Triangle, include a right angle.

Again

Againe it is plaine, that taking with your compaſſes ſo many degrees of the æquinoctiall as are contained in the difference of latitude: then guiding one foote in the æquinoctiall, and carrying forwardes the other parallel-wiſe, till it croſſe the rumbe of thoſe two places, in ſuch ſort, that one foote of the compaſſes being ſette in that croſsing, the other mooued about, may but onely touch the æquinoctiall: and laſtly, drawing from that croſsing a line perpendicular to the æquinoctiall: It is plaine I ſay, that by this perpendicular and the two ſegments, one of the æquinoctiall, betweene this perpendicular and the rumbe, the other of the rumbe, betweene the perpendicular and the æquinoctiall: by theſe ſegments I ſay, and the ſaide perpendicular, there is comprehended another right angled Triangle: which by the 14. *e* 4, *&* *c*. 3. *e*. 7 *Ram.* is like to the former right angled Triangle, becauſe two angles of them both are equall, that is, the right angles, and angles of the ſame rumbe. In the laſt of theſe triangles, the ſide perpendicular to the equinoctial, is proportionable to the difference of latitude, and the ſegment of the rumbe betweene the ende of this perpendicular and the æquinoctiall, is proportionable to the ſegment of the ſame rumbe contained betwixt the two places. Therefore by the 2 *p* 6. *&* 17 *p*. 11 *Eucl.* becauſe the line perpendicular to the æquinoctiall, containeth ſo many equall degrees of the æquinoctiall, as there are equal parts in the difference of latitude (that is) ſo many as there are degrees in the difference of latitude: theſe equall parts alſo of the perpendicu-

lar and difference of latitude are proportionable. Whereof it followeth that ſo oft as one of theſe equall parts of the difference of latitude is contained in the ſegment of the rumbe betwixt the two places (which before wee ſhewed to bee ſo oft as a degree of the meridian in the globe, is contained in the ſegment of the rumb betwixt the ſame places in the globe) ſo oft is one of the ſaid equal parts of the perpendicular aforeſaide (that is a degree of the æquinoctiall) contained in the ſegment of the ſame rumbe betweene the foreſayde croſsing or ende of the perpendicular, and the æquinoctiall. Therefore locke how many degrees of the æquinoctiall there are found in the ſegment of the rumbe of the two places, ſo many ſcore legues is the diſtance of thoſe two places, which was to be demonſtrated.

Thus haue you a way infallible to find out the diſtance betweene any twoo places meaſured in their rumbe: which becauſe it is then onely their true diſtance (that is the ſhorteſt ſpace betwixt thẽ vpon the ſuperficies of the terreſtriall globe) when both places lie north and ſouth each from other, or eaſt and weſt, hauing no latitude: whereas otherwiſe the ſegment of the rumbe betweene the two places is alwaies greater (yea ſometimes greater by halfe and more, in places farre northwardes or ſouthwardes) then the true diſtance: I thought good alſo here to ſette downe the way to finde out the true diſtance of any two places, wherein I haue beene, and yet am publikely charged with my premiſe, and meane at this time to diſcharge my ſelfe thereof.

The

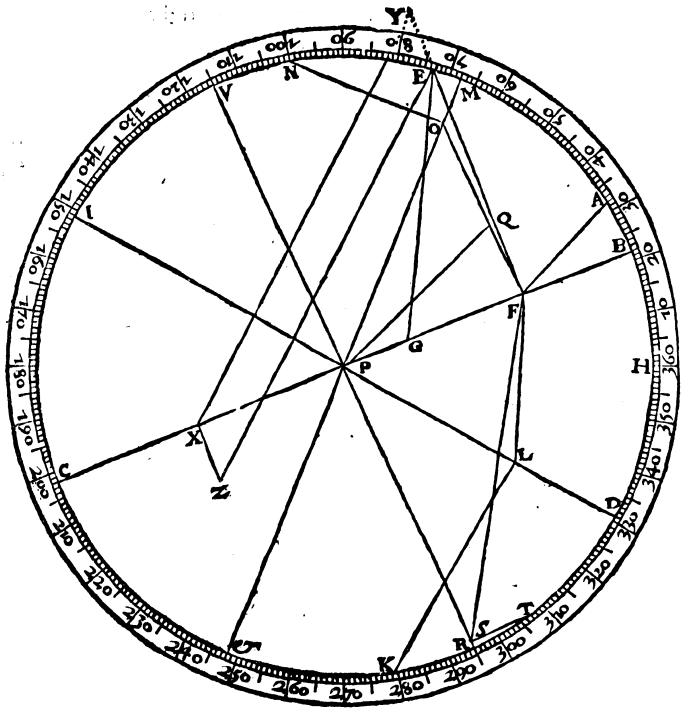
The true diſtance betwixt twoo places is the arch of a great circle intercepted betwixt them, which is thus to be fou nd out.

If both placees haue no latitude (as when they are both vnder the æquinoctiall) and one of them alſo no longitude, the longitude of the other being leſſe, or not more then 180. degrees: the longitude is the diſtance.

But if the longitude be greater then 180 degrees, ſubtract it out of 360. the remainder is the diſtance.

If both places haue either none or the ſame longitude (as when they are in the ſame ſemicircle of the meridian betweene the poles) and one of them onely haue latitude, that latitude is the diſtance. But if both places agreeing in longitude haue latitudes alſo of like denomination (as both northerly, or both ſoutherly) ſubtract the leſſer latitude out of the greater, the diſtance remaineth. If one place haue northerly latitude, and the other ſoutherly, adde them together, the ſumme is the diſtance.

If one or both places haue latitude, and differ alſo in longitude: in a great circle diuided exactly into degrees (with figures ſet to euerie fifth or tenth degree) note the longitudes of both places.



Now if one place onely haue latitude, drawe a diameter from the longitude thereof, noted in the circle, and with your compaſſes take ſo many degrees and minutes in the ſame circle, as that latitude containeth: then ſetting one foote of the compaſſes

ſes in the longitude of that place, with the other make a pricke in the circle, which may be called the poynt of latitude. From this poynt draw a line perpendicular, croſsing the diameter drawne from the longitude of that place. Take with your compaſſes the diſtance of this croſsing, from the poynt of the other places longitude, noted in the circle, and leauing one foote in the ſayde croſsing, with the other make a pricke, in the foreſaid diameter: take the diſtance of this pricke from the poynt of latitude noted in the circle. Then ſetting one foote of the compaſſes in that poynt of the circle where the degrees beginne to be numbred, the other foot extended that way, which the nūbers proceed, ſhal ſhewe you in the cirele the diſtance of the places.

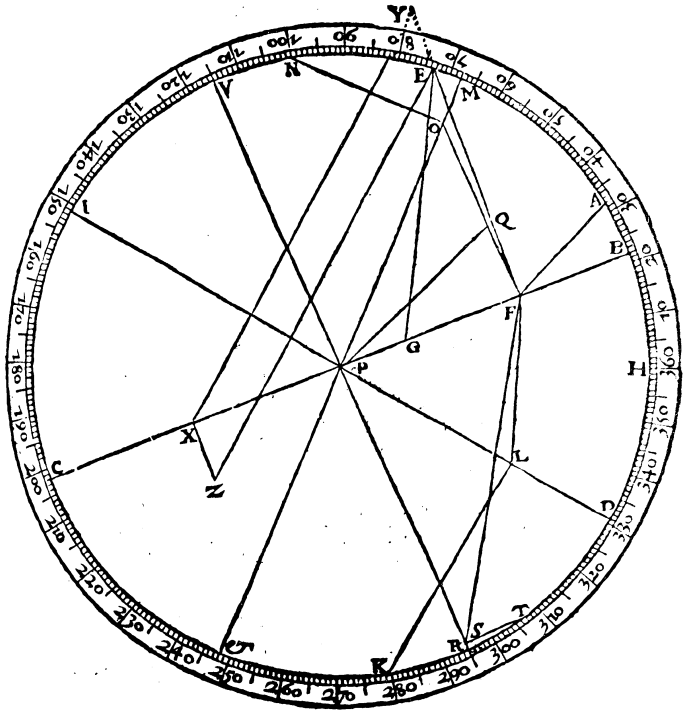
Take for example the cittie of *London*, and Saint *Thomas* Iland, which lieth right vnder the æquinoctiall line, in 32 degrees of longitude. The longitude of *London* admit: to be 22 degrees, the latitude 51 degrees, 32 minutes. Marke the longitudes of Saint *Thomas* Iland and of *London* with A and B. From the longitude of *London*. (becauſe *London* hath alſo latitude) draw the diameter B C. Hauing taken with the compaſſes the latitude of *London* in the circle, ſet one foote in B, and with the other make the pricke E in the circle, and draw the perpendicular E F, croſsing the diameter B C at F. Make F G equall to F A. which is the diſtance of Saint *Thomas* Iland from the ſine of *Londons* latitude. Then G E ſhall bee the line ſubtending the diſtance of thoſe two places. Taking therefore the length of G E with the compaſſes, and ſetting one

foote in H (where the degrees beginne) the other ſtretched forwardes in the circle, will poynte you out the diſtaunce of Saint *Thomas* Ilande and *London*, 52 degrees of a great circle, and about one halfe, that is, 1050 leagues, or 3150 engliſh miles.

If both places haue latitude, do the like for both places as before you did for the one place hauing latitude, till you haue croſſed both diameters with perpendiculars: then take with your compaſſes the diſtance of thoſe croſsings. Now if both their latitudes bee of one denomination (that is, both nottherly or both ſoutherly) and equall, ſette one foote of the compaſſes where the degrees begin to be numbred in the circle, and the other foote extended therein, that way which the numbers ſucceede will ſhew you the diſtance.

As for example, *London* and Cape *Blanco* (neare the coaſt of new found land) haue both northerly and almoſt equal latitude of 51 degrees, 32 minutes. Hauing therefore drawne as well the diameters B C and D I, from B, determining the longitude of *London* (*viz.* 22 degrees) and from the poynt of the longitude of Cape *Blanco* (which admitte to be 332 degrees, as alſo the perpendiculars or ſines of both their latitudes, E F, and K L, (as before was ſhewed) croſsing the diameters in F and L. The diſtance F L taken with the compaſſes, and tranſlated into the circle (as the former example) wil ſhew you the diſtance of cape *Blanco* from *London*, to bee almoſt 31 degrees, of a great circle that is 620 leagues, or 1860 miles.

If the latitudes be not both equall, and alſo of one

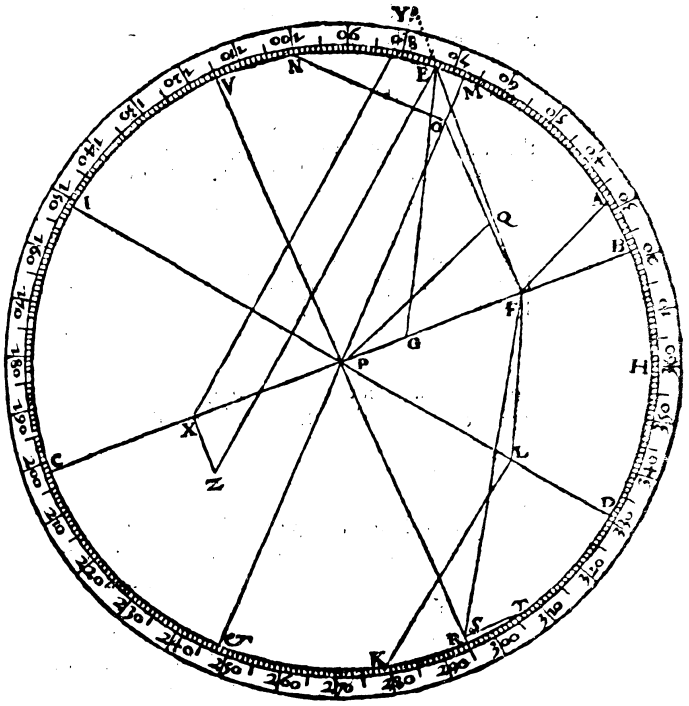


one denomination, leauing one foote of the compaſſes in the croſsing of the ſine or perpendicular diſcending from the poynt of the greater latitude, with thother foot make a prick in the ſame diameter, wherein that croſsing is: Then if the latitudes be

be both of one denomination, take with the compaſſes the length of the perpendicular or ſine drawne from the poynt of the leſſer latitude: and ſetting one foote in the poynt of the greater latitude, with the other make a pricke in the perpendicular deſcending from it, that is, in the ſine thereof: Take the diſtance of this pricke from the former, made in the diameter: This diſtance tranſferred into the circle (as in the firſt example) wil giue you the diſtance of the places giuen.

As *London* and *Hieruſalem* haue both northerly and vnequall latitudes, *Hieruſalems* latitude being onely 32 degrees. Firſt therefore note in the circle both their longitudes: the longitude of *London* (*viz.* 22 degrees) as before with B: The longitude of *Hieruſalem* (68 degrees) note with M. Let the perpendicular or the ſines of the latitudes of *London* and *Hieruſalem*, E F, and N O be drawne as in the former examples. Make F P equall to O F, and P Q equall to N O. The ſpace betwixt P and Q taken with the compaſſes, and then both feete ſet in the circle (in ſuch ſort as the firſt example was ſhewed) ſhall containe betweene them the deſired diſtance of *Hieruſalem* from *London*, 38 degrees, and about ⅓ that is 775 leagues, which are 2325 miles.

But if the latitudes be of diuers denominations, (that is, one northerly and the other ſoutherly) continue forth the perpendicular (that croſſeth the diameter, wherin the foreſayd prick was made) till it be equall to both perpendiculars, that is, to the ſines of both latitudes. The diſtance of the



ende of this continued perpendicular from the pricke aforeſayd in the diameter, taken with the compaſſes, and tranſlated into the graduated periphery of the circle (as before) will ſhewe you how

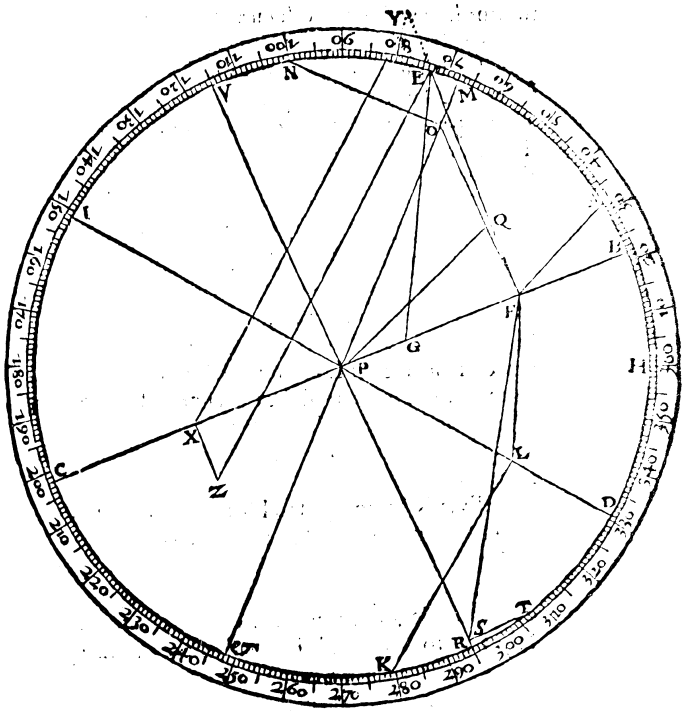
many degrees of a great circle are contained betweene both places.

To shut vp this matter with one example, suppose you would know how farre *Cusco* in *Peru* is from *London*. Let the longitude of *Cusco* be 295 degrees, the latitude 11 degrees southerly: The longitude of *London*, as before, 22 degrees, the latitude 51 degrees, 32 minutes. From both these longitudes noted in the circle with B and R, draw the diameters, as before, B C, and R V: as also the perpendiculars or lines of their latitudes E F, and T S. Make F K equall to F S, the distance of those lines, and E Y equall to S R the line of *Cuscoes* latitude. Take the distance Y X betweene the feete of the compasses, and set it from both in the circumference of the circle, as in the first example, so shall you finde that there are betwixt *London* and *Cusco* almost 97 degrees, of a great circle that is 1940 leagues or 5820 miles.

If you had rather keepe within the compasse of the circle, make the perpendicular X Z equall to S T, and proceede with E Z, as you did before with X Y.

He that desireth a demonstration of the former rules, must suppose the circle P H D R & C to be the æquinoctiall circle: let him also vnderstand the lines of latitude E F, K L, N O, T S, to stand perpendicularly erect from their diameters of longitude B C, D I, M &, V R, and from the plaine of the æquinoctiall, and consequently by the 3 *e.* 21. Ra, or 4. pt. 11. *Euc.* from the lines F A, F L, F O, F S, which lines are imagined to be in the plaine of the

æquino-



æquinoctiall, and are the distances of the lines of latitude. Therefore if F G be made æquall to F A (which is a line drawne in the plaine of the æquinoctiall from Saint *Thomas* Iland to the line of *Londons* latitude) E G must needes bee æquall to

the

the line ſubtending the diſtance of London and S. Thomas Iland by the 2. c 7. Ra. 4. 26. pr. 1. *Eucl.*

Alſo, becauſe all the ſines of latitude (beeing perpendicular to the ſame plaine of the equinoctiall) are parallels, by the 5. c 21. Ram 6. pr. 11. *Eucl.* Therefore by the 11. c 2. Ram. or 35 d. 1. *Euc.* F L is the line ſubtending the diſtaunce of London and Cape Blanco.

Againe, becauſe FP whereto EF is perpendicular is made equall to FO, (the diſtance of the ſines of London and Hieruſalem, to which (diſtance) EF is alſo perpendicular in the globe) and EQ alſo equall to NO: Therefore FQ being the difference of the ſines of Londons and Hieruſalems latitudes: there muſt needs be the ſame diſtance betwixt P and Q that there is betweene the toppes of the ſines of Hieruſalems and Londons latitudes in the globe.

Laſtly, FX being equal to FS (the diſtance of the ſines of latitude of London and Cuſco in Peru) & XZ perpendicular to FX, and æquall to ST the ſine of Cuſcoes latitude: as EF is the ſine of Londons latitude and perpendicular to the ſame line XF: EZ (to which XY is equall by the 6. c 12. c 5 *Ram.* 33 pr. 1. *Eucl.* YE being equall and parallel to XZ muſt needes be equall to a ſtreight line extended within the globe betweene the points of latitude of Cuſco and London.

Now out of this demonſtration it were an eaſie matter (if any liſt take the paines to be ſo curious) to find out the diſtance of any two places arithmetically by the doctrine of triangles, hauing alwaies two

two ſides giuen which are the ſines of the complements of the latitudes of the twoo places as OP, FP: LP, FP: RP, FP: AP, FP: together with the angle intercepted that is the difference of their longitudes: whereby FA: FO: FL: FS, the diſtances of the ſines of latitude being found by the 2, 3, 4, 5, *Copernic. de Triangulis planis*, the lines alſo ſubtending the diſtances of the places may moſt eaſily be found by the 3. *Copernic. de Triang. plan.* For the ſquares of the diſtance of the ſines, and of the difference of the ſines of their latitudes (if both be northerly or both ſoutherly) or of the ſumme of the ſines of their latitudes (if one be northerly another ſoutherly) are equall to the ſquare of the line ſubtending the diſtance of the places 5. c 12. *Ram.* 47. pr. 1. *Eucl.*

With no leſſe facilitie alſo by helpe of the former Tables, and the Canon of Triangles, any two places being giuen, there may arithmetically and moſt exactly be found out, firſt, by their longitudes and latitudes, the rumbe, and diſtance meaſured in the rumbe: ſecondly, by their diſtance, and latitudes, the rumbe and difference of longitude: thirdly, by their rumbe, and latitudes, the diſtance and difference of longitude: fourthly, by their longitudes, rumbe, and one latitude, the other latitude and diſtance: fifely, by the rumbe diſtance and one latitude, the other latitude, and the difference of longitude: or any other nauticall or geographical probleme that by the Chart may mœchanically be performed: and the whole Arte of Nauigation arithmeticall (as ſome call it) may as eaſily be pra-

ctifed : So as, hauing onely the longitudes and latitudes of the places (by which, and to which you are to saile) set downe in a Table, you may by arithmeticall calculation onely (if you list take the paines) without any chart, mappe, or globe, shewe the course and distance from anie place to other: and so giue most exact direction for the perfourmaunce of an whole voyage to any knowne place assigned, how oft soeuer you haue trauersed or bin tossed this way and that way by reason of scant, violent, or contrary windes, or any other occasion.

But seeing the first groundes of this Art, that is, the obseruations of the latitudes, but especially of the courses at sea, cannot but be farre from such exquisite trueth as is to be found in those arithmeticall operations: howe exact soeuer you be in the rest of the meanes, you can look for no more truth in conclusion then such as is answerable to the first groundes and principles, out of which the conclusion is gathered. So as the Mariner shall not need to trouble himself any further herewith, but only to cast vp his accounts vpon the chart truly made (as before is shewd) which of al other is most fit & ready for his ordinarie vse. Now therefore it may be sufficient, onely to shewe how the former Problemes may mechanically be performed vpon the nauticall planisphaere before described.

First, By the longitudes and latitudes of both places giuen, the rumbe and distance may thus be found: drawe parallels by both latitudes: take the distance of those parallels: according to which distance drawe a parallel to the æquinoctiall. Then from

from the end of the difference of longitude reckoned from the concurse of the rumbes in the æquinoctiall erect a perpendicular crossing the saide parallel: A line drawn by this crossing from the concurse of the rumbes is the rumbe of the two places. Now to finde out the distance, take so manie degrees of the æquinoctiall as the the difference of latitude containeth: and guiding one foote of the compasses in the æquinoctiall, with the other foot carried parallel-wise at equall distance from the æquinoctiall, crosse the rumbe newly found out: take the distaunce of this crosing from the concurse of the rumbes, and set both feete of the Compasses in the æquinoctiall, for the degrees intercepted shew you the distance desired.

Secondly, By the distance & latitudes (knowing which place is more eastwardes, or westwardes) the rumb & difference of longitude is thus found: Take with the compasses so many degrees and minutes of the æquinoctiall, as the difference of latitude containeth: According to that distance draw a parallel to the æquinoctiall, take so many degrees of the æquinoctiall with your Compasses, as the distance giuen commeth to: then one foote being set in the concurse of the rumbes in the æquinoctiall, with the other crosse the parallel aforesaide: A line drawne by that crosing from the concurse of the rumbes in the æquinoctiall giueth you the rumbe desired. Then both latitudes being noted in the graduated meridian, therein take their difference with the compasses, and guiding one foote in the æquinoctiall, with the other carried at that di-

diſtance parallel-wiſe from the æquinoctiall, croſſe the rumbe of the places: the diſtance of that croſſing from the meridian (that commeth from the common meeting of the rumbes in the æquinoctiall) taken with the compaſſes, and brought to the æquinoctiall, ſhal ſhew you the difference of longitude. Or a perpendicular to the æquinoctiall from that croſsing ſhal poynt you out therein, the difference of longitude.

Thirdly, By the rumb and latitudes (being both northerly or both ſoutherly) the diſtance and difference of longitude is thus found: Take the difference of latitudes in the æquinoctiall: according to that diſtance draw a parallel to the æquinoctiall (as before) croſsing the rumb of the two places giuen: take the diſtance of this croſsing from the concurſe of the rumbes: Then both feete of the compaſſes ſet in the æquinoctiall wil ſhew the diſtance of the places. The difference of longitude is found as before.

Fourthly, By the longitudes rumbe and one latitude (knowing whether it bee the leſſer or greater) to finde the other latitude, and the diſtance, do thus: From the concurſe of the rumbes in the æquinoctiall count the difference of longitude: from hence erect a perpendicular croſsing the rumbe: the diſtance of this croſsing from the æquinoctiall tranſlated into the graduated meridian (ſetting one foote in the knowne latitude, and extending the other northwardes or ſouthwardes according as the vnknowne latitude is greater or leſſer) ſhall ſhew you the latitude deſired. Now to finde the diſtance

diſtance worke as before in the firſt Probleme.

Fiftly, by the rumbe, diſtance, and one latitude, you may find the other latitude and the difference of longitude after this manner: Take the diſtance giuen with the Compaſſes in the æquinoctiall: ſet one foote in the concurſe of the rumbes, and with the other croſſe the rumbe giuen: from this croſsing drawe a perpendicular to the æquinoctiall: the length of that perpendicular taken with the Compaſſes and brought into the æquinoctiall ſhal ſhew you the difference of latitude. Thus hauing both latitudes giuen, the difference of longitude may alſo be found as before Prob. 2.

Nowe in euery one of theſe problemes there may be ſome particular caſes wherof ſome diuerſitie of working may follow, yet ſuch as can breed but ſmall trouble to him that well ſhall conceiue the reaſon of that is already ſet down in theſe fiue former Problemes: which are eſpecially to be applied to ſuch places as are both on the ſame ſide of the æquinoctiall, and differ alſo both in longitude & latitude: of which ſort is the greateſt number, and in which the greateſt vſe, and moſt difficultie of working conſiſteth. To proſecute euery particularitie at large (whereof ſome perhaps leſſe acquainted with the reaſon of theſe mathematical practiſes may be deſirous) would be now for mee too long and tedious. For ſome taſte therefore of the vſe of this nauticall planiſphere, let thus much for this time briefly ſuffice.