THE

Sea-man's Practice:

CONTAINING

A Fundamental Problem

IN

NAVIGATION,

EXPERIMENTALLY VERIFIED;

NAMELY,

Touching the Compaſs of the *Earth* and *Sea*, and the Quantity of a Degree in our *English* Meaſures.

ALSO

An exact Method or Form of keeping a Reckoning or Journal at SEA in any kind or manner of Sailing.

With certain TABLES and other *Rules* uſed in *Navigation*. As alſo the *Plotting* and *Surveying* of *Places*: The *Latitude* of the principal Places in *ENGLAND*: The finding of the Currents at Sea, and what Allowance is to be given in reſpect of them.

By Richard Norwood, Reader of the *Mathematicks*.

LONDON,

Printed for *Richard Mount*, and are to be ſold at his Shop at the *Poſtern* on *Towerhill*, 1699.

To the Reader.

THE Circuit of the Earth and Sea (as the Circumference of every Circle) contains 360 Degrees, by which Degrees the Distances thereon are measured, so that the Knowledg of the Quantity of such a Degree in our known Measures, is a fundamental Principle in Cosmography and Navigation, as upon which is grounded the Reckoning of the Ship's way, or Distance run. For though a Mariner, being in his Voyage on the vast Ocean, hath sometimes three things to certify him where he is, and how to shape his Course to his desired Port, namely, his Latitude, Course, and Distance; and sometimes a fourth, namely, some near conjecture of his Longitude by the Variation, or otherwise; yet oftentimes (as in close Weather) he hath nothing but his Course and Distance; otherwhile only his Latitude and Distance in his chief Guide in falling in with his intended Port. I know it is usual to allow near 7 Fathoms, or 41⅔ Feet to a Knot; and so many of these Knots as run out in half a minute, so many miles they account the Ship's way to be in an hour. And if in half a minute she run 41⅔ Feet, then in 60 minutes or an hour, she runs 5000 Feet; and thus they account 5000 English Feet, or 1000 Paces, to be a mile, and 60 of those miles to be a degree, such as the whole Circumference in any great Circle is 360. But how is this known to be true? If it be answered, that it is known to be so by experience; then I would know further by what Experiment this was found to be so? where, and by whom made? I press this so much the rather, because I am perswaded we have at this day as many excellent Navigators in this Kingdom, and as great Voyages performed, as from any other place in the World; and I should be glad to hear of the experimental Resolution of this Problem by some of them, tho it were but in running 8 or 10 degrees near the Meridian: for so I doubt not but that which I have here written thereof, would receive farther Confirmation, and better Entertainment, than haply it will now, being so much different from the common Opinion; and the Arts of Navigation and Cosmography, would be much more perfected in a short time. For one Error (as a fruitful Mother) is oftentimes the cause of more; and the removing of one is the occasion of removing others, especially when they do mutually support one another. As we shall here shew how the Error in the Projection and use of the common Sea-Chart, is supported by this Error of accounting only 300000 of our Feet to a Degree; and this in like sort upheld by that, so that they will stand or fall together. And surely that had fallen long since, being so manifestly convinced, if it had not been upheld by this. For the confuting of that (I mean the common Sea-Chart) it was sufficient to know that the Earth and Sea make one

Spherical Body. But in disproving and rectifying this, it is necessary to know moreover what is the Quantity of that Spherical Body. And to that end it was necessary to make a sensible application of our known Measures to a determinate part of the whole, that so the quantity of that determined Part being known, and the Proportion thereof to the whole, the quantity of the whole might also be discovered. And this I have endeavoured in the Experiment following, which if I had not handled so exactly in all Points as some would desire, (that requiring more Time and Charge than I could well bestow) yet I doubt not but it will be found that I have come very near the Truth. Some haply will censure me, for being my self at the expence to make such an Experiment. But I was as frugal in it as I could, adding Pains and Industry to save Expence; I came up in ten or eleven days, and had other necessary occasions to lead me from one place to the other, and did this as a thing falling opportunely in my way: But indeed, as in all other parts of Learning, so in the Mathematicks, especially in their Application, or middle Mathematicks, (as some call them) it is necessary with Speculation, to join actual and experimental Practices; the former being empty and uncertain without these. It is true, that the Mathematicks afford large Fields of delightful Speculations, wherein a man might walk far with much pleasure: But if from so many fair Flowers he bring home no Honey, or from such large Fields no Sheaves; I mean, if he bring not those Speculations to some useful Practices, neither himself nor others are like to receive much Fruit by them. But this indeed cannot be effected without more labour and difficulty; yea sometimes it requires mechanical and bodily Exercises, which some esteem too mean and unworthy to stoop unto. But for mine own part, I acknowledg to have had my Living and Maintenance by the Mathematicks, and not by Speculation only, but rather by my Practice therein; and therefore also I desire what in me lies to make them fruitful to my self and others; and to that end have spent in some principal parts of the Mathematicks, near as much time and means in experimental Practices and Conclusions, as in the Speculations. Moreover, considering that this particular Experiment was proposed above 30 Years since, by our Country-man Mr. Edward Wright, *to invite some to the Trial of it, as a thing which he would have done himself, if he had found such furtherance and oppertunity as he desired, which it seems he did not, nor any other since that time: Rather than so noble and necessary a* Problem *should longer rest unresolved, I took the oppertunity offered, hoping it may be an occasion to whet on some others to do the like. This with some other things which I conceived to be wanting in the Practice of* Navigation, *I have handled in this ensuing Treatise, which I commend to your friendly Acceptance. Farewel.*

THE

THE Sea-man's Practice.

CHAP. I.

The common Opinion touching the Compaſs of the Earth, and Quantity of a Degree of the ſame.

IT is a common received Opinion in *England*, (and the like is in other places) that allowing 5 of our *Engliſh* Feet to a Geometrical Pace, a thouſand of thoſe Paces make an *Italian* Mile, and 60 of thoſe Miles in any great Circle, upon the Spherical Surface of the Earth and Sea, make a Degree: and thus it is ſuppoſed, that a Degree contains 60 Miles, or 60000 Paces, or 300000 of our Engliſh Feet, and by ſuch Miles do Mariners in their Voyages by Sea keep their Reckonings. And becauſe the whole Circumference of a Circle is 360 degrees, therefore the Compaſs of the Earth, according to this opinion, ſhould be 21600 ſuch *Italian* Miles, or 21600000 Paces, or 108000000 of our Engliſh Feet. Whence this opinion came, or upon what Experiment it ſhould be grounded, I cannot certainly ſay: It may ſeem to be taken, or rather miſtaken, from *Ptolomy*, who ſaith, there are 500 *Stadiums* in a degree; the ſame was before affirmed by *Marinus Tyrius*, of whom *Ptolomy* ſpeaking in the 11*th* Chap. of his firſt Book of *Geography*, hath theſe words, *Sed in hoc quoque rectè ſentit, partem unam qualium eſt Circulus maximus tricentorum ſexaginta, quingenta in terra conſtituere Stadia, id enim confeſſis dimenſionibus conſonum exiſtit.* Now a *Stadium*, not only amongſt the *Greeks*, but as appears by *Herodotus*, amongſt all other Nations of *Aſia*, and in *Egypt*, did conſiſt of 600 Feet, or 100 *Orgays*, an *Orgay* containing 6 Feet, or 4 Cubits, as our Fathom doth; the ſame alſo is teſtified by *Suidas* and others: So that a Degree

Degree containing 500 *Stadiums*, and every *Stadium* 600 Feet, it follows that a Degree must contain 300000 Feet, exactly agreeing in number with the common received Opinion in *England*; which therefore may seem to be hence derived, and would also receive much Confirmation hereby, (he being an Author of such approved Credit) if it could be approved that our *English* Feet were exactly equal to the *Egyptian* or *Alexandrian* Feet, where *Ptolomy* wrote. Otherwise that being true, that so many of their Feet make a Degree, it will follow, that if ours be greater, there be fewer of them contained in a Degree; if lesser (as undoubtedly they are) there must be more of them contained in a degree.

Philander, in his Commentary upon the third Chapter of the third Book of *Vitruvius*, hath expressed the Quantity of the antient *Roman* Foot, where (by a competent allowance for the shrinking of the Paper, being printed wet) it may probably be gathered that it was something longer than our *English* Foot. But the *Alexandrian* and *Egyptian* Foot was much greater: for, according to *Hero Mechanicus*, 5 *Alexandrian* Feet were equal to 6 *Roman* Feet: seeing then the antient *Roman* Foot was something greater than ours, the *Alexandrian* must needs be much greater than ours. So that whereas *Ptolomy* saith, there are 500 *Stadiums* in a Degree; and, as we have shewed, a *Stadium* did consist of 600 Feet, these being *Egyptian* or *Alexandrian* Feet, as it is most probable, being the Place where *Ptolomy* lived; there must be a far greater number of our Feet in a *Stadium*, and so in a Degree; whence it is evident, that there is no sufficient footing for this common Opinion in the Assertion of *Ptolomy*.

Neither doth the Practice and Experiment of Mariners in their Voyages at Sea prove it; for there is no Reckoning or Experiment at Sea set down by any (that I have seen) to confirm it. And tho it be true, that in sailing between two Places that lie near to one and the same Parallel, they ground their Reckoning chiefly upon this Supposition, that 300000 of our English Feet make a Degree, yet can they seldom or never by those Reckonings discern the Error, the rather for that they have been, and for the most part are still kept upon the plain or common *Sea-Chart*, which makes a Degree in any Parallel equal to a Degree in the Equinoctial, and so makes a Degree in any Parallel to contain 300000 Feet: And it is true, that in some Parallel a Degree doth contain only 300000 of our English Feet; namely, about that Parallel which is in Lat. 35 deg. (as we shall further shew hereafter) near unto which have the principal of our Eastern & Western Voyages been made. And thus, tho this Opinion of 300000 Feet in a Degree, and

and the Projection of the common *Chart*, be both erroneous; yet, because the Error of the one doth somewhat salve the other, they could not be so easily discern'd by Experience only.

This Opinion of 300000 English Feet to a Degree, may seem also to be something confirmed by an Observation made by our Countryman Mr. *Edward Wright*, upon Mount *Edgcomb* near *Plimouth*, of the Semidiameter of the Earth, which he hath set down in his Book, *Of the Correction of Errors in Navigation*, Chap. 15. where he finds the Semidiameter to be 18312621 of our English Feet: whence it may be gathered, that in a Degree of a great Circle of the Earth, there should not be full out 300000 of our Feet. But the way by him then used, tho' it was very fit for the end whereunto he there applies it, namely, to find the dipping or depression of the apparent Horizon beneath the true, according to the Height of the Eye above the Water; yet will it easily be granted to be no exact way for finding the Semidiameter, and consequently the Circumference of the Earth, or the Quantity of a Degree on the same; and so he says there, that he used that way, because he wanted opportunity to put in practice a more exact way. Wherefore, for the farther satisfaction of my self and others in this Point, and chiefly for the necessary use it hath in the Practice of Navigation, I have made the Experiment following, that so the Quantity of a Degree, and of the whole Compass of the Earth, might at least-wise be nearly known in our English Measures.

CHAP. II.

An Experiment made for finding the Quantity of a Degree, and so of the Circumference of the Earth and Sea in our known Measures.

HAving occasion to be in the City of *York* about the beginning of *June*, *Anno* 1635, I made there several Observations of the Meridian Altitude of the Sun, the last of which was made the 11th of *June*; the Sky was every of those days something overcast at Noon, yet not so much but that an Observation might be made to a near Scantling: And because the last of these Observations is most fit for the present Occasion, and that day was as clear as any of the other, we will here especially make use of that, being as followeth.

Upon the 11th of *June* 1635, I made an Observation near the middle of the City of *York*, of the Meridian Altitude of the Sun, by an Arch of a *Sextant* of more than 5 Foot Semidiameter, and found the apparent Altitude of the Sun that day at Noon to be 59 deg. 33 min.

I had also formerly upon the 11th of *June*, *Anno* 1633, observed in the City of *London*, near the Tower, the apparent Meridian Altitude of the Sun, and found the same to be 62 deg. 1 min.

And seeing the Sun's Declination upon the 11th day of *June*, 1635, and upon the 11th day of *June*, 1633, was one and the same, without any sensible difference; and because these Altitudes differ but little, we shall not need to make any alteration or allowance, in respect of Declination, Refraction, or Parallax: Wherefore subtracting the lesser apparent Altitude, namely 59 deg. 33 min. from the greater 62 deg. 1 min. there remains 2 deg. 28 min. which is the difference of Latitude of these two Cities, namely, of *London* and *York*.

Also by the aforesaid Observation made in *York*, it appears that the Latitude of that City is 53 deg. 58 min almost.

But to our purpose: Coming at that time from thence to *London*, I further found by Measure, that the Parallel of *York* is from the Parallel of *London* 9149 Chains; every Chain being 6 Poles, and every Pole 16½ of our English Feet; that is, every Chain 99 Feet. (After what manner I found this to be so, we shall further express hereafter:) But thus, as I say, I found that *York* is more Northerly than *London* by 9149 Chains: And before we have noted that these two Places differ in Latitude 2 deg. 28 min. therefore it follows, that 2 deg 28 min. of the Meridian of the Earth and Sea, is equal to 9149 Chains. And if accordingly we would know how many of these Chains are contained in 1 Deg. we may find that by the Rule of Proportion, first reducing the Degrees into Minutes, and then say,

If the difference of Latitude	148 *co. ar.*	7.82974
give such a number of Chains,	9149	3.96137
Then 1 Degree, that is	60	1.77815
gives of such Chains	3709	3.56926

and somewhat more, namely, 5 Feet, which reduced into Feet, make 367196; that is, 367200 Feet in a Degree, lacking 4 Feet, which here we regard not.

Thus then according to this Experiment it is evident, that one degree of a great Circle measured on the Earth, is near 367200 Feet, which in our Poles of 16½ Feet, is 22254 Poles, and about one half; and these

these reduced into Furlongs, at 40 Poles to the Furlong, make 556 Furlongs and 14 Poles: And lastly, these reduced into our English Miles, of 8 Furlongs to a Mile, make 69 Miles, and 4 Furlongs 14 Poles, that is $69\frac{1}{2}$ Miles and 14 Poles in a Degree.

And hence, according to the most approved Hypothesis of the Sphericity of this Terrestrial Globe, we may find the Compass of it as followeth. But first you may note, that we speak not here of the Compass of the Earth in any Parallel, or lesser Circle described upon any side thereof, (that being various according to the different distance of those Circles from their Poles) but of the Compass taken in the middle or greatest thickness of the Globe; namely, in any great Circle, such as divide the whole Globe into two equal parts, of which kind are the Equinoctial and all Meridians, *&c.* this being properly the *Perimeter* or *Compass* of a Spherical Body.

Now seeing a Degree is the 360 part of the Circumference of a Circle, (for any Circumference being divided actually, or by supposition, into 360 equal parts, those parts are called Degrees) if we can find how many Feet, Paces, Miles, or other known Measures, are contained in one of those Degrees, then shall we easily conclude how many of the same known Measures are contained in the whole Circumference: But by the former Experiment we find, that in one Degree of a great Circle on the Spherical Superficies of the Earth, there is contain'd 367200 Feet; therefore it is evident, that 360 times 367200 Feet is the Compass of the whole; wherefore multiplying 367200 by 360, the Product is 132192000 Feet, which reduced into Poles, is 8011636: And these reduced into Furlongs, are 200290 Furlongs 36 Poles. And lastly, these reduced into Miles, are 25036 English Miles, and somewhat more, for the Circuit of the Earth and Sea.

If further, we desire the Diameter and Semidiameter of the Earth: Forasmuch as it is proved by *Archimedes*, that the Proportion of the Circumference of a Circle is the Diameter thereof almost, as 22 to 7; Therefore by the Rule of Proportion, as 22 to 7, so is the Circumference of the Earth to the Diameter thereof: So that multiplying the Circumference of the Earth, namely 132192000 Feet by 7, and dividing the Product, namely 925344000 by 22, the Quotient, namely 42061091, is the Diameter of the Earth in Feet; the half whereof, namely 21030545 Feet, is the Semidiameter of the same, being 21 Millions of Feet, and somewhat more; these reduced into English Miles, as before we did the Circumference, shew the Diameter of the Earth to be 7966 Miles, and somewhat more, and the Semidiameter

3983. And thus we have the Circumference, Diameter, and Semidiameter of the Earth, as also the Quantity of a Degree of the same Circumference, in known Measures of Feet, Furlongs and Miles, &c. There are only two things here which may seem doubtful; namely, the Experiment it self, and the Hypothesis of the Sphericity of this Terrestrial Globe, consisting of the Earth and Sea; for these being admitted, the Measures thence deduced, as before, will necessarily follow.

Now touching the Experiment; I confess, that to have made it so exact as were requisite, and in all Points, so as I shall shew in the Chapter following, would have required much more Time and Expence than mine Ability would reach unto: Yet having made Observation at *York*, as aforesaid, I measured (for the most part) the Way from thence to *London*; and where I measured not, I paced, (wherein through Custom, I usually come very near the Truth) observing all the way as I came with a Circumferentor all the principal Angles of Position, or Windings of the Way, (with convenient allowance for other lesser Windings, Ascents and Descents) and these I laid not down by a Protractor after the usual manner, but framed a Table much more exact, and fit for this purpose, as we shall after shew; so that I may affirm the Experiment to be near the Truth.

Touching the *Hypothesis*, that the Earth and Sea make one Spherical or round Body, it is generally agreed upon by all the principal Philosophers, Astronomers, Geographers, and Navigators, Ancient and Modern: Some Reasons demonstrative for the Confirmation thereof may be these.

First, The Eclipses, especially of the Moon, which are caused by the shadow of the Body of the Earth, being interposed between the Sun and the Moon: And forasmuch as this shadow doth fall upon the Moon always, and upon every side circular, and so appears to us; it is manifest by the Opticks, that the Earth, from whence it proceeds, is a Spherical Body.

Secondly, Likewise the Eclipses of the Sun, which are caused by the Interposition of the Moon between the Sun, and those places where it appears eclipsed; I say, it could not be determined when, and in what place such an Eclipse should appear, and where not, if the Form of the Earth were not known: But seeing the places where such Eclipses happen, and where not, may be, and are usually determined, and that upon this ground, That the Surface of the Earth is Spherical, it is thence also ratified to be a Truth.

Thirdly, The Sun, Moon, and Stars, do rise and set, and are upon the

the Meridian sooner to those that are resident in the Eastern parts, than to others more Westerly, and that in a proportion answerable to the Roundness of the Earth, as the Planets and Stars are upon our Meridian at *London* sooner by almost 4 Hours, than they are to those that inhabit the *Summer-Islands*, and the Confines of *Virginia* and *New-England*: And so in *East-India*, and other Eastern Regions, the Sun and Stars are sooner upon their Meridian than upon ours; which is manifest to be so, as by other reasons, so especially by the Eclipses of the Moon: For an Eclipse of the Moon hath not in it self any diversity of Time, being at one and the same instant without respect of places; yet because in the Eastern parts the Day is begun, and it may be far spent before it begin in places far Westerly, therefore such an Eclipse may appear to the Eastern Inhabitants toward the end of the Night, which to the Western appears in the beginning or middle of the same Night with them; and so the Difference will be more or less, according to the different Distance of those places in Longitude.

Fourthly, Furthermore we see, that going or sailing to the Northwards, we have the Artick Pole and Northern Stars more elevated, and the Antartick Pole and Southern Stars more depressed, the Elevation Northerly increasing equally with the Depression Southerly, and either of them proportional to the Distances which we go: The like happens in going to the Southwards. Besides, the Oblique Ascensions, Descensions, Occultations, Emersions, and Amplitudes of rising and setting of the Sun and Stars in every several Latitude, agreeable to the Hypothesis of the Earths Sphericity. All which could not be so, if the Earth were of any other than of a Spherical Form.

Fifthly, So if we stand upon the Sea-shore, and see a Ship far off under Sail, making towards the Land, at first we see only the Top-sails or highest parts, and withal do manifestly behold the Convex Superficies of the Sea, as it were raised and interposing it self between our Sight and the Hull, or lower parts of the Ship, till she approacheth nearer, and this uniformly every ways alike, and proportionably to the several Distances; which doth evidently demonstrate the Spherical Roundness thereof.

Sixthly and lastly, (to add no more) The Navigations of these latter times make it apparent, those especially that have been maade round about the World, as those two Voyages by our famous Country-men Sir *Francis Drake*, and Mr. *Thomas Candish*, both which severally sailing from our Coasts to the *West-Indies*, and passing the Straits of *Magellan*, continued their Course Westerly, till they came into those parts,

Parts, which are from us to the Eastward, namely, to the *East-Indies*, and so sailed still Westward till they came to *Cape bon Esperance*, and thence returned into *England*: Having sailed about the whole Terrestrial Globe, they found nothing by their Observations or Reckonings dissonant from the uniform Sphericity thereof in all its parts. That they came short in the number of Days, one, or reckoned the time of their Ablence less by one Day and a Night than they which remained at Home, this further confirms the thing in hand.

Yet whilst we speak here of the Roundness of the Earth and Sea, we intend it not so strictly as if it were a thing turned round without any Inequality to its Superficies; but as a Bowl or Ball, though it hath some Dust or small grains of Sand cleaving thereto, may still be said to be round. So, though the Land, Hills, and Mountains, be somewhat raised above the Spherical Superficies of the Sea; and if there should be also some Valleys or Bottoms more depressed; yet seeing the greatest of these Inequalities, have scarce any sensible proportion to the whole, we may well affirm the whole to be round.

The Relations made of the prodigious Height of some Mountains, as to be 60 or 70 Miles high, if it be understood of their perpendicular or direct height, are fabulous; the Mount *Atlas* is recorded by some of the Ancients, to reach up almost to the Moon, and to be as it were a Pillar for the Heavens to rest upon, being measured Geometrically by *Eratosthenes*, the Perpendicular, or upright Height from the Top thereof to the Valleys beneath, was found not to exceed 10 *Stadiums*, which of our English Measure is little more than a Mile and a Quarter, a *Stadium* not much differing from our Furlong; and the like might be shewed of others.

But if we admit the highest Mountain to rise perpendicularly above the Spherical Superficies of the Sea 2 Miles; yet seeing the Diameter or whole Thickness of the Earth is, as we have before shewed, 7966 Miles, this Exorbitancy or difference of 2 Miles is of small moment; yea, if there were any Mountain 8 Miles in height upright, yet this compared with the whole Thickness of the Earth, is little more than one thousand part thereof; therefore we may conclude, that this Terrestrial Globe, consisting of the Earth and Sea, is Spherical. We come in the next place to shew, by what way of measuring we found the Parallel of *York* to be distant from the Parallel of *London* 9149 Chains. And so how the Distance of the Parallels of two places may be exactly measured.

CHAP.

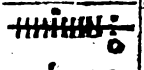
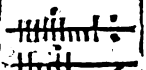
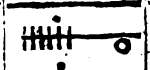
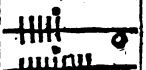
CHAP. III.

A most exact way for finding the Quantity of the Diameter and Circumference of the Earth and Sea, and of a Degree on the same.

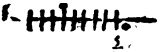
I Do the more fully set down the Way of making this Experiment, that so I may give occasion to any who are so nobly minded for a publick Good, as to be at that Charge to make a farther and more exact trial thereof. Now then, the best and perfectest way is, to observe so exactly as may be the Summer Solstitial Altitudes of the Sun at two Places so far distant asunder, and lying so near North and South each from other, with so direct and fair a Way betwixt them as conveniently may be chosen: Suppose for Example, *Christ-Church* and *Berwick*, or some other Place in the farthest parts of *Scotland*; for the further these two Places are each from other, the more perfectly may this business be performed. Then measure as truly as is possible, and set down in a Book all the way between those two Places, with all the Windings, Ascents and Descents that are therein, whereby with the help of the ensuing Table, you may easily and exactly find how much the one Place is more Southerly than the other. For this purpose the plain Table is not the fittest Instrument, but rather a *Theodolite* or *Peractor*, or some other of that kind, observing diligently the Variation of the Needle. The Chain may be 6 Poles long, or rather 100 Feet, and the Table fitted accordingly (but the Table following is for Poles) if it should be much longer, it would be too heavy.

The High-ways are commonly crooked; yet because of sundry Obstacles and Impediments which are incident out of the Way, and because a Man cannot certainly at first direct himself the neareſt and best way to the Place intended, it would be expedient to measure the distance as aforesaid; first in the High-ways leading from the one to the other, and then in the neareſt and best way that could be chosen between them; and so if any notable Error happen in the one, it may be discover'd and amended in the other. The form which I observed in setting down the Measures and Angles, was according to this Example.

Deg.

Deg.	Distances.	North.	South.	East.	West.
S. E. 31					
S. E. 20					
S. E. 13					
S. E. 13					
S. W. 2					
S. E. 5					

It is to be understood, That the Table here following, was before calculated to serve instead of a *Protractor* for a *Circumferentor*, or other graduated Instrument, and for a Chain of 3 Poles, which for the most part I use; yet it may be very well applied to a Chain of 6 Poles, (as in this business it was) reckoning every Chain to be two, *&c.* And thus for every ten Chains, of 6 Poles to a Chain, I make two strokes, signifying 2 Changes, or 20 Chains, and if there be any odd Chains, for those I set a Figure in another Line next below; and if moreover any odd Poles, whether one or two, for those I set another Figure in a third Line below.

Thus the last Entrance before going, being S. E. 5 Degrees,  signifies that the Line upon which I went, was from the South part of the Meridian to the Eastwards, making an Angle with the Meridian of 5 deg. the 9 strokes signifie 9 Changes, or 90 Chains; the Figure 5 signifieth 5 Chains, and Figure 2 two Poles. So that it is to be read thus, South-Easterly, 5 Degrees, 9 Changes, 5 Chains, and 2 Poles; and the like is to be understood of the rest. But for the most part, having liberty of Ground, I end the Measure of every Line, either with a whole number of Changes, or at least of Chains.

And thus proceeding all day, towards the Evening, or when else I have time convenient, I reduce all these Distances, upon what Lines or Angles soever they be, to Distances North or South, East or West, as here appeareth.

Deg.

Deg.	Distances.	North.	South.	East.	West.
			2571	1545	
S. E. 31	||||:o			2809	1026	
S. E. 20	||||||::			1692	616	
	||||| o			0169	062	
S. E. 13	||||||::			2923	675	
S. E. 13	||||||::			1754	494	
	||||| o			1499		050
S. W. 2	||||| o			2690	235	
				0149	013	
S. E. 5	||||||||| 5			0020	002	
	2					
Chains.	171		16286	4578	052
	2			0	52	
Poles.	1715		16286	4526	

We will explain the laſt, and ſo the reſt may eaſily be underſtood; S. E. 5 deg. ||||| m. 5. 2. Here becauſe I have S. E. the Numbers taken out of the Table muſt be put in the Columns entituled *South* and *Eaſt*. Then in the Table under 5 deg. I look for 9 Changes, and find againſt it 2690, and in the adjacent Columns under the Complement thereof 235; and becauſe S. E. 5 deg. is leſs than 45 deg. that is nearer to the South than to the Eaſt, I put into the Column entituled *South* 2690, and in that entituled *Eaſt* 235; then again in the ſame Tabular Column under 5 deg. I find againſt 5 Chains (cutting off a Figure, becauſe 5 Chains is but the tenth part of 5 Changes) 149 to be put in the South Column, and 13 for the Eaſt Column.

Laſtly, againſt 2 Poles I find for the South Column 20, and for the Eaſt 2; and the like is to be underſtood of all the reſt.

Now ſuppoſing this laſt to be a Place, whoſe Diſtance and Situation from the firſt is required; I ſum up the Columns ſeverally, and of the North and South Columns ſubtract the leſſer from the greater, and ſo of the Eaſt and Weſt Columns; and ſo it will appear how much North or South, and how much Eaſt or Weſt the laſt Place is from the firſt.

As in this Example, we find the firſt Place to be to the Southwards of the firſt 1628 Poles, for the laſt Figure may be cut off, being uſed in the

Table only for the more exactneſs, or may be made a Fraction, and ſo it is 1628 $\frac{6}{10}$ Poles; likewiſe the laſt place is to the Eaſtwards of the firſt 452 $\frac{6}{10}$ Poles; and thus I proceed all the way.

Now touching the Angles of Aſcent and Deſcent of Hills and Valleys; to have obſerved them exactly, would have required more Time and Charge than I could of my ſelf beſtow, yet I made allowance for ſuch of them as were of moſt moment: he that would obſerve them all, may either make 2 or 3 Columns more, or keep an account of them apart by themſelves. But if he intend no farther uſe of them, but to find the neareſt Diſtance, he need not ſet them down, but make allowance for them on the Ground, keeping his Diſtances entire without Fractions.

As, admit I obſerve the Aſcent from a Valley to the Brow of a Hill to be 14 deg. above the Level or Horizontal Line, and that meaſuring, I find the diſtance to be 30 Poles: I turn to the Table, and under 14 deg. and againſt 10 Chains, I find 2911, and 726, ſhewing that the Level, or horizontal Diſtance from my Station to that brow is only 29 $\frac{11}{100}$ Poles, and that the height of that Brow above the Level line is 7 $\frac{25}{100}$ Poles: But finding thus, that the Hypothenuſal being 30, the Baſe or level Line is but 29 $\frac{11}{100}$, that is, leſs by $\frac{89}{100}$; becauſe I would avoid this Fraction, I add to the end of the foreſaid meaſure of 30 Poles upon the Level line, $\frac{89}{100}$ of a Pole, and then I may account my ſelf diſtant from the place in the Valley where I made Obſervation 30 Poles in a Level or Horizontal Line, and ſo ſet down the diſtance without a Fraction: The like is to be underſtood of all other Aſcents and Deſcents.

Here followeth the Table.

	1 d.	89 d.	2 d.	88 d.	3 d.	87 d.	4 d.	86 d.	5 d.	85 d.
1	300	5	300	10	300	15	299	21	299	26
2	600	10	600	21	600	31	599	42	598	52
3	900	15	900	31	899	46	598	63	896	79
4	1200	20	1200	42	1198	62	1198	84	1195	105
5	1500	26	1500	53	1498	78	1497	105	1494	131
6	1800	31	1799	64	1798	93	1796	126	1794	157
7	2100	37	2099	74	2097	110	2095	147	2093	183
8	2400	42	2398	84	2397	124	2394	168	2391	209
9	2700	47	2698	95	2696	140	2694	189	2690	235
10	3000	52	2998	105	2996	157	2993	210	2989	262
1	10	00	10	0	10	0	10	1	10	1
2	20	00	20	1	20	1	20	1	20	2

6 d.

	6 d	84 d.	7 d.	83 d.	8 d.	82 d	9 d.	81 d.	10 d.	80 d.
1	298	31	298	37	297	42	296	47	295	52
2	597	62	596	74	594	84	592	94	590	104
3	895	64	894	111	891	125	889	140	887	156
4	1193	126	1192	146	1188	167	1185	187	1182	208
5	1492	157	1489	183	1485	209	1481	234	1477	260
6	1790	188	1787	223	1782	251	1777	281	1772	312
7	2089	223	2085	257	2080	292	2074	328	2069	365
8	2386	251	2383	292	2377	334	2371	375	2364	417
9	2686	282	2680	329	2674	376	2667	422	2659	469
10	2984	314	2978	366	2971	418	2963	469	2954	521
1	10	1	10	1	10	1	10	1	10	1
2	20	2	20	2	20	3	20	3	20	3

	11 d	79 d.	12 d.	78 d.	13 d.	77 d.	14 d.	76 d.	15 d.	75 d.
1	295	57	293	62	292	67	291	73	290	78
2	590	114	586	143	584	134	582	146	580	156
3	883	172	881	188	876	203	873	219	870	233
4	1178	229	1174	250	1169	270	1164	290	1160	310
5	1473	286	1467	312	1461	337	1455	363	1449	388
6	1768	343	1760	374	1754	404	1746	436	1739	466
7	2060	401	2055	436	2047	472	2038	508	2030	543
8	2355	458	2348	500	2339	540	2329	580	2320	621
9	2650	515	2641	562	2631	608	2620	653	2610	699
10	2945	572	2934	624	2929	675	2911	726	2898	776
1	10	2	10	2	10	2	10	2	10	3
2	18	4	19	4	19	4	19	4	19	5

	16 d.	74 d.	17 d.	73 d.	18 d.	72 d.	19 d.	71 d.	20 d	70 d.
1	288	83	287	88	285	93	284	98	282	103
2	576	166	574	177	570	186	568	196	564	206
3	865	250	861	264	855	279	851	294	846	308
4	1153	332	1148	352	1140	371	1135	391	1218	411
5	1442	413	1434	438	1426	463	1418	488	1410	513
6	1730	496	1721	526	1711	556	1702	586	1691	616
7	2019	580	2008	615	1997	649	1986	684	1973	719
8	2307	663	2296	703	2282	743	2270	782	2255	822
9	2596	746	2583	791	2567	836	2552	880	2537	924
10	2884	827	2869	877	2853	927	2836	977	2819	1026
1	10	3	10	3	10	3	10	3	10	3
2	20	5	19	6	19	6	19	6	19	6

	21 d.	69 d.	22 d.	68 d.	23 d.	67 d	24 d.	66 d.	25 d	65 d.
1	280	107	278	112	276	117	274	122	272	127
2	560	215	556	224	552	234	548	244	544	254
3	840	322	834	337	828	351	822	366	816	381
4	1120	429	1112	449	1104	468	1096	488	1088	508
5	1400	537	1391	562	1380	586	1370	610	1360	634
6	1680	645	1669	674	1656	703	1644	732	1632	764
7	1960	752	1947	768	1932	820	1918	854	1904	888
8	2240	860	2225	899	2209	937	2192	976	2175	1015
9	2521	968	2504	1011	2485	1054	2466	1098	2447	1142
10	2801	1075	2782	1124	2761	1172	2740	1220	2719	1268
1	9	4	9	4	9	4	9	4	9	4
2	18	7	18	8	18	8	18	8	18	8

26 d.

	26 d.	64 d.	27 d.	63 d.	28 d.	62 d.	29 d.	61 d	30 d.	60 d.
1	270	131	267	136	265	141	202	145	260	150
2	540	263	534	272	530	282	524	290	520	300
3	810	394	801	408	795	423	78	435	780	450
4	1079	525	1068	544	1060	564	1048	581	1040	600
5	1348	657	1336	681	1324	704	1311	727	1299	750
6	1618	788	1603	817	1589	845	1574	872	1559	900
7	1888	919	1870	953	1855	986	1836	1017	1819	1050
8	2157	1050	2138	1089	2120	1127	2098	1162	2079	1200
9	2427	1182	2405	1225	2384	1267	2361	1308	2339	1350
10	2696	1315	2673	1362	2649	1408	2624	1454	2598	1500
1	9	4	9	5	9	5	9	5	9	5
2	18	8	18	10	18	10	18	10	18	10

	31 d.	59 d	32 d	58 d.	33 d.	57 d.	34 d	56 d.	35 d.	55 d.
1	257	154	254	139	252	163	249	168	246	172
2	514	309	508	318	504	326	498	336	492	344
3	773	463	763	477	755	489	747	504	738	516
4	1028	617	1017	636	1007	653	995	671	983	688
5	1285	772	1272	795	1258	817	1243	838	1228	860
6	1542	927	1526	954	1510	980	1492	1006	1474	1032
7	1809	1081	1780	1113	1762	1144	1741	1174	1720	1204
8	2057	1235	2034	1272	2013	1307	1990	1342	1966	1377
9	2314	1390	2288	1431	2265	1470	2238	1510	2212	1549
10	2571	1545	2544	1590	2516	1634	2487	1677	2457	1721
1	9	5	8	15	8	5	8	6	8	6
2	18	10	16	a	16	10	16	12	16	12

36 d.

	36 d.	54 d.	37 d.	53 d.	38 d.	52 d.	39 d	51 d.	40 d.	50 d.
1	243	176	240	180	238	185	233	189	230	193
2	486	352	480	360	472	370	466	378	460	386
3	729	528	720	541	709	555	699	567	690	578
4	971	705	960	721	945	739	932	756	920	771
5	1213	881	1198	902	1182	923	1165	944	1149	964
6	1456	1057	1438	1082	1418	1108	1398	1133	1379	1157
7	1699	1234	1678	1262	1654	1293	1631	1322	1609	1350
8	1942	1410	1918	1443	1890	1479	1865	1511	1839	1543
9	2185	1586	2157	1624	2126	1663	2098	1700	2069	1735
10	2427	1763	2396	1805	2364	1847	2331	1888	2298	1928
1	8	6	8	6	8	6	8	6	8	6
2	16	12	16	12	16	12	16	12	46	12

	41 d	49 d.	42 d.	48 d.	43 d.	47 d.	44 d.	46 d.	45 d	45 d.
1	226	197	223	201	219	205	216	208	212	212
2	452	394	446	402	438	410	432	416	424	424
3	678	591	669	603	658	614	648	625	636	636
4	905	788	892	803	878	819	864	833	849	849
5	1132	984	1114	1003	1097	1023	1079	1042	1061	1061
6	1358	1181	1337	1204	1316	1228	1295	1250	1273	1273
7	1584	1378	1560	1406	1535	1433	1511	1458	1485	1485
8	1810	1575	1783	1607	1754	1638	1727	1666	1697	1697
9	2086	1772	2006	1807	1974	1842	1943	1874	1910	1910
10	2264	1968	2229	2007	2194	2046	2158	2084	2122	2122
1	8	7	7	7	7	7	7	7	7	7
2	16	14	14	17	14	14	14	14	14	14

The

The Structure of the Table is from this Ground:

As Radius is in proportion to the Distance of two places measured in their Rhomb; so is the Sine of the Complement of that Rhomb, to the difference of the Latitude of the two places.

And so is the Sine of the Rhomb, to the distance of the Meridians of those two Places. As, admit I measure South-Easterly 20 deg. 31 Poles, here then the Rhomb upon which I measure, making with the Meridian an Angle of 20 deg. I say,

As Radius is in proportion
to the Distance measured, 300 Poles; ——— 2.47712
So is the Sine Complement the Rhomb, S.E. 20 deg ——— 9.97299
to the Difference of Latitude 281 $\frac{21}{100}$ *ferè*, ——— 2.45011

Whereby it appears, that the Distance of the Parallels of these two places is 281 $\frac{21}{100}$ Poles; or that the place whereto I measure, is more Southerly than the place from whence I measured by 281 $\frac{21}{100}$ Poles.

Now for the distance of their Meridians say,

As *Radius* is in proportion
to the Distance measured 300 Poles, ——— 2.47712
So is the Sine of the Rhomb S. E. 20 deg. ——— 9.53405
to their Distance in Longitude 102 $\frac{60}{1000}$ ——— 2.01117

And thus I find the place whereunto I measured, is more Easterly than the place from which I measured, by 102 $\frac{6}{10}$ Poles, and somewhat more. And in like sort may be found all the other numbers expressed in this Table; but having thus found for every deg. to 45 deg. two Numbers, the rest may be deduced from them, as in this Example: 300 Poles at three Poles to the Chain, is 100 Chains, or ten Changes; finding that in ten Changes upon this degree, the difference Southerly is 281 $\frac{21}{100}$ Poles, it must be for five Changes, which is just half so much by almost 141; and for one Change, which is a tenth part, 28 $\frac{2}{10}$ *ferè*, and so for two Changes twice so much, that is 56 $\frac{42}{100}$; for three Changes thrice so much, that is, the sum of the two former, namely 84 $\frac{63}{100}$, and so by Addition only you may find the rest, as in this Table, which I shall need to prosecute no further. And thus you may make it to the hundred or thousand parts of a Pole; but this for ordinary occasions, for which it was at first intended, may suffice. And according

Ch.	*Poles.*
1	28.19
2	56.38
3	84.57
4	112.76
5	140.95
6	169.14
7	197.33
8	225.52
9	253.71
10	281.92

according to this Example, it will be eaſy to frame the like Table for a Chain of any other ſize, or for any other Meaſure which you uſe.

It may be objected, That howſoever this Rule holds true in Plain Triangles, yet the Triangles here uſed are neither Plain nor Spherical; for a Plain Triangle is made of three right Lines, a Spherical of three Arches of great Circles: But in this the three ſides are of ſeveral kinds; namely, one ſide is an Arch of the Meridian, and ſo of a great Circle; another an Arch of a Parallel, and ſo of a leſſer Circle; the third ſide, or *Hypothenuſal*, being the Rhomb, is no Arch of a Circle, but a Segment of an *Heliſpherical* Line.

But I anſwer, That notwithſtanding this may be ſpeculatively conceived, and ſo demonſtrated to be no Plain Triangle; yet in ſo ſmall Diſtances as theſe which here we uſe, there can be no ſenſible, nor ſcarce any numerable Difference. Yea, the diſtance between two Parallels by the Rhomb and Diſtance given (being the thing here chiefly aimed at) is very exactly found by this Rule, as before we have ſhewed, and as is more fully demonſtrated by Mr. *Wright*, in the Twelfth Chapter of his Book, *Of the Correction of Errors in Navigation*: Whence we may conclude, that the parts of the Meridian collected by this Table according to the Rhombs and Diſtances, as we have before ſhewed, do give the true Meaſure of the Segment of that Meridian intercepted between the Parallels of the two Places propoſed.

CHAP. IV.

Of the Difference of Longitude, Poſition, and Diſtance of York *and* London: *And how the Maps of* England *may by this Experiment be reformed, eſpecially in the Latitude of Places.*

WE come next to ſpeak of the Eaſterly and Weſterly Diſtances, gathered as before is ſhewed by theſe Tables, and to find thereby the Difference of Longitude: and of this we will give an Example in the foreſaid Experiment; whereby we find that the Diſtance in Longitude, or the Eaſt and Weſt Diſtance between *York* and *London*, is near 14000 Poles, *London* being ſo much more Eaſterly than *York*. And before we have found that in a Degree of the Meridian, and conſequently in a Degree of the Equinoctial, there is near

3709

$3709\frac{1}{10}$ Chains, at 6 Poles to the Chain; and these 14000 Poles converted into such Chains, are $2333\frac{1}{3}$.

Which $2333\frac{1}{3}$ Chains, for finding the Difference of Longitude, are not to be reckoned in the Parallel of *York*, that being too much Northerly; neither in the Parallel of *London*, being too much Southerly, but in a middle Parallel between both; namely, about the Latitude of 52 deg. 45 min. Now to find what difference of Longitude is answerable to this $2333\frac{1}{3}$ Chains in the Parallel of 52 deg. 45 min.

As *Radius* is in proportion	
to Sine Compl. the Latitude sc. 52 deg. 45 min.	9.78197
So in the Measure of a Degree in the Equinoctial $3709\frac{1}{10}$	3.56927
to the Measure of a Degree in that Parallel $2245\frac{1}{10}$	3.35124

And thus we find that in the Parallel, whose Latitude is 52 deg. 45 min. there are $2245\frac{1}{10}$ Chains answering to a Degree, whereby it appears that the Difference of Longitude between *York* and *London*, is more than one Degree. And to find how much more, say again by the Rule of Proportion,

As the Measure of a Degree $2245\frac{1}{10}$ ——— *Co. Ar.*	6.64876
is to a Degree in seconds, 3600	3.55630
So is the Measure given, $2333\frac{1}{3}$	3.36797
to the Number of seconds, 3741	3.57303

Which reduced, is 1 deg. 2 min. 21 sec. And thus we find that *London* doth differ in Longitude from *York* 1 deg. 2. min. 21 sec. being so much more Easterly.

Thus having the Difference of Latitude, as also the Difference of Longitude between these two places, we may (according to the second Problem of sailing by *Mercator*'s Chart) find the Rhomb from *London* to *York* to be 14 deg. 20 min. from the North to the Westward; that is, North and by West 3 deg. 5 min Westerly, and the Distance in that Rhomb 9442 Chains. But their distance in the High-way, by reason of the crookedness and unevenness of it, was more by about an eighth part.

And the like might be done for other immediate places between these; but affecting brevity, we pass that over, as not much pertinent to our present purpose; only expressing the Latitudes of some of the principal of them, as followeth.

	Latitudes. deg.	min.
As the Latitude of *York*, we find to be	53	58
Doncaſter,	53	32
Newark upon *Trent*	53	5
Grantham,	52	54
Stamford,	52	38
Huntington,	52	19
Royſton,	52	3
Ware,	51	48
London,	51	30

We further noted in this Experiment, that howſoever the Number of Miles between *Ware* and *London*, are almoſt the ſame by Eſtimation that they are by meaſure; yet all the way beſides from *York* to *Ware*, a meaſured Mile conſiſting of 320 Poles, is but three quarters of a Mile, as the Miles lie by Eſtimation or common Account; ſo that every where (for the moſt part) three Miles by Eſtimation make four meaſured Miles; and a min. or the 60th part of a deg. is almoſt in the middle between them both. So that look how much a meaſured Mile is leſs than a min. ſo much, or ſomewhat more, is a Mile by Eſtimation greater than a min. for as there is contained in a Degree of meaſured Miles $69\frac{1}{2}$ and ſomewhat more, as we have before ſhewed; ſo of our common eſtimated Miles, there are contained about $51\frac{2}{3}$ in a Degree.

Upon theſe grounds the whole Map of this Kingdom might be much rectified, eſpecially in the Latitude of Places; for tho' we cannot hence determine certainly the Latitudes of any other places beſides thoſe which were in the way, or at leaſt in ſight as we came up, (the principal of which we have before noted;) yet we may nearly conjecture the Latitudes of moſt parts of *England*, by their Diſtances and Poſitions from theſe: But theſe things being beſides our ſcope and purpoſe in this place, we ſhall only compare the Latitude of ſome principal Places, probably gathered from this Experiment, with the Latitudes of the ſame place, as they are ſet down by Mr. *Speed* in his Geographical Deſcription of *England*, that ſuch as pleaſe to examine both in any Particulars, may know to which they may more ſafely lean.

Canterbury

	Latitud. by this Exper.		Latit. by Mr. *Sp.* Map.	
	D.	M.	D.	M.
Canterbury	51	17	51	29
Chicheſter	50	48	50	51
Guilford	51	12	51	22
Wincheſter	51	03	51	11
Dorcheſter	50	40	50	44
Exceſter	50	43	50	48
Wells	51	12	51	22
Salisbury	51	04	51	12
Reading	51	28	51	42
London	51	30	51	45
Colcheſter	51	58	52	16
Ipſwich	52	08	52	30
Norwich	52	42	53	10
Cambridge	52	12	52	32
Hertford	51	49	52	06
Bedford	52	08	52	30
Buckingham	52	00	52	20
Royſton	52	04	52	24
Oxford	51	46	52	02
Gloceſter	51	53	52	12
Hereford	52	07	52	27
Worceſter	52	14	52	36
Warwick	52	20	52	45

	Latitud. by this Exper.		Latit. by Mr. *Sp.* Map.	
	D.	M.	D.	M.
Northampton	52	14	52	36
Huntington	52	19	52	44
Stamford	52	38	53	04
Leiceſter	52	40	53	06
Lincoln	53	14	53	50
Newark upon *Trent*	53	05	53	38
Nottingham	53	00	53	32
Derby	52	58	53	30
Stafford	52	52	53	22
Shrewsbury	52	47	53	16
Cheſter	53	16	53	52
Lancaſter	54	10	54	57
York	53	58	54	44
Richmond in *York-ſhire*	54	28	55	18
Kingſton upon *Hull*	53	48	54	29
Doncaſter	53	32	54	12
Durham	54	50	55	45
Carliſle	55	00	55	56
Newcaſtle	55	03	56	01
Berwick.	55	54	57	03

The Latitude of theſe places in the firſt Column expreſſed, are ſuch as are probably gathered from this Experiment. But in the ſecond Column there are ſet down the Latitudes of the ſame places, as they are expreſſed by Mr. *John Speed* in his Map of *England*, ſet forth in his Book, intituled, *The Theatre of the Empire of* Great Britain; and leſt there ſhould be any Miſtake in his Map, I have conferred theſe Latitudes thence gathered, with the Latitudes of the ſame places, ſet down by him in words at large, in his Deſcriptions of each ſeveral County, and find them nearly to agree, except in the Latitude of *Berwick*, which

in his Map he makes to be 57 deg. 3 min. But in his Historical Description of *Northumberland*, he relates it to be 55 deg 48 min. Which last is much nearer the Truth, but seems not to be his meaning; because then he should make it more Southerly than *Newcastle*; yea, more Southerly than he doth *Carlisle*, which by his Map, and also by his words in his Relation of *Cumberland*, is in the Latitude of 55 deg. 56 min. whereas *Berwick* is above 50 Miles more Northerly.

By these you may nearly conjecture the Latitudes of other parts of *England*, lying in or near the same Parallel with any of them: And hence it also appears, that the difference of Latitude between *Berwick*, and the South Coast of *England* near *Christ-Church*, is little more than 5 deg. not 6 deg. and more, as some of our Maps make it. But these things we must leave, that we may proceed to that which is principally intended, only we will first touch a little upon the Use of the foregoing Table, in plotting and surveying of Land.

CHAP. V.

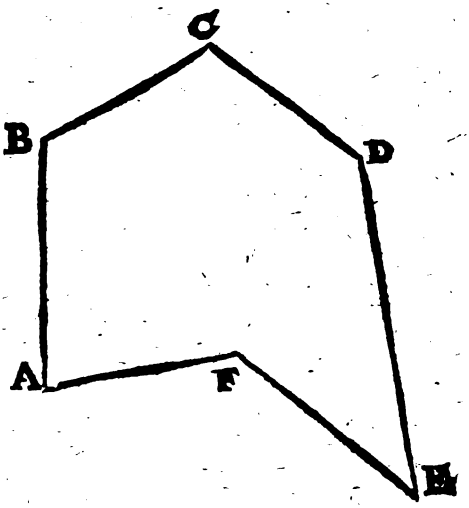
To delineate the Plot of any Forest, Park, Common, or other piece of Ground; as also of Rivers, Harbours, &c. speedily and most exactly.

MY Intent is not here to prosecute at large the Plotting of Grounds, being a thing handled by others, treating of *Surveying*: But considering the ways by them directed, and by others practised, in delineating or laying down the Distances and Angles observed by the *Circumferentor*, *Theodolite*, *Peractor*, or other graduated Instrument, are by a *Protractor*, and that the Table before-going, or that which followeth towards the end of this Treatise, serveth for that and the like purposes, almost as speedily, and far more exactly; I shall crave leave to digress a little, to shew the Use of it as briefly as I may. Therefore passing over the Method to be used in setting down the Names of the Grounds, the Tenants, Borderers, and other remarkable things, leaving every Man in these to the ways wherein he is accustomed: You may (as sometimes I do) make a Book in a long *Octavo*, and upon the left side thereof set down such things as these before mentioned, reserving every right side, and dividing them by ruled Lines into six Columns, as hereafter following appeareth.

And

And having taken and set down your Notes in the Field on the left sides or pages of your Book, you may in the Evening, or next Morning before you go out, or when else your Occasions will permit, set down in the first Columns on the right side, how many degrees the Lines upon which you have traversed, are distant from the North or South part of the Meridian towards the East or West; and in the second Columns the quantity of the same Lines, in Changes, Chains, and single Poles, and parts of Poles.

As in this Figure; suppose the Line from A to B to be directly East, 7 Changes, that is, 7 times 30 Poles, or 210 Poles. From B to



C to the Eastwards of the South 35 deg. 5 Changes, and 1 Chain; from C to D to the Westwards of the South 32 deg. 5 Changes, and 4 Chains; from D to E to the Westwards of the South 80 deg. 10 Changes; from E to F to the Eastwards of the North 35 deg. 6 Changes, 3 Chains, and two thirds of a Pole; and lastly, from F to A, the place where I first began, to the Westwards of the North, 9 deg. 5 Changes, 3 Chains, $2\frac{1}{2}$ Poles. All these I express in the first and second Columns on the right side, as hereafter following appeareth.

Which done, I take the Table, and find there the Northing and Southing, Easting or Westing answering to these Degrees and Distances, and set them down accordingly. As for the first, being East 7 Changes, I set down in the East Column 210 Poles with a Cypher behind

behind it. For the second, being South-East 35 deg. I find in the Table for 5 Changes 1228, to be set in the South Column, and 860 for the East Column; also upon the same degree for 1 Chain, 25 for the South Column, and 17 for the East Column; and so I proceed with all the rest, till I have finished.

Degrees.	Distance.	North.	South.	East.	West.
East.	0			2100	
South-east, 35	1		1228	0860	
			0025	0017	
South-west, 32	0 4		1272		0795
			0102		0064
South-west, 80	0		0521		2954
North-east, 35	3	1474		1032	
	0 2/3	0074		0025	
		0005		0004	
North-west, 09	3	1481			0234
	2 1/2	0089			0014
		0025			0004
		3148	3148	4065	4065

And being thus returned to my first Station, I sum up severally these four Columns of North, South, East and West; and finding that the Sum of the North Column is equal to that of the South, and the Sum of the East is equal to that of the West, I conclude the whole Work to be truly performed; whereas if there had been any difference, it had shewed an Error; and if that Difference had been great, it had been necessary to examine the Work again, and so to correct it.

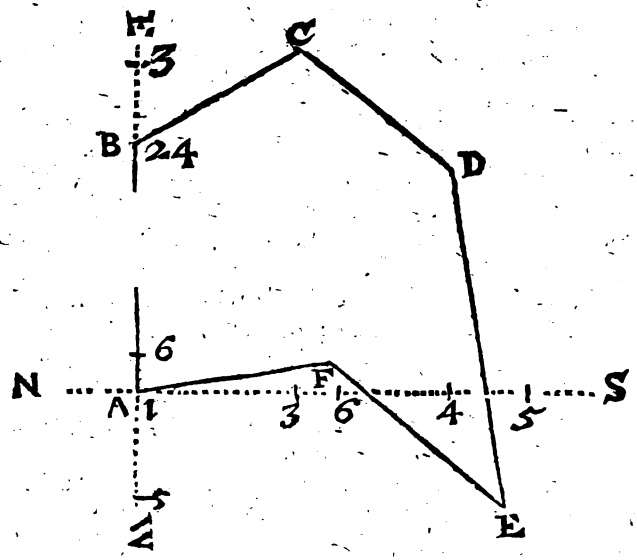
It is usual to add together all the Angles, and also to multiply two right Angles, or 180 deg. by the number of Angles lacking two; and if the Sum of the Angles added together, be equal to this product, the Work is thought to be true: As here, if we add the Inclinations and Reclinations of these Lines in this Figure, the Sum is 720 deg. or eight right Angles; and if we multiply two right Angles by 4 (because

cauſe here are ſix Angles) the Product is alſo eight right Angles. But the other by the Sums of the Columns, is a moſt abſolute way for examining the Truth of your Work, and to be preferred before any other that I know.

It may ſeem very laborious to ſet down every Station in this manner, but one that is a little exerciſed in it, may, as I take it, (for I never obſerved the time exactly) ſet down 40 or 50 Stations in this manner, within the ſpace of an Hour, or thereabouts. But I ſhould adviſe that it be done by two Men, having each a Table for that purpoſe, to avoid all Miſtakes.

If your Inſtrument give not the Angle with the Meridian expreſly, yet it may eaſily be gathered thence; or elſe you may divide a Circle as your Inſtrument is divided, and number the Degrees as they are there numbred; which done, number them alſo from the North and South part of the Meridian toward the Eaſt and Weſt, ſo ſhall you eaſily know the Angle of any Degree with the Meridian.

Now to proceed, theſe Meaſures may be ſet down in a Plot ſeveral ways. As firſt, conſidering which way the Ground lies, I take a Point for my firſt Station, ſo as the whole may fall conveniently within the Plot, which let be the Point A, by which Point I draw a Meridian and Parallel, namely two right Lines interſecting one another at right Angles; whereof let N. S. be the Meridian running North and South, and E. W. the Parallel running Eaſt and Weſt: This done, I look to the North and South Columns, and there, firſt in the South Column, and againſt the third Station, I find 1253, that is, 125 $\frac{3}{10}$ Poles; this I ſet in the Meridian from A to the Southwards, and mark the Point with the Figure 3; then in the South Column againſt the fourth Station, I find 1374, which I ſet in the Meridian from 3 to 4; alſo againſt the firſt Station I find 521, which I ſet in the Meridian from 4 to 5. Then againſt the ſixth Station, I find in the North Column 1553, which I ſet in the Meridian from 5 to 6; alſo againſt the ſeventh Station, which is the ſame with the firſt, I find 1595, which I ſet in the Meridian from 6, and it falls upon A, which is the firſt Station. And thus have I done with the South and North Columns.



In like ſort I expreſs the Meaſures in the Eaſt and Weſt Columns in the Parallel E. W. As finding firſt in the Eaſt Column 2100, I ſet it down from A to the Eaſtwards, and it extends to B, where I ſet 2, ſignifying my ſecond Station; I find next in the Eaſt Column 877, which I ſet down in that Parallel from 2 to 3; next in the Weſt Column 859, which I ſet in that Parallel from 3 to 4, and ſo I proceed with the reſt. And having thus ſet down the Meaſures in the Meridian and Parallel, we have alſo, as it falls out in this Example, two Stations expreſs'd, namely, A and B; now for the third, I take in the Parallel with my Compaſſes the diſtance A 3, and ſetting one foot in the Meridian at 3, I ſtrike an Arch near C; alſo taking in the Meridian the diſtance A 3, and fixing one Foot in the Parallel at 3, I croſs the foreſaid Arch near C, the interſection of theſe two Arches is the Point C, repreſenting the third Station.

In like ſort I proceed to find the Points D E F, for the fourth, fifth and ſixth Stations; then drawing Lines, namely, from the firſt Station A to the ſecond B, and from the ſecond to the third C, *&c.* we ſhall deſcribe the Figure required, ABCDEF.

Otherwiſe, whereas here you add and ſubtract the ſeveral Diſtances of South and North, as alſo of Eaſt and Weſt, by your Compaſſes, you may

may with a little more pains add and ſubſtract them by the Pen, which is the better way.

As having ſet down in the Meridian the Southerly Diſtance of the third Station 1253, I add thereto 1374, which is againſt the fourth Station, the Sun is 2627, the Southerly Diſtance of the fourth Station, which I ſet in the Meridian from A to 4. Again, to this I add 521, ſo have I 3148, the Southerly Diſtance of the fifth Station A 5, from which ſubſtracting 1553, the Northerly Diſtance ſet againſt the ſixth Station, there remains 1595, which is the Southerly Diſtance of the ſixth Station, to be ſet in the Meridian from A to 6. Laſtly from this, abating the Northerly Diſtance of the firſt Station from the Sixth, which I find there alſo to be 1595, there remains 0, ſhewing that I am returned to the ſame Parallel, or Eaſt and Weſt Line, in which at firſt I began. And in like ſort, you may proceed with the Eaſt and Weſt Columns, and then by the interſection of two Arches, find every Station as before.

Other ways might be preſcribed, which will not be hard to find of your ſelf. And as we may thus lay down any irregular right-lined Figure far more exactly than by the *Protracter*: So when it is laid down after this manner, we may caſt up the *Area* or ſuperficial Quantity of it very exquiſitly: Yea, if there ſhould be a Plot drawn (according to the Angles and Diſtances here given) after the uſual manner, by a Scale ſo large, that the Plot ſhould be an hundred times ſo great as this; yet could not the Content thereof be caſt up ſo exactly and certainly as it may be here.

But I muſt not inſiſt upon theſe things, they may of themſelves be conceived, and my Intent is only to touch them, that I be not prevented of Time, and by other Occaſions, from handling thoſe things which I have here more eſpecially intended.

But as I have ſaid, this Courſe is chiefly to be uſed in plotting large Grounds, and there indeed are graduated Inſtruments eſpecially to be uſed; for other ſmaller Grounds there is none more fit than the *Plain Table*.

CHAP

CHAP. VI.

Of the Compass of the Earth, and the Quantity of a Degree, according to the most approved Experiments, Antient and Modern.

ALthough the Compass of the Earth hath been in some sort observed by divers of the Antients, yet for some of them we cannot certainly gather what Measures they used; others used no Measure at all, but assumed the Distance of Places to be such as it was estimated by Travellers to be, and likewise the Latitude; therefore it will be needless to insist upon the Examination of their Observations: others of them which were taken by measure, and which we may upon any good ground reduce to our Measures, are these which follow.

Willebrordus Snellius in his Book, intituled, *Eratosthenes Batavus*, cites *Abel Fedas* a most diligent *Arabian* Geographer, that lived about the Year of Christ 1322, who records, that about the Year of Christ 827, certain Men, skilful in the Mathematicks, did, by the Commandment of their Prince *Almanon*, measure in the Fields of *Mesopotamia* (as he gathers) under one and the same Meridian, from the North towards the South, the quantity of a Degree, and found it to be 56 Miles, or somewhat more. The Quantity of their Mile, according to *Alphraganus*, was 4000 Cubits, or 6000 Feet, whence the Quantity of a Degree should be 336000 Feet: but of the length of their Foot we are something uncertain; only they define it to be so long as the extent of 96 Barly Corns laid side by side, whereas the *Rhynland* Foot, according to trial by him made, is but the extent of 90 Corns laid in like manner; so that if there be no inequality in the Grains, then 90 *Arabian* Feet are equal to 96 *Rhynland* Feet. But 96 *Rhynland* Feet are found to be about 91$\frac{1}{2}$ *English* Feet; therefore also by the Rule of Proportion, 336000 *Arabian* Feet do make of our *English* Feet 370222: So that according to this Experiment of the *Arabians*, a Degree should contain 370222 of our *English* Feet. And before we have found by the Observations taken at *London* and *York*, and by the distance of their Parallels measured, that a Degree contains of our

English

English Feet 367200. The difference is only 3022 Feet, that is, about the $\frac{1}{120}$ part of a *Degree*, or half a Minute.

He cites next *Alhazen* the *Arabian*, who in his Book *de Crepusculis*, declares the Compass of the Earth to be 24000000 Paces; so that proportionally there must be in one *Degree* 66666 $\frac{2}{3}$ Paces, that is, 333333 *Arabian* Feet. And seeing that 90 *Arabian* Feet make of our *English* Feet 99 $\frac{1}{2}$; therefore by the Rule of Proportion 333333 *Arabian* Feet, make of our *English* Feet 367283. So that according to *Alhazen*, there should be in a *Degree* 367283 of our *English* Feet, differing from the Experiment which I made only 83 Feet in a *Degree*.

I have not strained these numbers to bring them to this nearness, they are the same in effect which are set down by *Snellius* in his *Eratosthenes Batavus*, who with great Industry and Judgment hath compared the Measures of the Antients, and the Measures used by several Nations in these times, with the *Rhyniand Foot*. Much less have I strained my own Numbers to draw them up to these: But on the contrary, I confess upon the sight of his Book, observing the great Pains and Industry which he professeth himself to have bestowed, and which I doubt not but he did imploy in making his Experiment, and how he had found the measure of a *Degree* to be much less than mine, as we shall after shew; I began to doubt that I had not made sufficient allowance for the unevenness of the Ways, and for some small Bendings, sometimes to the Right-hand, sometimes to the Left, the Observation whereof I wittingly neglected, to spare Time and Expence. For I did often observe a Mile or two before me, some mark in the High-way, noting the *Degree* and measuring to it in the Way, neglecting to observe the intermediate swervings of the Way, sometimes three or four *Degrees* towards the Right-hand, sometimes as much to the Left; but making such allowance for that, and for the unevenness as I judged sufficient. And some Men may think, that the exact Observation of these lesser things thus neglected, and regulated only by Judgment or Conjecture, might deceive me much: But they may consider, That if there be two places a Mile distant, that is, in a right Line 320 Poles, if you measure from one of these places towards the other, not in that right Line, but always swerving from it by an Angle of four degrees, sometimes to the Right-hand, sometimes to the Left, till you come to that other Place; I say, that notwithstanding all these swervings (if there be nothing else to augment the Measure) it will not amount to 321. Now considering that I had all the Way, as occasion required, made such allowance as seemed convenient, and so found 367200 Feet in a *Degree*,

before I compared it with the Measures taken by any other, I resolved not to diminish nor to augment the Numbers thus arising by my Observations, Measures, and Allowances, in respect of the Opinions, Observations, or Measures of any other Man, until there be made some Experiment more evident and exact than any yet extant. And I am something the more confirmed by the near Agreement of these two Testimonies before recited, both exceeding me a little in the Measure of a Degree. But we cannot confidently rest upon them, because of that inequality which may be of Corns or Grains; for theirs may haply be something greater or lesser than ours.

Both these Measures of a Degree do much exceed the Quantity of a Degree found by *Snellius*, but when he compares them with his own another way, namely, placing the Barley-Corns so that they may not lie flat, but be set up edg-wise, and so by 96 Corns to make a Foot, and by such Feet to measure a Degree; then he finds that the Quantity of a Degree, according to the *Arabians*, is much less than by his Experiment it should be: but if some be laid flat, and others set up edg-wise, the *Arabian* measure of a Degree will agree with his. And so he proposeth this doubt, Whether the 96 Grains, whereof the *Arabian* Foot doth consist, must lie flat or be set up edg-wise, or some of them to lie flat, and others to be set up edg-wise. But it is most probable that they must lie flat, that being the Position which they are apt unto by Nature; they cannot be set edg-wise without much trouble, especially so many together as make the length of a Foot; and so the *Arabian* measure of a Degree doth nearly agree to this of mine.

We come next to hear the determination of *Ptolomy* of *Alexandria*, whose Authority and Credit in the Solution of this Question, is not inferiour to any of the Antients. He affirms the Compass of the Earth to be 180000 *Stadiums*, and the Quantity of a Degree 500 *Stadiums*; the same (as *Strabo* saith in his second Book of Geography) was before affirmed by *Posidonius*. Also *Marinus Tyrius* (before *Ptolomy*) had determined the Quantity of a Degree to be 500 *Stadiums*. *Ptolomy* confirmed it, not simply from their Relations, but as it seems from his own Experience, and that by some Measures diligently taken: for in the eleventh Chapter of the first Book of his Geography he hath these words; *Sed in hoc quoque recte sentit, partem unam, qualium est Circulus maximus trecentorum sexaginta, quinginta in Terra constituere Stadia, id enim confessis dimensionibus consonum existit.* Also *l. 7. cap. 5. Ita ut pars una, seu gradus unus quinginta contineat Stadia, quemadmodum ex diligentibus deprehensum est dimensionibus:* Now a *Stadium* not

not only amongst the *Greeks*, but, as appears by *Herodotus*, amongst all other Nations of *Asia*, and in *Egypt*, did consist of 600 Feet; therefore a Degree, according to *Ptolomy*, must contain 300000 Feet. But the Egyptian or Alexandrian Foot was much greater than our Foot; for, as we have before said, the antient Roman Foot was greater than ours, and the Egyptian Foot was much greater than the Roman: For it is often testified by *Hero Mechanicus*, that five Alexandrian Feet make six Roman Feet. And Mr. *Snellius* hath very ingeniously gathered, both from *Philander* and other ways, that the Rhynland Foot is equal to the antient Roman Foot; therefore also five Alexandrian Feet are equal to six Rhynland Feet: So that by the Rule of Proportion, 300000 Alexandrian Feet, will make of Rhynland Feet 360000. But by the size of our English Foot, which was sent him from the Iron Standard in *Guild-hall*, he finds it to contain but 968 such parts as the Rhynland contains 1000: So that 968 Rhynland Feet are equal to 1000 English Feet, or 121 Rhynland Feet are equal to 125 English Feet. Therefore also by the Rule of Proportion, 360000 Rhynland Feet are equal to 371900 of our English Feet. Therefore according to *Ptolomy*, there are contained in a Degree 371900 of our English Feet. But by our fore mentioned Experiment made between *York* and *London*, we find only 367200 Feet in a Degree, being less than *Ptolomy*'s by 4700 Feet, that is, by $\frac{1}{78}$ part of a Degree, or $\frac{1}{4}$ of a min. and little more.

Fernelius, a Mordern Author and Learned Physitian, measuring the Way by the Revolutions of a Wheel, and the Latitudes by Observation, finds in a Degre 68 Italian Miles, and 96 Paces, the Pace which he used being more than 5 of our English Feet. But because he handled not the Problem exactly, and is suspected by *Snellius* (though I think without cause) to have grounded his Conclusion rather upon the Experiment of the *Arabians* before set down, (wherewith it doth nearly agree) than upon his own, we will insist no longer upon it.

We come in the last place to the Experiment of *Willebrordus Snellius* a *Hollander*, made in the *Netherlands* about 20 Years past. We shall not need to recite the Particulars of it, being extant at large in his Book before-mentioned: But in conclusion, he finds in a Degree 342000 Rhynland Feet. Now a Rhynland Foot (as he hath there shewed, comparing both together) is greater than ours, and that in such proportion, as 1000 is to 968; (and so much, or little more, it appears to be by that Model of the Rhynland Foot printed in his Book) therefore 968 Rhynland Feet must make 1000 of ours; and hence by the

the Rule of Proportion, 342000 *Rhynland Feet* will make of our Engliſh *Feet* 353306. So that there ſhould be in a Degree only 353306 *Feet*, which is leſs than we have before found in a Degree by 13894 *Feet*, that is, by the $\frac{1}{25}$ parts of a deg. or $2\frac{1}{4}$ min. and ſomething more. He was a Man doubtleſs of ſingular Induſtry and Knowledg, and of much Exerciſe in the Mathematicks, and it may be as well experienced in this Particular, touching the Geometrical Menſuration of Diſtances and he hath beſtowed much Pains and Diligence in this Experiment, as by his Book appeareth. But if he had by a Chain meaſured the Diſtance of his two utmoſt Stations, (if the Ground would permit, which I ſuppoſe it would not) or at leaſt-wiſe if his meaſured Stations had been further diſtant, I conceive he would have found a greater Diſtance in his two utmoſt Places of Obſervation. But if a Man, intending to find the Diſtance of two Places, meaſure only the $\frac{1}{100}$ part of that Diſtance, and by that meaſured Line and the Angles, think to find their true Diſtance; whether he do it immediately from the two meaſured Stations, or mediately by help of others obſerved from them, he may eaſily fall into ſome notable Error. For tho the Problem be exactly true in Geometrical Demonſtrations, how ſmall ſoever the meaſure be, yet it is not ſo in ſenſible and experimental Practices, by reaſon of the weakneſs even of the beſt Eye, and the imperfection of the Inſtruments themſelves, and in their uſe. And beſides, that there were many Stations obliquely ſituate, a Man cannot always hit the juſt middle of that Turret, Steeple, or other Mark which he obſerves; neither when he comes to make his Station there, can he always place his Inſtrument juſt at the concourſe of his former viſual Lines, by reaſon of other impediments beſides the force of the Wind in ſuch eminent Places; and moreover, that amongſt ſo many Steeples as there are in ſome Towns, there a Man may at ſome times miſtake one for another. And if there ſhould happen no notable Error, by reaſon of any, or of all theſe Caſualties, yet may two Minutes, in the difference of the Latitudes of two Places be eaſily miſtaken, eſpecially being derived from the Latitudes of the Places which are very rarely ſet down true to a Minute.

If it be objected, That I might as well be ſo much miſtaken in the differences of the Latitudes of *York* and *London*.

I anſwer, it is not ſo likely, becauſe I had the opportunity of obſerving the Summer Solſtitial Altitude of the Sun in both Places, wherein I had no neceſſary uſe of the Sun's Parallax nor Refraction, nor of the Table of the Sun's Declination, any of which may cauſe more than a minute's Error in finding the Latitude of either Place.

Beſides,

Besides, If mine Error in those Observations should be full as much, yet would it not in the Conclusion be half so much, because the Difference in Latitude of the two Places of my Observation is more than twice so much as that of his.

About the Year 1672, Monsieur *Picart* published an Account in *French*, concerning the Measure of the Earth, a Breviate whereof may be seen in the *Philosophical Transactions*, Num. 112, wherein he concludes one Degree to contain 365184 English Feet, nearly agreeing to Mr. *Norwood*'s Experiment.

But let this suffice, leaving every Man to embrace that which he shall best approve. But our Experiments do sufficiently convince that common Error of counting only 300000 English Feet to a Degree, besides the consent of other Observations before-recited, Antient and Modern.

Mr. *Snellius* hath further in that Book of his, entituled, *Eratosthenes Batavus*, with much diligence compared some Antient Measures, as also the Measures of sundry Foreign Countries, with the *Rhyniand*-Foot; and amongst the Rest, our English Foot, according to a Size thereof to him sent from the Standard in *Guild-hall*, (from whence also I had about 20 Years past, the size of that Foot which I have used in this measure) we shall not need to repeat them all, because his Book is extant: Some of them are these following, which we here compare to our English Foot, as he hath there done to the *Rhyniand*, that so any of them may be the more easily reduced into our Feet. Therefore dividing the English Foot into 1000 equal Parts, we shew how many of those Parts are contained in other Antient and Foreign Feet.

Antient Feet compared with our English *Foot.*

Of such Parts as the *English* Foot contains ——— 1000

The
- Antient *Roman* foot contains ——— 1033
- Antient *Greek*-foot contains ——— 1076
- *Babylonian*-foot contains ——— 1211
- *Alexandrian* foot contains ——— 1240
- *Antiochian*-foot contains ——— 1405
- *Arabian*-foot contains ——— 1102

Foreign

Foreign Feet compared with our Engliſh *Foot.*

Of ſuch Parts as the *Engliſh* Foot contains		1000
The	*Rhynland*-Foot contains	1033
	Dort-Foot contains	1085
	Middleburg-Foot contains	992
	Amſterdam Foot contains	934
	Antwerp Foot contains	939
	Lovain-Foot contains	939
	Hafnian-Foot in *Denmark* contains	965
	Paris Foot, called the *King's Foot*, contains	1090
	Venice-Foot contains	1157
	Toledo-Foot contains	826
	Norimburg Foot contains	1006
	Scarsburgh-Foot contains	920

CHAP. VII.

Of dividing the Log-Line, *and reckoning the Ship's Way.*

THERE be four things upon which the Practice of Navigation is eſpecially grounded, namely, the Knowledge of the Longitude, Latitude, Courſe and Diſtance. Touching the Longitude, tho' it may be found by the other three, yet hitherto there hath not been delivered any general Rule true, and practicable, whereby the Longitudes of Places might be immediately and ordinarily found of themſelves. The Latitudes of Places may immediately be found by Obſervation of the Sun and Stars, as we have formerly ſhewed in the Appendix to the *Doctrine of Triangles* : The Courſe by the Compaſs, the Variation being duly obſerved, wherein we have many good Mariners very expert, this we have alſo handled in the *Doctrine of Spherical Triangles.* The Diſtance run, is found of it ſelf by the *Log-line*, whereof we are here to ſpeak.

The ground of finding the Diſtance run by the *Log-line* is meerly conjectural, being founded upon this Opinion, That 5 of our Feet make a Pace, and 1000 ſuch Paces make a Mile, and that 60 ſuch Miles make a Degree; ſo that a Degree ſhould contain 300000 of our Feet.

Feet. But it appears not only by this Experiment, but even by all others that were diligently taken, and their measures to us known, that there is a greater number of our Feet contained in a Degree.

There be three things (as I conceive) that have caused this Error to be so commonly received and tolerated. The one, for that it doth somewhat counterpoise another contrary Error in the Practice of Navigation, namely, in the use of the *Plain Chart*; for the Error which is there committed by making every Parallel equal to the Equinoctial, and so every Degree in them greater than they should be, is something moderated by this Error; whereby the measure of a *Degree* is esteemed less than indeed it is.

For instance; It is evident by the Globe, that the Meridians concurring in the Poles grow nearer and nearer together, as they grow towards the Poles; insomuch, as if two Meridians be distant in the Equinoctial 10 Degrees, that is 600 Miles, the same Meridians in the Latitude of 35 deg. will be distant little more than 490 Miles. Now if unto every Mile we account according to the former Experiment 6120 Feet, then is the distance of those two Meridians in that Parallel near 2000000 Feet. In like sort the *Plain Chart*, 10 deg. of that Parallel (as of all others) is made equal to 10 deg. of the Equinoctial or Meridian; so that the distance of these two Meridians will upon the *Plain Chart* be 600 Miles, but one of these Miles contain only 5000 Feet, so that the distance is but 3000000 Feet, equal to the former.

And although these Errors in other cases do not justly ballance one another, as in this Example, yet that of the *Plain Chart* is always something moderated by this other, and so much the more, by how much they are nearer to the foresaid Latitude. I grant that this is only so when the Course is near unto the East or West Points; but withal, I say, that this kind of Reckoning is (in a manner) then only used: For he that runs any Course near the Meridian Southerly or Northerly, hath a more certain way of reckoning, namely his Latitude, which he finds daily by the Observation of the Sun and Stars, upon which he will depend, either neglecting, or at least not regarding his Dead-reckoning. Yea, (it may be) never calling the *Log* so much as once in such a Voyage, having a more sure ground for his Reckoning. But in a Course that is near East and West, (forasmuch as there is no way discovered for finding the Longitude) he is driven of necessity to make use of his Dead-reckoning.

We might add moreover, that the principal Voyages of this kind, I mean of those which consist of Courses much Easterly and Westerly, as

to and from the *West-Indies*, and the Parallel of *Cape bon Esperance*, are near unto this Latitude of 35 deg. so that some of them are more Southerly, others of them are more Northerly.

But to insist no longer upon this, I suppose a second Cause to be, or that Men commonly desire to have their Reckoning before their Ship, (as they say) that they fall not with a Place before they look for it: And this comes to pass, whilst the Miles are accounted less in measure, and so more in number than they are indeed.

And thus, though there may seem to be some Commodity in these Errors especially when they do nearly ballance one another; yet because they seldom do so, but always leave Men in Uncertainties, and oftentimes in great Perplexity and Danger, it is much safer and better to reject them both, and to embrace those ways which are evidently grounded upon Truth, though there may be in them some more difficulty at the first. Yet I confess, that he which reforms one and not another, may sometimes err so much the more thereby. And I doubt not, but many would reform them both, if they could certainly do so.

Therefore a third Cause of admitting and retaining this Error seems to be, for that there hath been no Way delivered from evident and certain Grounds for the rectifying of it. I doubt not but many have found Errors in their Reckonings, arising from hence, that they account only 300000 of our Feet to a Degree; but not knowing certainly where to lay the Fault, have imputed it sometimes to ill Steerage, otherwhiles to the variation of the Needle, or to some mistake in their Reckonings, or to some Error in their Plots, or to some Current, or such other Accident, and so the Error hath rested unreformed. Wherefore although the practical performance of this Problem for finding the Circumference of the Earth, or the Quantity of a Degree on the same, have many singular Uses which I cannot now touch; yet that which amongst the rest I chiefly aimed at, was, that he might have a more sure and evident ground for dividing the *Log-line*, and for reckoning the Ship's way or distance run more truly upon any Rhomb. or Point of the Compass, than formerly.

And now to apply it to this purpose; we have noted before (Chap. 2.) that by the Experiment there expressed, we find in a Degree on the Circumference of the Earth and Sea, 367200 of our English Feet. Wherefore retaining still the same Division of a Degree into 60 Miles, or 20 Leagues, (as hath been formerly used) a Mile will contain 6120 Feet, or 1020 Fathoms: and so a League contains 18360 Feet, or 3060 Fathoms; for dividing 367200 by 60, the Quotient

is

is 6120, &c. Thus then 60 Miles being a Degree, every Mile is 6120 Feet.

Now supposing the Time of the running out of the *Log-Line* to be measured by a half-minute Glass, if we observe how many Feet or Fathom the runs in half a Minute, we may thereby find her way for an hour, or 4 hours, or for any other time propos'd.

As, admit there runs out of the *Log-line* in half a minute's space 51 Feet, or $8\frac{1}{2}$ Fathoms, and you would know what way the Ship makes every Hour after the same Rate; say by the Rule of Proportion,

If $\frac{1}{2}$ Minute gives 51 Feet,
what give 60 Minutes? Or,
If 1 Minute gives 102 Feet,
what give 60 Minutes?

And so multiplying, you shall find 6120 Feet, which is one Mile: Or, if you would find her way for four hours, which is 240 Minutes; say,

As 1 Minute is in proportion to 240 Minutes;
So are 102 Feet to 24480 Feet, or 4 Miles.

Or, if you would have in Fathoms; say,

As 1 Minute is in proportion to 240 Minutes;
So is 17 Fathoms to 4080 Fathoms, the Ship's way in four Hours.

The like is to be conceived, if your Glass be for any other quantity of time above or under half a Minute.

Some have thought that the Way which the Ship maketh, may be known to an old Sea-man by Experience (as they say) that is, by conjecture; which Opinion makes some neglect the use of the *Log*, lest they should be accounted young Sea-men. But as he that rides often, will have some near guess how far the pace he rides will carry him in an Hour (because he hath often observed it formerly;) so he which hath often sailed, and kept an account of the Ship's way by the *Log*, will be able to give some near estimate of her way without the *Log*. But it is incident to some Men to have such a conceit of this their Estimate, that they think it more certain than the Rule it self from whence it is derived, especially if it chance to answer their expectation at some times.

It is thought also that the Ship's way may be known by two marks on the Ship's side. But this is doubtless very uncertain both by reason of the shortness of the Time, and in respect of the dead Water (as they call it) by the Ship's side. For the Water which is near the Ship, is drawn

along with the Ship in her motion, and so much the more, by how much it is nearer.

But if any desire to make trial of this way, it is to be considered, that 17 Foot is $\frac{1}{360}$ part of a *Mile*, and 10 sec. of a minute is $\frac{1}{360}$ part of an Hour: Therefore if there be two marks on the Ship's side distant 17 Feet, if the ship run the distance of these two marks in 10 sec. she runs a Mile in an Hour, if in 5 sec. two Miles an Hour, if she runs that distance in 2 sec. she runs 5 Miles in an hour. And so always dividing 10 sec. by the number of sec. in which the Ship runs that Distance, the Quotient shews the miles and parts of a mile run in an Hour.

But if the Distance of those two marks be 34 Feet, if she runs it in 20 sec. it is after a mile an Hour; if in 10 sec. two miles an Hour; if in 5 sec. four miles an Hour: and so always dividing 20 sec. by the number of seconds, in which the Ship runs that Distance, the Quotient shews how many miles the Ship runs in an Hour. As if the Ship run that Distance of 34 Feet in 8 sec. then dividing 20 by 8, the Quotient is $2\frac{1}{2}$; shewing that she runs $2\frac{1}{2}$ miles in an Hour. Or, if you can conveniently make the Distance of the two marks on the Ship's side to be 51 Feet, (for the further they are distant, the better) then if the Ship run that Distance in 30 sec. it is a mile an Hour, if in 10 sec. it is 3 Miles an Hour; and so always dividing 30 sec. by the number of seconds, in which the Ship is running that Distance, the Quotient shews after that rate how many miles the Ship runs in an Hour.

Otherwise you may do thus: Divide 17 Feet into 10 parts, and set as many of those parts on the Ship's side as conveniently you may, which according to the Ship's length will be more or fewer. Then when the Ship runs one of those parts in a sec. of time, it is a mile an Hour; when two, it is two miles an Hour; when five, it is five miles an Hour. And in general, if you divide the number of Parts run by the Time of running accounted in sec. the Quotient shews what number of miles after that rate run in an Hour.

As if she run thirty of those parts in five seconds, it is six miles an Hour; for dividing 30 by 5, the Quotient is 6; so if she run forty two of those parts in 10 seconds, dividing 42 by 10, the Quotient is $4\frac{2}{10}$ which sheweth the Ship's way at that time to be after the rate of four miles and two tenths of a mile in an Hour.

But for keeping this Account of Time, it may be done either by a Sand-glass for that purpose, or by pronouncing certain words or numbers: as the Time wherein a Man tells twice 60, pronouncing every number as fast as he can conveniently and distinctly, is about a Minute; so

so that the time wherein a *Man* is numbring 60, is half a minute, or 30 seconds; and whilst a *Man* is numbring two (as one and twenty, two and twenty) is a second; and so whilst a *Man* is numbring from twenty to thirty, is five seconds; from twenty to forty ten seconds, *&c.* But in numbring from one to twenty, you may observe the same Times as in numbring from one and twenty to forty, and this will not be hard to do; for whilst a *Man* pronounceth one and twenty, two and twenty, three and twenty, *&c.* there remains a certain Impression in the *Fantasy*, whereby a *Man* is able in the same time to pronounce one, two, three, *&c.* And altho' this Rule of numbring twice 60 for a minute's space, be not general to all *Men*, because some are swifter or slower in their Pronunciation than others; yet after this Example, a *Man* making Trial, may frame a Rule to himself, whereby he may come something near the Truth.

But leaving these, we come to the Division of the *Log-line*, according to the half-minute Glass, which is more usual and certain. And considering that half a minute is of an Hour the $\frac{1}{120}$ part, therefore the Ship's way-running 51 *Feet* in half a minute, is a mile an Hour; if she runs twice so much, that is, 102 *Feet* in half a minute, it is two miles an Hour; if thrice so much, it is three miles an Hour: And in general, how many times 51 *Feet* she runs in half a minute, so many miles is her way for an Hour. Therefore leaving half a score *Fathom*, or more, from the Log, that so it may be out of the Eddy of the Ship's wake, before you begin to account or turn the Glass; if there you make a mark for the beginning, and so 51 *Feet* from thence a mark of one Knot, and 51 *Feet* further a mark of two Knots, and 51 *Feet* further (that is, 153 *Feet* from your first mark) another mark of three Knots; and so proceeding, look how many Knots are veered out in half a minute, so many miles is the Ship's way for an Hour. Now for that which is veered out more above the just measure of a Knot or Knots, you may allow for every 5 *Feet* the tenth part of a mile almost. As, admit she runs 5 Knots and 25 *Feet* in half a minute; then is her way according to $\frac{5}{10}$ or 5 miles and a half in an Hour; if 6 Knots and 10 *Feet*, it is $6\frac{2}{10}$ miles in an Hour, *&c.*

But according to the common Opinion of 5000 *Feet* to a mile, and 60 such miles to a Degree, there should be something less than 7 *Fathom*, namely, $41\frac{2}{3}$ *Feet* to a Knot.

And although he which veers the *Log-line* be careful to overhale it so slack, that it may not draw forward the Log, yet (no doubt) it doth lose some way, following the Ship a little as it is drawn by the Line, and withal

withal by the Eddy of the Ship's wake, and sometimes also is cast forwards by the Wind and Waves, when they come after the Ship: so that for these Causes, it is like, there may sometimes be allowed three or four Fathom more than is veered out; but this, (as a thing mutable and uncertain) being sometimes more, sometimes less, cannot be brought to any certain Rule, but such allowance may be made for it as a Man in his Experience and Discretion shall think fit.

If you would divide the *Log-line* so as it might give the Ship's way in *Centesms*, or the hundredth part of a Degree, and fit it to a half-minute Glass; Then seeing the hundredth part of a Degree is 3672 Feet, and the $\frac{1}{120}$ part thereof is $3\frac{1}{2}$ Feet; if you begin at the Mark at which you mean to turn the Glass, and measure from thence 30 Feet and three fifth parts of a Foot, you may there place 1 Knot; and thence again measuring 30 Feet, and three fifth parts of a Foot, there place two Knots; and so proceeding at the end of every 30 Feet and three fifths, adding a Knot, the number of Knots which run out in half a Minute, is the number of *Centesms* which the Ship runs in an Hour. As suppose there run out 10 Knots in half a Minute, then the Ship's way is according to 10 *Centesms* of a Degree in an Hour, that is, the tenth part of a Degree, or 6 Miles. And so every 3 Foot above the just measure of Knots, is near the tenth part of a *Centesm*, or the thousandth part of a Degree. As if there run out of the *Log-line* 5 Knots and 12 Feet, then the Ship's way for an Hour is 5 *Centesms*, and four tenth parts of a *Centesm*. the like is to be understood of others.

And after the Form of these Examples you may divide the *Log-line* for any other quantity of time, more or less than half a Minute, or for any other parts of a Degree proposed.

Thus have we handled the Division of the *Log-line*, according to the Measures before found of 367200 English Feet in a Degree. But because (as I have before shewed) the Ship's way is commonly more than by the *Log-line* it appears to be, and every Man desires to have his Reckoning something before his Ship, that he fall not with a Place unexpected; for these and such other causes, and for the Rotundity of the number, if any Man think it more safe and convenient in Sea-Reckonings, he may abate one in 51, and so assign to a Degree only 360000 Feet, and consequently to a Mile 6000 English Feet.

And upon this ground, if in half a Minute there run out 50 Feet of the *Log-line*, it is a Mile an Hour; and so if 100 Feet run out in a Minute.

For, as 1 minute is in proportion to 60 Minutes:

So is 100 Feet to 6000.

 And

And so forasmuch as 25 Feet is $\frac{1}{240}$ part of a Mile, and 15 seconds is also $\frac{1}{240}$ part of an Hour: Therefore if there be two Marks on the Ship's side distant 25 Feet, if the Ship run the Distance of these two marks in 15 seconds, it is after the rate of a Mile an Hour; if in 5 seconds, it is 3 Miles an Hour; and so always dividing 15 seconds by the number of seconds in which the Ship runs that distance, the Quotient sheweth the Miles and part of a Mile run in an Hour. But if the distance of these two marks be 50 Foot, and then if she run it in 30 seconds, or half a Minute, it is a Mile an Hour; if in 10 seconds, three Miles an Hour; if in 5 seconds, six Miles an Hour (for 30 divided by 5, the Quotient is 6.) And so always dividing 30 seconds by the number of seconds, in which the Ship runs that Distance; the Quotient shews how many Miles she runs in an Hour, *&c.*

Otherwise, if you make a Mark on the Ship's side at every 20 Inches, then when the Ship runs one of these parts in a second of Time, it is a Mile an Hour; when five, it is five Miles an Hour; if she run eighteen of these parts in three seconds, it is six Miles an Hour: For dividing 18 by 3, the Quotient is 6. And in general, if you divide the number of the parts run, by the number of seconds spent in running, the Quotient shews the Ship's way in Miles for an Hour.

But for dividing the *Log-line* according to this ground of 6000 Feet in a Mile, if you intend to use it with a half-minute Glass, then because half a minute is $\frac{1}{120}$ part of an Hour, and 50 Feet is also the $\frac{1}{120}$ part of a *Mile*; therefore when the Ship runs 50 Feet in half a minute, her way is after the rate of a *Mile* an Hour; if 100 Feet in half a minute, it is two *Miles* an Hour, *&c.*

Therefore half a score Fathom or more from the *Log*, you may make a *Mark*, and beginning from thence, measure 50 Feet, and there make the first Knot, and 50 Feet farther two Knots, and 50 Feet farther three Knots: And so proceeding, look how many Knots are run out in half a minute, so many *Miles* is the Ship's way for an Hour: and every 5 Feet more besides the Knots, is a tenth part of a *Mile*; as if there run out 6 Knots and 20 Feet in a half a minute, the Ship's way is after the rate of $6\frac{4}{10}$ miles in an hour, *&c.*

And so if the Glass were for any other time more or less than half a minute, you may make the Distance of your Knots proportional: As if it were for 20 seconds, then because 20 seconds are of an Hour the $\frac{1}{180}$ part, I divide a mile, which is 6000 Feet, by 180, and the Quotient is $33\frac{1}{3}$; therefore there must be a Knot at every 33 Feet and 4 Inches.

If

If your Glass be 36 seconds, which is $\frac{1}{100}$ part of an Hour, divide 6000 by 100, the Quotient is 60; shewing that there must be 60 Feet to every Knot; and then every 6 Foot over and above the Knots, is a tenth part of a Mile more.

And so it is better that your Glass be more than half a minute, rather than less; and the more the better, provided that there run out no more Line than you may hale in again, without danger of breaking.

Lastly; If you would so divide the *Log-line*, that it might shew the Ship's way in *Centesms* of a Degree, and fit it to an half-minute Glass: Then forasmuch as the hundredth part of a *Degree* is 3600 *Feet*, and the $\frac{1}{120}$ part thereof is 30 feet; therefore beginning at the mark whereat you intend to turn the Glass, measure from thence 30 *Feet*, and there make one Knot, and at 30 *Feet* farther two Knots; *&c.* Then look how many Knots run out in half a Minute, so many *Centesms* of a Degree is the Ship's way for an Hour. And so if the Glass be 36 seconds, then every Knot must have 36 *Feet*, *&c.*

Now if a Man sailing between any two places which lie near East and West one from another, have kept his Reckoning by Course and Distance, using a *Log-line* so divided, that it have a Knot at every 7 Fathom, (as many do) and would reduce the Distance of those two places so found, to their Distance in such Miles, as these of 60 to a Degree, each containing (as we have said) 6000 *Feet*; the proportion in number of those to these, is as 6 to 5, for six of them make five of these.

As, admit a Man in his dead Reckoning, using such a *Log-line* as hath a Knot at every 7 *Fathom*, and for every Knot running out in half a Minute, he accounts the Ship's way to be so many Miles an Hour; and according to such a Reckoning, suppose he finds the Distance of two places to be 1224 Miles, or 408 Leagues, and would know the Distance of the same places in Miles of 6000 *Feet* to a *Mile*, which is according to a *Log-line* that hath a Knot at every 50 *Feet*. Say then by the Rule of Proportion:

As the Number 6	*Co.ar.*	9.22185
is in proportion to 5;		0.69897
So is the Number of *Miles* given, 1224		3.08778
to the Number of *Miles* required, 1020		3.00860

Which 1020 is the Distance of those two places, in such miles whereof 60 make a Degree. Or to find the same in Leagues, the Proportion is: As 6 to 5, so is 408 Leagues to 340 Leagues.

And thus may the Distance of places be found in such miles, whereof 60 make a Degree, especially if with the Distance expressed in the *Plain Chart*,

Chart, you compare the Reckonings of ſome skilful Mariners that have ſailed from the one to the other. But thus to endeavour a Reformation of the *Plain Chart*, were a Labour to little purpoſe; for there the correcting of the true ſituation of two places, in reſpect of one another, is oftentimes an occaſion that the ſame places are the more falſly ſituate in reſpect of others. Like as if there were two places 8 Miles diſtant, and it was required to place a third three Miles from either of them; here, if we ſet the third in the middle, it will be four Miles diſtant from either: But if (attempting to mend that Error) we make the third to be three Miles from the firſt, then will it be five Miles from the ſecond. And thus unavoidably, the mending of the one is the marring of the other, becauſe the thing propoſed is not poſſible.

And ſuch is the Error of the plain or common *Sea-Chart*, repreſenting the Earth and Sea, not as a Spherical, but as a Plain Superficies; not as if the Meridians did concur in the Poles, but as if they were always parallel one to another. So that the Graduation and Projection being ſuch, the Situations and Diſtances of places cannot be generally and truly expreſſed therein.

But the Graduation and Projection of *Mercator's* Chart, agreeing without ſenſible Error with the Globe, there may in that be deſcribed all or any parts of the World, according to their Longitudes, Latitudes, Courſes, and Diſtances, as truly, and far more conveniently for the Mariner's uſe, than upon the Globe it ſelf; and upon ſuch a *Chart* ſo deſcribed, a Reckoning may be truly kept, and any Error committed may eaſily be diſcerned and amended. Whereas on the *Plain Chart*, if a Man find his Reckoning to diſagree, he is ſo far from knowing how to amend it, that he can ſeldom conjecture where the fault was.

The neglect and want of theſe *Charts* hath been, and is a great Imperfection in *Navigation* and *Geography*. For howſoever there be ſome which do daily ſet forth for ſale, Maps of the World, and of the parts thereof, according to this Projection; yet to have them truly ſuch, and fit for Navigation, requires in the Author or Maker of them good Knowledge, and ſome competent ability of his own, or Aid from others, with a greater love to Truth, than to his own Profit; which may induce him to beſtow ſuch Induſtry, Time and Expence, as I have formerly noted to be requiſite in ſuch a work.

For the furtherance whereof, and of the Practice of Navigation in general, I ſhall endeavour in the two next Chapters to ſhew a methodical and orderly way of keeping a Reckoning at Sea, more diſtinctly and exactly than hath been formerly uſed, and ſuch as may aptly be ſet

down in any *Chart*, and applied in the three principal kinds of sailing; namely, according to the *Plain Chart*, or *Mercator's*, or according to the Arch of a *Great Circle*. And by a few Reckonings truly set down according to this Form, the Maps of the World, and of the parts thereof, might be much reformed.

CHAP. VIII.

A formal and exact Way of setting down and perfecting a Sea Reckoning.

ALtho the Course and Distance cannot be so truly and certainly known as the Latitude may be; yet we must endeavour in these also to come as near the Truth as may be, the rather, for that some Reckonings must necessarily depend wholly upon them. And to that end, those which in their Voyages at Sea, have occasion to run far upon any Course or Courses near the Meridian, may do well to make trial of that which I have formerly set down, touching the Quantity of a Degree on the Earth and Sea in our known Measure; and especially in *East-India* Voyages; sailing from the *Lizard* in the West part of *England* to *Cape bon Esperance* in *Africk*, they have opportunity of making an ample Experiment hereof.

But leaving this to the practice of the skilful and industrious Seaman, we come now to shew an orderly and exact way of framing and keeping a Reckoning at Sea; for which purpose I have made the Table following, which sheweth how much a Ship is more Northerly or Southerly, and how much more Easterly or Westerly, by sailing upon any Point or half Point of the Compass, any number of Miles proposed.

The like Table I made many Years since, and taught the Use of it in *Navigation*: Whether it were then used by any other, I know not, I had it of no Man; but this I speak, that if any Man claim the first making and use of such an one, he may have it.

The ground of making this Table is the same with the former. *For as* Radius *is in proportion to the Distance run, so is the* Sine Complement *of the* Rhomb, *to the Distance of North or South; and so is the* Sine *of the* Rhomb, *to the Distance of East or West.* Therefore here, for 10 Miles upon any of the four Points from the Meridian, we set in the second Column the *Sine Complement* of that Point (reduced into Degrees) and in the third the *Sine* thereof. As the second Rhomb or Point from the Meridian, being 22 degrees 30 minutes, the *Sine Complement* thereof which

which is 9239 ſet in the ſecond Column againſt 10; and the *Sine* thereof 3827, I ſet here in the third Column: And having done thus for 10 Miles in every Column, the reſt may be eaſily drawn from them.

As in the ſecond Column, for the firſt half Point againſt 10 Miles finding 9952, I ſet the half thereof, namely, 4976 againſt 5 Miles, and the tenth part thereof, namely 995 againſt one Mile, which doubled, or added to it ſelf, is 1990, to be ſet againſt 2 Miles, whereto adding the ſame 995, the Sum is 2985 for three Miles; and ſo for the reſt.

And thus for every Point and half-Point from the Meridian, there are three Columns: In the firſt whereof there is ſet down a number of Miles run upon that Point or half-Point; the ſecond ſheweth how much the Latitude is alter'd, that is, how much you are more Southerly or Northerly, by running ſo far upon that Point or half-Point; the third, how much you are more Eaſterly or Weſterly, by running that Courſe and Diſtance.

The Numbers ſet in every firſt Column, from 1 to 10, are alſo to be underſtood from 10 to 100, or from 100 to 1000; and the Figure in the fourth place of the ſecond and third Columns, anſwers to the Figure in the firſt. As, admit a Ship runs South and by Weſt, (that is, South, one Point Weſterly) 165 Miles; I ſet down this number thus, and looking in the Columns of the firſt Rhomb againſt 10 (which may be underſtood to be 100) I find againſt it in the ſecond Column 981 almoſt, and in the third 195; as alſo againſt 60 (that is, 6) in the firſt Column, there is 588 in the ſecond, and 117 in the third: Alſo againſt 5 in the firſt Column, there is 49 in the ſecond, and almoſt 10 in the third.

	100	981	195
S. W. 1.	60	588	117
Point.	5	49	10
	165	161.8	32.2

Theſe ſet down, and ſumm'd up, as here appeareth, ſhew that a Ship running S. by W. 165 Miles, is to the Southwards of the place from whence ſhe departed 161 Miles, and 8 tenth parts of a Mile; and to the Weſtwards 32 Miles, and 2 tenth parts of a Mile. If you deſire more Exactneſs, you may uſe all the places for the firſt or greateſt Number, which is here 100.

As in this ſecond Example, where the Southerly Diſtance is 161 $\frac{83}{100}$ Miles, and the Weſterly 32 $\frac{17}{100}$ Miles.

	100	9808	1950
S. W. 1.	60	5885	1170
Point.	5	490	97
	165	161.83	32.17

A Table of the Northing or Southing, Easting or Westing of every Rhomb and half Rhomb from the Meridian, according to the number of Miles run upon that Rhomb.

	½ Point.	7½ Point	1 Point.	7 Point.	1½ Point	6½ Point	2 Point.	6 Point.
M.	5. 37½	84. 22½	11. 15	78. 45	16. 52	73. 7½	21. 30	67. 30
1	995	98	981	195	957	290	924	383
2	1990	196	1962	390	1914	580	1848	766
3	2986	294	2943	585	2871	870	2772	1148
4	3981	392	3923	780	3827	1161	3696	1531
5	4976	490	4904	975	4784	1451	4620	1914
6	5971	588	5885	1170	5741	1741	5544	2297
7	6966	686	6866	1365	6698	2031	6468	2680
8	7961	784	7846	1560	7655	2321	7392	3062
9	8957	882	8827	1755	8612	2612	8315	3445
10	9952	980	9808	1950	9569	2902	9239	3827

	2½ Point	5½ Point	3 Point.	5 Point	3½ Point	4½ Point	4 Point.	4 Point.
M.	82. 7½	61. 52½	33. 45	56. 15	39. 22½	50. 37½	45. 00	45. 00
1	882	471	831	556	773	634	707	707
2	1764	942	1663	1111	1546	1269	1414	1414
3	2646	1414	2494	1667	2319	1903	2121	2121
4	3528	1885	3326	2222	3092	2538	2828	2828
5	4410	2357	4158	2778	3865	3172	3535	3535
6	5292	2828	4989	3334	4638	3806	4242	4242
7	6174	3300	5820	3890	5411	4440	4949	4949
8	7056	3771	6652	4445	6184	5075	5656	5656
9	7937	4243	7483	5000	6957	5710	6364	6364
10	8819	4714	8315	5556	7730	6344	7071	7071

A larger Example may be that before set down in the last Problem of sailing by a great Circle, from *Summers Islands* to the *Lizard*, *Page* 170, *&c.* of the *Doctrine of Triangles*.

As admit I sail from thence; First, N E. half a Point Easterly 600 Miles; then N. E. by E. 300 Miles, E. N. E. half a Point Northerly

495 Miles; E. N. E. 390 Miles; E. N. E. ½ Point Easterly 264 Miles; E. by N. 210 Miles; East 951 Miles. These Courses and Distances I set down in such form as here appeareth; where in the first Column there is expressed the Course or Point of the Compass upon which a Man sails; in the second Column, the Distance of the Rhomb from the Meridian; in the third Column, the Distance run upon that Point; in the rest, the Difference of Latitude and Departure from the Meridian in Miles, and tenth parts of a Mile.

Course.	Rhomb from the	Dist. miles.	North.	South	East.	West.
N. E. ½ Po. E.	North. Easterly. 4½ P.	600	380.6		463.8	
N. E. by E.	N. East 5 Point.	300	166.7		2494	
E. N. E. Po. N.	N. East.	400	1885		3528	
	5½ Po.	90	424		794	
		5	24		44	
E. N. E.	N. East.	300	1148		277.2	
	6 Po.	90	344		831	
E. N. E. ½ Po. E.	N. East.	200	580		1914	
	6½ Po.	60	174		574	
		4	12		38	
E. by N.	N. East.	200	390		1962	
	7 Point.	10	20		98	
East.	East.	900			9510	
		50				
		1				
		3210			29197	

(In all which is to be conceived, that all the *Variations* are allowed) so that at the Foot of this Reckoning, I find the Sum of the North Column to be 1047 $\frac{4}{10}$ Miles, and the Sum of the East Column 2920 Miles almost; the first, namely 1047 Miles, converted into degrees, is 17 deg. 27 min. the difference of Latitude, which added to the Latitude of *Summers Islands* 32 deg. 25 min. (where this Reckoning began) the

the Sun is 49 deg. 52 min. which is the Latitude of this place where this Reckoning endeth. So that according to this Account, the Ship is run into the Latitude of 49 deg. 52 min. and hath altered her Longitude to the Eastwards 2920 Miles, of such Miles whereof 60 make a Degree of a great Circle.

Therefore if you set down this Reckoning on the *Plain Chart*, you must make a Point in the *Chart* that may be in the Latitude of 49 deg. 52 min. and to the Eastwards of *Summers Islands*, (where this Reckoning began) 2920 Miles; that is, you must run a Parallel (with your Compasses or otherwise) on your *Chart* in the Latitude of 49 deg. 52 min. and cross the same by a Meridian, which may be to the Eastwards of the Meridian of *Summers Islands* 2920 Miles; and so the Point of the Intersection of this Parallel and Meridian, is the Traverse-Point, or Point in the *Chart*, representing the place where the Ship is in the end of this Reckoning.

But if you set down this Reckoning on *Mercator's Chart*, you must also find a Point that may be in the Latitude of 49 deg. 52 min. and may likewise be to the Eastwards of *Summers Islands* 2920 Miles, which is done by running with your Compasses a Parallel in the Latitude of 49 deg. 52 min. and crossing the same by a Meridian, which may be to the Eastward of the Meridian of *Summers Islands* 2920 Miles; the Point of the Intersection of this Parallel with that Meridian, is the Traverse-Point, representing in the *Chart* the place where the Ship then is.

For it is to be conceived in this *Chart*, that the degrees of the Meridian intercepted between the Latitude of two places, are as a Scale for those places, to measure not only their difference of Latitude, but likewise their distance in their Rhomb, as also the distance of their Meridians.

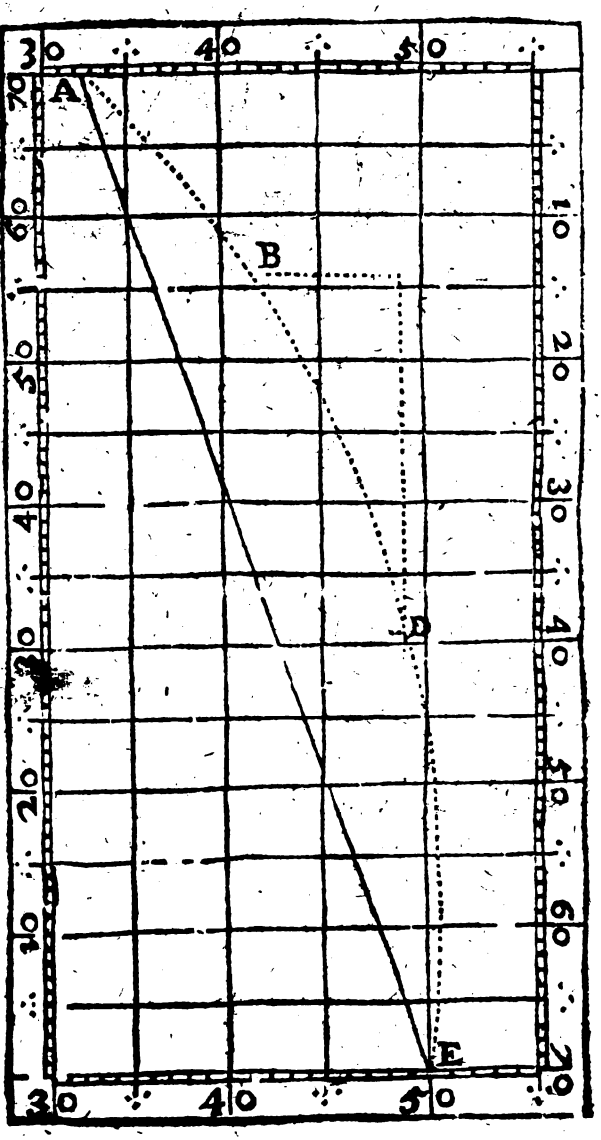
But because it often falls out, that in sailing from place to place, a Ship runs not near the Rhomb of the two places by many hundred Miles, especially in sailing by the Arch of a *Great Circle*, which is the most exquisite manner of sailing, and wherein a Man shifts his Course often, and runs much further in one Latitude than in another, as by the former Example may appear: Therefore once in three or four days, or so often as you alter your Course much, you may transfer or set down your Reckoning out of your Book into your *Chart*. As in transferring the former Example, you may set down the Northing and Easting of every of the Courses severally: But for brevity sake we will bring them into three parts; and so also we shall not much err.

And

And thus for the two first Courses, namely, N. E. ½ a Point Easterly 600 Miles, and N. E. by E. 300 Miles, I find in the North Column 547 Miles, and in the East Column 713 Miles; also for the three next Courses, summing up the North and East Columns, I find the Northing to be 459 Miles; and the Easting 1050 Miles. Also for the two last Courses, I find the Northing to be 41 Miles, and the Easting 1157 Miles.

North.	East.
547	713
459	1050
41	1157
1047	2920

Now to transfer these into the *Chart*, I consider that 547 Miles is 9 deg. 7 min. which added to the former Latitude 32 deg. 25 min. makes Latitude 41 deg. 32 min. In which Latitude I run a Parallel; then considering that 713 Miles is 11 deg. 53 min. I take this 11 deg. 53 min. in the Meridian, as much above the one Latitude as beneath the other, namely, from 31 deg. 0 min. to 42 deg. 53 min. and this I set in the aforesaid Parallel from the Meridian of *Summers Islands* to the Eastwards, and there make the Point B; then reducing 459 Miles into degrees, it makes 7 deg. 39 min. which added to 41 deg. 32 min. makes Latitude 49 deg. 11 min. Also the Easting 1050 Miles are 17 deg. 30 min. the half whereof 8 deg. 45 min I take in the Meridian from above 41 deg. 32 min. beneath 49 deg. 11 min. namely, from 41 deg. 20 min. to 50 deg. 5 min. And this being doubled (because it is but the half) I set from the Meridian of the Prick, or Traverse-Point B before made, in the Parallel of 49 deg. 11 min. making there another Prick D. Lastly, I add the Northing 41 Miles, to the former Latitude 49 deg. 11 min. the Sum is 49 deg. 52 min. the Latitude of the Parallel to which I am now come, wherein I am to set down the Easting 1157 Miles. This therefore converted into degrees of a great Circle, make 19 deg. 17 min. I take therefore 1 deg. of the Meridian, about that Latitude of 49 deg. 52 min. (because the most part is run in that Latitude) namely, from 49 deg. 30 min. to 50 deg 30 min. and set the same in the aforesaid Parallel from the Meridian of the Prick D last before made to the Eastwards 19 times; and moreover 17 min. take at the same Latitude, and this reacheth to the Point E. And so is all this Reckoning set down; and the like is to be understood of any other, which though in Expression it requires many words for Plainness, yet is there very little difficulty more in the Practice, than there is in setting down a Reckoning on the *Plain Chart*.



CHAP.

CHAP. IX.

A more ample Example, together with a larger Table for the keeping a Reckoning at Sea.

HAving thus (in a more general manner) ſhewed how to ſet down a Reckoning of the Ship's way for every Point and half-Point of the Compaſs, this to ſome Men might ſeem ſufficient. But becauſe a Ship doth not always make her way good as ſhe lies, nor doth her Leeward-way always fall juſtly upon a whole Point, or half-Point, or quarter: And moreover, conſidering that tho a Ship ſteer a way upon any Point of the Compaſs, yet her true way, by reaſon of the Variation of the Needle, may ſwerve from that Point towards the one ſide, or towards the other, 3 or 4 degrees, or more or leſs, and not always a Point, or half-Point, or quarter; therefore I have thought it requiſite to ſet down the *Table* following to every ſingle Degree; and that a Man might the more readily with one or two Entrances have his deſire, I have alſo enlarged the number of Miles unto 100. The ground and way of making this Table, differs not from the former, and it is to be uſed almoſt in the ſelf ſame manner; wherefore we ſhall uſe the more brevity in the handling it.

Here followeth a Table of the Northing or Southing, Eaſting or Weſting of every Degree from the Meridian, according to the number of Miles run upon that Degree. Which for brevity ſake we call——

A Table for the Difference of Latitude *and* Departure *from the Meridian.*

Dif.	1 Deg. Lat.	Dep.
1	1.0	.0
2	2.0	.0
3	3.0	.0
4	4.0	.1
5	5.0	.1
6	6.0	.1
7	7.0	.1
8	8.0	.1
9	9.0	.2
10	10.0	.2
11	11.0	.2
12	12.0	.2
13	13.0	.2
14	14.0	.2
15	15.0	.3
16	16.0	.3
17	17.0	.3
18	18.0	.3
19	19.0	.3
20	20.0	.4
21	21.0	.4
22	22.0	.4
23	23.0	.4
24	24.0	.4
25	25.0	.4
26	26.0	.5
27	27.0	.5
28	28.0	.5
29	29.0	.5
30	30.0	.5
31	31.0	.5
32	32.0	.6
33	33.0	.6
34	34.0	.6
Dif.	Dep.	Lat.
	89 Deg.	

Dif.	1 Deg. Lat.	Dep.
35	35.0	6
36	36.0	7
37	37.0	7
38	38.0	7
39	39.0	7
40	40.0	7
41	41.0	7
42	42.0	7
43	43.0	8
44	44.0	8
45	45.0	8
46	46.0	8
47	47.0	8
48	48.0	9
49	49.0	9
50	50.0	9
51	51.0	9
52	52.0	9
53	53.0	9
54	54.0	10
55	55.0	10
56	56.0	10
57	57.0	10
58	58.0	10
59	59.0	10
60	60.0	11
61	61.0	11
62	62.0	11
63	63.0	11
64	64.0	11
65	65.0	12
66	66.0	12
67	67.0	12
68	68.0	12
Dif.	Dep.	Lat.
	89 Deg.	

Dif.	1 Deg. Lat.	Dep.
69	69.0	1.2
70	70.0	1.2
71	71.0	1.3
72	72.0	1.3
73	73.0	1.3
74	74.0	1.3
75	75.0	1.3
76	76.2	1.3
77	77.0	1.4
78	78.0	1.4
79	79.0	1.4
80	80.0	1.4
81	81.0	1.4
82	82.0	1.4
83	83.0	1.5
84	84.0	1.5
85	85.0	1.5
86	86.0	1.5
87	87.0	1.5
88	88.0	1.5
89	89.0	1.6
90	90.0	1.6
91	91.0	1.6
92	92.0	1.6
93	93.0	1.6
94	94.0	1.7
95	95.0	1.7
96	96.0	1.7
97	97.0	1.7
98	98.0	1.7
99	99.0	1.7
100	100.0	1.8
200	200.0	3.5
300	300.0	5.3
Dif.	Dep.	Lat.
	89 Deg.	

Dist.	2 Deg. Lat.	Dep.
1	1.0	.0
2	2.0	.1
3	3.0	.1
4	4.0	.1
5	5.0	.2
6	6.0	.2
7	7.0	.2
8	8.0	.3
9	9.0	.3
10	10.0	.3
11	11.0	.4
12	12.0	.4
13	13.0	.4
14	14.0	.5
15	15.0	.5
16	16.0	.6
17	17.0	.6
18	18.0	.6
19	19.0	.7
20	20.0	.7
21	21.0	.7
22	22.0	.8
23	23.0	.8
24	24.0	.8
25	25.0	.9
26	26.0	.9
27	27.0	.9
28	28.0	1.0
29	29.0	1.0
30	30.0	1.0
31	31.0	1.1
32	32.0	1.1
33	33.0	1.1
34	34.0	1.2
Dist.	Dep.	Lat.

88 Deg.

Dist.	2 Deg. Lat.	Dep.
35	35.0	1.2
36	36.0	1.3
37	37.0	1.3
38	38.0	1.3
39	39.0	1.4
40	40.0	1.4
41	41.0	1.4
42	42.0	1.5
43	43.0	1.5
44	44.0	1.5
45	45.0	1.6
46	46.0	1.6
47	47.0	1.6
48	48.0	1.7
49	49.0	1.7
50	50.0	1.7
51	51.0	1.8
52	52.0	1.8
53	53.0	1.8
54	54.0	1.9
55	55.0	1.9
56	56.0	1.9
57	57.0	2.0
58	58.0	2.0
59	59.0	2.0
60	60.0	2.1
61	61.0	2.1
62	62.0	2.2
63	63.0	2.2
64	64.0	2.2
65	65.0	2.3
66	66.0	2.3
67	67.0	2.3
68	68.0	2.4
Dist.	Dep.	Lat.

88 Deg.

Dist.	2 Deg. Lat.	Dep.
69	69.0	2.4
70	70.0	2.4
71	71.0	2.5
72	72.0	2.5
73	73.0	2.5
74	74.0	2.6
75	75.0	2.6
76	76.0	2.6
77	77.0	2.7
78	78.0	2.7
79	79.0	2.8
80	80.0	2.8
81	80.9	2.8
82	81.9	2.9
83	82.9	2.9
84	83.9	2.9
85	84.9	3.0
86	85.9	3.0
87	86.9	3.0
88	87.9	3.1
89	88.9	3.1
90	89.9	3.1
91	90.9	3.2
92	91.9	3.2
93	92.9	3.2
94	93.9	3.3
95	94.9	3.3
96	95.9	3.4
97	96.9	3.4
98	97.9	3.4
99	98.9	3.5
100	99.8	3.5
200	199.9	7.0
300	299.8	10.5
Dist.	Dep.	Lat.

88 Deg.

Dist.	3 Deg. Lat.	Dep.
1	1.0	.1
2	2.0	.1
3	3.0	.1
4	4.0	.2
5	5.0	.2
6	6.0	.3
7	7.0	.4
8	8.0	.4
9	9.0	.5
10	10.0	.5
11	11.0	.6
12	12.0	.6
13	13.0	.7
14	14.0	.7
15	15.0	.8
16	16.0	.8
17	17.0	.9
18	18.0	.9
19	19.0	1.0
20	20.0	1.0
21	21.0	1.1
22	22.0	1.1
23	23.0	1.2
24	24.0	1.2
25	25.0	1.3
26	26.0	1.3
27	27.0	1.4
28	28.0	1.5
29	29.0	1.5
30	30.0	1.6
31	31.0	1.6
32	32.0	1.7
33	33.0	1.7
34	34.0	1.8
Dist.	Dep.	Lat.
	87 Deg.	

Dist.	3 Deg. Lat.	Dep.
35	35.0	1.8
36	36.0	1.9
37	37.0	1.9
38	38.0	2.0
39	39.0	2.0
40	40.0	2.1
41	41.0	2.1
42	42.0	2.2
43	43.0	2.2
44	44.0	2.3
45	45.0	2.3
46	46.0	2.4
47	47.0	2.4
48	48.0	2.5
49	49.0	2.6
50	50.0	2.6
51	50.9	2.7
52	51.9	2.7
53	52.9	2.8
54	53.9	2.8
55	54.9	2.9
56	55.9	2.9
57	56.9	3.0
58	57.9	3.0
59	58.9	3.1
60	59.9	3.1
61	60.9	3.2
62	61.9	3.2
63	62.9	3.3
64	63.9	3.3
65	64.9	3.4
66	65.9	3.5
67	66.9	3.5
68	67.9	3.6
Dist.	Dep.	Lat.
	87 Deg.	

Dist.	3 Deg. Lat.	Dep.
69	68.9	3.6
70	69.9	3.7
71	70.9	3.7
72	71.9	3.8
73	72.9	3.8
74	73.9	3.9
75	74.9	3.9
76	75.9	4.0
77	76.9	4.0
78	77.9	4.1
79	78.9	4.1
80	79.9	4.2
81	80.9	4.2
82	81.9	4.3
83	82.9	4.3
84	83.9	4.4
85	84.9	4.4
86	85.9	4.5
87	86.9	4.5
88	87.9	4.6
89	88.9	4.6
90	89.9	4.7
91	90.9	4.8
92	91.9	4.8
93	92.9	4.9
94	93.9	4.9
95	94.9	5.0
96	95.9	5.0
97	96.9	5.1
98	97.9	5.1
99	98.9	5.2
100	99.9	5.2
200	199.7	10.5
300	299.6	15.7
Dist.	Dep.	Lat.
	87 Deg.	

Dist.	4 Deg. Lat.	Dep.
1	1.0	.1
2	2.0	.1
3	3.0	.2
4	4.0	.3
5	5.0	.3
6	6.0	.4
7	7.0	.5
8	8.0	.6
9	9.0	.6
10	10.0	.7
11	11.0	.8
12	12.0	.8
13	13.0	.9
14	14.0	1.0
15	15.0	1.0
16	16.0	1.1
17	17.0	1.2
18	18.0	1.3
19	19.0	1.3
20	20.0	1.4
21	20.9	1.5
22	21.9	1.5
23	22.9	1.6
24	23.9	1.7
25	24.9	1.7
26	25.9	1.8
27	26.9	1.9
28	27.9	2.0
29	28.9	2.0
30	29.9	2.1
31	30.9	2.2
32	31.9	2.2
33	32.9	2.3
34	33.9	2.4
Dist.	Dep.	Lat.
	86 Deg.	

Dist.	4 Deg. Lat.	Dep.
35	34.9	2.5
36	35.9	2.5
37	36.9	2.6
38	37.9	2.7
39	38.9	2.7
40	39.9	2.8
41	40.9	2.9
42	41.9	2.9
43	42.9	3.0
44	43.9	3.1
45	44.9	3.1
46	45.9	3.2
47	46.9	3.3
48	47.9	3.4
49	48.9	3.4
50	49.9	3.5
51	50.9	3.6
52	51.9	3.6
53	52.9	3.7
54	53.9	3.8
55	54.9	3.8
56	55.9	3.9
57	56.9	4.0
58	57.9	4.0
59	58.9	4.1
60	59.9	4.2
61	60.9	4.3
62	61.9	4.3
63	62.9	4.4
64	63.9	4.5
65	64.8	4.5
66	65.8	4.6
67	66.8	4.7
68	67.8	4.8
Dist.	Dep.	Lat.
	86 Deg.	

Dist.	4 Deg. Lat.	Dep.
69	68.8	4.8
70	69.8	4.9
71	70.8	5.0
72	71.8	5.0
73	72.8	5.1
74	73.8	5.2
75	74.8	5.2
76	75.8	5.3
77	76.8	5.4
78	77.8	5.5
79	78.8	5.5
80	79.8	5.6
81	80.8	5.7
82	81.8	5.7
83	82.8	5.8
84	83.8	5.9
85	84.8	5.9
86	85.8	6.0
87	86.8	6.1
88	87.8	6.1
89	88.8	6.2
90	89.8	6.3
91	90.8	6.3
92	91.8	6.4
93	92.8	6.5
94	93.8	6.6
95	94.8	6.6
96	95.8	6.7
97	96.8	6.8
98	97.8	6.8
99	98.8	6.9
100	99.8	7.0
200	199.5	14.0
300	299.3	20.9
Dist.	Dep.	Lat.
	86 Deg.	

Dist.	5 Deg. Lat.	5 Deg. Dep.
1	1.0	.1
2	2.0	.2
3	3.0	.3
4	4.0	.3
5	5.0	.4
6	6.0	.5
7	7.0	.6
8	8.0	.7
9	9.0	.8
10	10.0	.9
11	11.0	1.0
12	12.0	1.0
13	13.0	1.1
14	14.0	1.2
15	15.0	1.3
16	15.9	1.4
17	16.9	1.5
18	17.9	1.6
19	18.9	1.7
20	19.9	1.7
21	20.9	1.8
22	21.9	1.9
23	22.9	2.0
24	23.9	2.1
25	24.9	2.2
26	25.9	2.3
27	26.9	2.4
28	27.9	2.4
29	28.9	2.5
30	29.9	2.6
31	30.9	2.7
32	31.9	2.8
33	32.9	2.9
34	33.9	3.0
Dist.	Dep.	Lat.
	85 Deg.	

Dist.	5 Deg. Lat.	5 Deg. Dep.
35	34.9	3.0
36	35.9	3.1
37	36.9	3.2
38	37.9	3.3
39	38.8	3.4
40	39.8	3.5
41	40.8	3.6
42	41.8	3.7
43	42.8	3.7
44	43.8	3.8
45	44.8	3.9
46	45.8	4.0
47	46.8	4.1
48	47.8	4.2
49	48.8	4.3
50	49.8	4.4
51	50.8	4.5
52	51.8	4.5
53	52.8	4.6
54	53.8	4.7
55	54.8	4.8
56	55.8	4.9
57	56.8	5.0
58	57.8	5.1
59	58.8	5.2
60	59.8	5.2
61	60.8	5.3
62	61.8	5.4
63	62.8	5.5
64	63.8	5.6
65	64.8	5.7
66	65.8	5.8
67	66.8	5.8
68	67.7	5.9
Dist.	Dep.	Lat.
	85 Deg.	

Dist.	5 Deg. Lat.	5 Deg. Dep.
69	68.7	6.0
70	69.7	6.1
71	70.7	6.2
72	71.7	6.3
73	72.7	6.4
74	73.7	6.5
75	74.7	6.5
76	75.7	6.6
77	76.7	6.7
78	77.7	6.8
79	78.7	6.9
80	79.7	7.0
81	80.7	7.1
82	81.7	7.1
83	82.7	7.2
84	83.7	7.3
85	84.7	7.4
86	85.7	7.5
87	86.7	7.6
88	87.7	7.7
89	88.7	7.8
90	89.7	7.8
91	90.7	7.9
92	91.6	8.0
93	92.6	8.1
94	93.6	8.2
95	94.6	8.3
96	95.6	8.4
97	96.6	8.4
98	97.6	8.5
99	98.6	8.6
100	99.6	8.7
200	199.2	17.4
300	298.9	26.2
Dist.	Dep.	Lat.
	85 Deg.	

Dist.	6 Deg. Lat.	Dep.
1	1.0	.1
2	2.0	.2
3	3.0	.3
4	4.0	.4
5	5.0	.5
6	6.0	.6
7	7.0	.7
8	8.0	.8
9	8.9	.9
10	9.9	1.0
11	10.9	1.1
12	11.9	1.2
13	12.9	1.4
14	13.9	1.5
15	14.9	1.6
16	15.9	1.7
17	16.9	1.8
18	17.9	1.9
19	18.9	2.0
20	19.9	2.1
21	20.9	2.2
22	21.9	2.3
23	22.9	2.4
24	23.9	2.5
25	24.9	2.6
26	25.9	2.7
27	26.8	2.8
28	27.8	2.9
29	28.8	3.0
30	29.8	3.1
31	30.8	3.2
32	31.8	3.3
33	32.8	3.4
34	33.8	3.5
Dist.	Dep.	Lat.

84 Deg.

Dist.	6 Deg. Lat.	Dep.
35	34.8	3.6
36	35.8	3.8
37	36.8	3.9
38	37.8	4.0
39	38.8	4.1
40	39.8	4.2
41	40.8	4.3
42	41.8	4.4
43	42.8	4.5
44	43.8	4.6
45	44.7	4.7
46	45.7	4.8
47	46.7	4.9
48	47.7	5.0
49	48.7	5.1
50	49.7	5.2
51	50.7	5.3
52	51.7	5.4
53	52.7	5.5
54	53.7	5.6
55	54.7	5.7
56	55.7	5.8
57	56.7	5.9
58	57.7	6.1
59	58.7	6.2
60	59.7	6.3
61	60.7	6.4
62	61.7	6.5
63	62.7	6.6
64	63.7	6.7
65	64.6	6.8
66	65.6	6.9
67	66.6	7.0
68	67.6	7.1
Dist.	Dep.	Lat.

84 Deg.

Dist.	6 Deg. Lat.	Dep.
69	68.6	7.2
70	69.6	7.3
71	70.6	7.4
72	71.6	7.5
73	72.6	7.6
74	73.6	7.7
75	74.6	7.8
76	75.6	7.9
77	76.6	8.0
78	77.6	8.1
79	78.6	8.2
80	79.6	8.3
81	80.6	8.5
82	81.5	8.6
83	82.5	8.7
84	83.5	8.8
85	84.5	8.9
86	85.5	9.0
87	86.5	9.1
88	87.5	9.2
89	88.5	9.3
90	89.5	9.4
91	90.5	9.5
92	91.5	9.6
93	92.5	9.7
94	93.5	9.8
95	94.5	9.9
96	95.5	10.0
97	96.5	10.1
98	97.5	10.2
99	98.5	10.3
100	99.5	10.4
200	198.9	20.9
300	298.3	31.3
Dist.	Dep.	Lat.

84 Deg.

Dist.	5 Deg. Lat.	Dep.
1	1.0	.1
2	2.0	.2
3	3.0	.3
4	4.0	.3
5	5.0	.4
6	6.0	.5
7	7.0	.6
8	8.0	.7
9	9.0	.8
10	10.0	.9
11	11.0	1.0
12	12.0	1.0
13	13.0	1.1
14	14.0	1.2
15	15.0	1.3
16	15.9	1.4
17	16.9	1.5
18	17.9	1.6
19	18.9	1.7
20	19.9	1.7
21	20.9	1.8
22	21.9	1.9
23	22.9	2.0
24	23.9	2.1
25	24.9	2.2
26	25.9	2.3
27	26.9	2.4
28	27.9	2.4
29	28.9	2.5
30	29.9	2.6
31	30.9	2.7
32	31.9	2.8
33	32.9	2.9
34	33.9	3.0
Dist.	Dep.	Lat.
	85 Deg.	

Dist.	5 Deg. Lat.	Dep.
35	34.9	3.0
36	35.9	3.1
37	36.9	3.2
38	37.9	3.3
39	38.8	3.4
40	39.8	3.5
41	40.8	3.6
42	41.8	3.7
43	42.8	3.7
44	43.8	3.8
45	44.8	3.9
46	45.8	4.0
47	46.8	4.1
48	47.8	4.2
49	48.8	4.3
50	49.8	4.4
51	50.8	4.5
52	51.8	4.5
53	52.8	4.6
54	53.8	4.7
55	54.8	4.8
56	55.8	4.9
57	56.8	5.0
58	57.8	5.1
59	58.8	5.2
60	59.8	5.2
61	60.8	5.3
62	61.8	5.4
63	62.8	5.5
64	63.8	5.6
65	64.8	5.7
66	65.8	5.8
67	66.8	5.8
68	67.7	5.9
Dist.	Dep.	Lat.
	85 Deg.	

Dist.	5 Deg. Lat.	Dep.
69	68.7	6.0
70	69.7	6.1
71	70.7	6.2
72	71.7	6.3
73	72.7	6.4
74	73.7	6.5
75	74.7	6.5
76	75.7	6.6
77	76.7	6.7
78	77.7	6.8
79	78.7	6.9
80	79.7	7.0
81	80.7	7.1
82	81.7	7.1
83	82.7	7.2
84	83.7	7.3
85	84.7	7.4
86	85.7	7.5
87	86.7	7.6
88	87.7	7.7
89	88.7	7.8
90	89.7	7.8
91	90.7	7.9
92	91.6	8.0
93	92.6	8.1
94	93.6	8.2
95	94.6	8.3
96	95.6	8.4
97	96.6	8.4
98	97.6	8.5
99	98.6	8.6
100	99.6	8.7
200	199.2	17.4
300	298.9	26.2
Dist.	Dep.	Lat.
	85 Deg.	

Dist.	6 Deg. Lat.	Dep.
1	1.0	.1
2	2.0	.2
3	3.0	.3
4	4.0	.4
5	5.0	.5
6	6.0	.6
7	7.0	.7
8	8.0	.8
9	8.9	.9
10	9.9	1.0
11	10.9	1.1
12	11.9	1.2
13	12.9	1.4
14	13.9	1.5
15	14.9	1.6
16	15.9	1.7
17	16.9	1.8
18	17.9	1.9
19	18.9	2.0
20	19.9	2.1
21	20.9	2.2
22	21.9	2.3
23	22.9	2.4
24	23.9	2.5
25	24.9	2.6
26	25.9	2.7
27	26.8	2.8
28	27.8	2.9
29	28.8	3.0
30	29.8	3.1
31	30.8	3.2
32	31.8	3.3
33	32.8	3.4
34	33.8	3.5
Dist.	Dep.	Lat.
	84 Deg.	

Dist.	6 Deg. Lat.	Dep.
35	34.8	3.6
36	35.8	3.8
37	36.8	3.9
38	37.8	4.0
39	38.8	4.1
40	39.8	4.2
41	40.8	4.3
42	41.8	4.4
43	42.8	4.5
44	43.8	4.6
45	44.7	4.7
46	45.7	4.8
47	46.7	4.9
48	47.7	5.0
49	48.7	5.1
50	49.7	5.2
51	50.7	5.3
52	51.7	5.4
53	52.7	5.5
54	53.7	5.6
55	54.7	5.7
56	55.7	5.8
57	56.7	5.9
58	57.7	6.1
59	58.7	6.2
60	59.7	6.3
61	60.7	6.4
62	61.7	6.5
63	62.7	6.6
64	63.7	6.7
65	64.6	6.8
66	65.6	6.9
67	66.6	7.0
68	67.6	7.1
Dist.	Dep.	Lat.
	84 Deg.	

Dist.	6 Deg. Lat.	Dep.
69	68.6	7.2
70	69.6	7.3
71	70.6	7.4
72	71.6	7.5
73	72.6	7.6
74	73.6	7.7
75	74.6	7.8
76	75.6	7.9
77	76.6	8.0
78	77.6	8.1
79	78.6	8.2
80	79.6	8.3
81	80.6	8.5
82	81.5	8.6
83	82.5	8.7
84	83.5	8.8
85	84.5	8.9
86	85.5	9.0
87	86.5	9.1
88	87.5	9.2
89	88.5	9.3
90	89.5	9.4
91	90.5	9.5
92	91.5	9.6
93	92.5	9.7
94	93.5	9.8
95	94.5	9.9
96	95.5	10.0
97	96.5	10.1
98	97.5	10.2
99	98.5	10.3
100	99.5	10.4
200	198.9	20.9
300	298.3	31.3
Dist.	Dep.	Lat.
	84 Deg.	

Dist.	7 Deg. Lat.	Dep.
1	1 0	.1
2	2.0	.2
3	3.0	.4
4	4.0	.5
5	5.0	.6
6	6.0	.7
7	6.9	.8
8	7.9	1.0
9	8.9	1.1
10	9.9	1.2
11	10.9	1.3
12	11.9	1.5
13	12.9	1.6
14	13.9	1.7
15	14.9	1.8
16	15.9	2.0
17	16.9	2.1
18	17.9	2.2
19	18.9	2.3
20	19.8	2.4
21	20.8	2.6
22	21.8	2.7
23	22.8	2.8
24	23.8	2.9
25	24.8	3.0
26	25.8	3.2
27	26.8	3.3
28	27.8	3.4
29	28.8	3.5
30	29.8	3.7
31	30.8	3.8
32	31.8	3.9
33	32.7	4.0
34	33.7	4.1
Dist.	Dep.	Lat.
	83 Deg.	

Dist.	7 Deg. Lat.	Dep.
35	34.7	4.3
36	35.7	4.4
37	36.7	4.5
38	37.7	4.6
39	38.7	4.8
40	39.7	4.9
41	40.7	5.0
42	41.7	5.1
43	42.7	5.2
44	43.7	5.4
45	44.7	5.5
46	45.6	5.6
47	46.6	5.7
48	47.6	5.9
49	48.6	6.0
50	49.6	6.1
51	50.6	6.2
52	51.6	6.3
53	52.6	6.5
54	53.6	6.6
55	54.6	6.7
56	55.6	6.8
57	56.6	6.9
58	57.6	7.1
59	58.6	7.2
60	59.6	7.3
61	60.5	7.4
62	61.5	7.6
63	62.5	7.7
64	63.5	7.8
65	64.5	7.9
66	65.5	8.1
67	66.5	8.2
68	67.5	8.3
Dist.	Dep.	Lat.
	83 Deg.	

Dist.	7 Deg. Lat.	Dep.
69	68.5	8.4
70	69.5	8.5
71	70.5	8.7
72	71.5	8.8
73	72.5	8.9
74	73.4	9.0
75	74.4	9.2
76	75.4	9.3
77	76.4	9.4
78	77.4	9.5
79	78.4	9.6
80	79.4	9.8
81	80.4	9 9
82	81.4	10.0
83	82.4	10.1
84	83.4	10.3
85	84.4	10.4
86	85.4	10.5
87	86.3	10.6
88	87.3	10.7
89	88.3	10.9
90	89.3	11.0
91	90.3	11.1
92	91.3	11.2
93	92.3	11.3
94	93.3	11.5
95	94.3	11.6
96	95.3	11.7
97	96.3	11.8
98	97.3	12.0
99	98.3	12.1
100	99.3	12.2
200	198.5	24.4
300	297.7	36.6
Dist.	Dep.	Lat.
	83 Deg.	

Dist.	8 Deg. Lat.	Dep.
1	1.0	.1
2	2.0	.3
3	3.0	.4
4	4.0	.6
5	5.0	.7
6	5.9	.8
7	6.9	1.0
8	7.9	1.1
9	8.9	1.3
10	9.9	1.4
11	10.9	1.5
12	11.9	1.7
13	12.9	1.8
14	13.9	1.9
15	14.8	2.1
16	15.8	2.2
17	16.8	2.4
18	17.8	2.5
19	18.8	2.6
20	19.8	2.8
21	20.8	2.9
22	21.8	3.1
23	22.8	3.2
24	23.8	3.3
25	24.8	3.5
26	25.7	3.6
27	26.7	3.8
28	27.7	3.9
29	28.7	4.0
30	29.7	4.2
31	30.7	4.3
32	31.7	4.4
33	32.7	4.6
34	33.7	4.7
Dist.	Dep.	Lat.

82 Deg.

Dist.	8 Deg. Lat.	Dep.
35	34.7	4.9
36	35.7	5.0
37	36.6	5.1
38	37.6	5.3
39	38.6	5.4
40	39.6	5.6
41	40.6	5.7
42	41.6	5.8
43	42.6	6.0
44	43.6	6.1
45	44.6	6.3
46	45.6	6.4
47	46.5	6.5
48	47.5	6.7
49	48.5	6.8
50	49.5	7.0
51	50.5	7.1
52	51.5	7.2
53	52.5	7.4
54	53.5	7.5
55	54.5	7.7
56	55.5	7.8
57	56.5	7.9
58	57.4	8.1
59	58.4	8.2
60	59.4	8.3
61	60.4	8.5
62	61.4	8.6
63	62.4	8.8
64	63.4	8.9
65	64.4	9.0
66	65.4	9.2
67	66.4	9.3
68	67.3	9.5
Dist.	Dep.	Lat.

82 Deg.

Dist.	8 Deg. Lat.	Dep.
69	68.3	9.6
70	69.3	9.7
71	70.3	9.9
72	71.3	10.0
73	72.3	10.2
74	73.3	10.3
75	74.3	10.4
76	75.3	10.6
77	76.3	10.7
78	77.2	10.9
79	78.2	11.0
80	79.2	11.1
81	80.2	11.3
82	81.2	11.4
83	82.2	11.5
84	83.2	11.7
85	84.2	11.8
86	85.2	12.0
87	86.2	12.1
88	87.2	12.2
89	88.1	12.4
90	89.1	12.5
91	90.1	12.7
92	91.1	12.8
93	92.1	12.9
94	93.1	13.1
95	94.1	13.2
96	95.1	13.4
97	96.1	13.5
98	97.0	13.6
99	98.0	13.8
100	99.0	13.9
200	198.1	27.8
300	297.1	41.8
Dist.	Dep.	Lat.

82 Deg.

Dist.	9 Deg. Lat.	Dep.
1	1.0	.2
2	2.0	.3
3	3.0	.5
4	4.0	.6
5	4.9	.8
6	5.9	.9
7	6.9	1.1
8	7.9	1.3
9	8.9	1.4
10	9.9	1.6
11	10.9	1.7
12	11.9	1.9
13	12.9	2.0
14	13.8	2.2
15	14.8	2.3
16	15.8	2.5
17	16.8	2.6
18	17.8	2.8
19	18.8	3.0
20	19.8	3.1
21	20.8	3.3
22	21.7	3.4
23	22.7	3.6
24	23.7	3.7
25	24.7	3.9
26	25.7	4.1
27	26.7	4.2
28	27.7	4.4
29	28.7	4.5
30	29.6	4.7
31	30.6	4.8
32	31.6	5.0
33	32.6	5.1
34	33.6	5.3
Dist.	Dep.	Lat.

81 Deg.

Dist.	9 Deg. Lat.	Dep.
35	34.6	5.5
36	35.6	5.6
37	36.6	5.8
38	37.5	5.9
39	38.5	6.1
40	39.5	6.3
41	40.5	6.4
42	41.5	6.6
43	42.5	6.7
44	43.5	6.9
45	44.5	7.0
46	45.4	7.2
47	46.4	7.3
48	47.4	7.5
49	48.4	7.7
50	49.4	7.8
51	50.4	8.0
52	51.4	8.1
53	52.4	8.3
54	53.4	8.4
55	54.3	8.6
56	55.3	8.8
57	56.3	8.9
58	57.3	9.1
59	58.3	9.2
60	59.3	9.4
61	60.3	9.5
62	61.2	9.7
63	62.2	9.8
64	63.2	10.0
65	64.2	10.2
66	65.2	10.3
67	66.2	10.5
68	67.2	10.6
Dist.	Dep.	Lat.

81 Deg.

Dist.	9 Deg. Lat.	Dep.
69	68.2	10.8
70	69.1	10.9
71	70.1	11.1
72	71.1	11.2
73	72.1	11.4
74	73.1	11.6
75	74.1	11.7
76	75.1	11.9
77	76.1	12.0
78	77.0	12.2
79	78.0	12.4
80	79.0	12.5
81	80.0	12.7
82	81.0	12.8
83	82.0	13.0
84	83.0	13.1
85	84.0	13.3
86	85.0	13.4
87	85.9	13.6
88	86.9	13.8
89	87.9	13.9
90	88.9	14.1
91	89.9	14.2
92	90.9	14.4
93	91.9	14.5
94	92.9	14.7
95	93.8	14.8
96	94.8	15.0
97	95.8	15.2
98	96.8	15.3
99	97.8	15.5
100	98.8	15.6
200	197.5	21.3
300	296.3	36.9
Dist.	Dep.	Lat.

81 Deg.

Dist.	10 Deg. Lat.	Dep.
1	1.0	.2
2	2.0	.3
3	3.0	.5
4	3.9	.7
5	4.9	.9
6	5.9	1.0
7	6.9	1.2
8	7.9	1.4
9	8.9	1.6
10	9.9	1.7
11	10.8	1.9
12	11.8	2.1
13	12.8	2.3
14	13.8	2.4
15	14.8	2.6
16	15.8	2.8
17	16.8	3.0
18	17.7	3.1
19	18.7	3.3
20	19.7	3.5
21	20.7	3.6
22	21.7	3.8
23	22.7	4.0
24	23.6	4.2
25	24.6	4.3
26	25.6	4.5
27	26.6	4.7
28	27.6	4.9
29	28.6	5.0
30	29.6	5.2
31	30.5	5.4
32	31.5	5.5
33	32.5	5.7
34	33.5	5.9
Dist.	Dep.	Lat.

80 Deg.

Dist.	10 Deg. Lat.	Dep.
35	34.5	6.1
36	35.5	6.2
37	36.5	6.4
38	37.4	6.6
39	38.4	6.8
40	39.4	6.9
41	40.4	7.1
42	41.4	7.3
43	42.4	7.5
44	43.3	7.6
45	44.3	7.8
46	45.3	8.0
47	46.3	8.1
48	47.3	8.3
49	48.3	8.5
50	49.2	8.7
51	50.2	8.8
52	51.2	9.0
53	52.2	9.2
54	53.2	9.4
55	54.2	9.5
56	55.2	9.7
57	56.1	9.9
58	57.1	10.1
59	58.1	10.2
60	59.1	10.4
61	60.1	10.6
62	61.1	10.8
63	62.0	10.9
64	63.0	11.1
65	64.0	11.3
66	65.0	11.5
67	66.0	11.6
68	67.0	11.8
Dist.	Dep.	Lat.

80 Deg.

Dist.	10 Deg. Lat.	Dep.
69	68.0	12.0
70	69.9	12.1
71	69.9	12.3
72	70.9	12.5
73	71.9	12.7
74	72.9	12.8
75	73.9	13.0
76	74.9	13.2
77	75.8	13.3
78	76.8	13.5
79	77.8	13.7
80	78.8	13.9
81	79.8	14.1
82	80.8	14.2
83	81.7	14.4
84	82.7	14.6
85	83.7	14.8
86	84.7	14.9
87	85.7	15.1
88	86.7	15.3
89	87.6	15.4
90	88.6	15.6
91	89.6	15.8
92	90.6	16.0
93	91.6	16.1
94	92.6	16.3
95	93.6	16.5
96	94.6	16.7
97	95.5	16.8
98	96.5	17.0
99	97.5	17.2
100	98.5	17.4
200	197.0	34.7
300	295.4	52.1
Dist.	Dep.	Lat.

80 Deg.

Dist.	11 Deg. Lat.	Dep.
1	1.0	.2
2	2.0	.4
3	2.9	.6
4	3.9	.8
5	4.9	.9
6	5.9	1.1
7	6.9	1.3
8	7.8	1.5
9	8.8	1.7
10	9.8	1.9
11	10.8	2.1
12	11.8	2.3
13	12.8	2.5
14	13.7	2.7
15	14.7	2.9
16	15.7	3.0
17	16.7	3.2
18	17.7	3.4
19	18.6	3.6
20	19.6	3.8
21	20.6	4.0
22	21.6	4.2
23	22.6	4.4
24	23.6	4.6
25	24.5	4.8
26	25.5	5.0
27	26.5	5.1
28	27.5	5.3
29	28.5	5.5
30	29.4	5.7
31	30.4	5.9
32	31.4	6.1
33	32.4	6.3
34	33.4	6.5
Dist.	Dep.	Lat.

79 Deg.

Dist.	11 Deg. Lat.	Dep.
35	34.3	6.7
36	35.3	6.9
37	36.3	7.1
38	37.3	7.2
39	38.3	7.4
40	39.3	7.6
41	40.2	7.8
42	41.2	8.0
43	42.2	8.2
44	43.2	8.4
45	44.2	8.6
46	45.2	8.8
47	46.1	9.0
48	47.1	9.2
49	48.1	9.3
50	49.1	9.5
51	50.1	9.7
52	51.0	9.9
53	52.0	10.1
54	53.0	10.3
55	54.0	10.5
56	55.0	10.7
57	55.9	10.9
58	56.9	11.1
59	57.9	11.2
60	58.9	11.4
61	59.9	11.6
62	60.9	11.8
63	61.8	12.0
64	62.8	12.2
65	63.8	12.4
66	64.8	12.6
67	65.8	12.8
68	66.8	13.0
Dist.	Dep.	Lat.

79 Deg.

Dist.	11 Deg. Lat.	Dep.
69	67.7	13.2
70	68.7	13.4
71	69.7	13.5
72	70.7	13.7
73	71.6	13.9
74	72.6	14.1
75	73.6	14.3
76	74.6	14.5
77	75.6	14.7
78	76.5	14.9
79	77.5	15.1
80	78.5	15.3
81	79.5	15.4
82	80.5	15.6
83	81.5	15.8
84	82.4	16.0
85	83.4	16.2
86	84.4	16.4
87	85.4	16.6
88	86.4	16.8
89	87.3	17.0
90	88.3	17.2
91	89.3	17.4
92	90.3	17.6
93	91.3	17.7
94	92.3	17.9
95	93.2	18.1
96	94.2	18.3
97	95.2	18.5
98	96.2	18.7
99	97.2	18.9
100	98.1	19.1
200	196.3	38.2
300	294.1	57.2
Dist.	Dep.	Lat.

79 Deg.

Dif.	12 Deg. Lat.	Dep.
1	1.0	.2
2	2.0	.4
3	2.9	.6
4	3.9	.8
5	4.9	1.0
6	5.9	1.2
7	6.8	1.5
8	7.8	1.7
9	8.8	1.9
10	9.8	2.1
11	10.8	2.3
12	11.7	2.5
13	12.7	2.7
14	13.7	2.9
15	14.7	3.1
16	15.6	3.3
17	16.6	3.6
18	17.6	3.8
19	18.6	4.0
20	19.6	4.2
21	20.5	4.4
22	21.5	4.6
23	22.5	4.8
24	23.5	5.0
25	24.5	5.2
26	25.4	5.4
27	26.4	5.6
28	27.4	5.8
29	28.4	6.0
30	29.3	6.2
31	30.3	6.4
32	31.3	6.6
33	32.3	6.9
34	33.3	7.1
Dif.	Dep.	Lat.
	78 Deg.	

Dif.	12 Deg. Lat.	Dep.
35	34.2	7.3
36	35.2	7.5
37	36.2	7.7
38	37.2	7.9
39	38.1	8.1
40	39.1	8.3
41	40.1	8.5
42	41.1	8.7
43	42.0	9.0
44	43.0	9.2
45	44.0	9.4
46	45.0	9.6
47	46.0	9.8
48	47.0	10.0
49	47.9	10.2
50	48.9	10.4
51	49.9	10.6
52	50.9	10.8
53	51.8	11.0
54	52.8	11.2
55	53.8	11.4
56	54.8	11.6
57	55.8	11.8
58	56.7	12.1
59	57.7	12.3
60	58.7	12.5
61	59.7	12.7
62	60.7	12.9
63	61.6	13.1
64	62.6	13.3
65	63.6	13.5
66	64.6	13.7
67	65.5	14.0
68	66.5	14.2
Dif.	Dep.	Lat.
	78 Deg.	

Dif.	12 Deg. Lat.	Dep.
69	67.5	14.4
70	68.5	14.6
71	69.4	14.8
72	70.4	15.0
73	71.4	15.2
74	72.4	15.4
75	73.4	15.6
76	74.3	15.8
77	75.3	16.0
78	76.3	16.2
79	77.3	16.4
80	78.3	16.6
81	79.2	16.8
82	80.2	17.0
83	81.2	17.3
84	82.2	17.5
85	83.1	17.7
86	84.1	17.9
87	85.1	18.1
88	86.1	18.3
89	87.0	18.5
90	88.0	18.7
91	89.0	18.9
92	90.0	19.1
93	91.0	19.3
94	92.0	19.5
95	92.9	19.7
96	93.9	20.0
97	94.9	20.2
98	95.9	20.4
99	96.8	20.6
100	97.8	20.8
200	195.6	41.6
300	293.4	62.4
Dif.	Dep.	Lat.
	78 Deg.	

Dist.	13 Deg. Lat.	Dep.
1	1.0	.2
2	2.0	.4
3	2.9	.7
4	3.9	.9
5	4.9	1.1
6	5.9	1.3
7	6.8	1.6
8	7.8	1.8
9	8.8	2.0
10	9.8	2.2
11	10.7	2.5
12	11.7	2.7
13	12.7	2.9
14	13.6	3.1
15	14.6	3.4
16	15.6	3.6
17	16.6	3.8
18	17.6	4.0
19	18.5	4.3
20	19.5	4.5
21	20.5	4.7
22	21.5	4.9
23	22.4	5.2
24	23.4	5.4
25	24.4	5.6
26	25.4	5.8
27	26.3	6.1
28	27.3	6.3
29	28.3	6.5
30	29.2	6.7
31	30.2	7.0
32	31.2	7.2
33	32.2	7.4
34	33.1	7.6
Dist.	Dep.	Lat.
	77 Deg.	

Dist.	13 Deg. Lat.	Dep.
35	34.1	7.9
36	35.1	8.1
37	36.1	8.3
38	37.0	8.6
39	38.0	8.8
40	39.0	9.0
41	40.0	9.2
42	40.9	9.4
43	41.9	9.7
44	42.9	9.9
45	43.8	10.1
46	44.8	10.3
47	45.8	10.6
48	46.8	10.8
49	47.7	11.0
50	48.7	11.2
51	49.7	11.5
52	50.7	11.7
53	51.6	11.9
54	52.6	12.1
55	53.6	12.4
56	54.6	12.6
57	55.5	12.8
58	56.5	13.0
59	57.5	13.3
60	58.5	13.5
61	59.4	13.7
62	60.4	14.0
63	61.4	14.2
64	62.4	14.4
65	63.4	14.6
66	64.3	14.8
67	65.3	15.1
68	66.3	15.3
Dist.	Dep.	Lat.
	77 Deg.	

Dist.	13 Deg. Lat.	Dep.
69	67.2	15.5
70	68.2	15.7
71	69.2	16.0
72	70.2	16.2
73	71.1	16.4
74	72.1	16.6
75	73.1	16.9
76	74.1	17.1
77	75.0	17.3
78	76.0	17.5
79	77.0	17.8
80	78.0	18.0
81	78.9	18.2
82	79.9	18.4
83	80.9	18.7
84	81.8	18.9
85	82.8	19.1
86	83.8	19.3
87	84.8	19.6
88	85.7	19.8
89	86.7	20.0
90	87.7	20.2
91	88.7	20.5
92	89.6	20.7
93	90.6	20.9
94	91.6	21.1
95	92.6	21.4
96	93.5	21.6
97	94.5	21.8
98	95.5	22.1
99	96.5	22.3
100	97.4	22.5
200	194.9	45.0
300	292.3	67.5
Dist.	Dep.	Lat.
	77 Deg.	

Dist.	14 Deg. Lat.	Dep.
1	1.0	.2
2	1.9	.5
3	2.9	.7
4	3.9	1.0
5	4.8	1.2
6	5.8	1.4
7	6.8	1.7
8	7.8	1.9
9	8.7	2.2
10	9.7	2.4
11	10.7	2.7
12	11.6	2.9
13	12.6	3.1
14	13.6	3.4
15	14.6	3.6
16	15.5	3.9
17	16.5	4.1
18	17.5	4.4
19	18.4	4.6
20	19.4	4.8
21	20.4	5.1
22	21.3	5.3
23	22.3	5.6
24	23.3	5.8
25	24.2	6.0
26	25.2	6.3
27	26.2	6.5
28	27.2	6.8
29	28.1	7.0
30	29.1	7.3
31	30.1	7.5
32	31.0	7.7
33	32.0	8.0
34	33.0	8.2
Dist.	Dep.	Lat.

76 Deg.

Dist.	14 Deg. Lat	Dep.
35	34.0	8.5
36	34.9	8.7
37	35.9	9.0
38	36.9	9.2
39	37.8	9.4
40	38.8	9.7
41	39.8	9.9
42	40.7	10.2
43	41.7	10.4
44	42.7	10.7
45	43.7	10.9
46	44.6	11.1
47	45.6	11.4
48	46.6	11.6
49	47.5	11.9
50	48.5	12.1
51	49.5	12.3
52	50.4	12.6
53	51.4	12.8
54	52.4	13.1
55	53.4	13.3
56	54.3	13.6
57	55.3	13.8
58	56.3	14.0
59	57.2	14.3
60	58.2	14.5
61	59.2	14.8
62	60.1	15.0
63	61.1	15.3
64	62.1	15.5
65	63.1	15.7
66	64.0	16.0
67	65.0	16.2
68	66.0	16.5
Dist.	Dep.	Lat.

76 Deg.

Dist.	14 Deg. Lat.	Dep.
69	66.9	16.7
70	67.9	16.9
71	68.9	17.2
72	69.8	17.4
73	70.8	17.7
74	71.8	17.9
75	72.8	18.2
76	73.7	18.4
77	74.7	18.7
78	75.7	18.9
79	76.6	19.1
80	77.6	19.4
81	78.6	19.5
82	79.6	19.7
83	80.5	20.0
84	81.5	20.2
85	82.5	20.5
86	83.4	20.7
87	84.4	20.9
88	85.4	21.3
89	86.4	21.5
90	87.3	21.8
91	88.3	22.0
92	89.3	22.3
93	90.2	22.5
94	91.2	22.7
95	92.1	23.0
96	93.1	23.2
97	94.1	23.5
98	95.1	23.7
99	96.0	24.0
100	97.0	24.2
200	194.1	48.4
300	291.1	72.6
Dist.	Dep.	Lat.

76 Deg.

Dist.	15 Deg. Lat.	Dep.
1	1.0	.3
2	1.9	.5
3	2.9	.8
4	3.9	1.0
5	4.8	1.3
6	5.8	1.6
7	6.8	1.8
8	7.7	2.1
9	8.7	2.3
10	9.7	2.6
11	10.6	2.8
12	11.6	3.1
13	12.6	3.4
14	13.5	3.6
15	14.5	3.9
16	15.5	4.1
17	16.4	4.4
18	17.4	4.7
19	18.3	4.9
20	19.3	5.2
21	20.3	5.4
22	21.3	5.7
23	22.2	6.0
24	23.2	6.2
25	24.2	6.5
26	25.1	6.7
27	26.1	7.0
28	27.1	7.3
29	28.0	7.5
30	29.0	7.8
31	30.9	8.0
32	31.9	8.3
33	32.9	8.5
34	33.8	8.8
Dist.	Dep.	Lat.
	75 Deg.	

Dist.	15 Deg. Lat.	Dep.
35	33.8	9.4
36	34.8	9.3
37	35.7	9.6
38	36.7	9.8
39	37.7	10.1
40	38.6	10.3
41	39.6	10.6
42	40.6	10.9
43	41.5	11.1
44	42.5	11.4
45	43.5	11.6
46	44.4	11.9
47	45.4	12.3
48	46.4	12.5
49	47.3	12.8
50	48.3	12.9
51	49.3	13.2
52	50.2	13.5
53	51.2	13.7
54	52.2	14.0
55	53.1	14.2
56	54.1	14.5
57	55.1	14.8
58	56.0	15.0
59	57.0	15.3
60	58.0	15.5
61	58.9	15.8
62	59.9	16.0
63	60.8	16.3
64	61.8	16.6
65	62.8	16.8
66	63.8	17.1
67	64.7	17.4
68	65.7	17.6
Dist.	Dep.	Lat.
	75 Deg.	

Dist.	15 Deg. Lat.	Dep.
69	66.6	17.9
70	67.6	18.1
71	68.6	18.4
72	69.6	18.6
73	70.5	18.9
74	71.5	19.2
75	72.4	19.4
76	73.4	19.7
77	74.4	20.0
78	75.4	20.2
79	76.3	20.5
80	77.3	20.7
81	78.3	21.0
82	79.2	21.2
83	80.2	21.5
84	81.1	21.7
85	82.1	22.0
86	83.1	22.3
87	84.0	22.5
88	85.0	22.8
89	86.0	23.0
90	86.9	23.3
91	87.9	23.6
92	88.9	23.8
93	89.8	24.1
94	90.8	24.3
95	91.8	24.6
96	92.7	24.8
97	93.7	25.1
98	94.7	25.4
99	95.6	25.6
100	96.6	25.9
200	193.2	51.8
300	289.8	77.6
Dist.	Dep.	Lat.
	75 Deg.	

Dist.	16 Deg. Lat.	Dep.
1	1.0	.3
2	1.9	.6
3	2.9	.8
4	3.8	1.1
5	4.8	1.4
6	5.8	1.7
7	6.7	1.9
8	7.7	2.2
9	8.6	2.5
10	9.6	2.8
11	10.6	3.0
12	11.5	3.3
13	12.5	3.6
14	13.4	3.9
15	14.4	4.1
16	15.4	4.4
17	16.3	4.7
18	17.3	5.0
19	18.3	5.3
20	19.2	5.5
21	20.2	5.8
22	21.1	6.1
23	22.1	6.3
24	23.1	6.6
25	24.0	6.9
26	25.0	7.2
27	25.9	7.5
28	26.9	7.7
29	27.9	8.0
30	28.8	8.3
31	29.8	8.5
32	30.8	8.8
33	31.7	9.1
34	32.7	9.4
Dist.	Dep.	Lat.

74 Deg.

Dist.	16 Deg. Lat.	Dep.
35	33.6	9.7
36	34.6	9.9
37	35.6	10.2
38	36.5	10.5
39	37.5	10.7
40	38.4	11.0
41	39.4	11.3
42	40.4	11.6
43	41.3	11.9
44	42.3	12.1
45	43.2	12.4
46	44.2	12.7
47	45.2	13.0
48	46.1	13.2
49	47.1	13.5
50	48.1	13.8
51	49.0	14.1
52	50.0	14.3
53	50.9	14.6
54	51.9	14.9
55	52.9	15.1
56	53.8	15.4
57	54.8	15.7
58	55.7	16.0
59	56.7	16.3
60	57.7	16.5
61	58.6	16.8
62	59.6	17.1
63	60.6	17.4
64	61.5	17.7
65	62.5	17.9
66	63.4	18.2
67	64.4	18.5
68	65.4	18.8
Dist.	Dep.	Lat.

74 Deg.

Dist.	16 Deg. Lat.	Dep.
69	66.3	19.0
70	67.3	19.3
71	68.2	19.6
72	69.2	19.9
73	70.2	20.1
74	71.1	20.4
75	72.1	20.7
76	73.1	21.0
77	74.0	21.3
78	75.0	21.5
79	75.9	21.8
80	76.9	22.0
81	77.9	22.3
82	78.8	22.6
83	79.8	22.9
84	80.7	23.2
85	81.7	23.5
86	82.7	23.7
87	83.6	24.0
88	84.6	24.3
89	85.6	24.5
90	86.5	24.8
91	87.5	25.1
92	88.4	25.4
93	89.4	25.7
94	90.4	25.9
95	91.3	26.2
96	92.3	26.5
97	93.2	26.7
98	94.2	27.0
99	95.2	27.3
100	96.1	27.6
200	192.3	55.1
300	288.4	82.7
Dist.	Dep.	Lat.

74 Deg.

Dist.	17 Deg. Lat.	Dep.
1	1.0	.3
2	1.9	.6
3	2.9	.9
4	3.8	1.2
5	4.8	1.5
6	5.7	1.7
7	6.7	2.0
8	7.6	2.3
9	8.6	2.6
10	9.6	2.9
11	10.5	3.2
12	11.5	3.5
13	12.4	3.8
14	13.4	4.1
15	14.3	4.4
16	15.3	4.7
17	16.2	5.0
18	17.2	5.2
19	18.2	5.5
20	19.1	5.8
21	20.1	6.1
22	21.0	6.4
23	22.0	6.7
24	23.0	7.0
25	23.9	7.3
26	24.9	7.6
27	25.8	7.9
28	26.8	8.2
29	27.7	8.5
30	28.7	8.8
31	29.6	9.1
32	30.6	9.3
33	31.6	9.6
34	32.5	9.9
Dist.	Dep.	Lat.

73 Deg.

Dist.	17 Deg. Lat.	Dep.
35	33.5	10.2
36	34.4	10.5
37	35.4	10.8
38	36.3	11.1
39	37.3	11.4
40	38.3	11.7
41	39.2	12.0
42	40.2	12.3
43	41.1	12.6
44	42.1	12.9
45	43.0	13.1
46	44.0	13.4
47	44.9	13.7
48	45.9	14.0
49	46.9	14.3
50	47.8	14.6
51	48.8	14.9
52	49.7	15.2
53	50.7	15.5
54	51.6	15.8
55	52.6	16.1
56	53.5	16.4
57	54.5	16.7
58	55.4	17.0
59	56.4	17.2
60	57.4	17.5
61	58.3	17.8
62	59.3	18.1
63	60.2	18.4
64	61.2	18.7
65	62.2	19.0
66	63.1	19.3
67	64.1	19.6
68	65.0	19.9
Dist.	Dep.	Lat.

73 Deg.

Dist.	17 Deg. Lat.	Dep.
69	66.0	20.2
70	66.9	20.5
71	67.9	20.7
72	68.8	21.0
73	69.8	21.3
74	70.8	21.6
75	71.7	21.9
76	72.7	22.2
77	73.6	22.5
78	74.6	22.8
79	75.5	23.1
80	76.5	23.4
81	77.5	23.7
82	78.4	24.0
83	79.4	24.3
84	80.3	24.6
85	81.3	24.8
86	82.2	25.1
87	83.2	25.4
88	84.2	25.7
89	85.1	26.0
90	86.1	26.3
91	87.0	26.6
92	88.0	26.9
93	88.9	27.2
94	89.9	27.5
95	90.8	27.8
96	91.8	28.1
97	92.7	28.4
98	93.7	28.7
99	94.7	28.9
100	95.6	29.2
200	191.3	58.5
300	286.9	87.7
Dist.	Dep.	Lat.

73 Deg.

Dist.	18 Deg. Lat.	Dep.
1	1.0	.3
2	1.9	.6
3	2.8	.9
4	3.8	1.2
5	4.7	1.5
6	5.7	1.8
7	6.6	2.2
8	7.6	2.5
9	8.5	2.8
10	9.5	3.1
11	10.4	3.4
12	11.4	3.7
13	12.3	4.0
14	13.3	4.3
15	14.2	4.6
16	15.2	5.0
17	16.1	5.3
18	17.1	5.6
19	18.0	5.9
20	19.0	6.2
21	20.0	6.5
22	20.9	6.8
23	21.9	7.1
24	22.8	7.4
25	23.8	7.7
26	24.7	8.1
27	25.7	8.4
28	26.6	8.7
29	27.6	9.0
30	28.5	9.3
31	29.5	9.6
32	30.4	9.9
33	31.4	10.2
34	32.3	10.5
Dist.	Dep.	Lat.

72 Deg.

Dist.	18 Deg. Lat.	Dep.
35	33.3	10.8
36	34.2	11.1
37	35.2	11.4
38	36.1	11.7
39	37.1	12.0
40	38.0	12.4
41	39.0	12.7
42	39.9	13.0
43	40.9	13.3
44	41.8	13.6
45	42.8	13.9
46	43.7	14.2
47	44.7	14.5
48	45.6	14.8
49	46.6	15.1
50	47.5	15.4
51	48.5	15.8
52	49.5	16.1
53	50.4	16.4
54	51.4	16.7
55	52.3	17.0
56	53.3	17.3
57	54.2	17.6
58	55.2	17.9
59	56.1	18.2
60	57.1	18.5
61	58.0	18.8
62	59.0	19.2
63	59.9	19.5
64	60.9	19.8
65	61.8	20.1
66	62.8	20.4
67	63.7	20.7
68	64.7	21.0
Dist.	Dep.	Lat.

72 Deg.

Dist.	18 Deg. Lat.	Dep.
69	65.6	21.3
70	66.6	21.6
71	67.5	21.9
72	68.5	22.2
73	69.4	22.5
74	70.4	22.9
75	71.3	23.2
76	72.3	23.5
77	73.2	23.8
78	74.2	24.1
79	75.1	24.4
80	76.1	24.7
81	77.0	25.0
82	78.0	25.3
83	78.9	25.6
84	79.9	26.0
85	80.8	26.3
86	81.8	26.6
87	82.7	26.9
88	83.7	27.2
89	84.6	27.5
90	85.6	27.8
91	86.5	28.1
92	87.5	28.4
93	88.4	28.7
94	89.4	29.0
95	90.3	29.3
96	91.3	29.7
97	92.2	30.0
98	93.2	30.3
99	94.1	30.6
100	95.1	30.9
200	190.2	61.8
300	285.3	92.7
Dist.	Dep.	Lat.

72 Deg.

Dist.	19 Deg. Lat.	Dep.
1	.9	.3
2	1.9	.6
3	2.8	1.0
4	3.8	1.3
5	4.7	1.6
6	5.7	2.0
7	6.6	2.3
8	7.5	2.6
9	8.5	2.9
10	9.4	3.3
11	10.4	3.6
12	11.3	3.9
13	12.3	4.2
14	13.2	4.6
15	14.2	4.9
16	15.1	5.2
17	16.1	5.5
18	17.0	5.9
19	18.0	6.2
20	18.9	6.5
21	19.9	6.8
22	20.8	7.2
23	21.7	7.5
24	22.7	7.8
25	23.6	8.2
26	24.6	8.5
27	25.5	8.8
28	26.5	9.1
29	27.4	9.4
30	28.4	9.8
31	29.3	10.1
32	30.3	10.4
33	31.2	10.7
34	32.1	11.1
Dist.	Dep.	Lat.

71 Deg.

Dist.	19 Deg. Lat.	Dep.
35	33.1	11.4
36	34.0	11.7
37	35.0	12.1
38	35.9	12.4
39	36.9	12.7
40	37.8	13.0
41	38.8	13.4
42	39.7	13.7
43	40.7	14.0
44	41.6	14.4
45	42.5	14.7
46	43.5	15.0
47	44.4	15.3
48	45.4	15.6
49	46.3	16.0
50	47.3	16.3
51	48.2	16.6
52	49.2	16.9
53	50.1	17.3
54	51.0	17.6
55	52.0	17.9
56	52.9	18.2
57	53.9	18.6
58	54.8	18.9
59	55.8	19.2
60	56.7	19.5
61	57.7	19.9
62	58.6	20.2
63	59.6	20.5
64	60.5	20.8
65	61.5	21.2
66	62.4	21.5
67	63.4	21.8
68	64.3	22.2
Dist.	Dep.	Lat.

71 Deg.

Dist.	19 Deg. Lat.	Dep.
69	65.2	22.5
70	66.2	22.8
71	67.1	23.1
72	68.1	23.4
73	69.0	23.8
74	69.9	24.4
75	70.9	24.1
76	71.8	24.7
77	72.8	25.1
78	73.7	25.4
79	74.7	25.7
80	75.6	26.1
81	76.6	26.4
82	77.5	26.7
83	78.5	27 0
84	79.4	27.4
85	80.4	27.7
86	81.3	28.0
87	82.2	28.3
88	83.2	28.7
89	84.1	29.0
90	85.1	29.3
91	86.0	29.6
92	87.0	30.0
93	87.9	30.3
94	88.9	30.6
95	89.8	30.9
96	90.8	31.3
97	91.7	31.6
98	92.6	31.9
99	93.6	32.2
100	94.5	32.6
200	189.1	65.1
300	283.6	97.7
Dist.	Dep.	Lat.

71 Deg.

Dist.	20 Deg. Lat.	Dep.
1	.9	.3
2	1.9	.7
3	2.8	1.0
4	3.8	1.4
5	4.7	1.7
6	5.6	2.0
7	6.6	2.4
8	7.5	2.7
9	8.5	3.1
10	9.4	3.4
11	10.3	3.8
12	11.3	4.1
13	12.2	4.4
14	13.2	4.8
15	14.1	5.1
16	15.0	5.5
17	16.0	5.8
18	16.9	6.1
19	17.9	6.5
20	18.8	6.8
21	19.7	7.2
22	20.7	7.5
23	21.6	7.9
24	22.6	8.2
25	23.5	8.5
26	24.4	8.9
27	25.4	9.2
28	26.3	9.6
29	27.2	10.0
30	28.2	10.3
31	29.1	10.6
32	30.1	10.9
33	31.0	11.3
34	31.9	11.6
Dist.	Dep.	Lat.

70 Deg.

Dist.	20 Deg. Lat.	Dep.
35	32.9	12.0
36	33.8	12.3
37	34.8	12.6
38	35.7	13.0
39	36.6	13.3
40	37.6	13.7
41	38.5	14.0
42	39.5	14.4
43	40.4	14.7
44	41.3	15.0
45	42.3	15.4
46	43.2	15.7
47	44.2	16.1
48	45.1	16.4
49	46.0	16.8
50	47.0	17.1
51	47.9	17.4
52	48.9	17.8
53	49.8	18.1
54	50.7	18.5
55	51.7	18.8
56	52.6	19.1
57	53.6	19.5
58	54.5	19.8
59	55.4	20.2
60	56.4	20.5
61	57.3	20.9
62	58.3	21.2
63	59.2	21.5
64	60.1	21.9
65	61.1	22.2
66	62.0	22.6
67	63.0	22.9
68	63.9	23.3
Dist.	Dep.	Lat.

70 Deg.

Dist.	20 Deg. Lat.	Dep.
69	64.8	23.6
70	65.8	23.9
71	66.7	24.3
72	67.7	24.6
73	68.6	25.0
74	69.5	25.3
75	70.5	25.6
76	71.4	26.0
77	72.4	26.5
78	73.3	26.7
79	74.2	27.0
80	75.2	27.4
81	76.1	27.7
82	77.1	28.0
83	78.0	28.4
84	79.9	28.7
85	80.9	29.1
86	80.8	29.4
87	81.8	29.8
88	82.7	30.1
89	83.6	30.4
90	846	30.8
91	85.5	31.1
92	86.4	31.5
93	87.4	31.8
94	88.3	32.1
95	89.3	32.5
96	90.2	32.8
97	91.2	33.2
98	92.1	33.5
99	93.0	33.9
100	94.0	34.2
200	187.9	68.4
300	281.9	102.6
Dist.	Dep.	Lat.

70 Deg.

Dist.	21 Deg. Lat.	Dep.
1	.9	.4
2	1.9	.7
3	2.8	1.1
4	3.7	1.4
5	4.7	1.8
6	5.6	2.1
7	6.5	2.5
8	7.5	2.9
9	8.4	3.2
10	9.3	3.6
11	10.3	3.9
12	11.2	4.3
13	12.1	4.7
14	13.1	5.0
15	14.0	5.4
16	14.9	5.7
17	15.9	6.1
18	16.8	6.4
19	17.7	6.8
20	18.7	7.2
21	19.6	7.5
22	20.5	7.9
23	21.5	8.2
24	22.4	8.6
25	23.3	9.0
26	24.3	9.3
27	25.2	9.7
28	26.1	10.0
29	27.1	10.4
30	28.0	10.7
31	28.9	11.1
32	29.9	11.5
33	30.8	11.8
34	31.7	12.2
Dist.	Dep.	Lat.

69 Deg.

Dist.	21 Deg. Lat.	Dep.
35	32.7	12.5
36	33.6	12.9
37	34.5	13.2
38	35.5	13.6
39	36.4	14.0
40	37.3	14.3
41	38.3	14.7
42	39.2	15.0
43	40.1	15.4
44	41.1	15.8
45	42.0	16.1
46	42.9	16.5
47	43.9	16.8
48	44.8	17.2
49	45.7	17.6
50	46.7	17.9
51	47.6	18.3
52	48.5	18.6
53	49.5	19.0
54	50.4	19.3
55	51.3	19.7
56	52.3	20.1
57	53.2	20.4
58	54.1	20.8
59	55.1	21.1
60	56.0	21.5
61	56.9	21.9
62	57.9	22.2
63	58.8	22.6
64	59.8	22.9
65	60.7	23.3
66	61.6	23.6
67	62.6	24.0
68	63.5	24.4
Dist.	Dep.	Lat.

69 Deg.

Dist.	21 Deg. Lat.	Dep.
69	64.4	24.7
70	65.3	25.1
71	66.3	25.4
72	67.2	25.8
73	68.1	26.2
74	69.1	26.5
75	70.0	26.9
76	70.9	27.2
77	71.9	27.6
78	72.8	27.9
79	73.7	28.3
80	74.7	28.7
81	75.6	29.0
82	76.6	29.4
83	77.5	29.7
84	78.4	30.1
85	79.4	30.5
86	80.3	30.8
87	81.2	31.2
88	82.2	31.5
89	83.1	31.9
90	84.0	32.3
91	84.9	32.6
92	85.9	33.0
93	86.8	33.3
94	87.7	33.7
95	88.7	34.0
96	89.6	34.4
97	90.5	34.8
98	91.5	35.1
99	92.4	35.5
100	93.4	35.8
200	186.7	71.7
300	280.1	107.5
Dist.	Dep.	Lat.

69 Deg.

Dist.	22 Deg. Lat.	Dep.
1	.9	.4
2	1.9	.7
3	2.8	1.1
4	3.7	1.5
5	4.6	1.9
6	5.6	2.2
7	6.5	2.6
8	7.4	3.0
9	8.3	3.4
10	9.3	3.7
11	10.2	4.1
12	11.1	4.5
13	12.0	4.9
14	13.0	5.2
15	13.9	5.6
16	14.8	6.0
17	15.7	6.4
18	16.7	6.7
19	17.6	7.1
20	18.5	7.5
21	19.5	7.9
22	20.4	8.2
23	21.3	8.6
24	22.2	9.0
25	23.2	9.4
26	24.1	9.7
27	25.0	10.1
28	26.0	10.5
29	26.9	10.9
30	27.8	11.2
31	28.7	11.6
32	29.7	12.0
33	30.6	12.4
34	31.5	12.7
Dist.	Dep.	Lat.

68 Deg.

Dist.	22 Deg. Lat.	Dep.
35	32.4	13.1
36	33.4	13.5
37	34.3	13.9
38	35.2	14.2
39	36.1	14.6
40	37.1	15.0
41	38.0	15.4
42	38.9	15.7
43	39.9	16.1
44	40.8	16.5
45	41.7	16.9
46	42.6	17.2
47	43.6	17.6
48	44.5	18.0
49	45.4	18.4
50	46.4	18.7
51	47.3	19.1
52	48.2	19.5
53	49.1	19.9
54	50.1	20.2
55	51.0	20.6
56	51.9	21.0
57	52.9	21.4
58	53.8	21.7
59	54.7	22.1
60	55.6	22.5
61	56.6	22.9
62	57.5	23.2
63	58.4	23.6
64	59.4	24.0
65	60.3	24.4
66	61.2	24.7
67	62.1	25.1
68	63.1	25.5
Dist.	Dep.	Lat.

68 Deg.

Dist.	22 Deg. Lat.	Dep.
69	64.0	25.9
70	64.9	26.2
71	65.8	26.6
72	66.7	27.0
73	67.7	27.4
74	68.6	27.7
75	69.5	28.1
76	70.5	28.5
77	71.4	28.9
78	72.3	29.2
79	73.3	29.6
80	74.2	30.0
81	75.1	30.4
82	76.0	30.7
83	77.0	31.1
84	77.9	31.5
85	78.8	31.9
86	79.7	32.2
87	80.6	32.6
88	81.6	33.0
89	82.5	33.4
90	83.4	33.7
91	84.4	34.1
92	85.3	34.5
93	86.2	34.9
94	87.1	35.2
95	88.1	35.6
96	89.0	36.0
97	89.9	36.4
98	90.9	36.7
99	91.8	37.1
100	92.7	37.5
200	185.4	74.9
300	278.2	109.4
Dist.	Dep.	Lat.

68 Deg.

Dist.	23 Deg. Lat.	Dep.
1	.9	.4
2	1.8	.8
3	2.8	1.2
4	3.7	1.6
5	4.6	1.9
6	5.5	2.3
7	6.4	2.7
8	7.4	3.1
9	8.3	3.5
10	9.2	3.9
11	10.1	4.3
12	11.0	4.7
13	12.0	5.1
14	12.9	5.5
15	13.8	5.9
16	14.7	6.2
17	15.6	6.6
18	16.6	7.0
19	17.5	7.4
20	18.4	7.8
21	19.3	8.2
22	20.2	8.6
23	21.2	9.0
24	22.1	9.4
25	23.0	9.8
26	23.9	10.2
27	24.8	10.5
28	25.8	10.9
29	26.7	11.3
30	27.6	11.7
31	28.5	12.1
32	29.4	12.5
33	30.4	12.9
34	31.3	13.3
Dist.	Dep.	Lat.

67 Deg.

Dist.	23 Deg. Lat.	Dep.
35	32.2	13.7
36	33.1	14.1
37	34.0	14.4
38	35.0	14.8
39	35.9	15.2
40	36.8	15.6
41	37.7	16.0
42	38.6	16.4
43	39.6	16.8
44	40.5	17.2
45	41.4	17.6
46	42.3	18.0
47	43.3	18.4
48	44.2	18.7
49	45.1	19.1
50	46.0	19.5
51	46.9	19.9
52	47.9	20.3
53	48.8	20.7
54	49.7	21.1
55	50.6	21.5
56	51.5	21.9
57	52.4	22.3
58	53.4	22.6
59	54.3	23.0
60	55.2	23.4
61	56.1	23.8
62	57.1	24.2
63	58.0	24.6
64	58.9	25.0
65	59.8	25.4
66	60.8	25.8
67	61.7	26.2
68	62.6	26.6
Dist.	Dep.	Lat.

67 Deg.

Dist.	23 Deg. Lat.	Dep.
69	63.5	26.9
70	64.4	27.3
71	65.3	27.7
72	66.3	28.1
73	67.2	28.5
74	68.1	28.9
75	69.0	29.3
76	69.9	29.7
77	70.9	30.1
78	71.8	30.5
79	72.7	30.8
80	73.6	31.2
81	74.6	31.6
82	75.5	32.0
83	76.4	32.4
84	77.3	32.8
85	78.2	33.2
86	79.2	33.6
87	80.1	34.0
88	81.0	34.4
89	81.9	34.8
90	82.8	35.2
91	83.8	35.6
92	84.7	36.0
93	85.6	36.3
94	86.5	36.7
95	87.4	37.0
96	88.4	37.5
97	89.3	37.9
98	90.2	38.3
99	91.1	38.7
100	92.0	39.1
200	184.1	78.1
300	276.1	117.2
Dist.	Dep.	Lat.

67 Deg.

Dist.	24 Deg. Lat.	Dep.
1	.9	.4
2	1.8	.8
3	2.7	1.2
4	3.6	1.6
5	4.6	2.0
6	5.5	2.4
7	6.4	2.8
8	7.3	3.2
9	8.2	3.7
10	9.1	4.1
11	10.0	4.5
12	10.9	4.9
13	11.9	5.3
14	12.8	5.7
15	13.7	6.1
16	14.6	6.5
17	15.5	6.9
18	16.4	7.3
19	17.3	7.7
20	18.3	8.1
21	19.2	8.5
22	20.1	9.0
23	21.0	9.4
24	21.9	9.8
25	22.8	10.2
26	23.7	10.6
27	24.6	11.0
28	25.6	11.3
29	26.5	11.7
30	27.4	12.2
31	28.3	12.6
32	29.2	13.0
33	30.1	13.4
34	31.0	13.8
Dist.	Dep.	Lat.

66 Deg.

Dist.	24 Deg. Lat.	Dep.
35	32.0	14.2
36	32.9	14.6
37	33.8	15.1
38	34.7	15.5
39	35.6	15.9
40	36.5	16.3
41	37.4	16.7
42	38.4	17.1
43	39.3	17.5
44	40.2	17.9
45	41.1	18.3
46	42.0	18.7
47	42.9	19.1
48	43.8	19.5
49	44.8	19.9
50	45.7	20.3
51	46.6	20.7
52	47.5	21.1
53	48.4	21.6
54	49.3	22.0
55	50.2	22.4
56	51.1	22.8
57	52.1	23.2
58	53.0	23.6
59	53.9	24.0
60	54.8	24.4
61	55.7	24.8
62	56.6	25.2
63	57.5	25.6
64	58.5	26.0
65	59.4	26.4
66	60.3	26.8
67	61.2	27.2
68	62.1	27.6
Dist.	Dep.	Lat.

66 Deg.

Dist.	24 Deg. Lat.	Dep.
69	63.0	28.1
70	63.9	28.5
71	64.8	28.9
72	65.8	29.3
73	66.7	29.7
74	67.6	30.1
75	68.5	30.5
76	69.4	30.9
77	70.3	31.3
78	71.2	31.7
79	72.1	32.1
80	73.1	32.5
81	74.0	32.9
82	74.9	33.3
83	75.8	33.7
84	76.7	34.1
85	77.6	34.5
86	78.5	34.9
87	79.5	35.3
88	80.4	35.7
89	81.3	36.2
90	82.2	36.6
91	83.1	37.0
92	84.0	37.4
93	84.9	37.8
94	85.8	38.2
95	86.8	38.6
96	87.7	39.0
97	88.6	39.3
98	89.5	39.9
99	90.4	40.3
100	91.3	40.7
200	182.7	81.3
300	274.0	122.0
Dist.	Dep.	Lat.

66 Deg.

Dist.	25 Deg. Lat.	Dep.
1	.9	.4
2	1.8	.8
3	2.7	1.3
4	3.6	1.7
5	4.5	2.1
6	5.4	2.5
7	6.3	3.0
8	7.2	3.4
9	8.1	3.8
10	9.1	4.2
11	10.0	4.7
12	10.9	5.1
13	11.8	5.5
14	12.7	5.9
15	13.6	6.3
16	14.5	6.8
17	15.4	7.2
18	16.3	7.6
19	17.2	8.0
20	18.1	8.4
21	19.0	8.9
22	19.9	9.3
23	20.8	9.7
24	21.8	10.1
25	22.7	10.6
26	23.6	11.0
27	24.5	11.4
28	25.4	11.8
29	26.3	12.3
30	27.2	12.7
31	28.1	13.1
32	29.0	13.5
33	29.9	14.0
34	30.8	14.4
Dist.	Dep.	Lat.
	65 Deg.	

Dist.	25 Deg. Lat.	Dep.
35	31.7	14.8
36	32.6	15.2
37	33.5	15.6
38	34.4	16.1
39	35.3	16.5
40	36.2	16.9
41	37.2	17.3
42	38.1	17.8
43	39.0	18.2
44	39.9	18.6
45	40.8	19.0
46	41.7	19.5
47	42.6	19.9
48	43.5	20.3
49	44.4	20.7
50	45.3	21.1
51	46.2	21.6
52	47.1	22.0
53	48.0	22.4
54	48.9	22.8
55	49.8	23.2
56	50.7	23.7
57	51.6	24.1
58	52.6	24.5
59	53.5	25.0
60	54.4	25.4
61	55.3	25.8
62	56.2	26.2
63	57.1	26.7
64	58.0	27.1
65	58.9	27.5
66	59.8	27.9
67	60.7	28.3
68	61.6	28.8
Dist.	Dep.	Lat.
	65 Deg.	

Dist.	25 Deg Lat.	Dep.
69	62.5	29.2
70	63.4	29.6
71	64.3	30.0
72	65.2	30.5
73	66.2	30.9
74	67.1	31.3
75	68.0	31.7
76	68.9	32.1
77	69.8	32.6
78	70.7	33.0
79	71.6	33.4
80	72.5	33.8
81	73.4	34.3
82	74.3	34.7
83	75.2	35.1
84	76.1	35.5
85	77.0	36.0
86	77.9	36.4
87	78.8	36.8
88	79.7	37.2
89	80.7	37.6
90	81.6	38.0
91	82.5	38.4
92	83.4	38.9
93	84.3	39.3
94	85.2	39.7
95	86.1	40.1
96	87.0	40.6
97	87.9	41.0
98	88.8	41.4
99	89.7	41.8
100	90.6	42.3
200	181.3	84.5
300	271.9	126.8
Dist.	Dep.	Lat.
	65 Deg.	

Dist.	26 Deg. Lat.	Dep.
1	.9	.4
2	1.8	.9
3	2.7	1.3
4	3.6	1.8
5	4.5	2.2
6	5.4	2.6
7	6.3	3.1
8	7.2	3.5
9	8.1	3.9
10	9.0	4.4
11	9.9	4.8
12	10.8	5.3
13	11.7	5.7
14	12.6	6.1
15	13.5	6.6
16	14.4	7.0
17	15.3	7.4
18	16.2	7.9
19	17.1	8.3
20	18.0	8.8
21	18.9	9.2
22	19.8	9.6
23	20.7	10.1
24	21.6	10.5
25	22.5	10.9
26	23.4	11.4
27	24.3	11.8
28	25.2	12.3
29	26.1	12.7
30	27.0	13.1
31	27.9	13.6
32	28.8	14.0
33	29.7	14.4
34	30.6	14.9
Dist.	Dep.	Lat.

64 Deg.

Dist.	26 Deg. Lat.	Dep.
35	31.5	15.3
36	32.4	15.8
37	33.3	16.2
38	34.2	16.6
39	35.1	17.1
40	36.0	17.5
41	36.8	17.9
42	37.7	18.4
43	38.6	18.8
44	39.5	19.3
45	40.4	19.7
46	41.3	20.2
47	42.2	20.6
48	43.1	21.0
49	44.0	21.4
50	44.9	21.9
51	45.8	22.3
52	46.7	22.8
53	47.6	23.2
54	48.5	23.7
55	49.4	24.1
56	50.3	24.5
57	51.2	25.0
58	52.1	25.4
59	53.0	25.8
60	53.9	26.3
61	54.8	26.7
62	55.7	27.2
63	56.6	27.6
64	57.5	28.0
65	58.4	28.5
66	59.3	28.9
67	60.2	29.4
68	61.1	29.8
Dist.	Dep.	Lat.

64 Deg.

Dist.	26 Deg. Lat.	Dep.
69	62.0	30.2
70	62.9	30.7
71	63.8	31.1
72	64.7	31.6
73	65.6	32.0
74	66.5	32.4
75	67.4	32.9
76	68.3	33.3
77	69.2	33.8
78	70.1	34.2
79	71.0	34.6
80	71.9	35.1
81	72.8	35.5
82	73.7	35.9
83	74.6	36.4
84	75.5	36.8
85	76.4	37.2
86	77.3	37.7
87	78.2	38.1
88	79.1	38.5
89	80.0	39.0
90	80.9	39.4
91	81.8	39.9
92	82.7	40.3
93	83.6	40.7
94	84.5	41.2
95	85.4	41.6
96	86.3	42.1
97	87.2	42.5
98	88.1	42.9
99	89.0	43.4
100	89.9	43.8
200	179.8	87
300	269.6	31
Dist.	Dep.	La

64 Deg.

Diff.	27 Deg. Lat.	Dep.
1	.9	.5
2	1.8	.9
3	2.7	1.4
4	3.6	1.8
5	4.5	2.3
6	5.3	2.7
7	6.2	3.2
8	7.1	3.6
9	8.0	4.1
10	8.9	4.5
11	9.8	5.0
12	10.7	5.4
13	11.6	5.9
14	12.5	6.3
15	13.4	6.8
16	14.3	7.2
17	15.1	7.7
18	16.0	8.2
19	16.9	8.6
20	17.8	9.1
21	18.7	9.5
22	19.6	10.0
23	20.5	10.4
24	21.4	10.9
25	22.3	11.3
26	23.2	11.8
27	24.1	12.2
28	24.9	12.7
29	25.8	13.2
30	26.7	13.6
31	27.6	14.1
32	28.5	14.5
33	29.4	15.0
34	30.3	15.4
Diff.	Dep.	Lat.

63 Deg.

Diff.	27 Deg. Lat.	Dep.
35	31.2	15.9
36	32.1	16.3
37	33.0	16.8
38	33.8	17.2
39	34.7	17.7
40	35.6	18.2
41	36.5	18.6
42	37.4	19 1
43	38.3	19.5
44	39.2	20.0
45	40.1	20.4
46	41.0	20 9
47	41.9	21.3
48	42.8	21.8
49	43.6	22.2
50	44.5	22.7
51	45.4	23.2
52	46.3	23.6
53	47.2	24.1
54	48.1	24 5
55	49.0	25.0
56	49.9	25.4
57	50.8	25 9
58	51.7	26 3
59	52.6	26.8
60	53.5	27.2
61	54.3	27.7
62	55.2	28.2
63	56.1	28.6
64	57.0	29.1
65	57.9	29 5
66	58.8	30.0
67	59.7	30 4
68	60.6	30.9
Diff.	Dep.	Lat.

63 Deg.

Diff.	27 Deg. Lat.	Dep.
69	61.5	31.3
70	62.4	31.8
71	63.3	32.2
72	64.1	32.7
73	65.0	33.2
74	65.9	33.6
75	66.8	34.1
76	67.7	34.5
77	68.6	35.0
78	69.5	35.4
79	70.4	35.9
80	71.3	36.3
81	72.2	36.8
82	73.1	37 2
83	73.9	37.7
84	74.8	38.1
85	75.7	38.6
86	76.6	39.0
87	77.5	39.5
88	78.4	40.0
89	79.3	40.4
90	80.2	40.9
91	81.1	41.3
92	82.0	41.8
93	82.9	42.2
94	83.7	42.7
95	84.6	43.1
96	85.5	43.6
97	86.4	44.0
98	87.3	44.5
99	88.2	44.9
100	89.1	45.4
200	178.2	90.9
300	267.3	136.3
Diff.	Dep.	Lat.

63 Deg.

Dist.	28 Deg. Lat.	Dep.
1	.9	.5
2	1.8	.9
3	2.6	1.4
4	3.5	1.9
5	4.4	2.3
6	5.3	2.8
7	6.2	3.3
8	7.1	3.7
9	7.9	4.2
10	8.8	4.7
11	9.7	5.2
12	10.6	5.6
13	11.5	6.1
14	12.4	6.6
15	13.2	7.0
16	14.1	7.5
17	15.0	8.0
18	15.9	8.4
19	16.8	8.9
20	17.7	9.4
21	18.5	9.9
22	19.4	10.3
23	20.3	10.8
24	21.2	11.3
25	22.1	11.7
26	23.0	12.2
27	23.8	12.7
28	24.7	13.1
29	25.6	13.6
30	26.5	14.1
31	27.4	14.5
32	28.2	15.0
33	29.1	15.5
34	30.0	16.0
Dist.	Dep.	Lat.
	62 Deg.	

Dist.	28 Deg. Lat.	Dep.
35	30.9	16.4
36	31.8	16.9
37	32.6	17.4
38	33.5	17.8
39	34.4	18.3
40	35.3	18.8
41	36.2	19.2
42	37.1	19.7
43	38.0	20.2
44	38.8	20.7
45	39.7	21.1
46	40.6	21.6
47	41.5	22.1
48	42.4	22.5
49	43.2	23.0
50	44.1	23.5
51	45.0	23.9
52	45.9	24.4
53	46.8	24.9
54	47.7	25.4
55	48.5	25.8
56	49.4	26.3
57	50.3	26.8
58	51.2	27.2
59	52.1	27.7
60	53.0	28.2
61	53.8	28.6
62	54.7	29.1
63	55.6	29.6
64	56.5	30.0
65	57.4	30.5
66	58.3	31.0
67	59.1	31.5
68	60.0	31.9
Dist.	Dep.	Lat.
	62 Deg.	

Dist.	28 Deg. Lat.	Dep.
69	60.9	32.4
70	61.8	32.9
71	62.7	33.3
72	63.6	33.8
73	64.4	34.3
74	65.3	34.7
75	66.2	35.2
76	67.1	35.7
77	68.0	36.1
78	68.9	36.6
79	69.7	37.1
80	70.6	37.6
81	71.5	38.0
82	72.4	38.5
83	73.3	39.0
84	74.2	39.4
85	75.0	39.9
86	75.9	40.4
87	76.8	40.8
88	77.7	41.3
89	78.6	41.8
90	79.5	42.2
91	80.3	42.7
92	81.2	43.2
93	82.1	43.7
94	83.0	44.1
95	83 9	44.6
96	84.8	45.1
97	85.6	45 5
98	86.5	46.0
99	87.4	46.5
100	88.3	46.9
200	176.6	93.9
300	264.9	140.8
Dist.	Dep.	Lat.
	62 Deg.	

Dist.	29 Deg. Lat.	Dep.
1	.9	.5
2	1.7	1.0
3	2.6	1.4
4	3.5	1.9
5	4.4	2.4
6	5.2	2.9
7	6.1	3.4
8	7.0	3.9
9	7.9	4.3
10	8.7	4.8
11	9.6	5.3
12	10.5	5.8
13	11.4	6.3
14	12.2	6.8
15	13.1	7.3
16	14.0	7.7
17	14.9	8.2
18	15.7	8.7
19	16.6	9.2
20	17.5	9.7
21	18.4	10.2
22	19.2	10.7
23	20.1	11.1
24	21.0	11.6
25	21.9	12.1
26	22.7	12.6
27	23.6	13.1
28	24.5	13.6
29	25.4	14.1
30	26.2	14.5
31	27.1	15.0
32	28.0	15.5
33	28.9	16.0
34	29.7	16.5
Dist.	Dep.	Lat.
	61 Deg.	

Dist.	29 Deg. Lat.	Dep.
35	30.6	17.0
36	31.5	17.4
37	32.4	17.9
38	33.2	18.4
39	34.1	18.9
40	35.0	19.4
41	35.9	19.9
42	36.7	20.3
43	37.6	20.8
44	38.5	21.3
45	39.4	21.8
46	40.2	22.3
47	41.1	22.8
48	42.0	23.3
49	42.9	23.7
50	43.7	24.2
51	44.6	24.7
52	45.5	25.2
53	46.4	25.7
54	47.2	26.2
55	48.1	26.7
56	49.0	27.1
57	49.9	27.6
58	50.7	28.1
59	51.6	28.6
60	52.5	29.1
61	53.4	29.6
62	54.2	30.1
63	55.1	30.5
64	56.0	31.0
65	56.9	31.5
66	57.7	32.0
67	58.6	32.5
68	59.5	33.0
Dist.	Dep.	Lat.
	61 Deg.	

Dist.	29 Deg. Lat.	Dep.
69	60.4	33.4
70	61.2	33.9
71	62.1	34.4
72	63.0	34.9
73	63.8	35.4
74	64.7	35.9
75	65.6	36.3
76	66.5	36.8
77	67.3	37.3
78	68.2	37.8
79	69.1	38.3
80	70.0	38.8
81	70.8	39.3
82	71.7	39.7
83	72.6	40.2
84	73.5	40.7
85	74.3	41.2
86	75.2	41.7
87	76.1	42.2
88	77.0	42.7
89	77.8	43.1
90	78.7	43.6
91	79.6	44.1
92	80.5	44.6
93	81.3	45.1
94	82.2	45.6
95	83.1	46.1
96	84.0	46.5
97	84.8	47.0
98	85.7	47.5
99	86.6	48.0
100	87.5	48.5
200	174.9	97.0
300	262.4	145.4
Dist.	Dep.	Lat.
	61 Deg.	

Dist.	30 Deg Lat.	Dep.
1	.9	.5
2	1.7	1.0
3	2.6	1.5
4	3.5	2.0
5	4.3	2.5
6	5.2	3.0
7	6.1	3.5
8	6.9	4.0
9	7.8	4.5
10	8.7	5.0
11	9.5	5.5
12	10.4	6.0
13	11 3	6.5
14	12.1	7.0
15	13 0	7.5
16	13.9	8.0
17	14.7	8.5
18	15.6	9.0
19	16.5	9.5
20	17.3	10.0
21	18.2	10.5
22	19.1	11.0
23	19.9	11 5
24	20.8	12 0
25	21.7	12.5
26	22.5	13.0
27	23.4	13.5
28	24.2	14.0
29	25.1	14.5
30	26.0	15.0
31	26.8	15.5
32	27.7	16.0
33	28.6	16 5
34	29.4	17.0
Dist.	Dep.	Lat.

60 Deg.

Dist.	30 Deg. Lat.	Dep.
35	30.3	17.5
36	31.2	18 0
37	32.0	18 5
38	32 9	19.0
39	33 8	19.5
40	34 6	20.0
41	35.5	20.5
42	36.4	21.0
43	37 2	21.5
44	38 1	22.0
45	39.0	22.5
46	39.8	23.0
47	40.7	23.5
48	41.6	24.0
49	42.4	24.5
50	43.3	25 0
51	44.2	25.5
52	45.0	26.0
53	45 9	26.5
54	46.8	27 0
55	47.6	27.5
56	48.5	28.0
57	49.4	28.5
58	50.2	29 0
59	51.1	29.5
60	52.0	30 0
61	52 8	30 5
62	53.7	31.0
63	54 6	31.5
64	55.4	32.0
65	56.3	32.5
66	57.2	33.0
67	58.0	33.5
68	58.9	34.0
Dist.	Dep.	Lat.

60 Deg.

Dist.	30 Deg. Lat.	Dep.
69	59 8	34.5
70	60.6	35.0
71	61.5	35.5
72	62 3	36.0
73	63 2	36.5
74	64.1	37.0
75	64 9	37.5
76	65.8	38.0
77	66.7	38.5
78	67 6	39.0
79	68.4	39.5
80	69.3	40.0
81	70.2	40.5
82	71.0	41.0
83	71.9	41.5
84	72.7	42.0
85	73.6	42.5
86	74 5	43.0
87	75 3	43.5
88	76.2	44.0
89	77.1	44.5
90	77.9	45.0
91	78.8	45.5
92	79 7	46.0
93	80.6	46.5
94	81.4	47.0
95	82.3	47.5
96	83 2	48.0
97	84 0	48.5
98	84 9	49.0
99	85.7	49.5
100	86.6	50.0
200	173 2	100.5
300	259.8	150.0
Dist.	Dep.	Lat.

60 Deg.

Dist.	31 Deg. Lat.	31 Deg. Dep.
1	.9	.5
2	1.7	1.0
3	2.6	1.5
4	3.4	2.1
5	4.3	2.6
6	5.1	3.1
7	6.0	3.6
8	6.9	4.1
9	7.7	4.6
10	8.6	5.1
11	9.4	5.7
12	10.3	6.2
13	11.1	6.7
14	12.0	7.2
15	12.9	7.7
16	13.7	8.2
17	14.6	8.8
18	15.4	9.3
19	16.3	9.8
20	17.1	10.3
21	18.0	10.8
22	18.9	11.3
23	19.7	11.8
24	20.6	12.4
25	21.4	12.9
26	22.3	13.4
27	23.1	13.9
28	24.0	14.4
29	24.9	14.9
30	25.7	15.4
31	26.6	16.0
32	27.4	16.5
33	28.3	17.0
34	29.2	17.5
Dist.	Dep.	Lat.
	59 Deg.	

Dist.	31 Deg. Lat.	31 Deg. Dep.
35	30.0	18.0
36	30.9	18.5
37	31.7	19.1
38	32.6	19.6
39	33.4	20.1
40	34.3	20.6
41	35.1	21.1
42	36.0	21.6
43	36.9	22.1
44	37.7	22.7
45	38.6	23.2
46	39.4	23.7
47	40.3	24.2
48	41.1	24.7
49	42.0	25.2
50	42.9	25.7
51	43.7	26.3
52	44.6	26.8
53	45.4	27.3
54	46.3	27.8
55	47.1	28.3
56	48.0	28.8
57	48.9	29.4
58	49.7	29.9
59	50.6	30.4
60	51.4	30.9
61	52.3	31.4
62	53.1	31.9
63	54.0	32.4
64	54.9	33.0
65	55.7	33.5
66	56.6	34.0
67	57.4	34.5
68	58.3	35.0
Dist.	Dep.	Lat.
	59 Deg.	

Dist.	31 Deg. Lat.	31 Deg. Dep.
69	59.1	35.5
70	60.0	36.0
71	60.9	36.6
72	61.7	37.1
73	62.6	37.6
74	63.4	38.1
75	64.3	38.6
76	65.1	39.1
77	66.0	39.7
78	66.9	40.2
79	67.7	40.7
80	68.6	41.2
81	69.4	41.7
82	70.3	42.2
83	71.1	42.7
84	72.0	43.3
85	72.9	43.8
86	73.7	44.3
87	74.6	44.8
88	75.4	45.3
89	76.3	45.8
90	77.1	46.3
91	78.0	46.9
92	78.9	47.4
93	79.7	47.9
94	80.6	48.4
95	81.4	48.9
96	82.3	49.4
97	83.1	50.0
98	84.0	50.5
99	84.9	51.0
100	85.8	51.5
200	171.4	103.0
300	257.2	154.5
Dist.	Dep.	Lat.
	59 Deg.	

Dist.	34 Deg. Lat.	Dep.
1	.8	.6
2	1.7	1.1
3	2.5	1.7
4	3.3	2.2
5	4.1	2.8
6	5.0	3.4
7	5.8	3.9
8	6.6	4.5
9	7.5	5.0
10	8.3	5.6
11	9.1	6.1
12	9.9	6.7
13	10.8	7.3
14	11.6	7.8
15	12.4	8.4
16	13.3	8.9
17	14.1	9.5
18	14.9	10.1
19	15.8	10.6
20	16.6	11.2
21	17.4	11.7
22	18.2	12.3
23	19.1	12.9
24	19.9	13.4
25	20.7	14.0
26	21.6	14.5
27	22.4	15.1
28	23.2	15.7
29	24.0	16.2
30	24.9	16.8
31	25.7	17.3
32	26.5	17.9
33	27.4	18.4
34	28.2	19.0
Dist.	Dep.	Lat.
	56 Deg.	

Dist.	34 Deg. Lat.	Dep.
35	29 0	19 6
36	29.8	20.1
37	30.7	20 7
38	31.5	21.2
39	32.3	21.8
40	33.2	22.4
41	34.0	22.9
42	34.8	23.5
43	35.6	24.0
44	36.5	24.6
45	37.3	25.1
46	38.1	25.7
47	39.0	26.3
48	39.8	26.8
49	40.6	27.4
50	41.4	28.0
51	42.3	28.5
52	43.1	29.1
53	43.9	29.6
54	44.8	30.2
55	45.6	30.7
56	46.4	31.3
57	47.3	31.9
58	48.1	32.4
59	48.9	33.0
60	49.7	33.5
61	50.6	34.1
62	51.4	34.6
63	52.2	35.2
64	53.0	35.8
65	53.9	36.3
66	54.7	36.9
67	55.5	37.4
68	56.4	38.0
Dist.	Dep.	Lat.
	56 Deg.	

Dist.	34 Deg. Lat.	Dep.
69	57.2	38.6
70	58.0	39.1
71	58.8	39.7
72	59.7	40.3
73	60.5	40.8
74	61.3	41.4
75	62.2	41.9
76	63.0	42.5
77	63.8	43.1
78	64.7	43.6
79	65.5	44.2
80	66.3	44.7
81	67.1	45.3
82	68.0	45.8
83	68.8	46.4
84	69.6	47 0
85	70.5	47.5
86	71.3	48.1
87	72.1	48.6
88	72.9	49.2
89	73.8	49.8
90	74.6	50.3
91	75.4	50.9
92	76.3	51.4
93	77.1	52.0
94	77.9	52.6
95	78.8	53.1
96	79.6	53.7
97	80.4	54.2
98	81.2	54.8
99	82.1	55.4
100	82.9	55.9
200	165.8	111.8
300	248.7	167.8
Dist.	Dep.	Lat.
	56 Deg.	

Dist.	35 Deg. Lat.	Dep.
1	.8	.6
2	1.7	1.1
3	2.5	1.7
4	3.3	2.3
5	4.1	2.9
6	4.9	3.4
7	5.7	4.0
8	6.6	4.6
9	7.4	5.2
10	8.2	5.7
11	9.0	6.3
12	9.8	6.9
13	10.6	7.5
14	11.5	8.0
15	12.3	8.6
16	13.1	9.2
17	13.9	9.8
18	14.7	10.3
19	15.6	10.9
20	16.4	11.5
21	17.2	12.0
22	18.0	12.6
23	18.8	13.2
24	19.6	13.8
25	20.5	14.3
26	21.3	14.9
27	22.1	15.5
28	22.9	16.1
29	23.7	16.6
30	24.6	17.2
31	25.4	17.8
32	26.2	18.4
33	27.0	18.9
34	27.8	19.5
Dist.	Dep.	Lat.

55 Deg.

Dist.	35 Deg. Lat.	Dep.
35	28.6	20.1
36	29.5	20.6
37	30.3	21.2
38	31.1	21.8
39	31.9	22.4
40	32.8	22.9
41	33.6	23.5
42	34.4	24.1
43	35.2	24.6
44	36.0	25.2
45	36.8	25.8
46	37.7	26.4
47	38.5	27.0
48	39.3	27.5
49	40.1	28.1
50	41.0	28.7
51	41.8	29.2
52	42.6	29.8
53	43.4	30.4
54	44.2	31.0
55	45.1	31.5
56	45.9	32.1
57	46.7	32.7
58	47.5	33.3
59	48.3	33.8
60	49.1	34.4
61	50.0	35.0
62	50.8	35.6
63	51.6	36.1
64	52.4	36.7
65	53.3	37.3
66	54.1	37.9
67	54.9	38.4
68	55.7	39.0
Dist.	Dep.	Lat.

55 Deg.

Dist.	35 Deg. Lat.	Dep.
69	56.5	39.6
70	57.3	40.2
71	58.2	40.7
72	59.0	41.3
73	59.8	41.9
74	60.6	42.5
75	61.5	43.0
76	62.3	43.6
77	63.1	44.2
78	63.9	44.8
79	64.7	45.3
80	65.5	45.9
81	66.4	46.5
82	67.2	47.0
83	68.0	47.6
84	68.8	48.2
85	69.6	48.8
86	70.5	49.3
87	71.3	49.9
88	72.1	50.5
89	72.9	51.1
90	73.7	51.6
91	74.6	52.2
92	75.4	52.8
93	76.2	53.4
94	77.0	53.9
95	77.8	54.5
96	78.6	55.1
97	79.5	55.6
98	80.3	56.2
99	81.1	56.8
100	81.9	57.4
200	163.8	114.7
300	245.8	172.1
Dist.	Dep.	Lat.

55 Deg.

Dist.
1
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34
Dist.

Dist.	32 Deg. Lat.	Dep.
1	.8	.5
2	1.7	1.1
3	2.5	1.6
4	3.4	2.1
5	4.2	2.6
6	5.1	3.2
7	5.9	3.7
8	6.8	4.2
9	7.6	4.8
10	8.5	5.3
11	9.3	5.8
12	10.2	6.4
13	11.0	6.9
14	11.9	7.4
15	12.7	7.9
16	13.6	8.5
17	14.4	9.0
18	15.3	9.5
19	16.1	10.1
20	17.0	10.6
21	17.8	11.1
22	18.7	11.7
23	19.5	12.2
24	20.4	12.7
25	21.2	13.2
26	22.0	13.8
27	22.9	14.3
28	23.7	14.8
29	24.6	15.3
30	25.4	15.9
31	26.3	16.4
32	27.1	17.0
33	28.0	17.5
34	28.8	18.0
Dist.	Dep.	Lat.

58 Deg.

Dist.	32 Deg. Lat.	Dep.
35	29.7	18.5
36	30.5	19.1
37	31.4	19.6
38	32.2	20.1
39	33.1	20.7
40	33.9	21.2
41	34.8	21.7
42	35.6	22.3
43	36.5	22.8
44	37.3	23.3
45	38.2	23.8
46	39.0	24.4
47	39.8	24.9
48	40.7	25.4
49	41.5	26.0
50	42.4	26.5
51	43.2	27.0
52	44.1	27.5
53	44.9	28.1
54	45.8	28.6
55	46.6	29.1
56	47.5	29.7
57	48.3	30.2
58	49.2	30.7
59	50.0	31.3
60	50.9	31.8
61	51.7	32.3
62	52.6	32.9
63	53.4	33.4
64	54.3	33.9
65	55.1	34.4
66	56.0	35.0
67	56.8	35.5
68	57.7	36.0
Dist.	Dep.	Lat.

58 Deg.

Dist.	32 Deg. Lat.	Dep.
69	58.5	36.6
70	59.4	37.1
71	60.2	37.6
72	61.0	38.1
73	61.9	38.7
74	62.7	39.2
75	63.6	39.7
76	64.4	40.3
77	65.3	40.8
78	66.1	41.3
79	67.0	41.9
80	67.8	42.4
81	68.7	42.9
82	69.5	43.4
83	70.3	44.0
84	71.2	44.5
85	72.1	45.0
86	72.9	45.6
87	73.8	46.1
88	74.6	46.6
89	75.5	47.2
90	76.3	47.7
91	77.2	48.2
92	78.0	48.7
93	78.8	49.3
94	79.7	49.8
95	80.5	50.3
96	81.4	50.9
97	82.2	51.4
98	83.1	51.9
99	83.9	52.4
100	84.8	53.0
200	169.6	106.0
300	254.4	159.0
Dist.	Dep.	Lat.

58 Deg.

Dist.	33 Deg. Lat.	Dep.
1	.8	.5
2	1.7	1.1
3	2.5	1.6
4	3.4	2.2
5	4.2	2.7
6	5.0	3.3
7	5.9	3.8
8	6.7	4.4
9	7.6	4.9
10	8.4	5.4
11	9.2	6.0
12	10.1	6.5
13	10.9	7.1
14	11.7	7.6
15	12.6	8.2
16	13.4	8.7
17	14.3	9.3
18	15.1	9.8
19	15.9	10.4
20	16.8	10.9
21	17.6	11.4
22	18.5	12.0
23	19.3	12.5
24	20.1	13.1
25	21.0	13.6
26	21.8	14.2
27	22.7	14.7
28	23.5	15.3
29	24.3	15.8
30	25.2	16.3
31	26.0	16.9
32	26.9	17.9
33	27.7	18.0
34	28.5	18.5
Dist.	Dep.	Lat.

57 Deg.

Dist.	33 Deg. Lat.	Dep.
35	29.4	19.1
36	30.2	19.6
37	31.1	20.2
38	31.9	20.7
39	32.7	21.2
40	33.5	21.8
41	34.4	22.3
42	35.2	22.9
43	36.1	23.4
44	36.9	24.0
45	37.7	24.5
46	38.6	25.1
47	39.4	25.6
48	40.3	26.2
49	41.1	26.7
50	41.9	27.2
51	42.8	27.8
52	43.6	28.3
53	44.5	28.8
54	45.3	29.4
55	46.1	30.0
56	47.0	30.5
57	47.8	31.0
58	48.7	31.6
59	49.5	32.1
60	50.3	32.7
61	51.2	33.2
62	52.0	33.8
63	52.9	34.3
64	53.7	34.8
65	54.5	35.4
66	55.4	35.9
67	56.2	36.5
68	57.1	37.0
Dist.	Dep.	Lat.

57 Deg.

Dist.	33 Deg. Lat.	Dep.
69	57.9	37.6
70	58.7	38.1
71	59.6	38.6
72	60.4	39.2
73	61.2	39.7
74	62.1	40.3
75	62.9	40.8
76	63.7	41.4
77	64.6	41.9
78	65.4	42.5
79	66.3	43.0
80	67.1	43.6
81	67.9	44.1
82	68.8	44.6
83	69.6	45.2
84	70.5	45.7
85	71.3	46.2
86	72.1	46.8
87	73.0	47.3
88	73.8	47.9
89	74.7	48.4
90	75.5	49.0
91	76.3	49.5
92	77.2	50.1
93	78.0	50.6
94	78.9	51.2
95	79.7	51.7
96	80.5	52.2
97	81.4	52.8
98	82.2	53.3
99	83.1	53.9
100	83.9	54.5
200	167.7	108.9
300	251.6	163.4
Dist.	Dep.	Lat.

57 Deg.

Dist.	38 Deg. Lat.	Dep.
1	.8	.6
2	1.6	1.2
3	2.4	1.8
4	3.1	2.5
5	3.9	3.1
6	4.7	3.7
7	5.5	4.3
8	6.3	4.9
9	7.1	5.5
10	7.9	6.2
11	8.7	6.8
12	9.5	7.4
13	10.2	8.0
14	11.0	8.6
15	11.8	9.2
16	12.6	9.9
17	13.4	10.5
18	14.2	11.1
19	15.0	11.7
20	15.8	12.3
21	16.6	12.9
22	17.3	13.6
23	18.1	14.2
24	18.9	14.8
25	19.7	15.4
26	20.5	16.0
27	21.3	16.6
28	22.1	17.2
29	22.9	17.9
30	23.6	18.5
31	24.4	19.1
32	25.2	19.7
33	26.0	20.2
34	26.8	20.8
Dist.	Dep.	Lat.
	52 Deg.	

Dist.	38 Deg. Lat.	Dep.
35	27.6	21.6
36	28.4	22.2
37	29.2	22.8
38	29.9	23.4
39	30.7	24.0
40	31.5	24.6
41	32.3	25.2
42	33.1	25.9
43	33.9	26.5
44	34.7	27.1
45	35.5	27.7
46	36.2	28.3
47	37.0	28.9
48	37.8	29.6
49	38.6	30.2
50	39.4	30.8
51	40.2	31.4
52	41.0	32.0
53	41.8	32.6
54	42.6	33.2
55	43.3	33.9
56	44.1	34.5
57	44.9	35.1
58	45.7	35.7
59	46.5	36.3
60	47.3	36.9
61	48.1	37.6
62	48.9	38.2
63	49.6	38.8
64	50.4	39.4
65	51.2	40.0
66	52.0	40.6
67	52.8	41.2
68	53.6	41.9
Dist.	Dep.	Lat.
	52 Deg.	

Dist.	38 Deg. Lat.	Dep.
69	54.4	42.5
70	55.2	43.1
71	55.9	43.7
72	56.7	44.3
73	57.5	45.0
74	58.3	45.6
75	59.1	46.2
76	59.9	46.8
77	60.7	47.4
78	61.5	48.0
79	62.2	48.6
80	63.0	49.3
81	63.8	49.9
82	64.6	50.5
83	65.4	51.1
84	66.2	51.7
85	67.0	52.3
86	67.8	53.0
87	68.6	53.6
88	69.3	54.2
89	70.1	54.8
90	70.9	55.4
91	71.7	56.0
92	72.5	56.6
93	73.3	57.3
94	74.1	57.9
95	74.9	58.5
96	75.6	59.1
97	76.4	59.7
98	77.2	60.3
99	78.0	61.0
100	78.8	61.6
200	157.6	123.1
300	236.4	184.7
Dist.	Dep.	Lat.
	52 Deg.	

Dist.	39 Deg. Lat.	Dep.
1	.8	.6
2	1.6	1.3
3	2 3	1.9
4	3.1	2.5
5	3.9	3.1
6	4.7	3.8
7	5.4	4.4
8	6.2	5.0
9	7.0	5.7
10	7.8	6 3
11	8.5	6.9
12	9.3	7.5
13	10.1	8.2
14	10.9	8.8
15	11.6	9.4
16	12.4	10.1
17	13.2	10.7
18	14.0	11.3
19	14.8	11.9
20	15.5	12 6
21	16.3	13.2
22	17.1	13.8
23	17.9	14.5
24	18.6	15.1
25	19.4	15.7
26	20.2	16.4
27	21.0	17.0
28	21.7	17 6
29	22.5	18.2
30	23.3	18.9
31	24.1	19.5
32	24.9	20.1
33	25.6	20.8
34	26.4	21.4
Dist.	Dep.	Lat.

51 Deg.

Dist.	39 Deg. Lat.	Dep.
35	27.2	22 0
36	28.0	22 6
37	28 7	23.3
38	29 5	23 9
39	30.3	24.5
40	31.1	25.2
41	31.8	25.8
42	32 6	26.4
43	33.4	27.1
44	34.2	27.7
45	35.0	28.3
46	35 7	28.9
47	36.5	29 6
48	37.3	30.2
49	38.1	30.8
50	38.8	31.5
51	39.6	32.1
52	40.4	32.7
53	41.2	33.4
54	41.9	34.0
55	42.7	34 6
56	43 5	35.2
57	44.3	35.9
58	45.1	36.5
59	45.8	37.1
60	46.6	37.8
61	47.4	38.4
62	48.2	39.0
63	48.9	39.6
64	49 7	40.3
65	50 5	40.9
66	51.3	41 5
67	52.1	42.2
68	52.8	42.8
Dist.	Dep.	Lat.

51 Deg.

Dist.	39 Deg. Lat.	Dep.
69	53.6	43 4
70	54.4	44.0
71	55.2	44.7
72	55.9	45.3
73	56.7	45.9
74	57.5	46.6
75	58.3	47.2
76	59.1	47.8
77	59.8	48.5
78	60.6	49.1
79	61.4	49.7
80	62.2	50.3
81	62.9	51.0
82	63.7	51.6
83	64 5	52.2
84	65.3	52.9
85	66.1	53.5
86	66 8	54.1
87	67.6	54.7
88	68.4	55.4
89	69 2	56.0
90	69.9	56.6
91	70.7	57.3
92	71.5	57.9
93	72.3	58.5
94	73.1	59.1
95	73.8	59.8
96	74.6	60.4
97	75.4	61.0
98	76.2	61.7
99	76.9	62.3
100	77.7	62.9
200	155.4	125.9
300	233.1	188.8
Dist.	Dep.	Lat.

51 Deg.

Dist.	36 Deg. Lat.	Dep.
1	.8	.6
2	1.6	1.2
3	2.4	1.8
4	3.2	2.3
5	4.0	2.9
6	4.8	3.5
7	5.7	4.1
8	6.5	4.7
9	7.2	5.3
10	8.1	5.9
11	8.9	6.5
12	9.7	7.0
13	10.5	7.6
14	11.3	8.2
15	12.1	8.8
16	12.9	9.4
17	13.8	10.0
18	14.6	10.6
19	15.4	11.2
20	16.2	11.8
21	17.0	12.3
22	17.8	12.9
23	18.6	13.5
24	19.4	14.1
25	20.2	14.7
26	21.0	15.3
27	21.8	15.9
28	22.6	16.4
29	23.5	17.0
30	24.3	17.6
31	25.1	18.2
32	25.9	18.8
33	26.7	19.4
34	27.5	20.0
Dist.	Dep.	Lat.

54 Deg.

Dist.	36 Deg. Lat.	Dep.
35	28.3	20.6
36	29.1	21.1
37	29.9	21.7
38	30.7	22.3
39	31.5	22.9
40	32.4	23.5
41	33.2	24.1
42	34.0	24.7
43	34.8	25.3
44	35.6	25.8
45	36.4	26.4
46	37.2	27.0
47	38.0	27.6
48	38.8	28.2
49	39.6	28.8
50	40.4	29.4
51	41.3	30.0
52	42.1	30.6
53	42.9	31.1
54	43.7	31.7
55	44.5	32.3
56	45.3	32.9
57	46.1	33.5
58	46.9	34.1
59	47.7	34.7
60	48.5	35.3
61	49.3	35.8
62	50.2	36.4
63	51.0	37.0
64	51.8	37.6
65	52.6	38.2
66	53.4	38.8
67	54.2	39.4
68	55.0	40.0
Dist.	Dep.	Lat.

54 Deg.

Dist.	36 Deg. Lat.	Dep.
69	55.8	40.6
70	56.6	41.1
71	57.4	41.7
72	58.2	42.3
73	59.0	42.9
74	59.9	43.5
75	60.7	44.1
76	61.5	44.7
77	62.3	45.3
78	63.1	45.8
79	63.9	46.4
80	64.7	47.0
81	65.5	47.6
82	66.3	48.8
83	67.1	48.2
84	68.0	49.4
85	68.8	50.0
86	69.6	50.6
87	70.4	51.1
88	71.2	51.7
89	72.0	52.3
90	72.8	52.9
91	73.6	53.5
92	74.4	54.1
93	75.2	54.7
94	76.0	55.3
95	76.8	55.8
96	77.7	56.4
97	78.5	57.0
98	79.3	57.6
99	80.1	58.2
100	80.9	58.8
200	161.8	117.6
300	242.7	176.3
Dist.	Dep.	Lat.

54 Deg.

Dist.	37 Deg. Lat.	Dep.
1	.8	.6
2	1.6	1.2
3	2.4	1.8
4	3.2	2.4
5	4.0	3.0
6	4.8	3.6
7	5.6	4.2
8	6.4	4.8
9	7.2	5.4
10	8.0	6.0
11	8.8	6.6
12	9.6	7.2
13	10.4	7.8
14	11.2	8.4
15	12.0	9.0
16	12.8	9.6
17	13.6	10.2
18	14.4	10.8
19	15.2	11.4
20	16.0	12.0
21	16.8	12.6
22	17.6	13.2
23	18.4	13.8
24	19.2	14.4
25	20.0	15.0
26	20.8	15.6
27	21.6	16.2
28	22.4	16.8
29	23.2	17.4
30	24.0	18.0
31	24.8	18.6
32	25.6	19.2
33	26.4	19.8
34	27.1	20.4
Dist.	Dep.	Lat.
	53 Deg.	

Dist.	37 Deg. Lat.	Dep.
35	27.9	21.0
36	28.7	21.6
37	29.5	22.2
38	30.3	22.8
39	31.1	23.4
40	31.9	24.1
41	32.7	24.7
42	33.5	25.3
43	34.3	25.9
44	35.1	26.5
45	35.9	27.1
46	36.7	27.7
47	37.5	28.3
48	38.3	28.9
49	39.1	29.5
50	39.9	30.1
51	40.7	30.7
52	41.5	31.3
53	42.3	31.9
54	43.1	32.5
55	43.9	33.1
56	44.7	33.7
57	45.5	34.3
58	46.3	34.9
59	47.1	35.5
60	47.9	36.1
61	48.7	36.7
62	49.5	37.3
63	50.3	37.9
64	51.1	38.5
65	51.9	39.1
66	52.7	39.7
67	53.5	40.3
68	54.3	40.9
Dist.	Dep.	Lat.
	53 Deg.	

Dist.	37 Deg. Lat.	Dep.
69	55.1	41.5
70	55.9	42.1
71	56.7	42.7
72	57.5	43.3
73	58.3	43.9
74	59.1	44.5
75	59.9	45.1
76	60.7	45.7
77	61.5	46.3
78	62.3	46.9
79	63.1	47.5
80	63.9	48.1
81	64.7	48.7
82	65.5	49.3
83	66.3	50.0
84	67.1	50.6
85	67.9	51.2
86	68.7	51.8
87	69.5	52.4
88	70.3	53.0
89	71.1	53.6
90	71.9	54.2
91	72.7	54.8
92	73.5	55.4
93	74.3	56.0
94	75.1	56.6
95	75.9	57.2
96	76.7	57.8
97	77.5	58.4
98	78.3	59.0
99	79.1	59.6
100	79.9	60.2
200	159.7	120.4
300	239.6	180.5
Dist.	Dep.	Lat.
	53 Deg.	

Dist.	40 Deg. Lat.	Dep.
1	.8	.6
2	1.5	1.3
3	2.3	1.9
4	3 1	2.6
5	3.8	3.2
6	4.6	3.8
7	5.4	4.5
8	6.1	5.1
9	6.9	5.8
10	7.7	6.4
11	8.4	7.1
12	9.2	7.7
13	10.0	8.3
14	10.7	9.0
15	11.5	9.6
16	12.3	10.3
17	13.0	10.9
18	13.8	11.6
19	14.6	12.2
20	15.3	12.9
21	16.1	13.5
22	16.9	14.1
23	17.6	14.8
24	18.4	15.4
25	19.2	16.1
26	19.9	16.7
27	20.7	17.3
28	21.4	18.0
29	22.2	18.6
30	23.0	19.3
31	23.7	19.9
32	24.5	20.6
33	25.3	21.2
34	26.0.	21.9
Dist.	Dep.	Lat.
	50 Deg.	

Dist.	40 Deg. Lat.	Dep.
35	26.8	22.5
36	27.6	23.1
37	28.3	23.8
38	29.1	24.4
39	29.9	25.1
40	30.6	25.7
41	31.4	26.3
42	32.2	27.0
43	32.9	27.6
44	33.7	28.3
45	34.5	28.9
46	35.2	29.6
47	36.0	30.2
48	36.8	30.9
49	37.5	31.5
50	38.3	32.1
51	39.1	32.8
52	39.8	33.4
53	40.6	34.1
54	41.4	34.7
55	42.1	35.3
56	42.9	36.0
57	43.7	36.6
58	44.4	37.3
59	45.2	37.9
60	46.0	38.6
61	46.7	39.2
62	47.5	39.9
63	48.3	40.5
64	49.0	41.1
65	49.8	41.8
66	50.6	42.4
67	51.3	43.1
68	52.1	43.7
Dist.	Dep.	Lat.
	50 Deg.	

Dist.	40 Deg. Lat.	Dep.
69	52.9	44.3
70	53.6	45.0
71	54.4	45.6
72	55.2	46.3
73	55.9	46.9
74	56.7	47.6
75	57.4	48.2
76	58.2	48.5
77	59.0	49.5
78	59.7	50.1
79	60.5	50.8
80	61.3	51.4
81	62.0	52.1
82	62.8	52.7
83	63.6	53.3
84	64.3	54.0
85	65.1	54.6
86	65.9	55.3
87	66.6	55.9
88	67.4	56.6
89	68.2	57.2
90	68.9	57.9
91	69.7	58.5
92	70.5	59.1
93	71.2	59.8
94	72.0	60.4
95	72.7	61.1
96	73.5	61.7
97	74.3	62.3
98	75.1	63.0
99	75.8	63.6
100	76.6	64.3
200	153.2	128.6
300	229.8	192.8
Dist.	Dep.	Lat.
	50 Deg.	

Diff.	41 Deg. Lat.	Dep.
1	.8	.7
2	1.5	1.3
3	2.3	2.0
4	3.0	2.6
5	3.8	3.3
6	4.5	3.9
7	5.3	4.6
8	6.0	5.2
9	6.8	5.9
10	7.5	6.6
11	8.3	7.2
12	9.1	7.9
13	9.8	8.5
14	10.6	9.2
15	11.3	9.8
16	12.1	10,5
17	12.8	11.2
18	13.6	11.8
19	14.3	12.5
20	15.1	13.1
21	15.9	13.8
22	16.6	14.4
23	17.4	15.1
24	18.1	15.7
25	18.9	16.4
26	19.6	17.1
27	20.4	17.7
28	21.1	18.4
29	21.9	19.0
30	22.6	19.7
31	23.4	20.3
32	24.1	21.0
33	24.9	21.6
34	25.7	22.3
Diff.	Dep.	Lat.
	49 Deg.	

Diff.	41 Deg. Lat.	Dep.
35	26.4	22.9
36	27.2	23.6
37	27.9	24.3
38	28.7	24.9
39	29.4	25.6
40	30.2	26.2
41	30.9	26.9
42	31.7	27.5
43	32.4	28.2
44	33.2	28.9
45	33.9	29.5
46	34.7	30.2
47	35.4	30.8
48	36.2	31.5
49	36.9	32.1
50	37.7	32.8
51	38.5	33.4
52	39.2	34.1
53	40.0	34.8
54	40.7	35.4
55	41.5	36.1
56	42.2	36.7
57	43.0	37.4
58	43.8	38.0
59	44.5	38.7
60	45.3	39.4
61	46.0	40.0
62	46.8	40.7
63	47.5	41.3
64	48.3	42.0
65	49.0	42.6
66	49.8	43.3
67	50.6	43.9
68	51.3	44.6
Diff.	Dep.	Lat.
	49 Deg.	

Diff.	41 Deg. Lat.	Dep.
69	52.1	45.2
70	52.8	45.9
71	53.6	46.6
72	54.3	47.2
73	55.1	47.8
74	55.8	48.5
75	56.6	49.2
76	57.4	49.8
77	58.1	50.5
78	58 9	51.2
79	59.6	51.8
80	60.4	52.5
81	61.1	53.1
82	61.9	53.8
83	62.6	54.4
84	63.4	55.1
85	64.1	55.7
86	64.9	56.4
87	65.6	57.1
88	66.4	57.7
89	67.1	58.4
90	67.9	59.0
91	68.7	59.7
92	69.4	60.3
93	70.2	61.0
94	70.9	61.6
95	71.7	62.3
96	72.4	62.9
97	73.2	63.6
98	73.9	64.3
99	74.7	64.9
100	75.5	65.6
200	150.9	131.2
300	226.4	196.8
Diff.	Dep.	Lat.
	49 Deg.	

Dist.	42 Deg. Lat.	Dep.
1	.7	.7
2	1.5	1.3
3	2.2	2.0
4	3.0	2.7
5	3.7	3.3
6	4.4	4.0
7	5.3	4.7
8	5.9	5.3
9	6.7	6.0
10	7.4	6.7
11	8.2	7.3
12	8.9	8.0
13	9.7	8.7
14	10.4	9.3
15	11.1	10.0
16	11.9	10.7
17	12.6	11.3
18	13.4	12.0
19	14.1	12.7
20	14.9	13.4
21	15.6	14.0
22	16.3	14.7
23	17.1	15.4
24	17.8	16.0
25	18.6	16.7
26	19.3	17.4
27	20.1	18.0
28	20.8	18.7
29	21.5	19.4
30	22.3	20.1
31	23.0	20.7
32	23.8	21.4
33	24.5	22.1
34	25.3	22.7
Dist.	Dep.	Lat.
	48 Deg.	

Dist.	42 Deg. Lat.	Dep.
35	26.0	23.4
36	26.7	24.1
37	27.5	24.7
38	28.2	25.4
39	29.0	26.1
40	29.7	26.8
41	30.4	27.4
42	31.2	28.1
43	31.9	28.7
44	32.7	29.4
45	33.4	30.1
46	34.2	30.8
47	34.9	31.4
48	35.7	32.1
49	36.4	32.8
50	37.2	33.5
51	37.9	34.1
52	38.6	34.8
53	39.4	35.4
54	40.1	36.1
55	40.9	36.8
56	41.6	37.5
57	42.3	38.1
58	43.1	38.8
59	43.8	39.4
60	44.6	40.1
61	45.3	40.8
62	46.1	41.5
63	46.8	42.1
64	47.5	42.8
65	48.3	43.5
66	49.0	44.2
67	49.8	44.8
68	50.5	45.5
Dist.	Dep.	Lat.
	48 Deg.	

Dist.	42 Deg. Lat.	Dep.
69	51.3	46.2
70	52.0	46.8
71	52.7	47.5
72	53.5	48.2
73	54.2	48.8
74	55.0	49.5
75	55.7	50.2
76	56.4	50.9
77	57.2	51.5
78	57.9	52.2
79	58.7	52.9
80	59.4	53.5
81	60.2	54.2
82	60.9	54.9
83	61.7	55.5
84	62.4	56.2
85	63.2	56.9
86	63.9	57.5
87	64.7	58.2
88	65.4	58.9
89	66.1	59.5
90	66.9	60.2
91	67.6	60.9
92	68.4	61.5
93	69.1	62.2
94	69.9	62.9
95	70.6	63.5
96	71.3	64.2
97	72.1	64.9
98	72.8	65.5
99	73.6	66.2
100	74.3	66.9
200	148.6	133.8
300	222.9	200.7
Dist.	Dep.	Lat.
	48 Deg.	

Dist.	43 Deg. Lat.	Dep.
1	.7	.7
2	1.5	1.4
3	2.2	2.0
4	2.9	2.7
5	3.6	3.4
6	4.4	4.1
7	5.1	4 8
8	5.8	5.4
9	6.6	6.1
10	7.3	6.8
11	8.0	7.5
12	8.8	8.2
13	9.5	8.9
14	10.2	9.5
15	11.0	10.2
16	11.7	10.9
17	12.4	11.6
18	13.2	12.3
19	13.9	13.0
20	14.6	13.6
21	15.3	14.3
22	16.1	15.0
23	16.8	15.7
24	17.5	16.4
25	18.3	17.0
26	19.0	17.7
27	19.7	18.4
28	20.5	19.1
29	21.2	19.8
30	21.9	20.5
31	22.7	21.1
32	23.4	21.8
33	24.1	22.5
34	24.8	23.2
Dist.	Dep.	Lat.
	47 Deg.	

Dist.	43 Deg. Lat.	Dep.
35	25.6	23.9
36	26.3	24.5
37	27.0	25.2
38	27.8	25 9
39	28.5	26.6
40	29.2	27.3
41	30.0	28.0
42	30.7	28.6
43	31.4	29.3
44	32.2	30.0
45	32.9	30.7
46	33.6	31.4
47	34.4	32.0
48	35.1	32.7
49	35.8	33.4
50	36.6	34.1
51	37.3	34.8
52	38 0	35.5
53	38.8	36.1
54	39.5	36.8
55	40.2	37.5
56	40.9	38.2
57	41.7	38.9
58	42.4	39.5
59	43.1	40.2
60	43.9	40.9
61	44.6	41.6
62	45.3	42.3
63	46.1	43.0
64	46.8	43.6
65	47.5	44.3
66	48.3	45 0
67	49.0	45.7
68	49.7	46.4
Dist.	Dep.	Lat.
	47 Deg.	

Dist.	43 Deg. Lat.	Dep.
69	50.5	47.0
70	51.2	47.7
71	51.9	48.4
72	52.6	49.1
73	53.4	49.8
74	54.1	50.5
75	54.8	51.1
76	55.6	51.8
77	56.3	52.5
78	57.0	53.2
79	57.8	53.9
80	58.5	54.6
81	59.2	55.2
82	60.0	55.9
83	60.7	56.6
84	61.4	57.3
85	62.2	58.0
86	62.9	58.7
87	63.6	59.3
88	64.3	60.0
89	65.1	60.7
90	65.8	61.4
91	66.5	62.1
92	67.3	62.7
93	68.0	63.4
94	68.7	64.1
95	69.5	64.8
96	70.2	65.5
97	70.9	66.1
98	71.7	66.8
99	72.4	67.5
100	73.1	68.2
200	146.3	136.4
300	219.4	204.6
Dist.	Dep.	Lat.
	47 Deg.	

Dist.	44 Deg. Lat.	Dep.
1	.7	.7
2	1.4	1.4
3	2.2	2.1
4	2.9	2.8
5	3.6	3.5
6	4.3	4.2
7	5.0	4.9
8	5.8	5.6
9	6.5	6.2
10	7.2	6.9
11	7.9	7.6
12	8.6	8.3
13	9.3	9.0
14	10.1	9.7
15	10.8	10.4
16	11.5	11.1
17	12.2	11.8
18	12.9	12.5
19	13.7	13.2
20	14.4	13.9
21	15.1	14.6
22	15.8	15.3
23	16.5	16.0
24	17.3	16.7
25	18.0	17.4
26	18.7	18.1
27	19.4	18.8
28	20.1	19.5
29	20.9	20.1
30	21.6	20.8
31	22.3	21.5
32	23.0	22.2
33	23.7	22.9
34	24.5	23.6
Dist.	Dep.	Lat.
	46 Deg.	

Dist.	44 Deg. Lat.	Dep.
35	25.2	24.3
36	25.9	25.0
37	26.6	25.7
38	27.3	26.4
39	28.0	27.1
40	28.8	27.8
41	29.5	28.5
42	30.2	29.2
43	30.9	29.9
44	31.6	30.6
45	32.4	31.3
46	33.1	32.0
47	33.8	32.7
48	34.5	33.4
49	35.2	34.0
50	36 0	34.7
51	36.7	35.4
52	37.4	36.1
53	38.1	36.8
54	38.8	37.5
55	39.6	38.2
56	40.3	38.9
57	41.0	39.6
58	41.7	40.3
59	42.4	41.0
60	43.2	41.7
61	43.9	42.4
62	44.6	43.1
63	45.3	43.8
64	46.0	44.5
65	46.8	45.2
66	47.5	45.8
67	48.2	46.5
68	48.9	47.2
Dist.	Dep.	Lat.
	46 Deg.	

Dist.	44 Deg. Lat.	Dep.
69	49.6	47.9
70	50.3	48.6
71	51.1	49.3
72	51.8	50.0
73	52.5	50.7
74	53.2	51.4
75	53.9	52.1
76	54.7	52.8
77	55.4	53.5
78	56.1	54.2
79	56.8	54.9
80	57.5	55.6
81	58.3	56.3
82	59.0	57.0
83	59.7	57.7
84	60.4	58.4
85	61.1	59.0
86	61.9	59.7
87	62.6	60.4
88	63.3	61.1
89	64.0	61.8
90	64.7	62.5
91	65.5	63.2
92	66.2	63.9
93	66.9	64.6
94	67.6	65.3
95	68.3	66.0
96	69.0	66.7
97	69.8	67.4
98	70.5	68.1
99	71.2	68.8
100	71.9	69.5
200	143.9	138.9
300	215.8	208.4
Dist.	Dep.	Lat.
	46 Deg.	

Dist.	45 Deg. Lat.	Dep.
1	.7	.7
2	1.4	1.4
3	2.1	2.1
4	2.8	2.8
5	3.5	3.5
6	4.2	4.2
7	4.9	4.9
8	5.6	5.6
9	6.4	6.4
10	7.1	7.1
11	7.8	7.8
12	8.5	8.5
13	9.2	9.2
14	9.9	9.9
15	10.6	10.6
16	11.3	11.3
17	12.0	12.0
18	12.7	12.7
19	13.4	13.4
20	14.1	14.1
21	14.8	14.8
22	15.5	15.5
23	16.3	16.3
24	17.0	17.0
25	17.7	17.7
26	18.4	18.4
27	19.1	19.1
28	19.8	19.8
29	20.5	20.5
30	21.2	21.2
31	21.9	21.9
32	22.6	22.6
33	23.3	23.3
34	24.0	24.0
Dist.	Dep.	Lat.
	45 Deg.	

Dist.	45 Deg. Lat.	Dep.
35	24.7	24.7
36	25.4	25.4
37	26.1	26.1
38	26.8	26.8
39	27.5	27.5
40	28.3	28.3
41	29.0	29.0
42	29.7	29.7
43	30.4	30.4
44	31.1	31.1
45	31.8	31.8
46	32.5	32.5
47	33.2	33.2
48	33.9	33.9
49	34.6	34.6
50	35.3	35.3
51	36.0	36.0
52	36.7	36.7
53	37.5	37.5
54	38.2	38.2
55	38.9	38.9
56	39.6	39.6
57	40.3	40.3
58	41.0	41.0
59	41.7	41.7
60	42.4	42.4
61	33.1	43.1
62	43.8	43.8
63	44.5	44.5
64	45.2	45.2
65	45.9	45.9
66	46.6	46.6
67	47.4	47.4
68	48.1	48.1
Dist.	Dep.	Lat.
	45 Deg.	

Dist.	45 Deg. Lat.	Dep.
69	48.8	48.8
70	49.5	49.5
71	50.2	50.2
72	50.9	50.9
73	51.6	51.6
74	52.3	52.3
75	53.0	53.0
76	53.7	53.7
77	54.4	54.4
78	55.1	55.1
79	55.8	55.8
80	56.6	56.6
81	57.3	57.3
82	58.0	58.0
83	58.7	58.7
84	59.4	59.4
85	60.1	60.1
86	60.8	60.8
87	61.5	61.5
88	62.2	62.2
89	62.9	62.9
90	63.6	63.6
91	64.3	64.3
92	65.0	65.0
93	65.7	65.7
94	66.5	66.5
95	67.2	67.2
96	67.8	67.8
97	68.6	68.6
98	69.3	69.3
99	70.0	70.0
100	70.7	70.7
200	141.4	141.4
300	212.1	212.1
Dist.	Dep.	Lat.
	45 Deg.	

Now for the form of ſetting down a Reckoning, altho he who is accuſtomed to keep it in this manner, may haply by uſe and practice diſcern how to order it in a better way than I can preſently preſcribe or think upon, becauſe he hath occaſion often to conſider it in every particular; yet in the mean time, I conceive it will be fit to have a Book in Folio, that is, two Leaves to a Sheet of Paper, and to keep the left ſide of your Book void, that you may write therein all ſuch Occurrents as you ſhall think requiſite. As namely, the Winds, and the Points of the Compaſs upon which your Ship lies; and what allowance you make for Leeward-way when you ſail by a Wind; the number of Glaſſes or Hours, and how many Knots or Miles in each Hour; alſo the Latitudes, which you find by obſervation of the Meridian Altitude of the Stars, and what elſe you ſhall think remarkable. But before all this, the Title of the Voyage in theſe, or the like words;

The Journal of our Voyage, intended by God's Aſſiſtance from S. I. *in the Latitude of* 32 *deg.* 25 *min. to the Coaſt of* England, *&c.*

The right hand Pages, or the right ſide of your Book throughout, may by Lines be divided into twelve Columns, as in the Example following doth appear. In the firſt Column may be expreſſed the Day, in the ſecond the Month, or at leaſt once in the top of the Page; likewiſe in the ſame ſecond Column, being large enough, may be ſet down the Latitudes, which you find by the Meridian Altitudes of the Sun at ſuch times as you make obſervation. In the third Column the Courſe (the Leeward-way, if there be any Leeing allowed.) In the fourth, the Variation of the Needle. In the fifth (having made allowance for the Variation) ſet down the Angle of your Rhomb with the Meridian. In the ſixth Column, ſet down the Diſtance in Miles run upon that Rhomb. In the ſeventh, eighth, ninth and tenth Columns, the Northing or Southing, Eaſting or Weſting, thereto anſwering, as you ſhall find it by your Table. In the eleventh, your Latitudes by Dead-reckoning. And laſtly, in the twelfth Column, you may at ſuch times as you think fitteſt, ſet down your Longitude from the Place from which you firſt departed, or the Difference of Longitude from Place to Place.

Days.

Days.	Latit. by observat.	Course.	Variation.	deg. from the merid.	dist. in miles.	North	Sou.	East.	Weſt.	Lat. by dead r.	Longitude.
										deg.	
20	February.	N. E. by E.	8 deg. Weſt.	ne 48 d.	miles 78	522		579		33.17	
21	Latitude 34 d. 25′	N. E. by E.	8 deg. Weſt.	ne 48 d.	100	669		743		34.24	
				Sum is		1191		1322		34.24	02.38
21	34 d. 25′										
22		e. n. e. ½ poin.	8 deg. Weſt.	ne 54 d.	100	588		809		35.56	
					56	329		453			
23	Latitude 37 d. 46′	e. n. e. ½ nor.	8 deg. Weſt.	ne 54 d.	100	588		809		37.40	
					78	458		631			
24	Latitude 39 d. 36′	e. n. e. ½ nor.	8 deg. Weſt.	ne 54 d.	100	588		809		39.28	
					84	494		679			
				Sum is		3045		4190			
		The Correction by Obſervat. is				80		110		08	
24	39.36					3125		4300		39.36	11.36
25	February.	e. n. e.	8 deg. Weſt.	ne 59 ½	100	507		861		41.05	
					76	385		655			
26		e. n. e.	8 deg. Weſt.	ne 59 ½	100	507		861		42.37	
					80	412		686			
27	Latitude 43 d. 55′	e. n. e.	7½ deg. Weſt.	ne 60 d.	100	500		866		44.09	
					84	420		728			
				Sum is		2731		4657			
				Correction			140		245	14	
27	L. 43.55.					2591		4412		43.55	21.28
28	February.	e. n. e. ½ e.	6 deg. Weſt.	ne 67 d.	100	391		921		44.54	
					51	199		469			
29		e. n. e. ½ e.	5 deg. Weſt.	ne 68 d.	100	375		927		46.02	
					81	304		751			
1	March.	e. n. e. ½ e.	4 deg. Weſt.	ne 69 d.	100	358		934		47.02	
					66	237		616			
2	La. 48. 4.	e. n. e. ½ e.	2 deg. Weſt.	ne 71 d.	100	326		946		48.00	
					78	254		737			
				Sum is		2444		6301		48.00	36.33
2	La. 48. 4.										

Days.	Latit. by observat.	Course.	Variation.	deg. from the merid.	dist. in miles.	North.	Sou.	East.	West.	Lat. by dead-r.	Longitude.
3	*March.*	e. n. e. ½ e.	0 deg. West.	n e 73 d.	100	292		956		48.44	
					52	152		497			
4		e. n. e. ½ e.	2 deg. East.	n e 75 d.	100	259		966		49.28	
					68	176		657			
5	Latitude 49 d. 58′	e. n. e. ½ e.	3 deg. East.	n e. 76 d.	98	237		951		49.52	
5	L49 d. 58′			Sum is		1116		4027		49.52	46. 52
5	8 hours.	n. by e. ½ e.	4 deg. East.	n. e. 21 d.	18	168		64		50.09	
6		south by e.	4 deg. East.	s. e. 7 de.	34		337	41		49.35	
6	15 hours.	north by East	4 deg. East.	n. e. 15 d.	36	348		93		50.10	
7		s. e. by East	4 deg. East.	s. e. 52 d.	20		123	158		49.58	
8	Latitude 50 d. 4′	East.	4 deg. East.	s. e. 86 d.	96		67	958		49.51	
	The Current set. by estim.	e. n. e.		n. e. 67½	60	230		554		50.14	
				Sum is		219		1868			
				Correction			100			10′	
8						119		1868		50.04	51.43
9		East ½ so. n.	6 deg. East.	s. e. 89½	70		60	700		49.58	
10		East ½ so. n.	6 deg. East.	s. e. 89½	52		41	520		49.54	
10	*March*			Sum is			101	1220		49.54	54. 53
	Here the *Lizard* bears.	N. by E.			13						

For an Example, we may frame a Reckoning between the two places before mentioned; namely, from *Summers Islands* to the *Lizard*, whose distance in the Rhomb we have before supposed to be 3299 Miles, as some *Charts* make it, and consequently their difference of Longitude 70 deg. I would not be understood as if I affirmed it to be so much, for I suppose it is less. I was there indeed about 20 Years past, and surveyed it, and then kept a Reckoning both outwards and homewards, but I have lost those Reckonings long since, and forgotten what they were, and in this case it matters not: for whether the Supposition be near the truth or not, it serves sufficiently to exemplify the Rule, that being the end for which it is used. But if their distance be 3299 such Miles as contain only 1000 Paces in a Mile, the same being reckoned in such Miles as we have before mentioned, namely, in such whereof 60 make a degree of a great Circle, which, as we find, contains 6120 Feet in a Mile, their distance will be little more than 2695 Miles; and consequently, the difference of Longitude little more than $55\frac{1}{2}$ degrees.

Let us therefore suppose the difference of Longitude between those two places to be 55 degrees, and their Latitudes to be the same as before; namely, of the one 32 deg. 25 min. and of the other 50 degrees. And let the Courses, Distances, and other Observations from *Summers Islands* to the *Lizard* be such as before is shewed.

The first entrance in this Journal (which is the 20*th* day of *February*) is thus to be understood; namely, that from the time of setting Sail (which we suppose to be the 19*th* of *February*) till the 20*th* day at Noon, the Ship lies away, and makes her way good upon the North-East and by East Point of the Compass; but the Variation being 8 degrees to the Westwards (as in the fourth Column appears) the Rhomb upon which she hath run is from the North to the Eastwards only 48 degrees, as is expressed in the fifth Column (it is indeed 48 $\frac{1}{4}$ deg. but the $\frac{1}{4}$ deg. we omit, as for the other Circumstances not to be regarded:) upon this Rhomb she runs 78 Miles, as in the sixth Column appears; and answerable thereto, I find in the Table beforegoing the Northing to be $52\frac{2}{10}$ Miles, and the Easting $57\frac{1}{10}$, as here in the seventh and ninth Column is expressed by these Numbers 522 and 579 (for the first Figure towards the Right-hand signifieth the tenth part of a Mile, the rest Miles.) Hence then the Northing being 52 Miles, if that be added to the Latitude from which it is reckoned, namely, 32 deg. 25 min. it makes the Latitude here to be 33. deg. 17 min. as in the eleventh Column appears. In like sort, the second entrance

entrance being the 21*st* of *February*, sheweth that from the 20*th* day at Noon to the 21*st*, she made her way good upon the North east by East Point of the Compass; but the Variation being 8 degrees Westerly, the Angle of the Rhomb, with the true Meridian, was from the North to the Eastwards 48 degrees; and so sailing 100 Miles, the Northing is 69$\frac{3}{10}$ Miles, and the Easting 74$\frac{3}{10}$ Miles; so that the Latitude is now 34 deg. 24 min. and the like is to be understood of all the rest.

Touching the Longitude expressed in the last Column, although a Reckoning may be kept and set down without it, yet it is of very good use; and how to convert the Easting or Westing (that is, the Miles expressed in the East and West Columns of your Journal) into degrees and minutes of Longitude, we will shew afterwards; as also how you may easily correct your Course, and give the true Course or Rhomb, allowing the Variation.

But first to proceed with this Journal. Observing the Meridian Altitude of the Sun upon the 23*d* and 24*th* of *February*, I find that my Latitude upon the 24*th* is 39 deg. 36 min. whereas by Dead-reckoning it is but 39 deg. 28 min. so the Difference is 8 more Northerly: But being well assured of the Latitude found by Observation, I correct the Dead-reckoning thereby, which may be done by the Rule of Proportion, saying;

As the Sum of the North Column,	3125	*Co. ar.*	6.50515
to the Sum of the East Column,	4300		3.63347
So the foresaid increase Northerly	80		1.90309
to the increase Easterly,	110		2.04171

That is, 11 Miles; for the first place towards the Right-hand is only for the 10*th* part of a Mile.

The same may also sufficiently be found without the Rule of Proportion, by the foregoing Table, only for looking there under the Degree upon which I have sailed; namely, under 54 degrees for 8 Miles, or 80 tenths of a Mile; tho' I find not the same exactly, yet I find one which is near it, namely 82, and against it in the next collateral Column 113, which is 11$\frac{3}{10}$ Miles (being too much by $\frac{1}{10}$ of a Mile, because the other is too much by $\frac{2}{10}$;) I add therefore in the North Column of the Journal, 8 Miles, and the East Column 11 Miles; and so whereas by Dead-reckoning, the Northing was but 304$\frac{1}{10}$ Miles, and the Easting 419 Miles; now having corrected it by Observation, the Northing is 312$\frac{3}{10}$ Miles, and Easting 430 Miles.

In the like sort, upon the 27*th* Day, I should by Dead-reckoning be

in the Latitude of 44 deg. 9 min. but by a clear and good Observation I find my ſelf in the Latitude of 43 deg. and 55 min. that is, not ſo much Northerly by 14 min. therefore to correct it, I put in the South Column 14 Miles, or 140 Tenths: and ſeeing my Courſe was between the North and the Eaſt, and that I find my ſelf to be leſs to the Northwards, that is, more to the Southwards than my Reckoning; therefore in probability, I am alſo leſs to the Eaſtwards; that is, more to the Weſtwards than my Reckoning: but to find how much, I look in the foregoing Table for the Degree upon which I have ſailed, being from the North part of the Meridian to the Eaſtwards 60 deg. and under 60 deg. I look for 14 Miles, or 140 Tenths, and againſt it in the Column adjoining I find 242, which I ſet down in my Journal in the Weſt Column: and ſo ſubtracting the firſt from the North Column, the other from the Eaſt, I find that whereas by Dead-reckoning I ſhould be to the Northwards 273$\frac{1}{10}$ Miles, and to the Eaſtwards 465$\frac{7}{10}$; now having corrected it by Obſervation, I find that from the 24 day till this time I have run more Northerly than I was by 259$\frac{1}{10}$ Miles, and more Eaſterly by 441$\frac{3}{10}$ Miles.

But if your Courſe be near the Eaſt or Weſt, it may ſuffice to correct it in Latitude only, as in the Example of the 8*th* of *March* appears: for in that caſe you cannot correct the Longitude, but from ſome farther ground.

If there be any Current, you may note it, as is done in that Example, following the 8*th* of *March*.

Now if you would ſet down this Reckoning upon the plain or common *Sea Chart*; Firſt, if you deſire to expreſs every Day's Account, you may begin from the 20*th* of *February*, and make a prick in your Plot that may be from the place from which you ſet ſail to the Northwards 52$\frac{2}{10}$ Miles, and to the Eaſtwards 57$\frac{9}{10}$; and ſo will this Point be diſtant from the place of your ſetting ſail 78 Miles N. E. and almoſt a quarter of a Point Eaſterly: Then for the 21*ſt* Day you may make another Prick, which may be from the former to the Northwards 66$\frac{2}{10}$ Miles, and to the Eaſtwards 74$\frac{1}{10}$ Miles, and ſo you may proceed with the reſt. And thus you ſhall have a Prick on the Plot for every Day more exactly ſet down, than could be done after the ordinary way by Courſe and Diſtance, or Courſe and Latitude; eſpecially, becauſe in lining the Plot, there are not, nor cannot conveniently be drawn any more than the 32 Points of the Compaſs, *viz.* not half-Points, Quarters, or ſingle Degrees.

But if you deſire not to ſet down every Day's Reckoning, (which is not

not necessary to be done) you may set down every of the Sums as they are corrected by Observation, after the self same manner.

Or you may add together all those Sums, and so the Sum total of the North Column will be 1049 Miles, and of the East Column 2345 Miles: therefore in the Meridian of the Place from which you depart, you may set down to the Northwards of that Place 1049 Miles, which will fall in the Latitude of 49 deg. 54 min. almost; and from thence in that Parallel set down directly to the Eastwards 2345 Miles, and there make a prick for the place where the Ship then is the tenth of *March*; and so is all this Reckoning set down at once.

If you keep Reckoning according to *Mercator*, it will be requisite sometimes to sum up your Reckonings past, namely, so often as you make any notable Alteration in your Course; and so this Reckoning, or any other, may be set down almost as easily on *Mercator*'s Chart; the Difference is, that here you must often alter your Scale, because the Degrees of Latitude on this Chart are not equal, but grow greater and greater towards the Poles. Now then the Distance between the two Places is to be measured by that part of the Meridian which is intercepted between the Latitudes of those two places: Or if both places lie in one and the same Latitude, their Distance is measured by a Degree, or other less Quantity taken about that Latitude; namely, half above, and half beneath.

Wherefore if you would make a Prick or Traverse-point in *Mercator*'s Chart, answering to your Reckoning for the first Day, namely, until the 20*th* of *February* at Noon; it appears by your Journal that prick must be to the Northwards of the place from which you departed $52\frac{3}{10}$ Miles, and to the Eastwards $57\frac{2}{10}$ Miles.

Now instead of the North or South Columns, you may more conveniently use the last Column but one, shewing in what Latitude every Account doth fall; and so it appears that the Prick for the 20*th* of *February* must be in the Latitude of 33 deg. 17 min. Therefore in the Meridian of *Summers Islands* from which you departed, make a Prick in the Latitude of 33 deg. 17 min. and from that Prick set down to the Eastwards in the same Latitude $57\frac{2}{10}$ Miles; and where it ends, is the Traverse-point answering to the 20*th* of *February*. The like may be done for the 21*st* Day, and so for all the rest. This 58 Miles may be taken in the Meridian from the Latitude of 32 deg. 22 min. to the Latitude of 33 deg. 20 min. Or otherwise, you may take the half of it, which is 29 Miles, about the middle between both Latitudes, and double it.

But

But it is sufficient to set down the Sums of every two or three Days Accounts, or so often as there is any notable Difference in your Course. Thus if you would make a prick in the Chart, answering to the 21*st* of *February*, being the first Sum; I see by the Journal, that it must be in the Latitude of 34 deg. 24 min. and to the Eastwards of the place from which I departed $132\frac{2}{10}$ Miles. Therefore in the Meridian of the place from whence I departed, I make a prick in the Latitude of 34 deg. 24 min. and from that prick I set in the same Latitude to the Eastwards $132\frac{2}{10}$ Miles, and where it ends is the Traverse-point answering to the 21*st* of *February*, being the first Sum, This 132 Miles may be taken in the Meridian within, or a little without the two Latitudes, as before, namely, from 32 deg. 20 min. to 34 deg. 22 min.

In like sort, if you would make a prick for the second Sum, being the 24*th* of *February*; it there appears that it must be in the Latitude of 39 deg. 36 min. and to the Eastwards of the Traverse-point last before made 430 Miles; therefore in the Meridian of that Traverse-point, I make a prick in the Latitude of 39 deg. 36. min. and from that prick I set to the Eastwards in the same Latitude 430 Miles, and where that ends, is the Traverse-point answering to the 24*th* Day; and the like is to be understood of all the rest.

Now this 430 Miles may be taken several ways: for, first, if I take 1 Degree about the middle of that part of the Meridian which is intercepted between the Latitudes of the two places, (as from 36 deg. 30 min. to 37 deg. 30 min) and that Degree seven times taken, is 420 Miles; then about the middle, namely, 37 deg. I take ten Minutes more, and so have 430 Miles.

In like manner you may take 2 Degrees, or 120 Miles, to measure it thereby, which may be taken from 36 deg. to 38 deg. and the residue about 37 deg. as before, *&c.*

Or you may take the half of 430 Miles, namely, 215 Miles, which is 3 deg. 35 min. which must be taken as before, about the middle of that part of the Meridian which is intercepted between the two Latitudes, and that doubled, is 430 Miles to be set to the Eastward, as before.

And thus may this, or any other Reckoning, be set down without knowledge of the Longitudes, but more aptly and exactly by some Longitudes known; for then shall you have in the two last Columns the Substance and principal Scope of your Reckoning, namely, the Latitudes and Longitudes of all places as you sail, which may more easily

and exactly be expreſs'd upon this Chart, than the Eaſterly or Weſterly diſtances: Therefore how this alſo may be done we will ſhew; but firſt ſomething touching the Compaſs, and the Variation thereof, which ought not to be neglected in a Reckoning.

CHAP. X

Of the Variation of the Compaſs, and how to rectify a Courſe by the Variation known.

AMongſt all the Myſteries which God hath of late Years diſcovered to the World for the furtherance of NAVIGATION, there is none more neceſſary, nor yet more admirable than that Property of the *NEEDLE* touched with the Loadſtone, whereby in the vaſt Ocean, where all Landmarks fail, yea even in the darkeſt Nights and cloſeſt Weather, when neither Sun nor Stars are to be ſeen, the Mariner (as it were by a Meſſenger ſent from Heaven) is taught which way to direct his Ship; yea, as it were accompanied with a Guide towards his deſired Port.

For the Needle touched, beſides other ſtrange Properties, hath this, to point out in all quarters of the World, the North and South parts of the Horizon; and ſo having a Card thereto fitted with Rhombs and Degrees, it ſheweth all Points of the Compaſs, and Degrees of the Horizon.

Yet very ſeldom exactly of it ſelf, without ſome farther Art and Induſtry of him that uſeth it; for though in ſome places it ſwerves not, yet in moſt parts of the World the North and South Points of the Needle have ſome Variation from the true North and South parts of the Horizon, to the Eaſtwards or to the Weſtwards, which how to diſcover in kind and quantity, we have ſhewed heretofore.

It may be thought, (and ſome Men, otherwiſe Learned, before this Property was fully diſcovered, have ſaid) that this ſhould be ſome Blemiſh and Imperfection in a Stone ſo precious; but it is ſo far from being an Imperfection, that it makes it ſo much the more precious, yet (as I have ſaid) not without the Induſtry of him that uſeth it. He that is negligent or unskilful to obſerve it, eſpecially in long Voyages and various Courſes, may be led into many dangers by it, becauſe he frames not his Mind to the Rule, but the Rule to his Mind, imagining it to be what it is not: And hence I ſuppoſe ſprang that Cuſtom of placing the Needle, or Wires, a Point, or half a Point, to the Eaſtwards of the

the North-point of the Card, thinking by this means to ſhun the labour of obſerving the Variation; which indeed they might if the Variation were the ſame in all Places, and at all times; but becauſe it is not, this doth often increaſe the Error.

But he that diligently obſerves the Variation, finds (as I ſay) no prejudice in it, only it requires daily, or once in two or three Days, half an hour's Work, and this Labour it doth abundantly recompenſe: for by this means he knows at the preſent how to direct his Courſe; and for the future, by thoſe Notes which he keeps of the Variations and Latitudes by him obſerved, he knows (coming that way again) when he draws near to any of thoſe Places where ſuch Obſervations were made, and ſo falls the more certainly with any Place intended.

There is further diſcovered of late, a Motion or Alteration in the Variation of the Needle, and this is ſcarce yet certainly diſcovered. But comparing the Variations which were obſerved about fifty Years paſt, with the preſent Variations, it appears they are leſſer Eaſterly and more Weſterly by 6 or 7 Degrees, than they were at that time. For whereas the Variation hath formerly been obſerved near *London* to be 11½ deg. to the Eaſtwards, it doth now ſcarce exceed 4 degrees. And there is the like Alteration (as I have heard by ſome Mariners) in other parts of the World; which we now leave to the farther diſcovery of Time and Induſtry, and come to ſhew how to rectify a Courſe by the Variation known.

The Point of the Compaſs upon which you ſail, and the Variation of the Needle known, to find the Rhomb or Degree upon which the Ship hath made her way.

IT is beſt that the Needle, or Wiers, be placed directly under the Flower-de-luce, or North or South Points of the Card, and ſo in the Rules following we preſuppoſe them to be. Now then it is to be underſtood, that the Needle having Variation (as for the moſt part it hath) the Ship doth not make her way upon the Rhomb, or Point of the Compaſs, which ſhe ſeems to ſail upon, but either more to the Right-hand or to the Left, according as the Variation is towards the Right-hand, or towards the Left, and that ſo much towards the one ſide, or towards the other, as that Variation is: We ſpeak not here of Leeward-way, but of the Variation only. Therefore for the Solution of this Problem, you muſt know how much the Variation is, and

and which way; and how this may be done, we have briefly shewed upon the 12th Case of Right-angled Spherical Triangles, and the 11th of Oblique; which known, you may find the Angle of the Rhomb, or Line of your Ship's way with the Meridian, being the thing in this Problem required.

A Table of the Angles of every Point and half Point of the Compass with the Meridian.

	North.	South.	D. M.	North.	South.
			00 00		
½			05 37		
1	N. by E.	S. by W.	11 15	N. by W.	S. by E.
1½			16 52		
2	N.N.E.	S.S.W.	22 30	N.N.W.	S.S.E.
2½			28 07		
3	N.E. by N.	S.W. by S.	33 45	N.W. by N.	S.E. by S.
3½			39 22		
4	N.E.	S.W.	45 00	N.W.	S.E.
4½			50 37		
5	N.E. by E.	S.W. by W.	56 15	N.W. by W.	S.E. by E.
5½			61 52		
6	E.N.E.	W.S.W.	67 30	W.N.W.	E.S.E.
6½			73 07		
7	E. by N.	W. by S.	78 45	W. by N.	E. by S.
7½			84 22		
8	East.	West.	90 00	West.	East.
	Add East Variation, Subtract West.			Add West Variation, Subtract East.	

For the effecting whereof, we will set down two ways; the one by the Pen alone, the other instrumentally. If you do it by the Pen alone, although it be not hard to find what Angle every Point or half Point makes with the Meridian; yet for your farther ease herein, I have expressed the same in the Table before going; the Quarters of Points I have omitted, because the Steerage upon a quarter of a Point is very

 uncertain,

uncertain, (the Points being undivided, as usually they are;) for a Man is able by his Eye to guess very nearly which is the middle between two Points, but he cannot guess so nearly which is the fourth Part. Yet if you desire any quarter, you may add to the next before going almost three degrees, namely, 2 deg. 49 min.

Now then by the Magnetical Rhomb, or Point of the Compass, and Variation given, to find the Rhomb, you are to observe these two Rules following.

1. *If the Rhomb and Variation be both the same way from the Meridian, (namely, both to the right Hand, or both to the Left) add them together, and that Sum is the true Rhomb from that part of the Meridian.*

Yet if that Sum exceed 90 *degrees, subtract it from* 180 *Degrees, the Remainder is the Rhomb from the opposite part of the Meridian.*

2. *If the one be towards the right Hand, the other towards the Left, subtract the Variation from the Rhomb, and the Remainder is the true Rhomb.*

Yet if the Rhomb be the smaller Number, subtract it from the Variation, and the Remainder is the true Rhomb the other way.

These Rules we shall endeavour to illustrate by Examples following.

But first for distinction sake, we say the Rhombs or Degrees from the North towards the East, are towards the right Hand, and so from the South towards the West, but from the North to the Westwards on the left Hand, and so from the South Eastwards: For a Man's Face being towards the North, the East is on his right Hand, and the West on his Left, *&c.*

In like sort for the Variation of the Compass; if it have Easterly Variation, that is, if the Needle and Flower-de-luce of the Card stand to the Eastwards of the North, we say that Variation is towards the right Hand; for not only the North Point, but all the other Points of the Compass direct a Course more towards the right Hand than they would do if there were no Variation. And so if it have Westerly Variation, that is, if the Needle and Flower-de-luce stand to the Westwards of the true North Point of the Horizon, we say, that Variation is towards the left Hand; forasmuch as not only the North Point, but all the other Points of the Compass stand more towards the left Hand than they would do if there were no Variation. This being premised, we come to give Examples of the two Rules before-going.

Exam-

Example 1. Let the Magnetical Rhomb or Point of the Compass be North East, and the Variation 10 degrees to the Eastwards, I demand the true Rhomb?

Here the Rhomb and Variation are both one way; that is, both towards the right Hand: therefore

	deg.	min.
To the Magnetical Rhomb being North Easterly	45	00
Add the Variation Easterly	10	00
The Sum is the true Rhomb North Easterly	55	00

Example 2. Admit a Ship sails upon the North Point of the Compass, and that the Variation be 10 deg. to the Eastwards; how doth she make her way?

The Magnetical Rhomb is North; that is,	00	00
To which adding the Easterly Variation	10	00
The Sum is the Angle from the North part of the Meridian to the Eastwards	10	00

Which is almost N. by E. and so hath the Ship made her way.

Example 3. Let the Point of the Compass be East ½ Point Northerly; that is, from the North to the Eastwards 7 ½ Points, which is 84 deg. 22 min. and the Variation, as before, 10 deg. to the Eastwards, I demand the true Rhomb?

To the Magnetical Rhomb, being North East	84	22
Add the Easterly Variation	10	00
The Sum is the Angle from the North	94	22
Which subtracted from	180	00
There rests the true Rhomb South Easterly	85	38

Example 4. Let the Course by the Compass be West and by South; that is, 7 Points from the South to the Westwards, or 78 deg. 45 min. and let the Variation be as before, 10 deg. to the Eastwards; what is the true Rhomb?

To the Magnetical Rhomb South Westerly	78	45
Add the Easterly Variation	10	00
The Sum is the true Rhomb South Westerly	88	45

You may conceive that the Rhomb and Variation are here both one way, namely, both from the Meridian towards the right hand. For the Variation of the North Point is from the North towards the East, and consequently of the South Point from the South towards the West, both towards the right Hand of the Meridian, as the Rhomb is.

Example 5. Let the Course by the Compass be West, that is, from the South to the Westwards 8 Points, or 90 Degrees, and let the Variation be, as before, 10 deg. to the Eastwards; I would know the true Course or Rhomb?

	deg.	min.
To the Magnetical Rhomb South West	90	00
Add the Variation Easterly	10	00
The Sum is the Angle with the South part of the Meridian	100	00
Which subtracted from	180	00
There rests the true Rhomb North West	80	00

Example 6. Let the Course of the Compass be West; that is, from the North to the Westwards 8 Points, or 90 Degrees, and let the Variation be 10 deg. to the Westwards; I demand the true Rhomb?

To the Magnetical Rhomb North West	90	00
Add the Variation Westerly	10	00
The Sum is	100	00
Which subtracted from	180	00
There remains the true Rhomb South West	80	00

Object. The Magnetical Rhomb being here West 90 deg. why should it not as well be counted from the South, as from the North?

Answ. It may be counted from either: for as it is counted here from the North to the Westwards, it falls under the first Rule, because the Variation is the same way; but if it be reckoned from the South to the Westwards, it falls under the second Rule, whereof we now come to give some Examples, supposing these already given sufficient to illustrate the first Rule.

Example 7. Let the Point of the Compass be N. N. W. and the Variation 10 deg. Easterly; I demand the true Rhomb?

From the Magnetical Rhomb North West	22	30
Subtract the Easterly Variation	10	00
The Remainder is the true Rhomb North West	12	30

Example 8. Let the Point of the Compass be North, and the Variation Easterly 10 deg. what is the true Rhomb?

From the Easterly Variation	10	00
Subtract the Magnetical Rhomb N. W.	00	00
The Remainder is the true Rhomb the other way, namely, N. E.	10	00

Object.

Object. The Magnetical Rhomb may as well be named North Easterly 0 deg. 0 min.

Answ. It may; but then it is subject to the first Rule, as in the second Example.

Example 9. Let the Course by the Compass be West, that is, from the North to the Westwards, 8 Points, or 90 Degrees; and let the Variation be, as before, 10 deg. to the Eastwards; what is the true Rhomb?

From the Magnetical Rhomb N. W.	90	00
Subtract the Easterly Variation	10	00
There rests the true Rhomb N. W.	80	00

Here the Magnetical Rhomb might as well have been South Westerly 90 deg. and so it had fallen under the first Rule, as in the 5*th* Example.

Example 10. Let the Course by the Compass be West, that is, from the South to the Westwards 8 Points, or 90 Degrees, and let the Variation be 10 deg. to the Westwards, I demand the true Rhomb?

From the Magnetical Rhomb S. W.	90	00
Subtract the Westerly Variation	10	00
The Remainder is the true Rhomb S. W.	80	00

If the Rhomb here had been reckoned from the North, as in the sixth Example, it had fallen under the first Rule.

And this may suffice for the illustration of the two former Rules in the solution of this Problem.

The same may also more easily be resolved, by such an Instrument as is here described, consisting of two Circles; the one being the nethermost, divided into 4 Quadrants, and every of those into 90 deg. numbred from the North and South Points, towards the East and West.

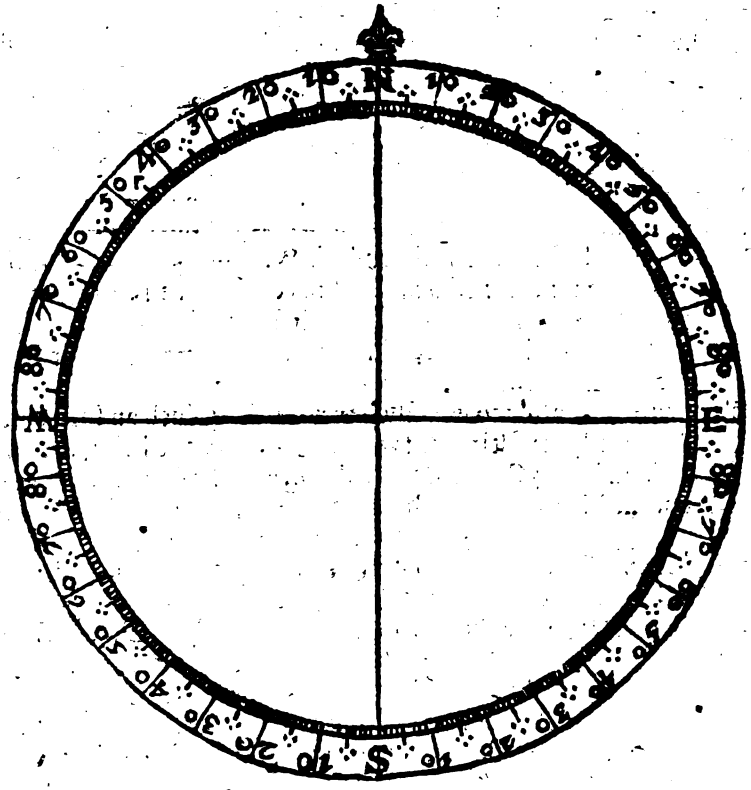
The other, being the uppermost, and moveable about the Center, divided as the Card of the Compass into XXXII Points, and those again subdivided into Halves and Quarters.

For if you turn the North Point of the upper Circle, from the North Point of the lower so many Degrees, and the same way that the Variation is, and then look in the same upper Circle for the Magnetical Course, or Point of the Compass proposed, you shall find right under it in the nether Circle, what number of Degrees the same is distant from the N. or S. Points of the true Meridian towards the E. or W. which is the true Rhomb here required.

As suppose the Variation to be 10 deg. Easterly, and the Course by the Compass East, half a Point Northerly, and there be required the true Rhomb:

I turn to the North Point of the upper Circle from the North Point of the lower 10 deg. to the Eastwards; and then I look in the upper Circle for East half a Point Northerly, and right under it in the nether Circle I find 85 deg. and about one half numbred from the South part of the Meridian towards the East; therefore I conclude, that the true Rhomb required is, from the South towards the East, 85 ½ deg. and something more.

By this you may readily find the true Rhomb for any Course and Variation given.



By this Instrument also (if you use the Pen only, as before we have shewed) you shall readily see when to add, and when to subtract.

CHAP.

CHAP. XI.

To keep a Reckoning of your Longitude, and so to set down a Reckoning by Longitude and Latitude only.

IN this Example before given of a Journal, we have in the 12*th* and last Column, expressed in such places as it seemed most requisite, the Longitudes: We come now to shew how the same may be known; And first,

By the Rhomb and Latitude given, to find the Difference of Longitude.

As the Radius is in proportion to the Tangent of the Rhomb;
So is the Difference of Latitude in Meridional Parts,
To the Difference of Longitude in Minutes.

As, let the Rhomb be North Easterly 48 deg. and suppose a Ship to run upon this Rhomb, from the Latitude of 32 deg. 25 min. into the Latitude of 34 deg. 24 min. there is required the Difference of Longitude. Here,

The Meridional Parts answering to	34 deg.	24 min.	.2200
The Meridional Parts for	32	25	.2058
The Difference of Latitude in such parts is			142.

Say then, as Radius is in proportion

To the Tangent of the Rhomb, *i.* 48 deg. 00 min.		10.0456
So the Difference of Latitude in Merid. Parts	142	2.1523
To the Difference of Longitude in Minutes	158	2.1979.

These Minutes converted into Degrees, are 2 deg. 38 min. which is the Difference of Longitude required, as the same is expressed in the Journal against the 21*st* of *February*.

And thus sailing upon one and the same Rhomb, you may find the Diff. of Longitude; and so often as you alter your Rhomb, so often working by the same Rule, you shall have all the Differences from place to place, which added together, make the whole Diff. of Longitude.

But you may also find the Difference of Longitude near enough at one Operation for many several Rhombs and Distances, provided those Rhombs differ not much one from another. As in the former Journal from *February* 27, till the 2*d* of *March*, I sail by several Rhombs and Distances from the Latitude of 43 deg. 55 min. into the Latitude of 58 deg. If you would find the Difference of Longitude hereto answerable at one Operation, it may be done by this Rule. As

As the difference of Longitude in Miles,
Is to the departure from the Meridian in Miles;
So is the difference of Latitude Meridional Parts,
To the difference of Longitude in Minutes.

As in that Example, the difference of Latitude for all those Courses, as in the North Column appears, is 2444.

The Departure from the Meridian, as there in the East Column appears, is 6301.

The Merid. parts for the Latitude of 43 deg. 55 min. are		2939
The Merid. parts for the Latitude of 58 deg. 00 min. are		3292
The Difference of Latitude in Meridional Parts, is		353
Say then, As the Difference of Latitude ——	2444	*Co. ar.* 6.6119
To the Departure from the Meridian ——	6301	3.7994
So the Difference of Latitude in Merid. parts	353	2.5478
To the Difference of Longitude in minutes	901	2.9591

Which reduced into degrees, is 15 deg. 10 min. And added to the former Longitude 21 deg. 28 min. gives the present Longit. 36 deg. 38 min. for the 2*d* of *March*.

The like may be done for the Account from the 2*d* of *March* to the 5*th* of the same, *&c.*

But if your Courses and Distances run be all near to one and the same Parallel or Latitude, (as in this Journal they are from the 5*th* of *March* to the 8*th*, and from the 8*th* to the 10*th*) then it is sufficient to find what Longitude in that Parallel is answerable to the Miles of Easting or Westing, or Departure from the Meridian, by this Rule.

As the Sine Complement of the Latitude of that Parallel,
Is in proportion to Radius,
So is the number of Miles in that Parallel,
To the Difference of Longitude in minutes.

As from the 5*th* of *March* to the 8*th*, the Latitude was near 50 deg. the Easterly distance 186 $\frac{8}{10}$ Miles: therefore for the Difference of Longitude, say;

As Sine Complement the Latitude, *&c.* 50 deg. 0 min.			1919
To Radius;			
So is the Departure from the Meridian —— ——	186	8	3.2714
To the Difference of Longitude —— ——	290	6	3.4633

Thus it appears, the Difference of Longitude is almost 291 min. which is 4 deg. 51 min. and this added to the Longitude upon the 5*th* of *March*, namely, to 46 deg. 52 min. the Sum is 51 deg. 43 min.

the

the Longitude for the 8th of *March*; the like might be done for the 10th of *March*.

And though this last Rule be then fittest to be used, when your Course is near East and West, or your difference of Latitude little, yet it may also be used at other times instead of the two former, without any great Error, if you take the middle Degree of Latitude, or somewhat more, as in the former Example.

	deg.	min.
The Latitude upon the 27th of *February* is	43	55
The Latitude upon the 2d of *March* is	48	00
The middle Latitude, or somewhat more, is	46	10

Say then;

As Sine Complement the Latitude *f. c.* 46 deg. 10 min.			.1595
To Radius;			
So the Easting or Departure from the Merid.	630	1	3.7994
To the difference of Longitude	909	7	3.9589

Which is almost 910 min. or 15 deg. 10 min. as before.

And thus you may in the 12th and last Column of your Journal set down your Longitude, so often as you think it requisite; and so in the two last Columns you shall have the Substance and principal scope of your Reckoning; namely, your Latitudes and Longitudes, which whensoever you desire to set down in *Mercator*'s Chart, or in the *Polar* Chart, or in any other, graduated with degrees of Longitude and Latitude, you may readily do it.

As if I would set down the Sum of the foresaid Journal from the 19th of *February* to the 10th of *March*, I find against the 10th of *March* the Latitude to be 49 deg. 54 min. and the Difference of Longitude 54 deg. 53 min. Therefore in the Latitude of 49 deg. 54 min. I draw an occult Parallel, and reckoning from *Summer-Islands* towards the East 54 deg. 53 min. I draw by that Longitude an occult Meridian; the intersection of this Meridian with the aforesaid Parallel, is the Traverse Point, or the point representing the place of the Ship: and the like is to be understood of any other.

This form of keeping and expressing a Reckoning, is (as I conceive) most apt and agreeable (of all others that I have seen or thought upon) to all sorts of *Charts* or *Maps*, and to the *Globe* it self; and to all the kinds or ways of Sailing, that are or may be used. We will here add some other Propositions which may sometimes be of good and necessary use in it.

The Rhomb and Difference of Latitude given, to find by the Table the Distance in the Rhomb, and the Departure from the Meridian thereto answerable, &c.

HOW to find the Northing or Southing, that is, the Distance in Latitude; as also the Easting or Westing, that is, the Distance in Longitude, or Departure, from the Meridian of any Rhomb, for any distance run upon it, we have before shewed: the like Operation is in these Propositions following; namely,

2. *The Rhomb and Distance in Latitude given: to find the Distance in the Rhomb and the Easting or Westing.*

3. *The Distance and Difference in Latitude given: to find the Departure from the Meridian and the Rhomb.*

4. *The Difference in Latitude and Departure from the Meridian given: to find the Course and Distance.*

5. *The Course and Departure from the Meridian given: to find the Difference of Latitude and Distance.*

6. *The Distance and Departure from the Meridian given: to find the Course and Difference of Latitude.*

So that with the first before-handled, here are six Propositions, and in every one of them two things required; and so they become twelve. We will not stand to give Examples of them all, but only of those which are most useful, the rest may be by them conceived.

And first, to find the Easting or Westing of any Rhomb for any difference of Latitude.

Admit a Ship run North-Easterly 60 deg. (that is, N. E. by E. and almost half a Point Easterly) till she have altered the Latitude 42 min. how much is she departed from the Meridian?

I run down the Column under 60 degrees till I find 42 Miles, or 420 tenths, and against it in the adjacent Column I find 720 tenths, that is, almost 73 Miles; which is the Departure from the Meridian to the Eastwards.

If you would also have the Distance upon the Rhomb, it is right against these numbers in the Column of Distances, being in this Example 84 Miles.

2 *Example.* But admit she run North-Easterly 60 deg. till she alter her Latitude 1 deg. 32 min. what is the Easterly distance?

This 1 deg. 32 min. is 92 miles, or 920 tenths; for which if I look in the Column under 60 deg. I find no number so great, but the greatest number there is 500; which substracted from 920, there remains 420:

420; therefore in that Column under 60 deg. I look for these two numbers, namely 500 and 420, and against the first in the adjacent Column I find 866, and against the second 728, which I set against them as above appeareth; and so adding them, I find for this difference of Latitude, the Departure from the Meridian to be 159 $\frac{4}{10}$ Miles.

100	500	866
84	420	728
184	920	1594

If further you desire the Distance run upon this Rhomb, you have it in the Column of Distances, right against the same numbers, as in the Example above appeareth, where being added, it amounts to 184 miles.

The Distance and Difference in Latitude given; to find the Rhomb and Departure from the Meridian.

ADmit a Ship run upon some Rhomb between the North and the East 84 Miles, and then have altered her Latitude 42 min. the Question is, Upon what Rhomb hath she run, and how many Miles is she to the Eastwards in Longitude?

I run cross the Table towards the Right hand, looking in every first Column of Distances for 84, till I find against it in one of the adjacent Columns 420; at the Top of which Column over 420, there is 60 deg. shewing the Rhomb to be North Easterly 60 deg. also against 420 in the adjacent Column, I find 728. which sheweth the Distance to the Eastwards to be almost 73 Miles.

2 *Example.* But if the Distance run be 184 Miles, and the Difference of Latitude 1 deg. 32 min. and there be required the Rhomb and Distance to the Eastwards;

Because the Column of Distance extends but to 100 Miles, and the Distance here given is 184 Miles, you may take the half thereof, which is 92 Miles, and likewise the half of 1 deg. 32 min. which is 46 Miles, or 460 tenths; and then look, as before, where you find 460 against 92; for there in the Top of the Column you shall find the Rhomb, which in this Example is 60 deg. shewing that the Rhomb is from the North Easterly 60 deg. and in the adjacent Column against 92 and 460 you shall find 797, which doubled (because it is for the half) is 1594. shewing that the Departure from the Meridian to the Eastwards is 159 $\frac{4}{10}$ Miles. These and the rest may also be performed by the *Doctrine of plain Triangles*, as we have formerly shewed.

CHAP. XII.

ALthough the Time be already expired which I assigned for this Work, and mine own more urgent occasions call me away, yet seeing it is necessary in *Navigation* to take notice of Currents, and to make a competent Allowance for them; I will briefly set down certain *Problems*, such as I have sometimes thought upon, whereby a Man may the better conceive and judge of that Allowance, the rather for that I know not any that have handled it.

First then, it is to be conceived, that a Ship or other Vessel sailing or rowing where there is a Current, hath a compound motion arising of two different Principles; namely, of the Current and Ship's way: so that here are three motions to be considered, namely, two simple, and the third compound of them. The first simple Motion is that of the Current, whereby it moveth, and is apt to move other things that are in it the same way. The second of the Ship or Boat, as it moveth by Wind or Oars, or is apt to be moved, if there were no Current. The third, compound of them, is the Line of the Ship's true Motion. The first we call the Way or Motion of the Current; the second, the Way or simple Motion of the Ship; the third her compound or true Way. The two simple Motions being either of them according to right Lines, and uniform, as in the *Problems* following we suppose them to be. The third also, which is composed of them, is a right Line; for whether the Ship sail directly opposite, against the Current, or directly with it the same way, or whether the one cross the other at Right-Angles or at Oblique; yet still either motion being direct and uniform, they both together beget a right-lin'd uniform motion, because the one retaineth to the other one and the same proportion in every Point: And according to these grounds we proceed in the *Problems* following, to determine the Proportions of every of these motions, and the Angles they make one with another.

1. Admit a Current run East 3 Miles an Hour, and that a Ship under Sail doth run West directly against it 6 Miles an Hour in her simple Motion, What is her true or compound Motion?

From the Ship's simple motion ——— 6 miles,
Subtract the Current ——— 3 miles;
The Remainder is the Ship's true motion ——— 3 miles.

So the Ships true Way is to the Westwards 3 miles an Hour.

2. *Admit a Current run West 6 Miles an Hour, and that a Ship under Sail run directly against it 5 Miles an Hour by the Log: What is the Ship's compound Motion, and which way?*

From the Current, being the greater——6 Miles,
Subtract the Ship's simple motion——5 Miles;
There remains the Ship's true motion——1 Mile.

Which 1 mile shews, that the Ship by her compound motion falls astern, that is, moves to the Westwards 1 mile an Hour.

In the experimental Practice of the two former Problems it may seem, that a Ship or Boat so ordered, hath also a motion to the right-hand or to the left; but this comes to pass, because it is hard, and in a manner impossible to stem a Tide or Stream so exactly, but that the Ship will swerve (or yaw, as they say) either to one side or to the other.

3 *Admit a Current run East 3 Miles an Hour, and that the Ship also run East 3 Miles an Hour by the Log; What is the Ship's true motion?*

To the Ship's simple motion——3 Miles,
Add the Current——3 Miles;
The Sum is the Ship's true motion——6 Miles.

So the Ship's Compound or true Way, is East 6 miles an Hour.

4. *Admit a Current run East 2 Miles an Hour, and the Ship South 6 Miles an Hour: What is the Ship's true motion, and which way?*

In handling of any Art to avoid circumlocution, there are used Terms or Words of Art, serving to express briefly the things handled. And forasmuch as this Subject hath not been formerly handled, nor the Principles or Grounds thereof laid (so far as I know) we will add a few such Terms as may seem most necessary, expressing here what we mean by them.

Let the Line AB run from A to the Southwards, and BD from B to the Eastwards; and let AB be in proportion to BD, as 6 to 2, or 3 to 1.

Then doth AB represent the Line of the Ship's simple motion, BD the Motion of the Current, and AD the compound motion of the Ship.

And DAB is the Angle contained between the Line of the Ship's simple motion, and the Line of her compound or true Motion, which for brevity sake we will henceforth call the *Angle of Deflection*. Also ADB is the Angle contained between the Line of the Ship's compound motion, and the set or drift of the Current, which we call the *Angle of Reflection*.

Easily

Laſtly ABD is the Angle contained between the Line of the Ship's ſimple Motion, and the ſet of the Current, which we will call the *Angle of Incidence.*

Then for the Rhomb, the proportion is thus:

As the ſimple Motion ——— AB 6 Miles — *co. ar.* ——— 9.2219
Is to the Current ——— BD 2 Miles ——— 0.3011
So is Radius,
To the Tangent of Deflection *t.* DAB 18 deg. 26 min. ——— 9.5230

So the Rhomb upon which the Ship makes her way good, is South 18 deg. 26 min. Eaſterly, that is, S. S. E. 4 deg. 4 min. Southerly.

2. For the Ship's true Way, or compound Motion.

As the Sine of the Deflection *f.* DAB 18 deg. 26 min. ——— 0.5000
To the Current ——— DB 2 Miles ——— 0.3011
So Radius,
To the true Motion ——— AD 6 $\frac{11}{100}$ ——— 0.8011

So the Ship's Compound Motion is 6 $\frac{11}{100}$ Miles hourly, that is 6 $\frac{1}{2}$ Miles almoſt.

5. A Ship ſails Weſt 5 days together, by the Log 7.25 *Mile: but there is a Current all this while ſetting to the Southwards 1 $\frac{1}{2}$ Miles an Hour: I demand how ſhe hath ſailed, and how far?*

The Current ſetting 1 $\frac{1}{2}$ Mile an Hour, ſets in 5 days 180 Miles: Therefore,

As the ſimple Motion ——— AB 725 Miles ——— 7.1397
Is to the Current ——— DB 180 Miles ——— 2.2553
So is Radius
To the Tangent of Deflection *t.* DAB 13 deg. 57 min. ——— 9.3950

For the Diſtance.

As Sine compl. the Deflection *ſc.* DAB 13 deg. 57 min. ——— 0.0130
Is to the ſimple Motion ——— AB 727 Miles ——— 2.8603
So is Radius
To the compound Motion ——— AD 747 Miles ——— 2.8733

So the Ship's true way is Weſt ſoutherly 13 deg. 57 min. or South-weſterly 76 deg. 3 min. 747 Miles.

A Ship ſails Weſt 5 days together, by the Log. 725 *Miles, in a Current ſetting to the Southwards, and then finds that ſhe hath altered her Latitude 3 Degrees; I demand the Motion of the Current, the true Rhomb, and true way of the Ship?*

This Queſtion differeth little from the former; for ſeeing the Difference of Latitude is 3 deg. the motion of the Current is 180 Miles; ſo there is given the Ship's ſimple motion, and the motion of the Current, before, &c.

7. *A Ship in 6 Hours sails from a certain Cape or Head land South, 30 Miles by the Log, in a Current setting Easterly; and then observing the same Cape, he finds that it bears N.N.W. I demand how fast that Current sets, and how far she hath sailed?*

As let a Ship sail from A towards B South 30 Miles; but by means of the Current she is driven more Easterly, namely to D; from whence setting the Cape A, it is found to bear N.N.W. And seeing the Current sets from B towards D Easterly; therefore the Angle of Reflection BDA is 6 Points, that is 67 deg. 30 min. Here then is demanded the Distance AD, and the drift of the Current in that time BD.

As the Sine of the Angle of Deflection *s.* BDA 67 d. 30 min.— .0344
To the simple Motion of the Ship AB 30 Miles——— ———1.4771
So the Sine of the Angle of Deflection *s.* DAB 22 d. 30 min.——9.5736
To the Motion of the Current BD 12 $\frac{16}{100}$———1.0851

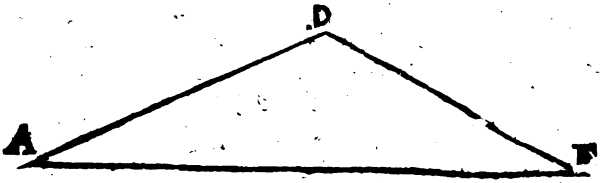
And further,

As the Sine of the Angle of Reflections *s.* BDA 67d, 30 m.— .0344
To the Distance run by the Log AB 30 miles,———1.4771
So is Radius,
To the compound Motion of the Ship AD 32 $\frac{47}{100}$———1.5115

And thus we find that Current to set 12 $\frac{16}{100}$, that is near 12$\frac{1}{6}$ Miles in 6 Hours, and the Distance run to be 32 $\frac{1}{2}$ Miles almost.

That the thing may be better conceived, we will use two or three Examples more familiar and obvious to every Man's Experience; yet grounded upon the same Principles and Reasons.

8. *Admit that* Tulis-stairs *bear from* Billingsgate-stairs *South-west southerly, namely, South-westerly* 40 *Degrees, and be distant* 80 *Poles; and suppose the Tide of Ebb to run there Eastward* 2 $\frac{1}{2}$ *Miles an Hour, and that a pair of Oars rowing* 4 $\frac{1}{2}$ *Miles an Hour, would go streight over from the first to the second: how shall they row over; namely, upon what Degree or Point of the Compass, and how far shall they row to get thither, and in what time?*



Let A represent *Billingsgate-stairs*, D *Tulis-stairs*, AE the simple Motion of the Boat, ED the Motion of the Current, then is A the Angle

Angle of Deflection, E the Angle of Incidence, D the Angle of Reflection, 130 deg. or 50 deg.

As the ſimple motion of the Boat--AE 4 $\frac{1}{4}$ miles——— ——9.34679
Is to the motion of the Tide——DE 2 $\frac{1}{2}$ miles——— ——0.39794
So the Sine of Reflection ———Ds 50 deg.——— ——9.88428
To the Sine of Deflection———As 23 deg. 3 min.———9.62893

Thus then the Poſition from A to D, being South-Weſterly 40 deg. and the Angle of Deflection A 23. deg 3. min. the Poſition from A towards E, is South-weſterly 63 deg. 3 min. that is, W.S.W. Southerly: And ſo muſt thoſe Oars row to go ſtreight over.

Secondly, For the Diſtance AE.

From the Angle of Reflection———D 50 deg. 00 min.
Subtract the Angle of Deflection———A 23 deg. 03 min.
And there reſts the Angle of Incidence———E 26 deg. 57 min.
As the Sine of Incidence.———ſ.E 26 deg. 57 min.———3.34370
To the true Diſtance———AD 80 Poles,——— ——1.90309
So the Sine of Reflection———ſ.D 50 deg. 00 min——9.88425
To the ſimple motion——AE 135 $\frac{3}{10}$ Poles——2.13104

Laſtly, for the Time.

Seeing 320 Poles make a mile, and they row 4 $\frac{1}{4}$ miles an hour, it is 1440 Poles in an Hour; ſo the proportion is,

As the ſimple hourly motion———1440——6.8416
To the ſimple motion before found——135 $\frac{3}{10}$——2.1310
So is an hour in minutes; namely,——60 min.——1.7781
To the Time required in minutes———5 $\frac{63}{100}$——0.7507

And ſo long will they be rowing over.

9. *But ſuppoſe they row harder, to go a ſhorter cut; namely, to go South-weſt by Weſt: How faſt muſt they row to go ſtreight over, and how far, and in what time?*

Then ſeeing the Poſition from A to D is South-weſterly 40 deg. nd South weſt by Weſt is South weſterly 56 deg. 15 min. therefore the gle of Deflection at A, is 16 deg. 15 min. the Angle of Reflection D fore, 50 deg. 00 min. the Angle of Incidence E is 33 deg. 45 min.

e Sine of Deflection———ſ.A 16 deg. 15 min.——.55311
he motion of the Tide ——DE 2 $\frac{1}{2}$ miles——0.39794
the Sine of the Angle of Reflection D 50 deg. 0 min.——9.88425
To the ſimple hourly motion of the Boat AE 6 $\frac{844}{1000}$——0.83530

And ſuch is the hourly motion of the Boat, namely, 6 $\frac{844}{1000}$ miles in an Hour.

Secondly,

Secondly, for the simple Motion.

As the Sine of Incidence	*f.* E 33 deg. 45 min.	0.25526
Is to the true Distance	AD 80 Poles	1.90309
So is the Sine of Reflection	*f.* D 50 deg. 00 min.	9.88425
To the simple Motion	AE 110 $\frac{3}{10}$ Poles	2.04260

Thus it appears they must row 110 $\frac{3}{10}$ Poles to get over.

Lastly, for the Time.

The hourly Motion before found 6 $\frac{844}{1000}$ reduced into Poles, is		2.190$\frac{1}{10}$
As the simple hourly motion	2190	6.65956
Is in proportion to an hour, or	60 min.	1.77815
So is the simple motion before found	110$\frac{3}{10}$	2.04260
To the time required	3 $\frac{022}{1000}$ min.	0.48031

And so long they will be rowing over.

10. *But admit a Sculler rowing 3 miles an hour, would cross streight over at the same time, upon what Point must he row, and how far, to get thither, and in what time will he do it?*

First, for the Angle of Position.

As the hourly motion of the Boat	AE 3 miles	9.52288
To the Sine of Reflection	D *f.* 50 deg.	9.88425
So is the hourly motion of the Stream	DE 2 $\frac{1}{2}$ min.	0.39794
To the Sine of Deflection	A *f.* 39 deg. 40 min.	9.80507

Now seeing the Position from *Billingsgate* to *Tulì-stairs*, namely, from A to D, is by supposition to the Westwards of the South 40 deg. and the Angle of Deflection A is here found to be 39 deg. 40 min. therefore the Position from A to E is from the South to the Westwards 79 deg. 40 min. which is W. and by S. and almost 1 deg. Westerly, and so must that Sculler row to go streight over.

Secondly, for the Distance AE.

		deg. min.
From the Angle of Reflection	D	50 00
Subtracting the Angle of Deflection	A	39 40
There rests the Angle of Incidence	E	10 20

As the Sine of Incidence	*f.* E. 10 deg. 20 min.	.74624
To the true Distance	AD 80 Poles	1.90309
So is the Sine of Reflection	*f.* D 50 deg. 00 min.	9.88425
To the simple Motion	AE 341 $\frac{5}{10}$ Poles	2.53358

And thus it appears, that though the Distance of the two places be but 80 Poles, yet, if according to the Question, he rows but after

3 miles an hour, and the Stream set after 2 $\frac{1}{2}$ miles an hour, then he must row 341 $\frac{6}{10}$ Poles, to go streight over.

Lastly, for the Time.

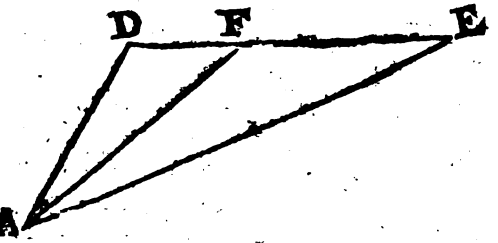
Three miles are 690 Poles; say then,

As the simple hourly Motion	960	7.01773
To the simple Motion before found	341 $\frac{6}{10}$	2.53358
So is an hour in minutes, namely	60 min.	1.77815
To the Time required in minutes	21 $\frac{35}{100}$	1.32946

And thus it appears, that the time requisite to row over, rowing 3 miles an hour, is 21 $\frac{35}{100}$ minutes; whereas we found before, that rowing there 4 $\frac{1}{2}$ miles an hour, they might row over in 5 $\frac{36}{100}$ minutes, which is little more than a fourth part of the Time.

There might be other, and that great variety of Questions of this nature proposed and resolved, many of good use in Practice, which the Watermen, by daily experience without other Rules, are able to guess at something nearly, sufficing for their occasions: My intent in these especially, is to explicate the compound Motion of a Ship, or other Vessel, sailing or rowing where there is a Current; which by such familiar Examples may seem more evident. I cannot insist upon them by reason of my other occasions, nor spend that time in these here handled, which else I should have done; whence if any defect or mistake should arise, if the Reader be pleased to give me friendly notice of it, I shall as thankfully accept it, and reform it. We purpose next a Question at Sea, which let be this.

11. *There is a Current at Sea, setting East 12 miles in 24 hours, a Ship sails in the time from a certain Port West South West six days; and then returning thence, and sailing North East and by North 3 days, falls with the Port from whence she first departed: I demand what her Dead Reckoning was outwards, and what back again, and how far these two Ports were asunder, and upon what Point of the Compass?*



As, let the Current set from E towards D, and let the first Port be A, the second F, and let the Course outwards bound be repre-

represented by AE, and the Course homeward by DA, &c.

And forasmuch as DE, is an East and West Line, and AE West South West, therefore the Angle at E is 22 deg. 30 min. and by the like reason, the Angle at D is 123 deg. 40 min. or 56 deg. 15 min. and the Angle at A 33 deg. 45 min. and ED, being the setting of the Current for 9 days, is 108 miles.

First then, for the Dead Reckoning outwards, namely, AE.

As the Sine of the Angle at A *f.* 33 deg. 45 min.		.25526
To the Line DE 108 miles		2.03342
So is the Sine of the Angle D *f.* 56 deg. 15 min.		9.91985
To the Line AE	74 $\frac{6}{10}$ miles	2.20853

Thus AE his Dead Reckoning outwards is 161 $\frac{6}{10}$.

Secondly, for AD.

As the Sine of the Angle DAE *f.* 33 deg. 45 min.		.25526
Is to the Line DE	108 miles	2.03342
So is the Sine of the Angle DEA *f.* 22 deg. 30 min.		9.58284
To the Line AD	74 $\frac{4}{10}$ miles	1.87152

Which 74 $\frac{4}{10}$ miles is the Dead Reckoning homewards.

Thirdly, for the Angle DAF *or* DFA.

The side AD is found 74 $\frac{4}{10}$ miles.
The side DF for three days is 36 miles.
The Sum of both is 110 $\frac{4}{10}$.
Their difference is 38 $\frac{4}{10}$.
The Sum of the Angles DAF and DFA 56 deg. 15 min.
The half Sum is 28 deg. 7 $\frac{1}{2}$ min.

The Proportion.

As the Sum of their sides	110 $\frac{4}{10}$.	7.95703
Is to their difference	38 $\frac{4}{10}$.	1.58433
So is the Tangent of	28 deg. 07 $\frac{1}{2}$	9.72706
To the Tangent of	10 d. 32 min.	9.26932

Which added together, make the Angle DFA 38 deg. 39 $\frac{1}{2}$.

And seeing the Rhomb from F to D is East, and the Angle DFA 38 deg. 39 min. $\frac{1}{2}$; therefore the Rhomb from F to A is to the Northwards of the East 38 deg. 39 min. $\frac{1}{2}$; that is, N.E. by E. almost half a Point Northerly; which is the Rhomb from the second Port to the first.

Lastly, for AF *the Distance of these two Ports.*

As the Sine of the Angle	DFA *f.* 38 deg. 39 $\frac{1}{2}$	.20434
To the Dead Reckoning homewards	AD 74 $\frac{4}{10}$ miles	1.87152

So is the Sine of the Angle D*f*. 56 deg. 14 min. 9.91985
To the distance A F 99$\frac{2}{100}$ miles 1.99571

Thus the true distance of those two Ports is 99 miles, and somewhat more.

Sundry other Questions of like nature might be proposed, which to him that well understandeth these, will not be difficult.

These Principles a little enlarged, may further with a few Experiments be applied in the discovery of some Mysteries in compound Motion, not yet divulged, tho much endeavoured by sundry famous Men in several parts of *Europe*; but these we shall not touch at present.

12. *To find where there is a Current at Sea; also which way it sets, and how fast.*

This may be done by comparing the Reckonings outwards with the Reckonings homewards, whereof we shall give an Example or two.

First, Admit a Ship sail from a certain Port, by one or several Rhombs or Distances, till she arrive at the second, and there find, reckoning by Course and Distance, that she is more Southerly than the Port from which she departed by 541 Miles, and more Westerly by 145 Miles: But by his Reckoning homewards, when he arrives again at the first Place, he finds himself to the Northwards of the second 541 Miles, as before, and to the Eastwards 305 Miles. Now supposing he was 3 days outward Bound, and 5 days homewards Bound, I would know which way the Current sets, and how fast; Here, because the Easterly Distance homewards is greater than the Westerly Distance outwards, therefore from the Easterly Distance 305 miles, subtract the Westerly Distance 145 miles, the Remaider being 160 miles, is the motion of the Current to the Westwards.

And thus it appeaas, that the Current sets to the Westwards, 160 miles in 8 days, that is 20 miles a day, or $\frac{5}{6}$ of a mile every hour.

Example 2. Admit a Ship sail from the *Summer-Islands*, by several Rhombs and Distances, till she arrive at Cape *Cod* in *New England*, namely, from the East part of *Summer-Islands*, (the Variation being allowed) first North 20 miles, and then N. N. W. 150 miles, the second day N. by W. 180 miles, the third day North 90 miles, the fourth day North-East 88 miles, and so arrive at Cape *Cod*: Then by these Courses and Distances we may gather by the foregoing Table, that Cape *Cod* should by this Reckoning be to the Northwards 487 miles, and to the Westwards 30 miles, as here appears.

North

	North.	South.	East.	West.
North 20 Miles	20 0			
North North-west 150 Miles	138 6			57 4
North by West 180 Miles	176 5			35 1
North 90 Miles	90 0			
North East 88 Miles	62 2		62 2	
528 Miles	487 3		62 2	92 5
				62 2
				30 3

Now suppose she sail back again from Cape *Cod* towards the *Summer-Islands*, the first day S. S. W. 150 Miles, the second day S. S. W. 160 Miles, the third day S. by W. 130 Miles, the fourth day South 140 Miles, the fifth day East 110 Miles, and so she come again to the East part of the *Summer-Islands*.

	North.	South.	East.	West.
South W. 150 Miles		138.6		57.4
South S. W. 160 Miles		147.8		61.3
South by W. 130 Miles		127.5		25.3
South 140 Miles		140.0		
East 110 Miles			110.0	
690 Miles		554.0	110.0	144.0
				110.0
				34.0

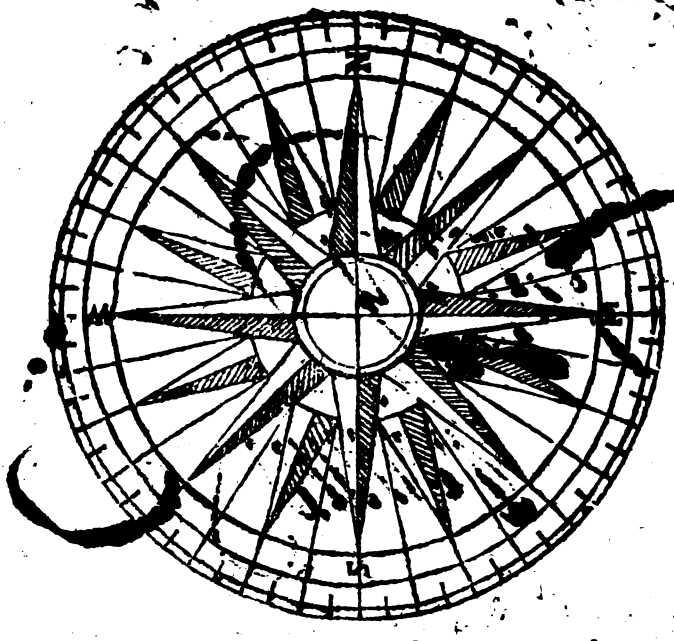
These Courses and Distances make, as here appeareth, the *Summer-Islands* to be to the Southwards of Cape *Cod* 554 Miles, and to the Westwards 30 Miles.

Therefore by this last Reckoning back again, Cape *Cod* should be to the Northwards of the *Summer-Islands* 554 Miles, and to the Eastwards 34 Miles, whereas by the former Reckoning outwards 30 Miles; so that the difference of these two Reckonings outwards and back again, is 67 Miles Northerly, and 64 Miles Easterly; which sheweth that the Current in that time, namely, in nine days, hath set to the Northwards 67 Miles, and to the Eastwards 64 Miles; that is, North East a little Northerly, 93 Miles, as by the foregoing Table doth appear, which is $10\frac{1}{3}$ Miles every day.

And what we have here done by the Tables, might have been done (as the foregoing Problems) by the *Doctrine of Plain Triangles*.

Note, That where the Author mentions *Summer-Islands*, it is the same as *Bermudas*.

FINIS.



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Samuell Chadik
His Book July 1771

Samuell
Chadik