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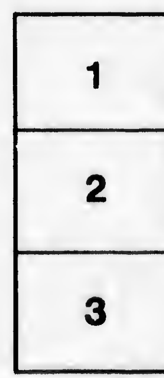

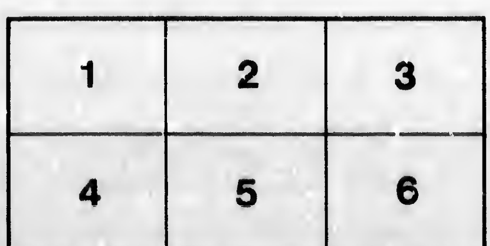

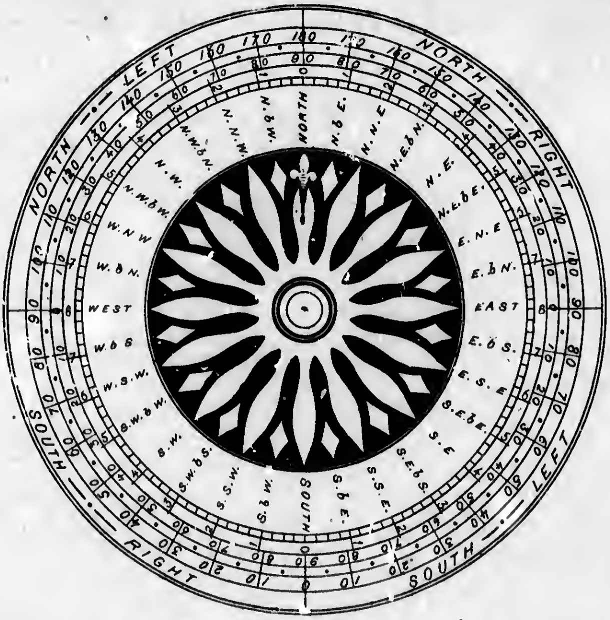

A TABLE OF THE ANGLES

which every Point & Quarter Point of the Compass makes with the Meridian.

NORTH.		POINTS.	°	′	″	POINTS.	SOUTH.	
		0 ¼	2	48	45	0 ¼		
		0 ½	5	37	30	0 ½		
		0 ¾	8	26	15	0 ¾		
N.b.E.	N.b.W.	1	11	15	0	1	S.b.E.	S.b.W.
		1 ¼	14	3	45	1 ¼		
		1 ½	16	52	30	1 ½		
		1 ¾	19	41	15	1 ¾		
N.N.E.	N.N.W.	2	22	30	0	2	S.S.E.	S.S.W.
		2 ¼	25	18	45	2 ¼		
		2 ½	28	7	30	2 ½		
		2 ¾	30	56	15	2 ¾		
N.E.b.N.	N.W.b.N.	3	33	45	0	3	S.E.b.S.	S.W.b.S.
		3 ¼	36	33	45	3 ¼		
		3 ½	39	22	30	3 ½		
		3 ¾	42	11	15	3 ¾		
N.E.	N.W.	4	45	0	0	4	S.E.	S.W.
		4 ¼	47	48	45	4 ¼		
		4 ½	50	37	30	4 ½		
		4 ¾	53	26	15	4 ¾		
N.E.b.E.	N.W.b.W.	5	56	15	0	5	S.E.b.E.	S.W.b.W.
		5 ¼	59	3	45	5 ¼		
		5 ½	61	52	30	5 ½		
		5 ¾	64	41	15	5 ¾		
E.N.E.	W.N.W.	6	67	30	0	6	E.S.E.	W.S.W.
		6 ¼	70	18	45	6 ¼		
		6 ½	73	7	30	6 ½		
		6 ¾	75	56	15	6 ¾		
E.b.N.	W.b.N.	7	78	45	0	7	E.b.S.	W.b.S.
		7 ¼	81	33	45	7 ¼		
		7 ½	84	22	30	7 ½		
		7 ¾	87	11	15	7 ¾		
East	West	8	90	0	0	8	East	West

A MANUAL

OF THE

EXAMINATION

OF

MASTERS AND MATES

AS INSTITUTED BY THE

DEPARTMENT OF MARINE AND FISHERIES OF CANADA

BY

WILLIAM C. SEATON

SUPERINTENDENT OF THE GOVERNMENT MARINE SCHOOLS

Late Nautical Master to the Society of Merchant Venturers
Bristol, England.

SECOND EDITION.

QUEBEC
DAWSON & Co.

1875.

Entered according to Act of Parliament of Canada, in the year of Our Lord One Thousand Eight Hundred and Seventy-five, by WILLIAM CHARLES SEATON, in the Office of the Minister of Agriculture.

PREFACE

TO THE

SECOND EDITION.

The First Edition of this work was issued almost in the light of an experiment, and it is consequently with all the more thankfulness that I have to acknowledge the favor with which it has met. In publishing this Second Edition of my Manual, I have endeavored to supply all the deficiencies which experience shewed existed in its predecessor and it is hoped that the large additions which have been made in consequence, will win for it the favor of the class for which it is specially designed.

Many hundreds of examples have been introduced, thus copiously illustrating every rule treated of; the answers to these exercises are also given at various stages of each problem, and the requisite elements from the Nautical Almanac and the Admiralty Tide Tables are appended, so as to make the book, as far as possible, complete in itself. I have thought it advisable to adapt both rules and examples to the Epitomes of Norie, Bowditch and Raper, the three works on Navigation in most common use, so that students who have accustomed themselves to either one or other of these books, may avoid the disadvantage of having to unlearn that which they may have already acquired, or of having to alter the text so that it may coincide with their Tables.

The section upon Seamanship appears for the first time in this edition, much care has been expended upon it, and it is hoped it will be found useful not only to the applicant for a Certificate of Competency, but also to the Master in actual command of his ship and the Officer in charge of the deck. It is with the greatest pleasure that I have to acknowledge the assistance which I have received in this particular from Capt. H. J. R. Langdon (in charge of the Government Marine School at Halifax, N. S.) for I have felt that his thorough knowledge of every thing appertaining to a seaman and his long experience in his profession, made all suggestions emanating from him, of the greatest practical value.

The leading lights have been corrected as far as possible to the time of publication, and the Definitions and answers to the questions in the various Examination papers have been made as concise as clearness would allow.

With the revision that the whole of the original work has undergone, together with the many additions made to it, I trust the result will be so far satisfactory that its shortcomings may be overlooked, in the good service it has been my endeavour to make this little Manual capable of performing.

WILLIAM C. SEATON.

Quebec, August 1875.

COPY OF HER MAJESTY'S ORDER

IN COUNCIL,

GIVING EFFECT TO CERTIFICATES OF COMPETENCY ISSUED IN CANADA, AND COPY OF RULES AND REGULATIONS RELATING TO EXAMINATION OF CANDIDATES AND OF CERTIFICATES OF COMPETENCY AND SERVICE.

At the Court at Balmoral, the 19th day of August, 1871.

PRESENT,

The QUEEN'S Most Excellent Majesty in Council.

WHEREAS by «The Merchant Shipping (Colonial) Act, 1869,» it is (among other things) enacted that where the Legislature of any British Possession provides for the examination of, and grant of certificates of competency to, persons intending to act as masters, mates, or engineers on board British ships, and the Board of Trade reports to Her Majesty that they are satisfied that the examinations are so conducted as to be equally efficient as the examinations for the same purpose in the United Kingdom under the Acts relating to Merchant Shipping, and that the Certificates are granted on such principles as to show the like qualifications and competency as those granted under the said Acts, and are liable to be forfeited for the like reasons and in the like manner, it shall be lawful for Her Majesty, by Order in Council:

1. To declare that the said certificates shall be of the same force as if they had been granted under the said Acts:
2. To declare that all or any of the provisions of the said Acts which relate to certificates of competency granted under those Acts shall apply to the certificates referred to in the said Order:
3. To impose such conditions, and to make such regulations with respect to the said certificates, and to the use, issue, delivery, cancellation, and suspension thereof, as to Her Majesty may seem fit, and to impose penalties not exceeding fifty pounds for the breach of such conditions and regulations:

And that upon the publication in the London Gazette of any such order in Council as last aforesaid, the provisions therein contained shall from a date to be mentioned for the purpose in such Order, take effect as if they had been contained in the Act; and that it shall be lawful for Her Majesty in Council to revoke any order made under this section:

And whereas the Legislature of the British possession of Canada has provided for the examination of and grant by the Minister of Marine and Fisheries in the said possession of certificates of competency for sea-going ships to persons intending to act as master or mates on board British seagoing ships, which Certificates are hereinafter denominated Colonial Certificates of Competency, and the Board of Trade have reported to Her Majesty that they are satisfied that the said examinations are so conducted as to be equally efficient as the examinations for the same purpose in the United Kingdon, under the Acts relating to Merchant Shipping, and that the certificates are granted on such principles as to show the like qualifications and competency as those granted under the said Acts, and are liable to be forfeited, for the like reasons and in the like manner:

Now therefore, Her Majesty, in exercise of the power vested in Her by the said recited Act, by and with the advice of Her Privy Council, is pleased,

(1) To declare that the said Colonial Certificates of Competency granted by the Minister of Marine and Fisheries in the said possession of Canada shall be of the same force as if they had been granted under the said Acts, that is to say, the said Colonial Certificates of Competency as Masters of such sea-going ships shall be of the same force as if they were Certificates of Competency as Masters of foreign-going ships, granted under the said Acts, and the said Colonial Certificates of Competency as Mates of such sea-going ships shall be of the same force as if they were Certificates of Competency as First Mates of foreign-going ships granted under the said Acts.

(2) To declare that all the provisions of the said Acts which relate to Certificates of Competency for the foreign trade granted under those Acts, except the 139th section of «The Merchant Shipping Act, 1854,» and so much of the 3rd paragraph of the 23rd section of «The Merchant Shipping Act Amendment Act, 1862,» as requires at the conclusion of a case relating to the cancelling or suspending of a Certificate, such Certificate, if cancelled, or suspended, to be forwarded to the Board of Trade. And the whole of the fourth paragraph of the same section shall apply to such Colonial Certificates of Competency.

(3) To impose and make the conditions and regulations following, numbered 1 to 10 respectively with respect to the said Colonial Certificates of Competency, and to the use, issue, delivery, cancellation, and suspension thereof, and to impose for the breach of such conditions and regulations the penalties therein mentioned.

Form of Certificate.

1. Every such Colonial Certificate of Competency shall be on parchment, and as nearly as possible simiiar in shape and form to the corresponding Certificate of Competency for the foreign trade, granted by the Board of Trade under the Acts relating to Merchant Shipping.

Name of Possession to be inserted.

2. Every such Colonial Certificate of Competency shall have the name of the said Possession of Canada inserted prominently on its face and back.

Certificates to be numbered consecutively.

3 Such Colonial Certificates of Competency shall be numbered in consecutive order.

Lists of Certificates granted, cancelled, &c., to be sent to Registrar-General of Seamen.

4. The Government of the said Possession shall furnish the Registrar-General of Seamen in London from time to time with accurate lists of all such Colonial Certificates of Competency as may be granted as aforesaid by the said Minister of Marine and Fisheries, or as may for any cause whatsoever, be cancelled, suspended, renewed, or re-issued.

Three years Domicile or Service necessary.

5. Such Colonial Certificates of Competency shall be granted

only to persons who have been domiciled in the said Possession, or who have served in ships registered therein for a period of, or for periods amounting to, at least three years immediately preceding their application for such Colonial Certificates.

Certificates of Competency granted contrary to this regulation shall be regarded as improperly granted.

Certificates not to be granted when former are Cancelled.

6. Such Colonial Certificates of Competency shall not be granted to any person who may have had a Certificate, whether granted by the Board of Trade or by the Government of a British Possession, cancelled or suspended under the provisions of the said Acts, or of any Act for the time being in force in any part of Her Majesty's Dominions unless the period of suspension has expired, or unless intimation has been received from the Board of Trade, or the Government by whom the cancelled or suspended Certificate was originally granted, to the effect that no objection to the grant of such Colonial Certificate is known to exist, or unless a new Certificate has been granted to him by such Board or Government, and in the last named event no such Colonial Certificate of Competency shall be for a higher grade than the Certificate so last granted as aforesaid. Colonial Certificates of Competency granted contrary to this regulation shall be regarded as improperly granted.

Certificates improperly granted may be cancelled without formal investigation.

7. Any such Colonial Certificate of Competency which appears from information subsequently acquired or otherwise, to have been improperly granted, whether in the above or in any other respect, may be cancelled by the Government of the said Possession or by the Board of Trade in the United Kingdom, without any formal investigation under « The Merchant Shipping Act, 1854, » and the holder of such Certificate shall thereupon deliver it to the Board of Trade or the Government of the said Possession, or as they or either of them may direct, and in default thereof shall incur a penalty not exceeding fifty pounds which shall be recoverable in the same manner as penalities imposed by the Acts relating to Merchant Shipping are thereby made recoverable.

Cancellation, &c., of a Certificate shall involve Cancellation of all the other Certificates possessed by its owner.

8. Every decision with respect to the cancellation or suspension of a certificate pronounced by any Board, Court or Tribunal under the provisions of the said Acts shall extend equally to all the

Colonial Certificates at the time possessed by the person in respect of whom the decision is made, as well as to all Certificates granted to him under any of the Acts relating to Merchant Shipping, and whether such Certificates be specified in such decision or not.

Certificates believed to be fraudulent may be demanded.

9. Any officer of the Board of Trade, or the Registrar-General of Seamen, or any of his officers, or a Superintendant of a Mercantile Marine Office, or a Consular Officer, or duly appointed shipping officer in a British Possession, may demand the delivery to him of any such Colonial Certificate of Competency which he has reason to believe has been improperly issued, or is forged, altered, cancelled or suspended, or to which the person using it is not justly entitled, and may detain such Certificate for a reasonable period for the purpose of making inquiries respecting such issue, forgery, alteration, cancellation, suspension, or possession and any person who without reasonable cause neglects or refuses to comply with such demand, shall incur a penalty not exceeding twenty pounds, which shall be recoverable in the same manner as penalties imposed by the Acts relating to Merchant Shipping are thereby made recoverable.

Suspended Certificates to be re-issued only by Colony by which originally granted.

10. Any such Colonial Certificate of Competency which has from any cause been cancelled or suspended whether by a Tribunal in Canada, or elsewhere, shall be renewed or re-issued only by the Government of Canada.

This Order shall take effect in the said Possession of Canada from and after the date hereof.

(Signed) EDMUND HARRISON.

NOTICE TO CANDIDATES FOR EXAMINATION AS MASTERS AND MATES, AND REGULATIONS RELATING THERETO.

Place of examination.

The examinations will be held in the ports of Montreal, Quebec, St. John, and Halifax, at such times as may be decided upon by the Minister of Marine and Fisheries, of which due notice will be given.

Testimonials of character, conduct and ability required.

Testimonials of character and of sobriety, experience, ability and good conduct on board ship, will be required of all applicants, and without producing them no person will be examined. As such testimonials will have to be closely examined by the examiners for verification before any certificates can be granted, it is desirable that candidates should lodge them as early as possible. The testimonials of servitude of foreigners and British seamen serving in foreign vessels, must be confirmed either by the Consul of the country to which the ship in which the candidate served belonged, or by some other official authority of that country, or by the testimony of some credible person on the spot, having personal knowledge of the facts required to be established. Upon application to the Board of Examiners, candidates will be supplied with a form which they will be required to fill up and lodge with their testimonials in the hands of the Examiners.

How time in Coasting Trade will count.

Where the Board of Examiners are in every respect satisfied with the testimonials of a candidate, service in the coasting trade may be allowed to count as service, in order to qualify him for a certificate of competency for a "sea-going ship," as a mate, and two years' service as mate in the coasting trade may be allowed to count as service for a Master's Certificate, provided the Candidate's name has been entered as mate in the Coasting Articles, or other proof satisfactory to the Examiners, and provided he has already passed an examination.

Rules.

Qualifications for certificates of competency as mate.

The qualifications required for the ranks undermentioned are as follow:

1. A *Mate* or *only Mate* must be nineteen years of age, and have been four years at sea. (Service in a superior capacity is in all cases to be equivalent to service in an inferior one.)

2. *In Navigation.*—He must write a legible hand, and understand the first rules of arithmetic, and the use of logarithms. He must be able to work a day's work complete, including the bearings and distance of the Port he is bound to, by Mercator's methot; to correct the sun's declination for longitude, find his latitude by the meridian altitude of the sun, and by single altitude of the same body off the meridian. He must be able to observe and compute the variation of the compass from azimuths and amplitudes; be able to compare chronometers and keep their rates; and be able to find the longitude by them from an observation of the sun by the usual methods. He must be able to lay off the place of the ship on the chart, both by the bearings of known objects, and by latitude and longitude. He must be able to determine the error of a sextant and to adjust it; also to find the time of high water from the known time at full and change. **Qualifications for certificates of competency as mates.**

3. *In Seamanship.*—He must give satisfactory answers as to the rigging and stripping of ships and stowing of holds; must understand the measurement of the logline, glass and lead-line; be conversant with the rule of the road, as regards both steamers and sailing vessels, and lights and fog-signals carried by them, and will also be examined as to his acquaintance with "the Commercial Code of Signals for the use of all nations." In addition to which he will be required to know how to moor and unmoor and keep a clear anchor; to carry out an anchor, and to make the requisite entries in the ship's log. He will also be questioned as to his knowledge of the use and management of the mortar and rocket lines in the case of the stranding of a vessel as explained in the official logbook. He will also be required to know to shift large spars and sails; to manage a ship in stormy weather, to take in and make sail, to shift yards and masts, &c., and to get heavy weights, anchors, &c., in and out; to cast a ship on a lee-shore; and to secure the masts in the event of accident to the bowsprit.

4. A *Master* must be twenty-one years of age, and have been six years at sea, of which at least two years must have been as *Mate* or *Only Mate*. **Master.**

5. In addition to the qualification for a *Mate* or *Only Mate*, he must be able to find the latitude by a star, &c. He will be asked questions as to the nature of the attraction of the ship's iron upon the compass, and as to the method of determining it. He will be

examined in so much of the laws of the tides as is necessary to enable him to shape a course, and to compare his soundings with the depths marked on the charts. He will be examined as to his competency to construct jury rudders and rafts; and as to his resources for the preservation of the ship's crew in the event of wreck. He must possess a sufficient knowledge of what he is required to do by law as to entry and discharge, and the management of his crew, and as to penalties and entries to be made in the official log, and a knowledge of the measures for preventing and checking the outbreak of scurvy on board ship. He will be questioned as to his knowledge of invoices, charter-party, Lloyd's agent, and as to the nature of bottomry, and he must be acquainted with the leading lights of the channel he has been accustomed to navigate, or which he is going to use.

Service in fore-and-aft rigged vessels.

6. In cases where an applicant for a certificate as *Master* has only served on a fore-and-aft rigged vessel, and is ignorant of the management of a square-rigged vessel, he may obtain a certificate on which the words "Fore-and-aft-rigged vessel" will be written. This certificate does not entitle him to command a square-rigged ship. This is not, however, to apply to *Mates*, who, being younger men, are expected for the future to learn their business completely.

Punctuality of candidate's attendance.

7. Candidates are required to appear at the examination room punctually at the time appointed.

8. Candidates are prohibited from bringing into the examination room books or paper of any kind whatever. The slightest infringement of this regulation will subject the offender to all the penalties of a failure.

Candidates injuring examination papers.

9. In the event of any candidate being detected in defacing, blotting, writting in, or otherwise injuring any book or books belonging to the Board, the papers of such candidate will be detained until the book or books so defaced be replaced by him. He will not, however, be at liberty to remove the damaged book, which will still remain the property of the Board.

Candidates discovered copying, etc.

10. In the event of any candidate being discovered copying from another or affording any assistance or giving any information to another, or communicating in any way with another during the time of examination, he will subject himself to a failure and its consequences.

11. No candidate will be allowed to work out his problems on a slate or on waste paper.

Time allowed to work out navigation papers.

12. No candidate will be permitted to leave the room until he has given up the paper on which he is engaged.

13. Candidates will be allowed to work out the various problems by the method and tables they have been accustomed to use, and will be allowed six hours to perform the work. At the expiration of six hours they will, if they have not finished, be declared to have failed, unless the Board of Examiners see fit to lengthen the period in any special case. If, however, the period is lengthened in any case the special circumstances of that case and the reasons for lengthening the period must be reported to the Minister of Marine and Fisheries by the Examiners at the time they send in the Report.

Corrections by inspection not allowed.

14. The corrections by inspection from the tables given in many works on navigation, will not be allowed (see Tables IX, XI and XXI, in Norie's Epitome, &c.); every correction must appear on the papers of the candidates. The first-class are referred to page 519 of the Nautical Almanac, 1867, for further information on this subject.

15. Candidates are expected to bring their answers to all problems within, or not exceed a margin of one mile of position from a correct result.

16. In finding the longitude by chronometer, the logarithms used in finding the hour-angle should be taken out for seconds of arc.

In all other problems the logarithms to the nearest minute will be sufficiently correct for all grades, except Master, from whom a degrees of precision will be required, both in the work and in the results, beyond what is demanded from the inferior grade.

Examination to commence with that of mates.

17. In every case the examination for Master is to commence with the problems for Mate.

Re-examination in case of failure.

18. In all cases of failure the candidate must be re-examined *de novo*. If the candidate fails in *Seamanship* he will not be re-examined until after a lapse of six months, to give him time to gain experience. If he fail three times in Navigation he will not be re-examined until after a lapse of three months.

Examination as to knowledge of commercial code of signals

19. The Examiners are to insert in the Report of Examinations (under heading Remarks), the words "passed," (or "failed,") in Commercial Code of Signals, as the case may be.

NOTES.

Correcting declination, &c.

Candidates will find it more convenient, both here and at sea, to correct the declination and other elements from the Nautical Almanac by the "hourly differences," which have been given in that work in order to facilitate such calculations, they will thereby render themselves independent of any proportion or logarithmic table for such purpose.

Standard of examination will be raised.

Standard of examination to be raised.

As the examinations for Masters and Mates are made compulsory, the qualifications have been kept as low as possible, but it is distinctly to be understood that the Minister of Marine and Fisheries may raise the standard from time to time, whenever, as will no doubt be the case, the general attainments of officers in the Merchant Service shall render it possible to do so without inconvenience; and officers are strongly urged to employ their leisure hours, when in port, to the acquirement of the knowledge necessary to enable them to pass their examinations; and masters will do well to permit apprentices and junior officers to attend schools of instruction, and to afford them as much time for this purpose as possible.

NOTICE.

EXAMINATION OF MASTERS AND MATES.

By virtue of an Order in Council bearing date the 26th of June, 1871, the following amendments have been made to the Rules and Regulations for examination of Candidates for Certificates of Competency as Masters and Mates in Mercantile Marine, as approved by Order in Council of 27th February, 1871.

1st. Rule 1st has been so amended as to require five years service at sea instead of four years, for a Mate or only Mate, of which one year must have been as either second or only Mate, or as both; services in a superior capacity being in all cases equivalent to service in an inferior capacity.

2nd. Candidates for Certificates of Masters and Mates must be examined in the use of the International Code of Signals, and failure in this branch will be treated as failure in Navigation.

By Order,

WM. SMITH,

Deputy of the Minister of Marine and Fisheries.

DEPARTMENT OF MARINE AND FISHERIES,
OTTAWA, 20th July, 1871.

EXAMINATIONS OF MASTERS AND MATES.

NOTICE OF ALTERATION IN EXAMINATION PAPERS.

By virtue of an Order in Council, bearing date the 12th October, 1872, all Candidates presenting themselves for examination for Masters' and Mates' Certificates for the first time will be required to give short definitions of so many of the terms contained in the following list [A]* as may be marked with a cross by the Examiner. These questions are at the same time intended to test the Candidate's handwriting and spelling, to both of which special attention should be paid by him.

For the "Table of Deviations" which heretofore formed part of Exu. 7, the questions contained in the following list [B]† have been substituted. Candidates for Certificates of Competency as Masters Ordinary will be required to answer at least eight of such of these questions as may be marked with a cross by the Examiner.

WM. SMITH,
Deputy of the Minister of Marine and Fisheries.

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* See Definitions in Navigation and Nautical Astronomy.

† See "Deviation."

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HINTS TO STUDENTS.

When a rule has been explained to you, study it in connection with the worked example until you can see a little into it; then work out the first example two or three times until you get into the swing of it, for you must remember, that it is not the number of examples you work out, but the number which you understand, that is the real test of your progress. Never puzzle too long over a difficulty, but go and ask for an explanation directly you find you cannot see your way clear; for you may not only be very needlessly wasting time, but you may be getting a wrong idea into your head which may give you a lot of trouble to unlearn; a very few words from a competent authority will generally make a crooked path appear straight. Again, refer *as little as possible* to the data given with the answers; these are only supplied to help you in detecting a possible error, but if you use them as a kind of running check while you are working out the exercises, you will be accustoming yourself to leading strings which you will look for in vain when before the Board of Examiners. Do not leave one kind of work for another until you are desired so to do, for there is often a great deal to learn in the work you are about, at the very time that you may think yourself master of it. Any one who understands and can work out the exercises given in this Manual may, with justice, consider himself a good navigator; but this is not enough for an applicant for a certificate of competency, for he not only requires a certain amount of polish in his work, but he requires to be kept posted in the little minor changes which are constantly occurring in the conduct of the examinations; this is effected by what may be termed the floating sets of examination papers in the schools under my control, and these will be given to the student when he is prepared to use them.

Lastly, learn every thing *thoroughly*, for in the same way that one weak link will destroy the strength of a cable, so one little problem, carelessly learnt, oftentimes brings a man to grief when he is before the examiners.

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LOGARITHMS.

TO FIND THE INDEX OF A NUMBER.

1. If the given number be a whole number.—Count the number of figures contained in it, and the index will be 1 less than that number :

Ex. 1 —	The index of	8	is	0
" 2 —	"	36	"	1
" 3 —	"	459	"	2

2. If the given number is a mixed number.—The index will be 1 less than the number of figures to the left hand of the decimal point :

Ex. 4 —	The index of	3·6	is	0
" 5 —	"	45·9	"	1
" 6 —	"	82·65	"	1
" 7 —	"	369·4	"	2

3. If the given number is a decimal number.—If there are not any cyphers following the decimal point, the index will be - 1, but every cypher between the point and the first significant *

* The first significant figure is the figure *not a cypher*.

figure will increase the index by 1; these are called negative indices:

Ex. 8	The index of	·36	is	– 1
" 9	"	·036	"	– 2
" 10	"	·0036	"	– 3

4. What are termed complementary indices are sometimes used in their place, to obviate any difficulty that may be found in using the negative sign; these indices are found by subtracting the negative index from 10— or directly, by subtracting the number of cyphers immediately following the decimal point from 9, the remainder being the index required. In the last three examples, the complimentary indices would be 9, 8 and 7 respectively. The objection to the use of these indices is, that in some computations, there may be a difficulty in judging, whether the resulting index be of a positive or negative character.

TO FIND THE LOGARITHM OF A GIVEN NUMBER.

5. In the left hand column of the table (*Norie* Table XXIV, *Bowditch* Table XXVI, *Raper* Table 64) will be found a series of numbers in regular order from 100 upward, and to the right of this column of numbers, will be seen several other columns, marked at the top and bottom from 0 to 9.

6. If the given number contains four figures.—Look in the column of numbers for the first three figures of the given number (never mind the decimal point of there is one) then in that line, and in the column marked with the fourth figure at the top (or bottom) will be found the logarithm required, which set down alongside its index.

Ex. 11.—The logarithm of 82·65 is 917243, and would be the same, if the decimal point in the natural number were in any other place, the change effected by a removal of the decimal point, being recorded by the index. The index of the above number being 1, the logarithm will be set down as 1·917243.

Ex. 12.—The logarithm of 369·4 is 2·567497.

7. If the given number contains less than four figures.—Suppose as many cyphers added to its right hand, as will made up four figures, then take out the log. of it as directed in the preceeding paragraph (5).

Ex. 13	The logarithm of	3·6 (or 3·600)	is	0·556302
" 14	"	45·9 (or 45·90)	"	1·661813

8. If the given number contains more than four figures.—Find the log. of the first four figures, after which take out the number found opposite in the "Diff" column* and multiply it by the remaining figures of the given number, cut off from the right of the product, as many figures as you have multiplied by, and the number thus left will be the correction, which is to be added to the log. first taken out.

9. In *Raper* this correction may be taken out by inspection, thus:—look at the bottom of the page for the line having your "Diff" number at its left hand, then in that line and under the fifth figure, found at the top of this subordinate table, will be given the correction required. Although the correction necessary for six or more figures may also be found, by placing each further tabular correction successively one place more to the right, yet when the natural number exceeds five figures, it will be found more accurate to compute the correction as directed in (8). See examples 15 and 16 where the correction there found by calculation, will be seen to be the same as those given by inspection.

Ex. 15 — Find the logarithm of 847·32

Log. of	847·3	2·928037	diff.	51
Correction for	2	+ 10		2
Log. of	847·32	2·928047	correction	10,2

Ex. 16 — Find the logarithm of 84·7325

Log. of	84·73	1·928037	diff.	51
Correction for	25	+ 13		25
Log. of	847325	1·928050		255
				102
(The left hand figure of those cut off being over 5 makes the correction 1 more)				12,75

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* In *Bowditch* this number is found by subtracting the log. taken out, from the one following it in the tables; and if the given number contains but five figures the correction may be found by inspection thus:—select the little table at the right of the page, which has this difference at the top; now find the fifth figure of the given number in its left hand column, and opposite will be given the required correction, which is additive to the log. of the first four figures.

TO FIND THE NUMBER CORRESPONDING TO A GIVEN LOGARITHM.

10. If a natural number containing four figures will be sufficient.—Find the nearest log. in the table to the given one, and in the number column opposite, will be found the first three figures of the required number, while the fourth will be given at the top (or bottom) of the column where the nearest log. was found ; the decimal point is now to be placed as explained in the rule below (10 & 11.)

Ex. 17.—Required a natural number to four places of figures corresponding to the logarithm 707847.

Here the nearest log. to that given is 707826 the natural number corresponding to which is 5103.

Ex. 18.—Required a natural number to four places of figures corresponding to the logarithm 863600.

In this case, the nearest log. is 863620 giving as a natural number 7305.

11. If the natural number is required to more than four places of figures.—Find the *nearest less* log. to that given, you will thus obtain the first four figures of the desired nnmber ; now subtract the log. taken out from the given one, and place a cypher to the right of the remainder ; divide the number so formed, by the number found in the " Diff." column * opposite the log. taken out, and the quotient will be the *fifth* figure required. If a *sixth* figure is desired, add a cypher to the last remainder and divide by the tabular difference as before ; in this manner, by placing a cypher to the right of each successive remainder, and dividing by the tabular difference, any number of additional figures may be obtained. It may be mentioned that if the exact log. is found in the table, any additional figures required will be cyphers.

12. In *Raper* a fifth figure may be found by inspection thus :—look in the table at the foot of the page for the line having your " Diff." number at its left hand ; then in this line, select the nearest you can to the difference between the given log. and that taken out, and the figure at the head of the column will be the fifth

* In *Bowditch*, as before, this difference is found, by subtracting the log. taken out from the one following it in the table; and if only one additional figure is required, it can be found by inspection, thus :— select the little table at the right of the page having this difference at its top ; then find in its right hand column, the nearest number to the difference between the log. taken out and the given one, and alongside will be found the fifth figure required.

figure required. Further figures may also be obtained by this method, but as their accuracy cannot be depended upon, it is better to find them by calculation, as explained for Norie's epitome.

See Ex. 19, and the fifth figure found by inspection will be seen to be the same as that given by calculation. In Ex. 20, the "Diff." by *Raper* is 333 instead of 332 as give by *Norie*, but this does not change the result.

Ex. 19.—Find the natural number to five places of figures corresponding to the logarithm 575916

Given log.	575916	
Nearest less log.	575880	corresponding natural number 3766

"Diff." 115) 360 (3
345
———
15

The required natural number therefore is 37663.

Ex. 20.—Required the natural number to six places of figures corresponding to the logarithm 115500.

Given log.	115500	
Nearest less log.	115278	corresponding natural number 1304

332) 22200 (66
1992
———
2280
1992
———
288

Here the remainder being more than half the divisor, shews that in the last figure of the quotient, 7 would be nearer than 6, the natural number required is consequently 130467.

Ex. 21.—Required the natural number to five places of figures corresponding to the logarithm 447003.

In this case the exact log. is found with a natural number of 2799 the natural number required with therefore be 27990.

TO PLACE THE DECIMAL POINT.

13. If the index is positive.—Add 1 to the index, and reckoning from the left of the natural number, point off that number of figures.

Ex. 22 — The natural number of 0·874550 is 7·491
" 23 — " " 1·567700 " 36·96
" 24 — " " 2·995315 " 989·3

14. If the index is negative.—Subtract 1 from the index, and prefix to the left of the natural number, that number of cyphers, placing the decimal point to the left of all.

Ex. 25 — The natural number of – 1·493190 is ·3113
" 26 — " " – 2·321184 " ·02095
" 27 — " " – 3·049692 " ·008906

15. If the complementary indices have been used, subtract the index from 9 and this will give the number of cyphers to be prefixed to the natural number.

In the three last examples, the complementary indices would have been 9, 8 and 7 respectively; and it will be seen, that the application of the rule will bring the same result to that given above.

TO FIND THE LOG. SINE, COSINE &c., OF A GIVEN ARC.

16. These logs. will be found in Table XXV of *Norie*, Table XXVII of *Bowditch* or Table 68 of *Raper* as follows :—

17. If the arc is less than 45°.—Find the page having the required degrees at its top, now seek the minutes in its left hand column and opposite to this, in the column marked with the name of the desired log. *at the top*, will be found the log. required.

Ex. 28 — The log. sine 11° 20' is 9·293399
" 29 — The log. Co. secant of 35° 41' " 10·234104
" 30 — The log Cosine of 23° 14' " 9·956447

18. If the arc is greater than 45°.— Now in seeking the proper page, the degrees will be found at the bottom of the page, with the minutes in its right hand column, opposite which, the log. required will be found in the column marked at foot with its name.

Ex. 31 — The log. secant of 47° 54' is 10·173649
" 32 — The log. Co. tangent of 70° 39' " 9·545524
" 33 — The log. sine of 57° 12' " 9·924572

19. If the arc exceeds 90°.—Either subtract the arc from 180° and take out the required log. of the remainder, or take out *the complement* of what the arc exceeds 90°, that is, the tangent for the Co-tangent &c.

Ex. 34 — Find the Co-Secant of 99° 18′.

The supplement of this arc (that is, what it is less than 180° is 80° 42′ the Co-Secant of which is 10.005746, and the Secant of 9° 18′ (which is what the arc exceeds 90°) will be found to give the same logarithm.

20. If the log. is required to seconds.—By *Norie*, take out the required log. for the degrees and minutes as above, and also the number opposite it in the difference column adjoining * ; now multiply the difference by your seconds, cut off two figures (always two) from the right of the product, and the figures remaining will be a correction, which is to be applied to the log. of the degrees and minutes; subtractive if it is a Cosine, Cotangent or Co-secant (that is, if it is a *Co.*) but additive, if it is a sine, tangent or secant (that is, if it is *not* a *Co*).

Ex. 35 — Required the log. sine of 18° 42′ 35″.

The log. sine of 18° 42′	9·505981	Diff.	622
Correction for 35″	+ 218		35
Log. required	9·506199		3110
			1866
		Correction	217,70

Ex. 36 — Required the log. Cosine of 49° 24′ 8″.

The log. Cosine of 49° 24′	9·813430	Diff.	246
Correction for 8″	— 20		8
Log. required	9.813410	Correction	19,68

Ex. 37 — Required the log. Co-Secant of 105° 14′ 40″.

The log. *secant* of 15° 14′	10·015534	Diff.	57
Correction for 30″	+ 23		40
Log. required	10·015557	Correction	22,80

21. By *Bowditch*, take out the required log. for degrees and minutes as above, and then look out your seconds in the left hand column of minutes (*always* the left hand) and in the "Diff." column adjoining the log. taken out will be found a correction,

* In the earlier editions of *Norie* the difference for the Co-Secant will be found alongside the Sine column, while that of the Secant will have to be taken from the difference column next the Cosine.

which is to be applied to the log of the degrees and minutes, subtractive if the log. taken out is a Cosine, Cotangent, or Cosecant (that is. if it is a *Co.*) but additive if it is a sine, tangent or secant (that is, if it is *not* a *Co.*)

The examples 35, 36 and 37 given above are now worked as under:—

Ex. 35.			Ex. 36.			Ex. 37.		
18° 42′	Sine	9·50598	49° 24′	Cos.	9·81343	11° 14′	Sec.	10·01553
35″	Cor.	+ 22	8″	Cor.	— 2	40′	Cor.	+ 2
		9·50620			9·81341			10·01555

It will be noticed, that for the first four pages of the table, there are no letters at the heads of the columns of logs. ; if the required log. falls in either of these pages, the correction must be calculated ; thus:— multiply the difference alongside the log. taken out, by the seconds, and divide the product by 60 (cut off the right hand figure and divide the remaining figures by 6) and the quotient will be the correction to be applied as before directed.

Ex. 38 — Required the log. sine of 4° 19′ 25″.

The log. sine of 4° 19′ is	8.87661	Diff.	168
Correction for 25″	+ 70		25
Log. required	8.87731		840
			336
		6)	420,0
		Correction	70

22. In *Raper* the logs. are given to every half minute, and therefore the required log. is to be taken out to the nearest less arc given, and adjoining it will be seen a column of "Parts" from whence the correction for the remaining seconds is to be taken, this is to subtracted from the log. taken out if it be a cosine, cotangent or cosecant (that is if it is a *co*) but added if it be a sine tangent or secant (that is if it is *not* a *co*). For the first few pages of the table, the columns of "Parts" belonging to some of the logs. are omitted, but Tables 66 and 67 supply their place ; the first, by giving the sines and cosines to every second of arc as far as the table extends ; and the other, by giving them to every 10″ with a table of corrections at the side for any seconds remaining; the tangents to seconds are not required for the problems treated of, but still, they may be found by adding the log sec. to the log. sine of the required arc. The Examples 35, 36, 37 and 38, given above, are now again worked underneath.

Ex. 35.			Ex. 36.		
18°.42′ 30″	sine	9·506168	49°24′	cos.	9·813430
5″	parts +	31	8″	parts −	20
		9·506199			9·813410

Ex. 37.			Ex. 38.		
15°14′ 30″	sec.	10·015551	4°19′20″	sin.	8.877172
10″	parts +	6	5″	parts +	140
		10·015557			8·877312

TO FIND THE ARC CORRESPONDING TO A LOG. SINE COSINE, &c.

23. In the proper column find the nearest to the given log., then if this column is marked with the name of the given log. at the top, take out the degrees at the head of the page, and the minutes will be found opposite the nearest log. in the left hand column of the page; but if the name of the given log. is found at the bottom, then the degrees are also taken from the bottom and the minutes from the right hand column of the page.

Ex. 39.—Find the arc corresponding to the log. sine 9·429600.

Here the nearest log. in a sine column is 9·429623 and the arc required s 15° 36′.

Ex. 40.— Find the arc corresponding to the log. tangent 10·280180.

The nearest log. is 10·280138 and consequently the desired arc is 62° 19.

MULTIPLICATION BY LOGARITHMS.

24. Take out the logs. of the two numbers to the multiplied, and add them together, the natural number corresponding to the sum will be the product required. As far as the indices are concerned, this is the *algebraic* sum, that is, if the indices are both positive or negative, add them together, marking the result with the same sign; but if one is positive and the other negative, then take their difference, and name the remainder positive or negative the same as the greater of the two, bearing in mind, that a carrying figure is *always positive.*

Ex. 1.—Multiply 289 by 6·991 by common logarithms.

	289	log. 2·460898
	6·991	log. 0·844539
PRODUCT	2020	3·305437

Ex. 2.—Multiply ·86341 by ·0054.

	·86341	log.–1·936217
	·0054	log.–3·732394
PRODUCT	·004662	–3·668611

Ex. 3.—Multiply 4·675 by ·00328.

	4·675	log.–0·669782
	·00328	log.–3·515874
PRODUCT	·01533	–2·185656

Ex. 4	Multiply	4·782	by	3·906	by common	logarithms.
" 5	"	62·72	"	4·273	"	"
" 6	"	4·792	"	49·96	"	"
" 7	"	367·46	"	29·678	"	"
" 8	"	49·074	"	382·67	"	"
" 9	"	4789·4	"	3·8892	"	"
" 10	"	82·291	"	468·46	"	"
" 11	"	42364	"	29·5467	"	"
" 12	"	10000	"	·100	"	"
" 13	"	28·887	"	462·92	"	"
" 14	"	7400·2	"	386·450	"	"
" 15	"	447·3	"	76·682	"	"
" 16	"	880·008	"	88·08	"	"
" 17	"	·77005	"	·6514	"	"
" 18	"	·00362	"	·0009	"	"
" 19	"	6543·2	"	·02475	"	"
" 20	"	·00699	"	·54427	"	"

DIVISION BY LOGARITHMS.

25. Take out the logs. of the two numbers, and from the log. of the number to be divided subtract the other log.; the remainder will be a log. the natural number corresponding to which, will be the quotient required. When the index of the divisor is the larger, or when the negative indices are used, the indices are subtracted as follows :— add the carrying figure (if any) to the index of the divisor, if the latter is positive, but subtract the carrying figure if the index is negative, naming the difference positive or negative the same as the larger; *now change the sign*, and add it, algebraically, to the other index as shewn in the rule for multiplication.

Ex. 1. Divide 396.7 by 82.76 by logarithms.

	396·7	log.	2·598462
	82·76	log.	1·917820
QUOTIENT	4·793		0·680642

Ex. 2. Divide 40.92 by 922.6.

	40·92	log.	1·611936
	922·6	log.	2·965013
QUOTIENT	·04435		–2·646923

Ex. 3. Divide ·000909 by ·04242.

	·000909	log.	–4·958564
	·04242	log.	2·627571
QUOTIENT	·02143		–2·330993

Ex.	4	Divide	4386	by	7	by common	logarithms.
"	5	"	987·4	"	31	"	"
"	6	"	8928·7	"	473·62	"	"
"	7	"	742·42	"	99·603	"	"
"	8	"	74620	"	9·9674	"	"
"	9	"	4268·8	"	1·2361	"	"
"	10	"	890000	"	29·282	"	"
"	11	"	740008	"	34702	"	"
"	12	"	·96473	"	·04552	"	"
"	13	"	·08643	"	·12111	"	"
"	14	"	456·78	"	·00523	"	"

Ex. 15	Divide	45·296	by	876	by common logarithms.		
" 16	"	4372·6	"	·64325	"	"	
" 17	"	·054776	"	·000596	"	"	
" 18	"	·000828	"	8·08	"	"	
" 19	"	·008376	"	·09547	"	"	
" 20	"	·005752	"	·0008621	"	"	

PARALLEL SAILING.

26. Take out the secant of the latitude (rejecting 10 in the index), and the log. of the departure; their sum will be a log., the natural number corresponding to which, will be the difference of longitude required.

Ex. 1.—In latitude 17° 18′ the departure made good was 51·34 miles, required the difference of longitude by parallel sailing.

Latitude	10° 18′	Sec.	0·0?0105
Departure	51·34	log.	1·710456
DIFF. LONG.	53·77		1·730561

With the following elements find the difference of longitude by parallel sailing.

Ex. 2—	In latitude	53°	16′	the dep.	made good	was 118·5	miles.
" 3—	"	12	12	"	"	75	"
" 4—	"	41	14	"	"	14·41	"
" 5—	"	39	22	"	"	10	"
" 6—	"	49	19	"	"	211·3	"
" 7—	"	40	37	"	"	29·6	"
" 8—	"	56	19	"	"	89·5	"
" 9—	"	0	0	"	"	329	"
" 10—	"	16	24	"	"	67	"
" 11—	"	46	14	"	"	39·64	"
" 12—	"	60	20	"	"	69·4	"

COURSE AND DISTANCE, BY MERCATOR.

TO FIND THE DIFFERENCES OF LATITUDE.

27. If the latitudes are both N. or both S.—Subtract the less from the greater, and bring the difference into miles; the result will be the *true* difference of latitude, to be named N. or S. the same as the latitudes, if in going to your destination you are increasing your latitude, but the contrary if you are decreasing it.

28. If the latitudes are one N. and the other S.—Add then together and bring the sum into miles, naming the true diff. lat. thus found, the same as the *lat. to.*

29. To find the Meridional difference of latitude.— Enter Table III (either *Norie* or *Bowditch*, *Raper* Table 6) and find the meridional parts corresponding to both the latitudes; add then together if the latitudes are of contrary names, but subtract them if they are of the same name, and the sum or remainder will be the mer. diff. lat.

TO FIND THE DIFFERENCE OF LONGITUDE.

30. If the longitudes are both E. or both W.—Take their difference, bring it into miles, and it will be the diff. long., to be named E. or W. the same as the longitudes, if in going to the desired port you are increasing your longitude but the contrary if you are decreasing it.

31. If the longitudes are the one E. and the other W.—Take their sum, and it will be the diff. long. E. or W. the same as the *long. to*; but if this sum should exceed 180°, take it from 360°, and reverse its name; in either case bring the diff. long. into miles.

TO FIND THE COURSE.

32. Take out the log. of the diff. long. adding 10 to its index, and from this subtract the log. of the mer. diff. lat., the remainder will be a log. tangent, the degrees and minutes corresponding to which will be the Course, to be named N. or S. the same as the diff. lat., and E. or W. the same as the diff. long.

TO FIND THE DISTANCE.

33. Take out the log. secant of the course, and after rejecting 10 in its index, add it to the log. of the true diff. lat., the natural number corresponding to the sum will be the Distance.

Ex. 1.—Required the course and distance from A to B by calculation on Mercator's principle.

Lat. of A	8° 34′ N	Mer. parts	516	Long. of A	81°21′ E
Lat. of B	4 35 S	Mer. parts	275	Long. of B	55 56 E
	13 9 S	Mer. diff. lat.	791		25 25 W
	60				60
True diff. Lat.	789			Diff. long.	1525

Diff. long. 1525	log. 13·183270	Course 62° 35′	Sec. 0·336810
Mer. diff. lat. 791	log. 2·898176	True diff. lat. 789	log. 2·897077
Course S 62° 35′ W	tang. 10·285094	Distance 1714	3·233877

Ex. 2.— Required the course and distance from Monte Video to Port Philip, by calculation on Mercator's principle.

Monte Video—Lat.	34° 54′ S	Mer. parts	2237	Long.	56° 16′ W
Port Philip —Lat.	38 18 S	Mer. parts	2491	Long.	144 38 E
	3 24 S		254		200 54 E
	60				360 00
True diff. lat.	204				159 6 W
					60
				Diff. long.	9546

Diff. long. 9546	log. 13·979821	Course 88° 29′	sec. 1·577283
Mer. diff. lat. 254	log. 2·404834	True diff. lat. 204	log. 2·309630
Course S. 88° 29′ W.	tang. 11·574987	Distance 7707	3·886913

Find the courses and distances between the following places, by calculation on Mercator's principle.

Ex. 3.—From	Sambro	Lat. 44° 26′ N	Long. 63° 33′ W
To	Cape Race	" 46 39 N	" 53 4 W
Ex. 4.—From	A	" 51 25 N	" 9 29 W
To	B	" 20 31 S	" 29 19 W
Ex. 5.—From	A	" 55 59 S	" 67 12 W
To	B	" 15 55 S	" 5 45 W
Ex. 6.—From	St. Agnes (Scilly)	" 49 54 N	" 6 21 W
To	St. Michaels	" 37 52 N	" 25 52 W

Ex. 7.—	From	Table Bay	Lat.	33	54	S	Long.	18	25	E
	To	Cape Otway	"	38	52	S	"	143	31	E
Ex. 8.—	From	A	"	49	54	N	"	46	19	W
	To	B	"	46	48	N	"	58	2	W
Ex. 9.—	From	Callao	"	12	4	S	"	77	11	E
	To	Mauritius	"	20	10	S	"	57	32	E
Ex. 10.—	From	A	"	33	17	N	"	72	12	W
	To	B	"	34	22	S	"	18	24	E
Ex. 11.—	From	A	"	37	49	N	"	122	27	W
	To	B	"	33	51	S	"	151	20	E
Ex. 12.—	From	A	"	33	51	S	"	151	18	E
	To	B	"	16	51	N	"	99	52	W
Ex. 13.—	From	A	"	12	3	S	"	76	59	W
	To	B	"	6	9	S	"	106	52	E
Ex. 14.—	From	A	"	9	47	S	"	122	27	E
	To	B	"	55	30	S	"	78	45	W
Ex 15.—	From	A	"	54	29	S	"	71	10	E
	To	B	"	41	38	N	"	122	57	W

PRELIMINARY RULES FOR WORKING A DAY'S WORK.

TO BRING COMPASS INTO TRUE COURSES.

34. The courses given in a Day's Work are Compass Courses (Def. 15), and to bring them into True Courses (Def. 13) the following corrections must be applied, viz: the Variation (Def. 16) of the place, the Deviation (Def. 17) corresponding to the direction of the ship's head, and the Leeway (Def. 19).

35. VARIATION if E is applied to the *right* of a course.
" W is applied to the *left* of a course.

36. Deviation is applied similarly to Variation of the same name, that is, E to the right and W to the left hand of a course.

37. Leeway is applied to the *right* if the vessel is upon the port tack, but to the *left* if she is upon the starboard tack.

38. The safest way to apply these several corrections is to find the residual correction and apply it to the compass course, thus : set down the leeway, marking it R (for right) if the vessel is upon the port tack, but L (for left) if she is upon the starboard tack ; underneath place the deviation naming it R if it is East, but L if West; now, if they are of the same name (both R or both L) add them together, but if of contrary names (one R and the other L) subtract them, and name the sum or remainder R or L the same as the greater. Under this result place the variation, naming it R if it is East, or L if West, again add or subtract according as they are of the same or of contrary names, and the result will be the correction, to be named R or L the same as the larger of the last two terms. Under the correction place the course,* expressed in degrees, marking it N if it is a northerly course, or S if it is a southerly one; and R if when looking from the centre of the compass, your course is to the right hand of the N or S point from which it is reckoned, but L if it is to the left hand; again add or subtract according whether they are of the same or of contrary names, and giving the result the same name as the greater; this will be the true course; should this last result exceed 90°, subtract it from 180°, and reverse *both* its names. In correcting the courses, it will be hardly necessary to say, that the sum of all terms having like names can be taken in one operation. Now to change the R or L of the true course into E or W.; if when looking to the R or L (as named) of the point from which your true course is reckoned, you look into an easterly quarter, name your course E, but if into a westerly quarter, then name it W.

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* If she is hove to, your course will be the middle point between where she comes up and falls off.

Correct the following courses :—

Ex. 1—Course, S 55 W — Wind, N 55 W

Leeway	18°	Leeway		18 L
Deviation	14° W	Deviation		14 L
				32 L
Variation	15° E	Variation		15 R
		Correct		17 L
		Course	S	55 R

TRUE COURSE S 38° W = S 38 R

Ex. 2—Course, N 23 W — Wind, West

Leeway	19°	Leeway		19 R
Deviation	8 E	Deviation		8 R
Variation	13 E	Variation		13 R
		Correction		40 R
		Course	N	23 L

TRUE COURSE N 17° E = N 17 R

Ex. 3—Course, S 45 W — Wind, W N W

Leeway	14°	Leeway		14 L
Deviation	6° E	Deviation		6 R
				8 L
Variation	22° W	Variation		22 L
		Correction		30 L
		Course	S	45 R

TRUE COURSE S 15° W = S 15 R

Ex. 4—Course, N 70 W — Wind, North

Leeway	16°	Leeway		16 L
Deviation	20° E	Deviation		20 R
				4 R
Variation	29° W	Variation		29 L
		Correction		25 L
			N	70 L
			N	95 L
				180

TRUE COURSE S 85° W = S 85 R

Ex.	Course.	Wind.	L,way	Dev.	Var.	True Courses
5	N 28° E	N 40° W	13°	21° E	15° E	N 77° E
6	N 26 W	N 40 E	20	13 E	34 W	N 67 W
7	S 68 E	South	16	23 W	19 E	S 88 E
8	West	N 20 W	10	10 W	13 E	S 83 W
9	N 54 E	S 60 E	18	20 E	22 W	N 34 E
10	S 10 W	S 55 E	12	5 E	12 E	S 39 W
11	N 73 E	North	12	20 W	32 E	S 83 E
12	S 82 E	N 28 E	8	10 E	28 W	N 88 E
13	N 52 W	NN E ½ E	10	9 W	22 W	S 87 W
14	S 58 W	S by E	10	30 E	18 E	N 64 W
15	Up West Off S 34 W	N W by N	55	12 W	12 E	S 7 W

THE TRAVERSE TABLES.

39. Enter Table II with your course, and if this is under 45° it will be found at the top of the page, but if it exceeds 45° it will be found at its foot, and you will have to take care that the different columns in this table, will have to take their names from the same end of the page, as that in which the course is found.

40. If the distance is expressed in miles only.—In that page in which the course appears, look for the distance in the distance column, and opposite in their respective columns will be found the diff. lat. and dep. corresponding.

Ex. 16—For the course 28° and distance 40 miles, the diff. lat. and dep. corresponding are respectively, 35·3 and 18·8.

41. If the distance is expressed in miles and tenths (a).—When the distance is less than 30 miles, pay no attention to the decimal point, but look for the distance as if it were altogether a whole number; now if the tenths of either the diff. lat. or dep. opposite are less than 5, throw them away, but if 5 or over, call the miles 1 more; now make the right hand figure of the miles into tenths, by placing a decimal point before it, and you will have the diff. lat. and dep. corresponding to your proper distance.

Ex. 17—Let the course be 54° and the distance 16·4; taking the distance as 164 miles, the diff. lat. opposite is 96·4 and the dep. 132·7; throwing away the ·4 in the diff. lat. and pointing off the right hand figure, it becomes 9·6; in the dep., make the miles 133 because of the ·7 and after placing the decimal point it will be 13·3; thus, 9·6 will be the diff. lat., and 13·3 the dep. for the given course and distance.

(b) If the distance exceeds 30 miles; first find the diff. lat. and dep. corresponding to the *miles* of your distance, after which enter the table with the *tenths* of the distance *as if they were miles*, and as in (a) make the right hand figure of the miles of the opposite diff. lat. and dep. into tenths, as before calling them one more if the actual tenths equal 5; add this to the diff. lat. and dep. of the miles of distance already found, and the sum will be the diff. lat. and dep. required.

Ex. 18—Given the course 42° and the distance 54.8.

Course 32° dist. 54, the diff. lat. is	45·8	and dep.	28·6
" dist. 8, gives 6·8	·7	and 4·2	·4
DIFF. LAT.	46·5	DEP.	29·0

DAY'S WORK.

42. To find the true courses.—Reverse the bearing (if any) and then apply the Deviation belonging to the first compass course, and the Variation (38)

To the set of the current (if any) apply the Variation.

Now with the Leeway, Deviation and Variation, correct the compass courses, and get the true courses corresponding.

43. To find the diff. lat. and dep. made good.—Opposite each of the above, set down the distances run upon each course respectively.

Turn out the diff. lat. and dep. corresponding to each course and distance (39 to 41), taking care to set the diff. lat. of all the Northerly courses in the N. column, and that of the Southerly courses in the S. column; in the same way the dep. of each course must be set in the E. or W. column, according as the course is East or West.

Find the sums of the N. and S. columns, and subtract the less from the greater, the remainder will be the *diff. lat. made good* to be named N. or S. the same as the greater; in a similar manner, find the difference between the sums of the E. and W. columns, and the result will be the *dep. made good* to be named E. or W. with the greater.

44. To find the Latitude in.—Place the diff. lat. made good under the lat. left, and add them together if they are of the same name, but take their difference if they are of contrary names, and in either case, the result will be the latitude in, which is to be named N. or S. the same as the greater.

45. To find the diff. long.—If the lat. left and the lat. in are of the same name, add them together and divide the sum by 2, the result will be the *middle lat.*; if the lat. left and lat. in are of contrary names, half their difference will be the middle lat., but in such a case, the dep. may at once be taken as the diff. long. Enter Table II with the middle lat. as a course, and then *in the diff. lat. column* find the nearest you can to your dep., the distance corresponding will be the diff. long., E. or W. the same as the dep.

46. To find the Long. in.—Place the diff. long. just found under the long left, and if they are of the same name, their sum will be the longitude in of the like name to the long. left, but should this long. in exceed 180°, it must be subtracted from 360°, and have its name reversed. If the long. left and the diff. long. are of contrary names, subtract the less from the greater, and the remainder will be the long. in of the same name as the greater.

47. To find the Course and Distance made good.—In any page of Table II and in the column next the distance, find the nearest to whichever may be the larger of the diff. lat. and the dep. made good, and see what is given in the adjoining column, if it exceeds the other of the two above terms, try a page or so back, otherwise look a page or so ahead, and so go on, page after page, until the nearest possible to your diff. lat. and dep. are found alongside one another; now take out the distance opposite, and this will be the Distance made good, and if the diff. lat. is larger than the dep. then the Course made good will be found at the top of the page, but at the bottom if the contrary.* The Course made good is named N. or S. the same as the diff. lat. made good, and E. or W. the same as the dep.

* It may be noticed, that if the diff. lat. is the larger, the column in which it is found is named diff. lat. *at the top*, therefore *take the course from the top*; while if the dep. is the greatest, the column in which it is found is named dep. *at the bottom*, in this case therefore, the Course will have to be taken *from the bottom*.

Ex. 1.

Hours.	Courses	Knots.	10 ths.	Winds.	L'way.	Dev.	Remarks, &c.
1	N 23° W	5	–	N E	4°	9° E	A point
2	. . .	5	–	. . .			in Lat. 46° 2' N
3	. . .	5	–	. . .			Long. 140° 9' W
4	. . .	5	–	. . .			bearing by Compass
5	N 50 W	5	5	N N E	7	17 E	S 14° W
6	. . .	5	5	. . .			Dist. 18 miles.
7	. . .	5	5	. . .			
8	. . .	5	5	. . .			
9	N 65 W	6	–	N ½ E	10	20 E	Variation 20° E.
10	. . .	5	5	. . .			
11	. . .	5	5	. . .			
12	. . .	6	–	. . .			
1	S 85 E	6	–	N N E	14	22W	
2	. . .	6	3	. . .			
3	. . .	6	4	. . .			
4	. . .	6	3	. . .			
5	S 76 E	7	–	N E by N	15	23W	A current set by compass }
6	. . .	7	–	. . .			N 40° E
7	. . .	7	–	. . .			12 miles from the
8	. . .	7	–	. . .			time the departure
9	N 13 W	7	–	Ditto	14	1 W	was taken until the
10	. . .	7	–	. . .			end of the day.
11	. . .	7	5	. . .			
12	. . .	7	5	. . .			

Cor. Courses.	Dist.	N.	S.	E.	W.
N 43° E	18·–	13·2		12·3	
N 60 E	12·–	6·–		10·4	
N 1 W	20·–	20·–			0·3
N 20 W	22·–	20·7			7·5
N 35 W	23·–	18·8			13·2
S 73 E	25·–		7·3	23·9	
S 64 E	28·–		12·3	25·2	
N 8 W	29·–	28·7			4·–
		107·4	19·6	71·8	25·0
		19·6		25·0	
Diff. lat. made good.		87·8N	Dep. made good	46·8E	

Lat. left	46° 2' N		Long. left	140° 9' W	
Diff. lat.	1 28 N		Diff. Long.	1 9 E	
LAT. IN	47 30 N		LONG. IN	139 0 W	
	2) 93 32				
Mid. lat.	46 46				

COURSE N 38° E DISTANCE 99 miles.

9° R	20 R	4 L
20 R	N 40 R	9 R
N 14 R	N 60 R	5 R
N 43 R		20 R
		25 R
		N 26 L
		N 1 L
7 L	10 L	14 R
17 R	20 R	22 L
10 R	10 R	8 L
20 R	20 R	20 R
30 R	30 R	12 R
N 50 L	N 65 L	S 85 L
N 20 L	N 35 L	S 73 L
	N 15 R	14 L
	23 L	1 L
	8 L	15 L
	20 R	20 R
	12 R	5 R
	S 76 L	N 13 L
	S 64 L	N 8 L

Ex. 2.

Hours.	Courses	Knots.	10 ths.	Winds.	L'way.	Dev.	Remarks, &c.
1	N 11° W	7	–	W by N	13	4 E	A point
2		7	2				in Lat. 47° 18′ S
3		7	5				Long. 8 21 W
4		7	–				bearing by Com-
5	N 25 E	6	2	N W	10	9 W	pass N W ½ W
6		6	2				Dist. 13 miles.
7		6	2				
8		5	2				
9	N 10 E	6	8	N W by W	12	3 W	Variation 15° W.
10		6	8				
11		6	9				
12		7	–				
1	North	7	–	W by N ¾ N	12	0	
2		7	–				
3		7	–				
4		6	4				
5	West	6	4	N N W	11	24 E	A current set
6		6	4				by compass
7		3	2				S by E
8		6	2				22 miles from the
9	S 76 W	6	2	N W by N	11	23 E	time the departure
10		6	–				was taken until
11		6	–				the end of the day.
12		6	–				

Cor. Courses	Dist.	N	S	E	W
S 62° E	13·–		6·1	11·5	
S 26 E	22·–		19·8	9·6	
N 9 W	28·7	28·4			4·5
N 11 E	24·8	24·3		4·7	
N 4 E	27·5	27·4		1·9	
N 3 W	27·4	27·4			1·4
S 88 W	25·2		–·9		25·2
S 73 W	24·2		7·1		23·1
		107·5	33·9	27·7	54·2
		33·9			27·7

Diff. lat. made good 73·6 N. Dep. made good 26·5 W.

Lat. left	47° 18′ S		Long. left	8° 21′ W
Diff. lat.	1 14 N		Diff. long.	39 W
LAT. IN	46 4 S		LONG. IN	9 00 W
	2) 93 22			
Mid. Lat.	46 41			

COURSE N 20° W DISTANCE 78 miles.

Ex. 3.

Hours	Courses	Knots	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	East	10	2	S S E	10°	24°E	A point
2		10	–				in Lat. 45° 24′ N
3		10	5				Long. 58 20 W
4		10	2				bearing by compass
5	S 70° W	10	–	Ditto	12	22W	N ¾ E.
6		9	5				Dist. 7½ miles.
7		9	5				
8		9	5				
9	Ditto	1[illegible]	–	Ditto	10	22W	Variation 26° W.
10		10	5				
11		10	–				
12		10	–				
1	N 80 E	9	7	S E by S	10	23 E	
2		9	5				
3		9	4				
4		9	2				
5	S 12 W	9	–	S E by E	8	1 E	A current set }
6		9	–				by compass }
7		9	–				S W ½ S.
8		8	7				20 miles from the
9	South.	8	7	E S E	11	6 E	time the departure
10		8	7				was taken until
11		8	7				the end of the day.
12		8	7				

Cor. Courses.	Dist.	N	S	E	W
S 6° W	7·5		7·5		–·8
S 13 W	28·–		27·3		6·3
N 78 E	40·9	8·5		40·–	
S 34 W	38·5		31·9		21·5
S 32 W	40·5		34·3		21·5
N 67 E	37·8	14·8		34·8	
S 5 E	35·7		35·6	3·2	
S 9 E	34·8		34·4	5·4	
		23·3	171·0	83·4	50·1
			23·3	50·1	
			147·7	33·3	

Lat. left	45° 24′ N	Long. left	58° 20′ W
Diff. lat.	2 28 S	Diff. long.	46 E
Lat. in	42 56 N	Long. in	57 34 W
	88 20		
Mid. lat.	44 10		

Course S 13° E. Distance 151 miles.

Ex. 4.

Hours	Courses	Knots	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	N 86° W	5	5	S S W	13°	33° E	A point
2		5	7				in Lat. 52° 15′ S
3		5	5				Long. 179 12 W
4		5	3				bearing by compass
5	N 79 W	6	2	S W by S	15	32 E	S E ½ E
6		6	2				Dist. 14½ miles.
7		6	2				
8		6	2				
9	S 75 W	6	2	S ½ W	10	32 E	
10		6	–				
11		6	–				
12		6	–				
1	S 58 W	6	–	S by E	10	30 E	Variation 18° E.
2		5	5				
3		5	5				
4		5	5				
5	N 65 W	5	5	S W	10	29 E	A current set by compass }
6		5	–				S ¾ W
7		5	–				23 miles from the
8		6	–				time the departure
9	S 19 W	6	–	West	11	12 E	was taken to the
10		6	5				end of the day.
11		6	5				
12		6	5				

Ex. 5.

Hours	Courses	Knots.	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	N 20° E	4	6	East	14°	7° E	A point
2		4	8				in Lat. 43° 46′ S
3		5	–				Long. 89 30 E
4		4	5				bearing by compass
5	S 22 E	4	5	Ditto.	13	1 W	North.
6		4	5				Dist. 11 miles.
7		5	–				
8		5	5				
9	S 45 E	5	5	E N E	14	25 E	
10		5	2				
11		5	–				
12		5	–				
1	N 34 E	4	6	E by S	12	13 E	Variation 23° E
2		4	6				
3		4	6				
4		4	2				
5	N 56 E	4	2	S E by E	10	21 E	A current set by compass }
6		4	2				
7		4	2				
8		4	2				— miles from the
9	S 16 E	4	4	E ½ S	11	0	time the departure
10		4	4				was taken to the
11		4	6				end of the day.
12		4	5				

Ex. 6

Hours	Courses	Knots	10 ths.	Winds	L'way.	Dev.	Remarks &c.
1	S 24° E	4	7	S W½ W	7	11W	A point
2		4	5				in Lat. 35° 26′ N
3		5	–				Long. 10 10 E
4		5	5				bearing by compass
5	N 65 W	5	–	Ditto.	6	19 E	S E by E ¾ E
6		4	5				Dist. 9 miles.
7		5	–				
8		4	8				
9	S 20 W	4	8	West.	6	8 E	Variation 14° W.
10		5	–				
11		5	5				
12		5	5				
1	S 43 W	6	–	W N W	7	17 E	
2		6	3				
3		6	3				
4		6	3				
5	South	6	3	W S W	8	2W	A current set
6		6	5				by compass
7		6	3				S 14° W
8		6	–				14 miles from the
9	S 56 W	5	4	S by E	6	21 E	time the departure
10		5	–				was taken in the
11		5	2				end of the day.
12		5	–				

Ex. 7.

Hours	Courses	Knots	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	North	3	8	E N E	9	5 W	A point
2		4	–				in Lat. 0° 46′ S
3		4	–				Long. 36 24 W
4		4	–				bearing by compass
5	Ditto.	5	–	E by S	0	5 W	
6		5	–				Dist. miles.
7		4	5				
8		4	–				
9	N 25° W	4	5	N E	12	18W	Variation 8° W.
10		5	–				
11		5	3				
12		5	–				
1	N 38 W	5	–	N E by N	10	24W	
2		4	6				
3		4	6				
4		4	–				
5	N 40 E	4	–	NWbyN½N	8	16 E	A current set
6		4	–				by compass
7		4	–				S 71° E
8		4	2				21 miles from the
9	N 28 E	4	5	N W ½ N	9	12 E	time the departure
10		4	2				was taken in the
11		4	5				end of the day.
12		4	5				

Ex. 8.

Hours	Courses	Knots	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	N 13° W	8	7	W by N ½ N	9°	8° E	A point
2		7	7				in Lat. 32° 42′ N
3		8	–				Long. 27 10 W
4		8	5				bearing by compass
5	N 25° E	9	–	N W	10	15W	S 27° E
6		9	5				Dist. 14 miles.
7		9	8				
8		10	–				
9	Ditto	10	8	do	14	15W	Variation 23° E
10		11	–				
11		11	–				
12		10	–				
1	N 18° E	9	–	N W by W½W	11	11W	
2		8	–				
3		9	–				
4		9	5				
5	N 37 W	8	–	N E by N	15	19 E	A current set }
6		8	2				by compass }
7		8	3				N by E ½ E
8		8	2				18 miles from the
9	North	7	–	E by N ¾ N	8	0	time the departure
10		7	4				was taken to the
11		7	6				end of the day.
12		7	5				

Ex. 9.

Hours	Courses	Knots	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	N 25° W	8	3	N E	14°	14°W	A point
2		8	3				in Lat. 38° 10′ N
3		8	3				Long. 148 47 W
4		8	–				bearing by compass
5	S 70 E	8	–	do	14	22 E	W ¾ N
6		8	–				Dist. 10 miles.
7		8	–				
8		8	5				
9	N 58 W	6	7	N by E	11	20W	Variation 16° E
10		6	7				
11		6	8				
12		7	–				
1	N 70 E	7	–	North	12	23 E	
2		6	5				
3		6	–				
4		6	5				
5	N 47 E	6	5	N N W	9	16 E	A current set }
6		6	–				by compass }
7		6	–				S 48° E
8		6	2				27 miles from the
9	N 45 E	6	5	N W by W	0	16 E	time the departure
10		6	5				was taken to the
11		6	5				end of the day.
12		6	–				

Ex. 10.

Hours	Courses	Knots	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	North	8	3	W N W	8°	0°	A point
2		8	2				in Lat. 44° 30′ N
3		8	3				Long. 25 19 W
4		8	3				bearing by com-
5	N 18° E	7	8	N W ½ W	12	6W	pass
6		7	8				E by S ¾ S
7		7	5				Dist. 3½ miles.
8		7	–				
9	S 71 W	7	–	Ditto	12	23 E	Variation 29° W.
10		7	–				
11		7	–				
12		6	5				
1	West	6	5	N N W	10	25 E	
2		6	5				
3		6	5				
4		7	–				
5	N 70 W	8	–	N N E	0	20 E	A current set }
6		8	–				by compass }
7		8	–				N W by N ¾ N
8		8	–				24 miles from the
9	Ditto	7	5	North.	14	20 E	time the depar-
10		7	5				ture was taken to
11		7	–				the end of the
12		7	5				day.

Ex. 11.

Hours	Courses	Knots	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	N 73° E	6	8	North.	18°	20W	A point
2		6	8				in Lat. 48° 22′ S
3		7	–				Long. 94 26 E
4		7	–				bearing by com-
5	{ Up N 34 E }	1	2	N N W	58	17 E	pass
6	{ Off N 80 E }	1	2				S by W
7		1	2				Dist. 13 miles.
8		1	2				
9	{ Up N 10 E }	1	–	N W	54	10W	
10	{ Off N 52 E }	1	–				
11		1	2				
12		1	2				
1	N 5 E	8	–	W N W	16	1 W	Variation 26° E.
2		8	–				
3		7	5				
4		7	–				
5	N 12 W	7	–	West.	12	12 E	A current set }
6		7	–				by compass }
7		7	–				S E ½ S.
8		7	3				29 miles from the
9	Ditto	7	6	Ditto	14	12 E	time the depart-
10		7	6				ure was taken to
11		8	–				the end of the
12		8	–				day.

Ex. 12.

Hours	Courses	Knots	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	East	9	5	S S E	11°	22°E	A point
2		9	5				in Lat. 48° 10′ N
3		9	5				Long. 29 50 W
4		10	–				bearing by compass
5	S 25° W	10	–	S E	13	2 W	N E ¾ N
6		10	–				Dist. 4½ miles.
7		10	–				
8		10	–				
9	East	10	–	S S E	13	22 E	Variation 34° W
10		10	–				
11		10	–				
12		9	6				
1	S 75 E	9	6	S ½ E	12	21 E	
2		9	6				
3		9	6				
4		9	6				
5	S 82 E	10	–	S by E	13	22 E	A current set in compass S 28° W.
6		9	5				
7		10	–				
8		9	–				18 miles from the
9	S 20 W	9	–	S E ½ E	11	1 W	time the departure
10		8	7				was taken in the
11		8	7				end of the day.
12		9	–				

Ex. 13.

Hours	Courses	Knots	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	S 36° E	8	7	S 32° W	14°	6°W	A point
2		8	8				in Lat. 35° 35′ N
3		8	9				Long. 0 47 W
4		9	–				bearing by compass
5	S 25 E	9	–	S 85 W	0	11 E	W ¾ N
6		9	–				Dist. 12 miles.
7		9	–				
8		9	–				
9	Ditto	8	5	S 45 W	13	11 E	Variation 18° W.
10		8	5				
11		8	5				
12		8	–				
1	S 70 E	8	5	South	11	20 E	
2		7	3				
3		7	8				
4		7	–				
5	S 29 W	8	–	S 40 E	12	3 W	A current set by compass N ½ E.
6		8	–				
7		7	6				
8		7	4				21½ miles from the
9	S 43 W	7	–	S 27 E	10	8 W	time the departure
10		7	–				was taken to the
11		7	2				end of the day.
12		7	4				

Ex. 14.

Hours	Courses	Winds	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	N 32° W	8	6	S 40° W	0°	17° E	A point
2		8	8				in Lat. 44° 15′ S
3		8	6				Long. 104 10 E
4		8	5				bearing by compass
5	N 30 W	8	–	S 80 W	8	16 E	N E by E
6		7	6				Dist. 5 miles.
7		7	6				
8		7	8				
9	N 16 W	8	5	N 85 W	10	9 E	
10		9	–				
11		9	–				
12		8	2				
1	N 80 W	8	2	N 11 W	9	32 E	Variation 17° E
2		8	2				
3		8	5				
4		8	5				
5	N 49 W	9	–	N 20 E	10	24 E	A current set
6		9	–				by compass
7		9	–				N E by E ½ E
8		9	5				18 miles from the
9	N 32 W	10	–	N 58 E	0	17 E	time the departure
10		10	–				was taken to the
11		10	–				end of the day.
12		9	5				

Ex. 15.

Hours	Courses	Knots.	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	Up S 76° W	1	5	W by S	60°	4° E	A point
2	Off S 26 E	1	5				in Lat. 30° 12′ N
3		1	5				Long. 179 30 W
4		1	–				bearing by compass
5	S 10 W	5	8	Ditto	18	1 E	
6		5	4				Dist. — miles.
7		5	9				
8		6	–				
9	Up West	1	2	NW by N	55	12W	
10	off S 34° W	1	2				
11		1	2				
12		1	2				
1	West	7	–	N N W	16	22W	Variation 12° E
2		7	5				
3		7	–				
4		7	–				
5	Ditto	7	–	North	0	22W	A current set
6		6	8				by compass
7		7	–				S 78° W
8		6	8				36 miles from the
9	W 14 S	6	5	NW by N	16	18W	time the departure
10		6	5				was taken to the
11		6	5				end of the day.
12		7	–				

LATITUDE BY THE MERIDIAN ALTITUDE OF THE SUN.

48. To find a Greenwich date.—As it must be noon at ship when this observation is taken, the ship time astronomically expressed, will be, the date of the observation followed by $0^h\ 0^m\ 0^s$. Turn the longitude into time * (*Norie* table XIX, *Bowditch* table XXI, *Raper* table 17) and add it to the ship date if the longitude is West, but subtract it if it is East, and the sum or remainder will be the Greenwich apparent Time.

49. To find the true declination.—In page I of the month in the Nautical Almanac, will be found the sun's declination at apparent noon of each day (for mean noon see NOTE). Take out the declination opposite the day of your Greenwich date, and also the "difference for 1 hour" alongside. Express the Greenwich time in decimals, by dividing the minutes by 6, and placing the result after the hours with a decimal point between. Multiply the difference for 1 hour by the Greenwich time decimally expressed; count the number of figures at the right hand of the decimal point of *both* the numbers multiplied, and point off the same number of figures from the right hand of the product, the number remaining will be the correction for the declination in seconds; and of course, if this exceeds 60 it must be brought into minutes. Place the correction under the declination, and if the declination in increasing, add then together; but if it is decreasing, subtract the less from the greater, bearing in mind that if the correction is the larger, the true declination will be N. or S. contrary to that taken from the almanac.

NOTE. The declination at mean noon is given in Page II of each month in the Nautical Almanac, but the hourly difference is still to be taken from Page I.

50. To find the Sun's true altitude.—To the observed altitude apply in rotation the following corrections, viz :

Index error (if any).—This is additive or subtractive according to its sign (+ additive, — subtractive).

*** This may be done by calculation, by multiplying the long. by 4 and dividing by 60 ; with a little practice this is much the quickest way of doing it.**

Dip.—In Table V *Norie*, Table XIII *Bowditch*, or Table 30 *Raper*, will be found the dip corresponding to the given height of the eye; the dip is always subtractive.

Refraction and Parallax.—In *Norie* this correction is found in Table XVIII opposite the App. Alt. and in the column marked "Sun's Cor." at the top. In the other Epitomes the Refraction and Parallax are given in separate tables, and the correction will be found by taking out the Refraction from Table XII in *Bowditch* or Table 31 in *Raper*, and from it subtracting the Parallax, *Bowditch* Table XIV, and *Raper* Table 34. This correction is always subtractive.

Semi-diameter. — Open the Nautical Almanac to the given month, and in page II, in its proper column, you will find the semi-diameter opposite the day of your Greenwich date. If the lower limb has been observed, the semi-diameter is additive; but if the upper limb has been taken, it is then subtractive. The result is the True Altitude of the Sun's centre.

51. To find the zenith distance.—Take the True Altitude from 90°, and the remainder will be the Zenith Distance, to be named N. or S. contrary to the observed altitude. In some very rare cases, the true altitude is found to exceed 90°; in such an event, take 90° from it, and the remainder will be the Zenith Distance of the *same* name as the observed altitude.

52. To find the Latitude.—Under the zenith distance place the true declination, add them together if they are of the same name, but take their difference if they are of contrary names, and in either case, the result will be the latitude N. or S. of the same name as the greater.

Ex. 1—1876, May 17th, in longitude 82° 30′ W., the observed meridian altitude of the sun's lower limb was 54° 54′ 0″ bearing North, index error + 1′ 14″, height of eye 17 feet. Required the latitude.

Ship date May	$17^d\ 0^h\ 0^m\ 0^s$	Decl.	19° 28′ 21″	Hourly diff. 33″·32
Long in time	+ 5 30 0		+ 3 3	5·5
Greenwich App. Time	17 5 30 0	T. decl.	19 31 24	16660
				16660
				183·260
				Correction 3 3

	Norie		Bowditch		Raper
Obs. Alt	54° 54′ 0″ N		54° 54′ 0″ N		54° 54′ 0″ N
Index error	+ 1 14		+ 1 14		+ 1 14
	54 55 14		54 55 14		54 55 14
Dip.	− 3 57		− 4 3		− 4 5
	54 51 17	R. 40″	54 51 11	R. 41″	54 51 9
Ref.-Par.	− 35	P. 6	− 34	P. 5	− 36
	54 50 42		54 50 37		54 50 33
Semi-diam.	+ 15 51		+ 15 51		+ 15 51
True alt.	55 6 33		55 6 28		55 6 24
	90		90		90
Zen. dist.	34 53 27 S		34 53 32 S		34 53 36 S
True decl.	19 31 24 N		19 31 24 N		19 31 24 N
LATITUDE	15 22 3 S		15 22 8 S		15 22 12 S

Ex. 2—1876, October 30th, in longitude 112° 48′ E, the observed meridian altitude of the Sun's lower limb was 53° 8′ 40″ bearing North, index error—1′ 20″, height of eye 14 feet. Required the latitude.

Ship date, Oct. 30ᵈ	0ʰ 0ᵐ 0ˢ	Decl.	13° 40′ 17″	Hourly diff. 49″·45
Long in time	7 31 12		13 36	16·5
Greenwich App. Time	29 16 28 48	T. decl.	13 53 53	24725
				29670
				4945
				815·925
				Correction 13 36

	Norie		Bowditch		Raper
Obs. Alt.	53° 8′ 40″ N		53° 8′ 40″ N		53° 8′ 40″ N
Ind. error	− 1 20		− 1 20		− 1 20
	53 7 20		53 7 20		53 7 20
Dip.	− 3 36		− 3 41		− 3 40
	53 3 44	R. 43″	53 3 39	R. 44″	53 3 40
Ref.–Par.	− 38	P 6	− 37	P 6	− 38
	53 3 6		53 3 2		53 3 2
Semi-diam	+ 16 9		+ 16 9		+ 16 9
True alt.	53 19 15		53 19 11		53 19 11
	90		90		90
Zen. dist.	36 40 45 S		36 40 49 S		36 40 49 S
True decl.	13 53 53 S		13 53 53 S		13 53 53 S
LATITUDE	50 34 38 S		50 34 42 S		50 34 42 S

Ex. 3—1876, April 26th, in longitude 109° 0′ E., the observed meridian altitude of the Sun's Lower Limb was 52° 10′ 0″ bearing North, index error + 1′ 16″, height of eye 11 feet. Required the latitude.

Ex. 4—1876, July 11th, in longitude 111° 25′ E., the observed meridian altitude of the Sun's Lower Limb was 18° 46′ 15″ bearing North, index error − 0′ 49″, height of eye 22 feet. Required the latitude.

Ex. 5—1876, November 8th, in longitude 11° 46′ E., the ob served meridian altitude of the Sun's Lower Limb was 73° 18′ 20″ bearing South, index error−−0′ 28″, height of eye 16 feet. Required the latitude.

Ex. 6.—1876, March 27th, in longitude 8° 22 W., the observed meridian altitude of the Sun's Lower Limb was 32° 22′ 10″ bearing South, index error + 1′ 47″ height of eye 13 feet. Required the latitude.

Ex. 7—1876, September 23rd, in longitude 104° 20′ E., the observed meridian altitude of the Sun's Upper Limb was 18° 47′ 50″ bearing North, index error 0′ 0″, height of eye 18 feet. Required the latitude.

Ex. 8—1876, January 24th, in longitude 73° 18′ W., the observed meridian altitude of the Sun's Lower Limb was 89° 53′ 50″ bearing North, index error + 1′ 27″, height of eye 14 feet. Required the latitude.

Ex. 9—1876, July 4th, in longitude 133° 48′ W., the observed meridian altitude of the Sun's Lower Limb was 51° 16′ 50″ bearing South, index error − 1′ 16″, height of eye 13 feet. Required the latitude.

Ex. 10.—1876, March 20th, in longitude 32° 48′ E., the observed meridian altitude of the Sun's Lower Limb was 39° 26′ 30″ bearing South, index error—0′ 20″, height of eye 12 feet. Required the latitude.

Ex. 11.—1876, September 22nd, in longitude 76° 24′ 30″ W., the observed meridian altitude of the Sun's Lower Limb was 49° 27′ 30″ bearing South, index error + 2′ 20″, height of eye 21 feet. Required the latitude.

Ex. 12.—1876, May 15th, in longitude 16° 45′ W., the observed meridian altitude of the Sun's Lower Limb was 38° 19′ 20″ bearing North, index error + 2′ 28″, height of eye 15 feet. Required the latitude.

Ex. 13.—1876, March 20th, in longitude 24° 15′ E., the observed meridian altitude of the Sun's Lower Limb was 38° 46′ 15″ bearing South, index error —1′ 15″ height of eye 16 feet. Required the latitude.

Ex. 14.—1876, June 29th, in longitude 160° 50′ E., the observed meridian altitude of the Sun's Lower Limb was 71° 2′ 30″ bearing North, index error—0′ 58″, height of eye 16 feet. Required the latitude.

Ex. 15.—1876, March 1st, in longitude 54° 55′ E., the observed meridian altitude of the Sun's Lower Limb was 62° 6′ 0″ bearing South, index error— 1′ 14″, height of eye 20 feet. Required the latitude.

TIME.

TO EXPRESS TIME ASTRONOMICALLY.

53. If the given time be P. M.—Set down the time as it stands, and prefix to it the day of the month upon which it occurs; thus—May 15th at $4^h\ 20^m$ P. M. is equal to $15^d\ 4^h\ 20^m$ astronomical time.

54. If the given time be A.M.—Add 12 hours to the time, and prefix the date of the preceding day; thus—May 15th at $5^h\ 30^m$ A. M. is equal to $14^d\ 17_h\ 30^m$ astronomical time.

55. The above rules may be explained by stating that all astronomical time counts *from noon;* now, in the example given above (52), the $4^h\ 20^m$ P. M. is reckoning from noon of the 15th as it stands, therefore no change is necessary beyond prefixing the noon from which it reckons; but in the following example (54) the $5^h\ 30^m$ is *not* reckoning from noon, but from the preceding midnight; it is plain, you cannot count your time from noon of the 15th, because that time has not yet arrived; you have no alternative therefore, but to reckon it from noon of the 14th, and this is done, by adding to your time the 12^h between noon of the 14th and the midnight from which your A. M. is reckoned, *and you must distinctly understand* that $5^h\ 30^m$ A. M. on the 15th, civil time, and $14^d\ 17_h\ 30^m$ astronomical time, is *exactly the same time* only differently stated.

TO GET A GREENWICH DATE.

56. Express your ship time astronomically (53 and 54). Turn your longitude into time by multiplying it by 4 and dividing by 60, or by inspection from Table XIX *Norie*, Table XXII *Bowditch*, or Table 17 *Raper*. Subtract the longitude in time from the astronomical time, if the longitude is East; but get their sum, if the longitude is West, the result in either case will be the Greenwich date; and will be either mean or apparent time the same as that at ship.

Ex. 1.—January 27th, in Lat. 18° 25′ N. Long. 87° 30′ E. the apparent time at ship was $3^h\ 17^m$ P. M.; required the corresponding Greenwich date.

Longitude		87	30 E		A. T. S.	27^d	3^h	17^m	0^s
			4		Long. in time	—	5	50	0
	6,0)	35,0	00		G. A. T.	26	21	27	0
Long. in time		5	50	00					

Ex. 2.—September 12th, in Lat. 47° 8′ S. Long. 109° 32′ 14″ W. the mean time at ship was $8^h\ 27^m\ 16^s$ A. M.; required the Greenwich date.

Longitude	109° 32′ 14″	M. T. S.		$11^d\ 20^h\ 27^m\ 16^s$
	4	Long. in time	+	7 18 9
	6,0) 43,8 8 56	G. M. T.		12 3 45 25
Long. in time	7 18 9			

Ex. 3.—Feb. 2nd in Lat. 0° 12′ S. Long. 48° 22′ W, the apparent time at ship was $5^h\ 29^m$ P. M.; required G. A. T.

Ex. 4.—October 12th in Lat. 17° 10′ N. Long. 12° 14′ 16″ E, the apparent time at ship was $3^h\ 27^m\ 40^s$ A. M.; required G. A. T.

Ex. 5.—August 20th in Lat. 32° 14′ N. Long. 112° 19′ 50″ W, the mean time at ship was $11^h\ 15^m\ 45^s$ P. M.; required G. M. T.

Ex. 6.—March 16th in Lat. 8° 42′ S. Long. 36° 24′ 25″ E, the apparent time at ship was $9^h\ 17^m\ 52^s$ A. M.; required G. A. T.

Ex. 7.—April 29th in Lat. 44° 25′ S. Long. 62° 12′ 15″ E.; the mean time at ship was $3^h\ 12^m\ 49^s$ P. M.; required G. M. T.

Ex. 8.—July 8th in Lat. 12° 13′ N. Long. 147° 18′ W.; the mean time at ship was $7^h\ 32^m\ 23^s$ P. M.; required G. M. T.

Ex. 9.—May 1st in Lat. 15° 24′ N. Long. 83° 22′ 30″ W.; the apparent time at ship was $10^h\ 26^m\ 30^s$ A. M.; required G. A. T.

Ex. 10.—Dec. 1st in Lat. 29° 30′ S. Long. 55° 55′ 45″ E.; the mean time at ship was $1^h\ 5^m\ 4^s$ P. M.; required G. M. T.

AMPLITUDE.

57.—With the ship's time and longitude, find the Greenwich apparent time (56). Get out the True Declination (49).

58. To find the True Amplitude.—Take out the secant of the latitude and the sine of the declination, the sum will be the log. sine of the True Amplitude; this is to be named E. if the observation was taken in the morning, but W. if in the afternoon, and N. or S the same as the True Declination. It must be understood that Amplitudes reckon *from* the E. or W. *towards* the N. or S. consequently the E. or W. from which your True Amplitude may count, is placed at its *left* hand. If the True Declination is 0° 0′ the True Amplitude is also 0° 0′.

59. To find the Error of the Compass.— Set down your Magnetic Amplitude under the True, making them both reckon from the same E. or W. point, now add the two together if one is N. and the other S, but get their difference of both are of the same name, and the result will be the Error of the Compass to be named E. or W. as follows:— make a cross to represent the four quarters of the compass, and lay off upon this the places of the Magnetic and True Amplitudes; now suppose yourself standing in the centre, looking along the line representing the Magnetic Amplitude, then if the True Amplitude falls to your right hand, the Error is to be named E., but W. if it falls to your left hand.

60. To find the Deviation.—Under the Error of the Compass place the Variation; add them together if they are of contrary names, but get their difference where they are of the same name, and the sum or remainder will be the Deviation, to be named E. or W the same as the error of the compass *except* when the Error and Variation *have like names* and the *Error is the least*, in this case, the Deviation takes the contrary name to the Error; thus:—

Error	14° 10′	W	Error	14° 10′	W	Error	14° 10′	W
Var.	2 25	E	Var.	2 25	W	Var.	22 25	W
Dev.	16 35	W	Dev.	11 45	W	Dev.	8 15	E

The name of the Deviation may also be found by laying off the Variation and the Error to the East or West, as named, of the North point of the compass; then if the Error is to the right of the Variation, the Deviation is East, but if to the left hand it is West.

Ex. 1.—1876, January 21st, at 7h 3m A. M. appt. T. Ship, in latitude 35° 20° N., longitude 48° 20′ W., the Sun's Magnetic Amplitude was E. by S. Required True Amplitude, and Error of the Compass, and supposing the Variation to be 17° 10′ W. required the Deviation of the Compass for that position of the ship's head.

Ship date	Jan. 20d 19h 3m 0″	Decl.	20° 11′ 57″ S.	32·23
Long. in time	+ 3 13 20		— 11 59	22·3
Greenwich App. Time	20 22 16 20	T. decl.	19 59 58	9669
				6446
				6446
				718·729
			Correction	11 59

Latitude		35° 20′	Secant	0·088416
True declination		20 00	Sine	9·534052
TRUE AMPLITUDE	E	24 47 S	Sine	9·622468
Mag. Amplitude	E	11 15 S		
ERROR OF THE COMPASS		13 32 E		
Variation		17 10 W		
DEVIATION		30 42 E		

Ex. 2.—1876, November 10th, at 6^h 20^m P. M Appt. T. Ship, in latitude 15° 33′ S, longitude 108° 59′ E, the Sun's Magnetic Amplitude was W 14° 4′ N. Required True Amplitude and Error of the Compass, and supposing the Variation to be 1° 24′ W, required the Deviation of the Compass for that position of the ship's head.

Ship date	Nov.	10^d 6^h 20^m 0^s	Decl.	17 3 17 S	42·″49
Long. in time		— 7 15 56		+ 16 22	23·1
G. A. T.		9 23 4 4	T. decl.	17 19 39	4249
					12747
					8498
					981·519
				Correction	16 22

Latitude		15° 33′	Secant	0·016195
True declination		17 20	Sine	9·474115
TRUE AMPLITUDE	W	18 1 S.	Sine	9·490310
Mag. Amplitude	W	14 4 N		
ERROR OF THE COMPASS		32 5 W		
Variation		1 24 W		
DEVIATION		30 41 W		

Ex. 3.—1876, April 15th, at 5^h 43^m P. M. Appt. T. Ship, in latitude 22° 56′ S, longitude 73° 18′ W, the Sun's Magnetic Amplitude was W 3° 30′ N. Required True Amplitude and Error of the Compass, and supposing the Variation to be 12° 56′ E, required the Deviation of the Compass for that position of the Ship's head.

Ex. 4.—1876 October 31st, at 4^h 40^m A. M. Appt. T. Ship, in latitude 54° 9′ S, longitude 168° 0′ E, the Sun's Magnetic Amplitude was S 81° 20′ E. Required True Amplitude and Error of the Compass, and supposing the Variation to be 19° 17′ E, required the Deviation of the Compass for that position of the Ship's head.

Ex. 5.—1876, February 8th, at 6^h 47^m P. M. Appt. T. Ship, latitude 37° 30′ S., longitude 116° 14′ E., the Sun's Magnetic Amplitude was N 85° 20′ W. Required True Amplitude and Error of the Compass, and supposing the Variation to be 8° 0′ W, required the Deviation of the Compass for that position of the Ship's head.

Ex. 6.—1876, July 2nd, at 2^h 17^m A. M. Appt. T. Ship, latitude 62° 42′ N, longitude 55° 38′ W, the Sun's Magnetic Amplitude was E 9° 30′ N. Required True Amplitude and Error of the Compass, and supposing the Variation to be 60° 15′ W, required the Deviation of the Compass for that position of the Ship's head.

Ex. 7.—1876, January 5th, at 5^h 46^m P. M. Appt. T. Ship, latitude 8° 13′ N, longitude 41° 29′ W, the Sun's Magnetic Amplitude was S W ¼ W. Required True Amplitude and Error of the Compass, and supposing the Variation to be 7° 0′ W, required the Deviation of the Compass for that position of the Ship's head.

Ex. 8.—1876, October 1st, at 6^h 12^m P. M. Appt. T. Ship, latitude 31° 46′ S, longitude 129° 56′ E, the Sun's Magnetic Amplitude was W S W. Required True Amplitude and Error of the Compass, and supposing the Variation to be 0° 0′, required the Deviation of the Compass for that position of the Ship's head.

Ex. 9.—1876, March 21st, at 6^h 5^m A. M. Appt. T. Ship, in latitude 48° 36′ N, longitude 0° 0′, the Sun's Magnetic Amplitude was S E by E ½ E. Required True Amplitude and Error of the Compass, and supposing the Variation to be 20° 20′ W, required the Deviation of the Compass for that position of the Ship's head.

Ex. 10.—1876, September 22nd, at 6^h 0^m P. M. Appt. T. Ship, in latitude 18° 9′ S, longitude 13° 35′ 30″ E., the Sun's Magnetic Amplitude was W by N ¾ N. Required True Amplitude and Error of the Compass, and supposing the Variation to be 24° 14′ W, required the Deviation of the Compass for that position of the Ship's head.

Ex. 11.—1876, December 25th, at 3^h 0^m P. M. Appt. T. Ship, in latitude 59° 0′ N, longitude 160° 46′ E, the Sun's Magnetic Amplitude was South. Required True Amplitude and Error of the Compass, and supposing the Variation to be 18° 0′ E, required the Deviation of the Compass for that position of the Ship's head.

Ex. 12.—1876, June 30th, at 2^h 14^m A. M. Appt. T. Ship, latitude 63° 18′ N., longitude 130° 10′ W., the Sun's Magnetic Amplitude was N 25° W. Required, True Amplitude and Error of the Compass, and supposing the Variation to be 38° 0′ E., required the Deviation of the Compass for that position of the ship's head.

Ex. 13.—1876, December 11th, at 9^h 2^m P. M., Appt T. Ship latitude 59° 16′ S., longitude 80° 30′ W., the Sun's Magnetic Amplitude was S. by E. Required, True Amplitude and Error of the Compass, and supposing the Variation to be 27° E., required the Deviation of the Compass for that position of the Ship's head.

Ex. 14.—1876, May 1st, at 6^h 0^m A. M., Appt. T. Ship, latitude 0° 0′, longitude 152° 21′ E., the Sun's Magnetic Amplitude was E by N ½ N. Required, True Amplitude and Error of the Compass, and supposing the Variation to be 5° 45′ E., required the Deviation of the Compass for that position of the Ship's head.

Ex. 15.—1876, July 31st, at 6^h 37^m P. M., Appt. T. Ship, latitude 27° 12′ N., longitude, 180° E., the Sun's Magnetic Amplitude was West. Required, True Amplitude and Error of the Compass, and supposing the Variation to be 11° 50′ E., required the Deviation of the Compass for that position of the Ship's head.

AZIMUTH.

61. With the Ship Time and Longitude find the Greenwich Date (56). From the Observed Altitude get the True Altitude (50). Find the True Declination (49) taking the declination from page II of the Nautical Almanac, and the "diff. for 1 hour" from page 1 as before. Subtract the true declination from 90° when the latitude and declination are of the same name, but add it to 90° when they are of contrary names, the sum or remainder will be the Sun's Polar Distance.

62. To find the True Azimuth.—Under the Polar Distance place the Altitude and Latitude, add them together and divide the sum by 2, now take the difference between the Half Sum and the Polar Distance and let the result be called the Remainder.

63. Turn out the following logs. to the nearest minute :—

of the	Altitude	the	Secant
"	Latitude	"	Secant
"	Half Sum	"	Cosine
"	Remainder	"	Cosine

64. By *Raper* the sum of these logs. will be the log. Sine Square of the True Azimuth; but by *Norie* or *Bowditch*, divide the sum of these logs. by 2, and look out this log. in the sine column, the degrees and minutes corresponding will be half the azimuth, which being doubled will given the True Azimuth. Name the True Azimuth N or S *contrary to the latitude*, and E if the observation was taken in the morning but W if in the afternoon. If the True Azimuth does not reckon from the N or S the same as the sun's bearing by Compass, make it do so by subtracting it from 180°.

65. To find the Error of the Compass.—Under the True Azimuth place the sun's bearing by compass, and if they are both E or both W take their difference, but if one is E and the other W add them together, and the result in either case will be the Error of the Compass. With two cross lines make the four cardinal points of the Compass, and upon this lay off the Compass and True Bearings of the Sun; now supposing yourself standing in the centre, looking along the line representing the sun's compass bearing, then, if the True Azimuth falls to your right hand the Error is E, but W if it is to your left hand.

66 To find the Deviation of the Compass.—With the Error of the Compass and the Variation find the Deviation (60).

Ex. 1—1876, April 16th; Mean Time Ship at $8^h\ 43^m$ A. M., in latitude 37° 18′ S, longitude 93° 22′ W. The Sun's bearing by Compass E N E, altitude ☉ 23° 24′ 0″. Height of the eye 20 feet. Required the True Azimuth and Error of the Compass; and supposing the Variation to be 15° 45′ E, required the Deviation of the Compass for that position of the Ship's head.

Ship date	April $15^d\ 20^h 43^m\ 0^s$	Decl.	10° 20′ 52″ N	52″·91
Long. in time	+ 6 13 28	Cor.	+ 2 33	2·9
G. M. T.	16 2 56 28	T. Dec.	10 23 25	47619
			90	10582
		Polar distance	100 23 25	153·439
			Correction	2 33

Norie.

Obs. Alt. ⊙	23° 24′ 0″	Polar distance	100 23 25		
Dip.	− 4 17	True altitude	23 33 38	Secant	0·037822
		Latitude	37 18 0	Secant	0·099374
	23 19 43				
Ref.–Par.	− 2 3	Sum	161 15 3		
		Half sum	80 37 32	Cosine	9·211526
	23 17 40	Remainder	19 45 53	Cosine	9·973625
Semi-diam.	+ 15 58				
					19·322347
True alt.	23 33 38				
			27° 17′	Sine	9·661174
			2		

True Azimuth	N	54 34	E
Magnetic Azimuth	N	67 30	E
Error of the Compass		12 56	W
Variation		15 45	E
Deviation		28 41	W

Bowditch.

Obs. Alt. ⊙	23° 24′ 0″	Polar distance	100° 23′ 25″		
Dip.	− 4 24	True Altitude	23 33 28	Secant	0·03777
		Latitude	37 18 0	Secant	0·09937
R. 2′ 14″	23 19 36				
P. − 8	− 2 6	Sum	161 14 53		
		Half Sum	80 37 27	Cosine	9·21229
	23 17 30	Remainder	19 45 58	Cosine	9·97363
Semi-diam.	+ 15 58				
					19·32306
True Alt.	23 33 28				
			27° 18′	Sine	9·66153
			2		

True Azimuth	N	54 36	E
Magnetic Azimuth	N	67 30	E
Error of the Compass		12 54	W
Variation		15 45	E
Deviation		28 39	W

Raper.

Obs. Alt. ⊙	23°	24′	0″	Polar distance	100°	23′	25″	
Dip.	–	4	20	True Altitude	23	33	33	Secant 0·037795
				Latitude	37	18	0	Secant 0·099374
R. 2′ 13″	23	19	40					
P. – 8	–	2	5	Sum	161	14	58	
				Half sum	80	37	29	Cosine 9·211909
	23	17	35	Remainder	19	45	56	Cosine 9·973625
Semi-diam.	+	15	58					
True Alt.	23	33	33					

TRUE AZIMUTH	N 54	35	E	Sine Sq.	9·322703
Magnetic Azimuth	N 67	30	E		
ERROR OF THE COMPASS	12	55	W		
Variation	15	45	E		
DEVIATION	28	40	W		

Ex. 2.—1876, August 13th; Mean Time Ship at 7^h 20^m A. M., in latitude 19° 10′ S., longitude 43° 38′ E. The Sun's bearing by Compass E. ¾ S., altitude ⊙ 12° 9′ 0″ Height of the eye 10 feet. Required the Time Azimuth, and Error of the Compass; and supposing the Variation to be 18° W., required the Deviation of the Compass for that position of the ship's head.

Ship date	Aug. 12^d	19^h	20^m	0^s	Decl.	14°	48′	40″	N.
Longitude in time	—	2	54	32	Cor.	—	12	26	
G. M. T.	12	16	25	28	True decl.	14	36	14	
						90			
					Polar distance	104	36	14	

Norie.

Obs. Alt. ⊙	12°	9′	0″	Polar distance	104°	36′	14″	
Dip.	—	3	2	True Altitude	12	17	36	Secant 0·010085
				Latitude	19	10	0	Secant 0·024767
	12	5	58					
Ref. — Par.	—	4	12		136	3	50	
					68	1	55	Cosine 9·572950
	12	1	46		36	34	19	Cosine 9·904804
Semi-diam.	+	15	50					
								19·512606
True alt.	12	17	36					
					34	47		Sine 9·756303
						2		

TRUE AZIMUTH	N 69	34	E	

TRUE AZIMUTH	N	69 34	E
		180 0	
	S	110 26	E
Magnetic Azimuth	S	81 34	E
ERROR OF THE COMPASS		28 52	W
Variation		18 0	W
DEVIATION		10 52	W

Bowditch.

Obs. Alt. ⊙	12° 9′ 0″	Polar distance	104° 36′ 14″		
Dip.	− 3 7	True Altitude	12 17 29	Secant	0·01006
		Latitude	19 10 0	Secant	0·02477
R. 4′ 23″	12 5 53				
P. − 9	− 4 14	Sum	136 3 43		
		Half Sum	68 1 52	Cosine	9·57295
	12 1 39	Remainder	36 34 22	Cosine	9·90480
Semi-diam.	+ 15 50				
					19·51258
True Alt.	12 17 29				
			34° 47′	Sine	9·75629
			2		
TRUE AZIMUTH			N 69 34 E		

The remainder of the work the same as in *Noric* above.

Raper.

Obs. Alt. ⊙	12° 9′ 0″	Polar distance	104° 36′ 14″		
Dip.	− 3 10	True Altitude	12 17 23	Secant	0·010071
		Latitude	19 10 0	Secant	0·024767
R. 4′ 25″	12 5 50				
P. − 8	− 4 17	Sum	136 3 37		
		Half sum	68 1 49	Cosine	9·572950
	12 1 33	Remainder	36 34 25	Cosine	9·904757
Semi-diam.	+ 15 50				
True alt.	12 17 23				
TRUE AZIMUTH			N 69 34 E	Sine Sq.	9·512545

The remainder of the work the same as in *Noric* above.

Ex. 3.—1876, January 28th; Mean Time Ship at $3^h\ 4^m$ P. M., in latitude 24° 10′ S, longitude 79° 14′ E. The Sun's bearing by Compass N. 87° 0′ W, altitude ⊙ 36° 1′ 20″. Height of the eye 13 feet. Required the True Azimuth and Error of the Compass; and supposing the Variation to be 8° 38′ E, required the Deviation of the Compass for that position of the Ship's head.

Ex. 4.—1876, February 25th; Mean Time Ship at 8^h 15^m A. M. in latitude 17° 35′ N, longitude 118° 26′ W. The Sun's bearing by Compass E. by S ¾ S, altitude $\underline{\odot}$ 28° 10′ 20″. Height of the eye 17 feet. Required the True Azimuth and Error of the Compass; and supposing the Variation to be 7° 14′ E., required the Deviation of the Compass for that position of the Ship's head.

Ex. 5.—1876, September 22nd; Mean Time Ship at 7^h 14^m A.M., in latitude 26° 26′ S, longitude 146° 6′ 45″ W. The Sun's bearing by compass S 78° 40′ E, altitude $\underline{\odot}$ 17° 59′ 45″. Height of the eye 10 feet. Required the True Azimuth and Error of the Compass; and supposing the Variation to the 8° E, required the Deviation of the Compass for that position of the Ship's head.

Ex. 6.—1876, October 1st; Mean Time Ship at 4^h 37^m, latitude 12° 26′ N, longitude 88° 26′ E. The sun's bearing by Compass N 74° 30′ W, altitude $\overline{\odot}$ 17° 15′ 40″. Height of the eye 14 feet. Required the True Azimuth and Error of the Compass, and supposing the Variation to be 2° E, required the Deviation of the Compass for that position of the Ship's head.

Ex. 7.—1876, December 20th; Mean Time Ship at 4^h 17^m, latitude 58° 52′ S, longitude 80° 22′ W. The sun's bearing by compass S 64° 20′ E, altitude $\underline{\odot}$ 8° 20′ 45″. Height of the eye 7 feet. Required the True Azimuth and Error of the Compass, and supposing the Variation to be 26° 30′ E, required the Deviation of the Compass for that position of the Ship's head.

Ex. 8.—1876, February 12th; Mean Time Ship at 4^h 8^m, latitude 27° 47′ S, longitude 94° 45′ E. The Sun's bearing by Compass N. W. by W ¼ W, altitude $\underline{\odot}$ 34° 0′ 45″. Height of the eye 21 feet. Required the True Azimuth and Error of the Compass, and supposing the Variation to be 9° 30′ W, required the Deviation of the Compass for that position of the Ship's head.

Ex. 9.—1876, November 14th, Mean Time Ship at 2^h 58^m, latitude 49° 12′ N, longitude 34° 29′ W. The Sun's bearing by Compass West, altitude $\underline{\odot}$ 9° 47′ 30″. Height of the eye 13 feet. Required the True Azimuth and Error of the Compass, and supposing the Variation of the Compass to be 35° 0′ W, required the Deviation of the Compass for that position of the Ship's head.

Ex. 10.—1876, March 20th, Mean Time Ship at $9^h\ 15^m$, latitude 26° 50′ N longitude 34° 32′ 45″ W. The Sun's bearing by Compass S 50° E, altitude ☉ 40° 30′ 40″. Height of the eye 20 feet. Required the True Azimuth and Error of the Compass, and supposing the Variation of the Compass to be 17° 40′ W, required the Deviation of the Compass for that position of the Ship's head.

Ex. 11.—1876, June 18th, Mean Time Ship at $4^h\ 17^m$, lat. 0° 0′, longitude 31° 28′ W. The Sun's bearing by Compass N 70° 20′ W, altitude ☉ 23° 30′ 50″. Height of the eye 17 feet. Required the True Azimuth and Error of the Compass, and supposing the Variation of the Compass to be 11° 0′ W, required the Deviation of the Compass for that position of the Ship's head.

Ex. 12.—1876, July 1st, Mean Time Ship at $2^h\ 45^m$, latitude 58° 16′ 40″ N, longitude 131° 30′ W. The Sun's bearing by Compass S 6° 20′ E, altitude ☉ 45° 5′ 10″. Height of the eye 6 feet. Required the True Azimuth and Error of the Compass, and supposing the Variation of the Compass to be 32° E, required the Deviation of the Compass for that position of the Ship's head.

Ex. 13.—1876, October 18th, Mean Time Ship at $5^h\ 28^m$, latitude 15° 47′ N, longitude 78° 47′ E. The Sun's bearing by Compass W ¼ N, altitude ☉ 1° 34′ 20″. Height of the eye 21 feet. Required the True Azimuth and Error of the Compass, and supposing the Variation of the Compass to be 1° 7′ E, required the Deviation of the Compass for that position of the Ship's head.

Ex. 14.— 1876, September 24th, Mean Time Ship at $2^h\ 19^m$, latitude 40° 12′ S, longitude 155° 51′ W. The Sun's bearing by Compass S 86° 30′ W, altitude ☉ 38° 44′ 15″. Height of the eye 7 feet. Required the True Azimuth and the Error of the Compass, and supposing the Variation of the Compass to be 10° 30′ E, required the Deviation of the Compass for that positien of the Ship's head.

Ex. 15.—December 24th, Mean Time Ship $2^h\ 18^m$, latitude 49° 17′ 20″ N, longitude 134° 10′ W. The Sun's bearing by Compass South, altitude ☉ 10° 58′ 0″. Height of the eye 12 feet. Required the True Azimuth and the Error of the Compass, and supposing the Variation of the Compass to be 22° 40′ E, required the Deviation of the Compass for that position of the Ship's head.

CHRONOMETER.

TO FIND THE MEAN TIME AT GREENWICH.

67. Upon looking at the time shewn by the Chronometer, it will be noticed that it is not specified whether it is A. M. or P. M.; the first thing to be done then, is to find whether it is A. M or P. M. at Greenwich. Get out what will be an "Approximate," Greenwich date with the given mean time at ship and the longitude by account (56); and generally, if the time thus found is less than 12 hours, the chronometer is shewing P. M. time upon the day of the Approximate Greenwich Date, while if it is over 12 hours, the chronometer is shewing A. M. time upon the day following the Greenwich Date. Cases may occur, however, in which this will not hold good, for if the actual time at Greenwich is close to noon or midnight, any inaccuracy in the approximate time may cause the chronometer to shew time in a different division of the day to that upon which the real time falls; and the same thing is liable to happen if the chronometer has a large error, but this should not cause any difficulty, for as the Approximative Greenwich Date cannot be very far from the truth, a moment's consideration will shew whether it will be necessary to take the chronometer time as A. M. or as P. M. to arrive at a date close to the approximate time. Having determined whether the chronometer is shewing A. M. or P. M. time, express it astronomically, and apply the last error of the chronometer to it, subtractive if it should be fast, but additive if slow, and let the result be called the Corrected Chronometer Time.

68. To find the Daily Rate.—Find the interval between the given errors of the chronometer, that is, if they are both fast or both slow, get their difference; but if one is fast and the other slow, get their sum. Bring the interval into seconds, and place a cypher at the right hand, now divide this by the number of days between the dates of the two errors, and after making a decimal of the right hand figure, the result will be the Daily Rate in seconds and tenths, and will be marked as a gaining or losing rate as follows :

Errors both fast.—If the chronometer is increasing its gain, it is evidently still "gaining"; but if is decreasing its gain, it must be "losing."

Errors both slow.—In the same way, if the chronometer is increasing its loss, it must be "losing," but if it is decreasing its loss, it is "gaining."

Errors one fast and the other slow.—In this case, the rate must evidently be of the same name as the second error.

69. To find the Accumulated Rate.—Find the number of days that have elapsed between the date of the second error and that of the corrected chronometer time. This may be done by taking out the "day of the year" corresponding to the date of the corrected chronometer time, and also to that of the second error, as given in page XX of their respective months in the Nautical Almanac; if they are both of the same year, then their difference will be the number of days required; but if the dates are in following years, take the "day of the year" corresponding to the date of the second error from 365, (unless the Nautical Almanac in use is for a leap year when 366 days must be applied if the date of the second error is after Feb. 28th, as is almost sure to be the case,) and add the remainder to the "day of the year" of the corrected chronometer time. Now change the hours of the corrected chronometer time into decimals, by taking them to the *nearest* hour, and after placing two cyphers to the right, divide first by 4 and then by 6, and if, as in the case of the first and second hour, the result only gives one figure, made it into two by prefixing a cypher. Place the decimals thus found after the number of days run by the chronometer. Multiply the number so formed by the daily rate, and point off from the right of the product as many figures as there are decimal figures in the numbers multiplied, the figures remaining will be the Accumulated Rate in seconds, which if more than 60 must be brought into minutes.

70. The Accumulated Rate must be applied to the corrected chronometer time, additive if the daily rate is losing, but subtractive if it is gaining; the result will be the Mean Time at Greenwich.

Ex. 1.—1876, May 18 at 2^h 18^m P. M. at ship, Longitude by account 88° 47′ W. Time by a chronometer 9^h 10^m 35^s, which was fast 47^m 15^s for mean noon at Greenwich on Feb. 4, and on Feb. 27 was fast 49^m 5^s for mean noon at Greenwich. Required the Mean Time at Greenwich by chronometer.

		d h m s		d h m s
Ship date	May	18 2 18 0	Time by chron. May	18 9 10 35
Long. in time		5 55 8	Error on Feb. 27	— 49 5
Approximate G. Date		18 8 13 8	Corrected chron.time	18 8 21 30
			Accumulated Rate	— 6 30
Hours since noon		4) 8·00	G. M. T. by chron.	18 8 15 0
		6) 2·00		
Decimals of a day		·33		

Error Feb. 4th *fast* 47m 15s
Error Feb. 27th *fast* 49 5

23	1 50		May 18th day of year	138
	60		Feb. 27 " "	57
	23) 110·0 (4·7		Interval	81·33
	92		Daily rate	4·8
	180			65064
	161			32532
Daily Rate 4·8 gaining	19			6,0) 39,0·384
			Accumulated Rate	6 30

Ex. 2.—1876, Sept. 24 at 8^h 47^m A. M. at ship, Long. by account 13° 48′ E. Time by a chronometer 7^h 41^m 47^s which was slow 18^m 17^s for mean noon at Greenwich on Jan. 24, and on Feb. 19 was slow 17^m 12^s for mean noon at Greenwich. Required the Mean Time at Greenwich by chronometer.

		d h m s		d h m s
Ship date	Sept.	23 20 47 0	Time by chron., Sept.	23 19 41 47
Long. in time		— 55 12	Error on Feb. 19	+ 17 12
Approximate G.Date		23 19 51 48	Corrected chron. time	23 19 58 59
			Accumulated Rate	— 9 5
			G. M. T. by chron.	23 19 49 54

		m s		
Error Jan. 24	*slow*	18 17		
Error Feb. 19	*slow*	17 12	4) 20·00 h	Sept. 23. day of year 266
				Feb. 19, " " 49
26		1 5	6) 5·00	
		60		Interval 217·83
			·83	Daily Rate 2·5
	26)	65·0 (2·5		
		52		108915
				43566
		130		
		130		6,0) 54,4·575
Daily rate 2s·5 gaining		...		Accumulated Rate 9 5

Ex. 3.—1876, Feb. 20 at 9^h 4^m A. M. at ship, Long. by account 43^o 32′ W. Time by a chronometer 0^h 1^m 22^s which was fast 14^s for mean noon at Greenwich on Jan. 31, and on Feb. 18 was slow 0^m 9^s for mean noon at Greenwich. Required the Mean Time at Greenwich by chronometer.

		d h m s			d h m s
Ship date	Feb.	19 21 4 0	Time by chron.	Feb.	20 0 1 22
Long. in time		+ 2 54 8	Error on Feb. 18		+ 9
Approx. G. Time		19 23 58 8	Corrected Chr. Time		20 0 1 31
			Accumulated Rate		+ 3
			G. M. T. by Chron.		20 0 1 34

		m s		
Error Jan. 31	*fast*	0 14	Interval from	d
Error Feb. 18	*slow*	0 9	Feb. 18 to Feb. 20 =	2
			Daily Rate	1·3
18	18)	23·0 (1·2		
		18	Accumulated Rate	2·6
		50		
		36		
Daily Rate 1s·3 losing		14		

Ex. 4.—1876, Aug. 12 at 3^h 10^m P.M. at ship, Long. by account 124^o 20′ E. Time by a chronometer 6^h 37^m 28^s which was slow 2^m 46^s for mean noon at Greenwich on June 1, and on June 12 was slow 4^m 40^s for mean noon at Greenwich. Required the Mean Time at Greenwich by Chronometer.

Ex. 5.—1876, April 18 at 8^h 24^m A. M. at ship, Long. by account 47° 48′ E. Time by a Chronometer 5^h 36^m 9^s which was fast 12^m 22^s for mean noon at Greenwich on Jan. 5, and on Jan. 19 was fast 13^m 49^s for mean noon at Greenwich. Required the Mean Time at Greenwich by Chronometer.

Ex. 6.—1876, June 26 at 2^h 44^m P. M. at ship., Long. by account 30° W. Time by a Chronometer 4^h 47^m 50^s which was slow 6^m 17^s for mean noon at Greenwich on May 12, and on May 20 was slow 4^m 29^s for mean noon at Greenwich. Required the Mean Time at Greenwich by Chronometer

Ex. 7.—1876, Nov. 16 at 2^h 47^m P. M. at ship, Long. by account 47° 45′ E. Time by a Chronometer 0^h 4^m 54^s which was slow 0^m 48^s for mean noon at Greenwich on March 10, and on Sept. 23 was fast 22^m 31^s for mean noon at Greenwich. Required the Mean Time at Greenwich by Chronometer.

Ex. 8.—1876, Oct. 28 at 7^h 28^m A. M. at ship, Long. by account 99° 10′ W. Time by a Chronometer 2^h 2^m 40^s which was fast 18^m 22^s for mean noon at Greenwich on June 2, and on July 15 was fast 12^m 25^s for mean noon at Greenwich. Required the Mean Time at Greenwich by Chronometer.

Ex. 9.—1876, Dec. 2 at 2^h 47^m P. M. at ship. Long. by account 18° 27′ E. Time by a chronometer 10^h 36^m 12^s which was slow 2^h 58^m 40^s for mean noon at Greenwich on July 14, and on Sept. 1 was slow 2^h 58^m 6^s for mean noon at Greenwich. Required the Mean Time at Greenwich by chronometer.

TO CORRECT THE ELEMENTS.

71. From the observed altitude find the True Altitude (50); get also the True Declination (49) taking the declination from page II of the Almanac and the diff. for 1 hour from page I as before.

72. Subtract the True Declination from 90° when the latitude and declination are of the same name, but add it to 90° when they are of contrary names, and the sum or remainder will be the sun's Polar Distance.

73. From page I* of the Nautical Almanac, take out the

*** Theoretically, the Equation of Time should be taken from page II, but as errors are very likely to occur in consequence of having to refer to page I to see how it is to be applied, it is better—more especially as it makes no practical difference—to take the Equation also from page I.**

Equation of Time opposite the Greenwich date, marking it + or − as directed at the head of the column from which it is taken. Multiply its "diff. for 1 hour" by the Greenwich Time decimally expressed (this is the same as the hourly difference of the declination is multiplied by), cut off from the right as many figures as there are decimals in the two numbers multiplied, and the result will be the correction in seconds.

Place this correction (to two places of decimals) under the Equation of Time, and add them together if the equation is increasing, but subtract them if it is decreasing; in this latter case, if the equation is less than the correction, the True Equation of Time, thus found, will have a contrary sign to that taken out.

TO FIND THE APPARENT TIME AT SHIP.

74. Underneath the True Altitude set down the Polar Distance and Latitude; now add them together, get half the sum, and then the difference between the Half Sum and the True Alt., and let the result be called the Remainder.

75. Take out the following logs. to seconds (20 to 22)

Of the	Polar Distance,	the Co-Secant.		*When the Polar dist.*
"	Latitude,	"	Secant.	*exceeds 90°, take*
"	Half sum,	"	Cosine.	*out the Secant of*
"	Remainder,	"	Sine.	*the T. Dec.*

76. Norie.—Take the sum of these four logs. and in Table XXXI find the Apparent Time corresponding to it, as under, viz :

If it is P. M. at Ship.—Take out the time corresponding to the log. from the top of the page, (start by taking the next less log. to the given one) prefix the date at Ship, and it will now be the Apparent Time at Ship.

If it is A. M. at Ship.—Take out the time corresponding to the log. from the bottom of the page, (choosing the next greatest log. to the given one) and it will be the Apparent Time at Ship, reckoning from the day before the ship's date. In the earlier additions of *Norie*, the time is *always* taken fron the top, therefore when it is A. M. at ship, the time found will have to be subtracted from 24^h, and the remainder will be the apparent time at ship, reckoning from *the day before* the ship's date.

77. Bowditch.—Take the sum of these four logs. and divide it by 2, now look for this log. in the sine column of Table XXVII, choosing the next less to the given log. if it is P. M. at ship but the next greater if it is A. M. at ship, so that the odd seconds may always be additive, then :—

If it is P. M. at Ship.—Take out the time corresponding in the P. M. column, to which prefix the ship's date, and you will have the Apparent Time at Ship.

If it is A. M. at Ship.—Take out the corresponding time in the A. M. column, add 12^h to it, and you will have the Apparent Time at Ship, reckoning from the day before the ship's date.

78. Raper.—The sum of these four logs. will be the log. Sine Square (Table 69) of the Hour Angle, then :—

If it is P. M. at Ship.—The Hour Angle is the Apparent Time at Ship, reckoning from the day of the ship's date.

If it is A. M. at Ship.—Take the Hour Angle from 24^h, and the remainder will be the Apparent Time at Ship, reckoning from *the day before* the ship's date.

TO FIND THE MEAN TIME AT SHIP.

79. To the Apparent time at Ship apply the Equation of Time, additive or subtractive according to its sign, and the result will be the Mean Time at Ship.

TO FIND THE LONGITUDE.

80. Under the Mean Time at Ship place the Mean Time at Greenwich, subtract the less from the greater (mind and look at your days), and the remainder is the "Longitude in Time," turn this into arc by multiplying it by 60 and dividing by 4, or by Table XIX *Norie*, Table XXI *Bowditch*, or Table 18 *Raper*, and this will be the longitude, which can be named E. or W. by the following well known couplet :

"Greenwich time best, Longitude West,"
"Greenwich time least, Longitude East."

Ex. 1.—1876, July 16th at $3^h\ 6^m$ P. M. Mean Time at ship, in latitude $27^\circ\ 14'$ N., longitude by account $18^\circ\ 18'$ W. The observed altitude of the Sun's Lower Limb was $48^\circ\ 34'\ 10''$. Height of eye 18 feet. Time by a Chronometer $4^h\ 19^m\ 46^s$ which was fast $8^m\ 13^s$ for mean noon at Greenwich on April 10th, and on May 5th was fast for mean noon at Greenwich $6^m\ 18^s$. Required the longitude by Chronometer.

		d h m s			d h m s
Ship Time	July	16 3 6 0	Time by Chron.	July	16 4 19 46
Long. in Time		+ 1 13 12	Error on May 5		− 6 18
Approx. G. Date		16 4 19 12	Corrected Chron. time		16 4 13 28
			Accumulated rate		+ 5 32
Hours since noon		4) 4·00	G. M. T. by Chron.		16 4 19 0
		6) 1·00			
Decimals of a day		·17			

Error, April	10, fast	8m 13s	July 16th, day of year	197
May	5, fast	6 18	May 5th " "	125
	25	1 55	Interval	72.17
	—	60	Daily rate	4.6
	25)	115·0 (4s. 6		43302
		100		28868
Daily rate 4s 6 losing		150		60) 331.982
		150	Accumulated rate	5 32
		. . .		

				m s	
Declin.	21° 17′ 17″	Hourly diff.	Equ. of T.	+ 5 47·51	Hourly diff.
Cor.	− 1 48	25·08	Correction	+ ·98	·227
		4·3			4·3
T. decl.	21 15 29		True E. T.	5 48·49	
	90	7524			681
		10032			908
P. dist.	68 44 31				
		107·844		Correction	·9761

Correction 1 48

Norie.

Obs. Alt. ⊙	48° 34′ 10″	True altitude	48° 45′ 8″		
Dip.	− 4 4	Polar distance	68 44 31	Cosecant	0·030605
		Latitude	27 14 0	Secant	0·051025
	48 30 6				
Ref.–Par.	− 44	Sum	144 43 39		
		Half sum	72 21 50	Cosine	9·481400
	48 29 22	Remainder	23 36 42	Sine	9·602641
Semi-diam.	+ 15 46				
		A. T. S.	16d 3h 0m 0s		9·165671
True Alt.	48 45 8	Equ. Time	+ 5 48		
		M. T. S.	16 3 5 48		
		G. M. T.	16 4 19 0		
		LONGITUDE	1 13 12 = 18° 18′ 0″ W.		

Bowditch.

Obs. Alt. ⊙	48° 34′ 10″	True altitude	48° 45′ 0″		
Dip.	− 4 11	Polar distance	68 44 31	Cosecant	0·03060
		Latitude	27 14 0	Secant	0·05102
P. 0′ 51″	48 29 59				
R. − 6	− 45	Sum	144 43 31		
		Half sum	72 21 46	Cosine	9·48142
	48 29 14	Remainder	23 36 46	Sine	9·60266
Semi-diam.	+ 15 46				
					2) 19·16570
True Alt.	48 45 0				
		A. T. S.	16d 3h 0m 0s	Sine	9·58285
		Equ. Time	+ 5 48		
		M. T. S.	16 3 5 48		
		G. M. T.	16 4 19 0		
		LONGITUDE	1 13 12 = 18° 18′ 0″ W.		

Raper.

Obs. Alt. ⊙	48° 34′ 10″	True altitude	48° 45′ 0″		
Dip.	– 4 10	Polar distance	68 44 31	Cosecant	0·030604
		Latitude	27 14 0	Secant	0·051025
P. 0′ 51″	48 30 0				
R. – 5	– 46	Sum	144 43 31		
		Half sum	72 21 46	Cosine	9·481427
	48 29 14	Remainder	23 36 46	Sine	9·602660
Semi-diam.	+ 15 46				
		A. T. S.	16ᵈ 3ʰ 0ᵐ 0ˢ	Sine sq.	9·165716
True Alt.	48 45 0	Equ. Time	+ 5 48		
		M. T. S.	16 3 5 48		
		G. M. T.	16 4 19 0		
		LONGITUDE	1 13 12	=	18° 18′ 0″ W.

Ex. 2.—1876, December 25th, at 9^h 37^m A. M., mean time at ship, in latitude 49° 57′ N. Longitude by account 7° 28 W. The observed altitude of the Sun's Lower Limb was 9° 55′ 30″ Height of eye 15 feet. Time by a chronometer 10^h 17^m 47^s which was slow 4^m 32^s for mean noon at Greenwich on February 12th, and on June 8th was fast for mean noon at Greenwich 1^m 7^s. Required the Longitude by chronometer.

	d h m s		d h m s
Ship Time	Dec. 24 21 37 0	Time by chron.	24 22 17 47
Long. in Time	+ 29 52	Error on June 8th	– 1 7
Approx. G. Date	24 22 6 52	Corrected Chr. Time	24 22 16 40
		Accumulated rate	– 9 40
		G. M. T. by Chron.	24 22 7 0

Hours since noon 4) 22·00

6) 5·50

Decimals of a day ·92

		m	s
Error, Feb. 12th slow		4	32
Error, June 8th fast		1	7
	117	5	29
		60	

117) 339·0 (2·8
234
1050
936
114

Daily rate 2·9s gaining

Dec. 25, day of the year	358
June 8 " "	159
Interval	199·92
Daily rate	2·9
	179928
	39984
	579·768
Accumulated rate	9 40

				Hourly diff.
Declin.	23°	25′	16″	
Cor.	−	1	20	3″·60
				22·1
Tr. decl.	23	23	56	360
	90			720
P. dist.	113	23	56	720
				79·560
			Correction	1·20

			Hourly diff.
Equ of T.	+ 0	6·68	
Correction		+ 27·54	1s·246
			22·1
True E. T.	0	34·22	1246
			2492
			2492
		Correction	27·5366

Norie.

Obs. Alt. ⊙	9°	55′	30″
Dip.	−	3	42
	9	51	48
Ref.—Par.	−	5	10
	9	46	38
Semi-diam.	+	16	18
True alt.	10	2	56

True altitude	10°	2′	56″			
Polar distance	113	23	56		Cosecant	0·037270
Latitude	49	57	0		Secant	0·191481
Sum	173	23	52			
Half sum	86	41	56		Cosine	8·760297
Remainder	76	39	00		Sine	9·988103
						8·977151

	d	h	m	s
A. T. S.	24	21	36	29
Equ. time	+			34
M. T. S.	24	21	37	3
G. M. T.	24	22	7	0

LONGITUDE 29 57 = 7° 29′ 15″ W.

Bowditch.

Obs. alt. ☉	9° 55′ 30″	True altitude	10° 2′ 48″		
Dip.	− 3 49	Polar distance	113 23 56	Cosecant	0·03727
		Latitude	49 57 0	Secant	0·19148
R. 5 20	9 51 41				
P. − 9	− 5 11	Sum	173 23 44		
		Half-sum	86 41 52	Cosine	8·76046
	9 46 30	Remainder	76 39 4	Sine	9·98810
Semi-diam.	+ 16 18				
				2)	18·97731
True alt.	10 2 48				
			d h m s	Sine	9·48866
		A. T. S.	24 21 36 27		
		Equ. time	+ 34		
		M. T. S.	24 21 37 1		
		G. M. T.	24 22 7 0		
		LONGITUDE	29 59	= 7° 29′ 45″ W.	

Raper.

Obs. alt. ☉	9° 55′ 30″	True altitude	10° 2′ 42″		
Dip.	− 3 50	Polar distance	113 23 56	Cosecant	0·037270
		Latitude	49 57 0	Secant	0·191481
R. 5′ 25″	9 51 40				
P. − 9	− 5 16		173 23 38		
			86 41 49	Cosine	8·760552
	9 46 24		76 39 7	Sine	9·988106
Semi-diam.	+ 16 18				
		Hour angle	2 23 34	Sine sq.	8·977409
True alt.	10 2 42		24		
			d h m s		
		A. T. S.	24 21 36 26		
		Equ. time	+ 34		
		M. T. S.	24 21 37 0		
		G. M. T.	24 22 7 0		
		LONGITUDE	30 0	= 7° 30′ 0″ W.	

Ex. 3.—January 26th at 3^h 20^m P. M. Mean time at ship, in latitude 25^o $50'$ S., longitude by account 70^o $25'$ W. The observed altitude of the Sun's Lower Limb was 46^o $8'$ $0''$. Height of eye 18 feet. Time by a Chronometer 8^h 3^m 14^s which was fast 2^m 47^s for mean noon at Greenwich on January 2nd, and on January 12th was fast for mean noon at Greenwich 2^m 16^s. Required the longitude by Chronometer.

Ex. 4.—1876, March 19th, at 8^h 38^m A. M. Mean time at ship, in latitude 23^o $0'$ N., longitude by account 13^o $27'$ E. The observed altitude of the Sun's Lower Limb was 33^o $41'$ $20''$. Height of eye 7 feet. Time by a Chronometer 8^h 0^m 0^s which was fast 15^h 8^s for mean noon at Greenwich on January 13th and on January 22nd was fast for mean noon at Greenwich 15^m 15^s. Required the longitude by Chronometer.

Ex. 5.—1876, February 12th, at 6^h 57^m A. M. Mean time at ship, in latitude 56^o $17'$ S., longitude by account $9°$ $40'$ W., the observed altitude of the Sun's Lower Limb was $17°$ $17'$ $0''$. Height eye 18 feet. Time by a Chronometer 9^h 19^m 37^s which was fast 1^h 49^m 16^s for mean noon at Greenwich on January 2nd, and on January 18th was fast for mean noon at Greenwich 1^h 47^m 3^s. Required the longitude by Chronometer.

Ex. 6.—1876, May 25th at 8_h 57^m A. M. Mean time at ship, in latitude $45°$ $15'$ $26''$ S., longitude by account $45°$ $48'$ W. The observed altitude of the Sun's Lower Limb was $11°$ $58'$ $30''$. Height of the eye 20 feet. Time by a Chronometer 11^h 45^m 12^s which was slow 18^m 38^s for mean noon at Greenwich on April 4th, and on April 19th was slow for mean noon at Greenwich 17^m 30^s. Required the longitude by Chronometer.

Ex. 7.—1876, June 13th at 7^h 29^m A. M. Mean time at ship in latitude $47°$ $12'$ N., longitude by account $106°$ $50'$ E. The observed altitude of the Sun's Upper Limb was $32°$ $9'$ $0''$. Height of the eye 18 feet. Time by a Chronometer 9_h 18^m 7^s which was slow 3_h 8^m 7^s for mean noon at Greenwich on May 10th and on June 1st was slow for mean noon at Greenwich 3^h 5^m 7^s. Required the longitude by Chronometer.

Ex. 8—1876, October 18th at 4^h 57^m P. M. Mean time at ship, in latitude 44^o $12'$ $30''$ S., longitude by account 128^o $4'$ E. The observed altitude of the Sun's Lower Limb was 15^o $14'$ $30''$ Height of the eye 19 feet. Time by a Chronometer 8^h 40^m 10^s which was fast 13^m 25^s for mean noon at Greenwich on September 26th, and on October 17th was fast for mean noon at Greenwich 15^m 12^s. Required the longitude by Chronometer

Ex. 9.—1876, January 25th at 3^h 47^m P. M. Mean time at ship, in latitude 18° 40′ S., longitude by account 114° 2′ E. The observed altitude of the Sun's Lower Limb was 39° 16 40″. Height of the eye 18 feet. Time by a Chronometer 7^h 30^m 37^s which was slow 47^m 27^s for mean noon at Greenwich on October 18th 1875 and on November 22nd 1875 was slow for mean noon at Greenwich 44^m 50^s. Required the longitude by Chronometer.

Ex. 10.—1876, April 19th, at 6^h 48^m A. M. Mean time at ship, in latitude 43° 12′ 25″ N., longitude by account 39° 27 E. The observed altitude of the Sun's Lower Limb was 16° 21′ 30″. Height of the eye 19 feet. Time by a Chronometer 5^h 25^m 28^s which was fast 57^m 57^s for mean noon at Greenwich on January 3rd and on March 4th was fast for mean noon at Greenwich 1^h 9^m 14^s. Required the Longitude by Chronometer.

Ex. 11.—1876, February 29th at 7^h 48^m A. M. Mean time at ship, in latitude 15° 15′ 15″ N., longitude by account 122° 50′ W. The observed altitude of the Sun's Lower Limb was 20° 23′ 45″ Height of the eye 11 feet. Time by a Chronometer 4^h 9^m 28^s which was slow 0^m 36^s for mean noon at Greenwich on January 1st and on January 25th was fast for mean noon at Greenwich 3^m 29^s. Required the Longitude by Chronometer.

Ex. 12.—1876, May 1st at 6^h 50^m A. M. Mean time at ship, in latitude 51° 31′ 16″ N., longitude by account 12° 22′ E. The observed altitude of the Sun's Upper Limb was 20° 23′ 30″. Height of the eye 12 feet. Time by a Chronometer 3^h 57^m 17^s which was slow 2^h 18^m 24^s for mean noon at Greenwich on September 30th and on November 13th was slow for mean noon at Greenwich 2^h 15^m 10^s. Required the Longitude by Chronometer.

Ex. 13.—1876, March 25th, at 4^h 10^m P. M. Mean time at ship, in latitude 38° 12′ N., longitude by account 15° 54′ W. The observed altitude of the Sun's Lower Limb was 23° 38′ 0″. Height of the eye 18 feet. Time by a Chronometer 5^h 8^m 50^s which was fast 1^m 46^s for mean at Greenwich on January 31st and on March 1st was slow for mean noon at Greenwich 2^m 5^s. Required the Longitude by Chronometer.

Ex. 14.—1876, May 20th, at 2^h 14^m P. M. Mean time at ship, in latitude 22° 54′ 45″ N., longitude by account 104° 14′ E. The observed altitude of the Sun's Upper Limb was 58° 11′ 20″. Height of the eye 12 feet. Time by a Chronometer 7^h 25^m 28^s which was fast 19^m 19^s for mean noon at Greenwich on March 1st and on April 6th was fast for mean noon at Greenwich 13^m 23^s. Required the Longitude by Chronometer.

Ex. 15.—1876, October 28th at 9^h 17^m A. M. Mean time at ship, in latitude 18° 18′ 35″ S., longitude by account 68° 58′ W. observed altitude of the Sun's Lower Limb was 54° 12′ 0″. Height of the eye 8 feet. Time by a Chronometer 1^h 48^m 30^s which was fast 0^m 32^s for mean noon at Greenwich on May 13th and on June 2nd was fast for mean noon at Greenwich 0^m 0^s. Required the Longitude by Chronometer.

Ex. 16.—1876, June 27th at 10^h 59^m A. M. Mean time at ship, in latitude 28° 16′ 40″ N., longitude by account 15° 32′ W. The observed altitude of the Sun's Lower Limb was 74° 37′ 20″. Height of the eye 17 feet. Time by a Chronometer 0^h 3^m 54^s which was fast 17^m 32^s for mean noon at Greenwich on February 2nd and on March 3rd was fast for mean noon at Greenwich 14^m 44^s. Required the Longitude by Chronometer.

Ex. 17.—1876, August 1st at 7^h 54^m A. M. Mean time at ship, in latitude 14° 34′ 9″ S., longitude by account 167° 0′ E. The observed altitude of the Sun's Lower Limb was 20° 20′ 0″. Height of the eye 12 feet. Time by a Chronometer 8^h 45^m 37^s which was slow 0^m 0^s for mean noon at Greenwich on May 19th and on June 19th was slow for mean noon at Greenwich 1^m 27^s. Required the Longitude by Chronometer.

Ex. 18.—1876, July 28th at 4^h 0^m P. M. Mean time at ship, in latitude 29° 40′ 40″ N., longitude by account 73° 40′ E. The observed altitude of the Sun's Lower Limb was 35° 51′ 10″. Height of the eye 12 feet. Time by a Chronometer 0^h 0^m 0^s which was fast 52^m 0^s for mean noon at Greenwich on February 28th and on April 1st was fast for mean noon at Greenwich 52^m 20^s. Required the Longitude by Chronometer.

Ex. 19.—1876, September 24th at 4^h 52^m P. M. Mean time at ship, in latitude 37° 21′ N., longitude by account 173° 44′ E. The observed altitude of the Sun's Lower Limb was 11° 21′ 15″. Height of the eye 7 feet. Time by a Chronometer 5^h 20^m 30^s which was slow 0^m 35^s for mean noon at Greenwich on November 22nd and on January 5th was correct for mean noon at Greenwich. Required the Longitude by Chronometer.

Ex. 20.—1876, January 18th at $8^h\ 0^m$ A. M. Mean time at ship, in latitude $15°\ 54'\ 40''$ N., longitude by account $0°\ 36'$ W. The observed altitude of the Sun's Lower Limb was $18°\ 38'\ 30''$. Height of the eye 19 feet. Time by a Chronometer $8^h\ 1^m\ 58^s$ which was fast $0^m\ 29^s$ for mean noon at Greenwich on August 16th and on October 9th was slow for mean noon at Greenwich $0^m\ 20^s$. Required the Longitude by Chronometer.

Ex. 21.—1876, July 15th at $1^h\ 17^m$ P. M. Mean time at ship, in latitude $20°\ 46'\ 18''$ N., longitude by account $37°\ 18'\ 0''$ E The observed altitude of the Sun's Lower Limb was $73°\ 10'\ 40''$. Height of the eye 19 feet. Time by a Chronometer $1^h\ 17^m\ 0^s$ which was fast $1^h\ 48^m\ 56^s$ for mean noon at Greenwich on January 28th and on March 5th was fast for mean noon at Greenwich $1^h\ 57^m\ 45^s$. Required the Longitude by Chronometer.

Ex. 22.—1876, December 16th at $9^h\ 1^m$ A. M. Mean time at ship, in latitude $31°\ 47'\ 16''$ S., longitude by account $180°$ W. The observed altitude of the Sun's Lower Limb was $50°\ 19'\ 0''$. Height of the eye 11 feet. Time by a Chronometer $9^h\ 1^m\ 0^s$ which was slow $31^m\ 13^s$ for mean noon at Greenwich on February 3rd and on May 6th was slow for mean noon at Greenwich $22^m\ 4^s$ Required the Longitude by Chronometer.

Ex. 23.—1876, September 22nd at $5^h\ 0^m$ P. M. Mean time at ship, in latitude $0°\ 0'$, longitude by account $0°\ 0'$. The observed altitude of the Sun's Lower Limb was $13°\ 21'\ 40''$. Height of the eye 18 feet. Time by a Chronometer $4^h\ 59^m\ 48^s$ which was slow $0^m\ 17^s$ for mean noon at Greenwich on May 5th and on July 3rd was fast for mean noon at Greenwich $0^m\ 24^s$. Required the Longitude by Chronometer.

Ex. 24.—1876, November 10th at $3^h\ 47^m$ P. M. Mean time at ship, in latitude $42°\ 27'\ 30''$ N., longitude by account $177°\ 47'$ W. The observed altitude of the Sun's Lower Limb was $7°\ 52'\ 50''$ Height of the eye 13 feet. Time by a Chronometer $4^h\ 49^m\ 53^s$ which was fast $1^h\ 14^m\ 36^s$ for mean noon at Greenwich on October 15th and on November 9th was fast for mean noon at Greenwich $1^h\ 10^m\ 11^s$. Required the Longitude by Chronometer.

Ex. 25.—1876, March 20th at $3^h\ 51^m$ P. M. Mean time at ship, in latitude $53°\ 35'$ S., longitude by account $145°$ E. The observed altitude of the Sun's Lower Limb was $19°\ 20'\ 50''$. Height of the eye 19 feet. Time by a Chronometer $6^h\ 24^m\ 43^s$ which was slow $5^m\ 50^s$ for mean noon at Greenwich on November 30th and on January 1st was fast for mean noon at Greenwich $0^m\ 2^s$. Required the Longitude by Chronometer.

EX-MERIDIAN.

TO FIND THE APPARENT TIME AT SHIP.

81. Express the ship time astronomically, and apply to it the error of the watch, additive if it should be slow, but subtractive if the contrary; now take the difference of longitude made since the error was determined, turn it into time, and add it if it should be East, but subtract it if West (you will notice that this is contrary to the usual rule), the result will be the Apparent Time at Ship. Now observe this, if your observation is taken in the morning, the hours of the apparent time at ship *must* be 23^h, while if it is an afternoon sight, *it must be* 0^h.

TO FIND THE HOUR ANGLE.

82. If it is P. M. at ship, the apparent time at ship is the Hour Angle.

83. If it is A. M. at ship, subtract the apparent time at ship from 24^h, and the remainder is the Hour Angle.

TO FIND THE GREENWICH DATE.

84. With the Apparent Time at Ship and the Ship's Longitude, get the Greenwich Apparent Time according to the usual rule (56).

85. Get out the True Declination (49) using the declination found in page I of the Nautical Almanac. From the observed find the True Altitude (50).

TO FIND THE AUGMENTATIONS.

86. These augmentations are found in Towson's Ex-Meridian Tables. Table I is entered with the True Declination and the Hour Angle; at the top of the page, find the nearest to your True Declination, and underneath, opposite the Hour Angle, or the nearest given, will be found the 1st correction, which is always to be added to the true declination, the sum being called the Augmented Declination; take out also the Index Number found in the margin of the Table opposite the Correction. Table II is entered with the True Altitude and the Index Number, found above; at the head of the Table find the nearest to the True Altitude, then underneath, opposite the Index Number, will be found the 2nd Correction, which is always additive to the true altitude; the sum is called the Augmented Altitude.

TO FIND THE LATITUDE.

87. Subtract the Augmented Altitude from 90°, and name the Zenith Distance resulting, contrary to the bearing of the sun; underneath, set down the Augmented Declination, and add the two together if they are of the same name, but subtract them if they are of contrary names, and the sum or remainder will be the Latitude of the same name as the greater.

Ex. 1.—1876, September 4th P. M. at ship, in latitude by account 51° 53′ N., longitude 18° 49′ W., the observed altitude of the Sun's L. L. South of the observer was 44° 39′ 20″. Height of eye 20 feet. Time by watch 0^h 19^m 18^s which had been found to be slow 6^m 12^s of apparent time at Ship. The difference of longitude made to the West was 37′·5 after the error on Apparent Time at Ship was determined. Required the Latitude by the Reduction to the Meridian.

		d	h	m	s				
Time by watch	Sept.	4	0	19	18	Decl.	6°	58′	20″ N.
Error		+		6	12	Correction	−	1	29
		4	0	25	30		6	56	51
Ship's run West		−		2	30	Aug. (Index 59)	+	2	4
A. T. S.		4	0	23	0	Aug^d Decl.	6	58	55
Longitude in time		+	1	15	16				
G. A. T.		4	1	38	16				

Hourly diff.	55″.55
	1.6
	33330
	5555
	88·880
Correction	1 29

	Norie.		**Bowditch.**		**Raper.**
Obs. Alt. ⊙	44° 39′ 20″ S		44° 39′ 20″ S		44° 39′ 20″ S
Dip.	4 17		− 4 24		− 4 20
	44 35 3	R. 0 57	44 34 56	R. 0 58	44 35 0
Ref.-Par.	− 51	P. − 7	− 50	P. − 6	52
	44 34 12		44 34 6		44 34 8
Semi-diam.	+ 15 54		+ 15 54		+ 15 54
True Alt.	44 50 6		44 50 0		44 50 2
Aug.(Index59)	+ 16 58		+ 16 58		+ 16 58
Aug^d Alt.	45 7 4		45 6 58		45 7 ·
	90		90		90
Zenith dist.	44 52 56 N		44 53 2 N		44 53 0 N
Aug^d decl.	6 58 55 N		6 58 55 N		6 58 55 N
LATITUDE	51 51 51 N		51 51 57 N		51 51 55 N

Ex. 2.—1876, July 3rd A. M. at ship, in latitude by account 52° 0′ N., longitude 166° 0′ W., the observed altitude of the Sun's L. L. South of the observer was 60° 30′ 30″. Height of eye 21 feet. Time by watch 11^h 48^m 40^s which had been found to be fast 7^m 30^s of apparent time at Ship. The difference of longitude made to the East was 38′ after the error on apparent Time at Ship was determined. Required the latitude by the Reduction to the Meridian.

Time by watch.	July	2^d 23^h 48^m 40^s	Declination	22° 55′ 53″
Error		— 7 30	Correction	— 2 17
		2 23 41 10		22 53 36
Longitude run East		+ 2 32	Aug. (Index 28)	+ 3 8
A. T. S.		2 23 43 42	Aug^d decl.	22 56 44
		24		
Hour Angle		0 16 18	Hourly diff.	12″·66
				10·8
A. T. S.	July	2^d 23^h 43^m 42^s		10128
Longitude in time		+ 11 4 0		1266
G. A. T.		3 10 47 42		136·728
			Correction	2 17

	Norie.		**Bowditch.**		**Raper.**
Obs. Alt. ⊙	60° 30′ 30″ S		60° 30′ 30″ S		60° 30′ 30″ S
Dip.	— 4 23		— 4 31		— 4 25
	60 26 7	R 0′ 33″	60 25 59	R 0′ 34″	60 26 5
Ref.—Par	— 28	P – 4	— 29	P – 4	— 30
	60 25 39		60 25 30		60 25 35
Sem-diameter	+ 15 46		+ 15 46		+ 15 46
True altitude	60 41 25		60 41 16		60 41 21
Aug. (index 28)	+ 13 7		+ 13 7		+ 13 7
Aug. altitude	60 54 32		60 54 23		60 54 28
	90		90		90
Zenith dist.	29 5 28 N		29 5 37 N		29 5 32 N
Aug. Decl.	22 56 44 N		22 56 44 N		22 56 44 N
LATITUDE	52 2 12 N		52 2 21 N		52 2 16 N

Ex. 3.—1876, May 14th A. M. at ship, in latitude by account 66° 55′ N., longitude 68° 14′ W., the observed altitude of the Sun's L. L. South of the observer was 41° 26′ 0″. Height of eye 19 feet. Time by watch $11^h\ 33^m\ 16^s$ which had been found to be fast $5^m\ 19^s$ of apparent time at Ship. The difference of longitude made to the West was 27′·4 after the error on Apparent Time at Ship was determined. Required the Latitude by the Reduction to the Meridian.

Ex. 4—1876, March 25th, A. M. at ship, in latitude by account 41° 43′ N., longitude 19° 59′ W., the observed altitude of the Sun's L. L. South of the observer was 49° 55′ 10″. Height of eye 22 feet. Time by watch $1_h\ 0^m\ 34^s$ which had been found to be fast $1^h\ 21^m\ 14^s$ of apparent time at ship. The difference of longitude made to the East was 11′ after the error on Apparent Time at Ship was determined. Required the Latitude by the Reduction to the Meridian.

Ex. 5—1876, May 10th, A. M. at ship, in latitude by account 37° 50′ S., longitude 18° 49′ W., the observed altitude of the Sun's L. L. North of the observer was 33° 30′ 15″. Height of eye 16 feet. Time by watch $11^h\ 23^m\ 5^s$ which had been found to be correct upon apparent time at ship. The difference of longitude made to the West was 12′¼ after the error on Apparent Time

Ship was determined. Required the Latitude by the Reduction to the Meridian.

Ex. 6—1876, June 29th P. M., at ship, in latitude by account [illegible] S., longitude 124° 0′ E, the observed altitude of the Sun's L. L. North of the observer was 29° 18′ 45″. Height of eye 16 feet. Time by watch 3^h 14^m 27^s which had been found to be fast 2^h 42^m 15^s of apparent time at ship. The difference of longitude made to the East was 1′ after the error on Apparent Time at Ship was determined. Required the Latitude by the Reduction to the Meridian.

Ex. 7—1876, December 15th, A. M. at ship, in latitude by account 53° 50′ S., longitude 86° 56′ 15″ W., the observed altitude of the Sun's L. L. North of the observer was 58° 50′ 0″. Height of eye 11 feet. Time by watch 5^h 12^m 42^s which had been found to be fast 5^h 42^m 29^s of apparent time at ship. The difference of longitude made to the East was 26′ after the error upon Apparent Time at Ship was determined. Required the Latitude by the Reduction to the Meridian.

Ex. 8—1876, November 23rd, P. M. at ship, in latitude by account 29° 0′ N., longitude 77° 20′ W., the observed altitude of the Sun's L. L. South of the observer was 39° 24′ 50″. Height of eye 19 feet. Time by watch 7_h 43^m 42^s which had been found to be slow 5^h 0^m 36^s of apparent time at Ship. The difference of longitude made to the West was 1° 9′ 30″ after the error on Apparent Time at Ship was determined. Required the Latitude by a Reduction to the Meridian.

Ex. 9—1876, August 5th, A. M. at ship, in latitude by account 47° 7′ S., longitude 79° 5′ E., the observed altitude of the Sun's L. L. North of the observer was 25° 46′ 15″. Height of eye 15 feet. Time by watch 5^h 27^m 20^s which had been found to be fast 5^h 27^m 12^s of apparent time at Ship. The difference of longitude made to the West was 45′ after the error on Apparent Time at Ship was determined. Required the Latitude by a Reduction to the Meridian.

Ex. 10—1876, January 28th, A. M. at ship, in latitude by account 47° 40′ N., longitude 175° 57′ W., the observed altitude of the Sun's L. L. South of the observer was 23° 18′ 0″. Height of eye 13 feet. Time by watch 0^h 17^m 42^s which had been found to be fast 1^h 2^m 3^s of apparent time at Ship. The difference of longitude made to the East was 8′¾ after the error upon Apparent Time at Ship was determined. Required the Latitude by a Reduction to the Meridian.

Ex. 11—1876, March 1st, P. M. at ship, in latitude by account 42° 15′ S., longitude 16° 28′ 30″ E. The observed altitude of the Sun's L. L. North of the observer was 54° 50′ 20″. Height of eye 18 feet. Time by watch $11^h\ 18^m\ 47^s$ which had been found to be slow $45^m\ 22^s$ of apparent time at Ship. The difference of longitude made to the East was 22·8′ after the error upon Apparent Time at Ship was determined. Required the Latitude by a Reduction to the Meridian.

Ex. 12.—1876, September 22nd P. M. at ship, in latitude by account 39° 20′ N., longitude 72° 27′ W., the observed altitude of the Sun's L. L. South of the observer was 50° 20′ 20″. Height of the eye 14 feet. Time by watch 10° 58′ 29″ which has been found to be slow $1^h\ 18^m\ 30^s$ of apparent time at Ship. The difference of longitude made to the West was 17′·2 after the error upon Apparent Time at Ship was determined. Required the Latitude by a Reduction to the Meridian.

Ex. 13.—October 11th A. M. at ship, in latitude by account 31° 15′ S., longitude 125° 30′ W., the observed altitude of the Sun's L. L. North of the observer was 65° 50′ 40″. Height of the eye 10 feet. Time by watch $8^h\ 0^m\ 55^s$ which had been found to be fast $7^h\ 59^m\ 48^s$ of Apparent Time at Ship. The difference of longitude made to the West was 2° 1′ 15″ after the error upon Apparent Time at Ship was determined. Required the latitude by a Reduction to the Meridian.

Ex. 14.—1876, January 25th A. M. at ship, in latitude by account 18° 26′ N., longitude 142° 37′ W., the observed altitude of the Sun's L. L. South of the observer was 51° 41′ 45″. Height of the eye 15 feet. Time by watch $8^h\ 16^m\ 24^s$ which had been found to be fast $8^h\ 47^m\ 9^s$ of apparent time at ship. The difference of longitude made to the East was 16·2 since the error on Apparent Time at Ship was determined. Required the Latitude by a Reduction to the Meridian.

Ex. 15.—1876, November 5th P. M. at ship, in latitude by account 46° 17′ N., longitude 91° 0′ E., the observed altitude of the Sun's L. L. South of the observer was 27° 37′ 0″. Height of the eye 10 feet. Time by watch $6^h\ 17^m\ 32^s$ which had been found to be slow $5^h\ 56^m\ 30^s$ of apparent time at ship. The difference of longitude made to the East was $18'\frac{1}{4}$ after the error upon Apparent time at Ship was determined. Required the Latitude by a Reduction to the Meridian.

LATITUDE BY THE MERIDIAN ALTITUDE OF A STAR.

88. To the observed altitude of the star, apply the following corrections :

Index error (if any), according to its sign.

Dip, subtractive, Table V *Norie*, Table XIII *Bowditch*, Table 30 *Raper*.

Refraction, from Table XVIII *Norie* found under the Star's Correction, *Bowditch* Table XII, or *Raper* Table 31 ; having subtracted which the remainder is the Star's True Altitude.

89. Subtract the True Altitude from 90°, and get the Zenith Distance, naming it N or S contrary to the bearing of the star.

90. To find the Star's Declination.—About page 325 in the Nautical Almanac will be found a catalogue of fixed stars, whose Right Ascensions and Declinations are given for every tenth day in a table immediately following. In this catalogue find your star, and take out the hours and minutes of Right Ascension opposite ; now, in the table following, the stars are arranged in the order of their Right Ascensions, that is, from 0^h to 24^h, therefore, using the Right Ascension just taken out *as an index*, it is easy to find your star in the table ; having done this, take out the degrees and minutes of Declination, found at the head of the column which is underneath the star, and the seconds will be found opposite the nearest date to that given ; no correction is necessary. The Declination is named N. or S. at the head of the column.

91. To find the Latitude.—Under the Zenith Distance set down the Declination, add the two together if they are of the same name, but subtract them if they are of contrary names, and the sum or remainder will be the Latitude of the same name as the greater.

Ex. 1.—1876, July 10th, The observed Meridian Altitude of the Star π Leonis, bearing North, was 30° 37′ 30″, height of the eye 14 feet. Required the Latitude.

	Norie.	Bowditch.	Raper.
Obs. Alt.	30° 37′ 30″ N.	30° 37′ 30″ N.	30° 37′ 30″ N.
Dip.	— 3 36	— 3 41	— 3 40
	30 33 54	30 33 49	30 33 50
Refraction	— 1 36	— 1 35	— 1 39
True Alt.	30 32 18	30 32 14	30 32 11
	90	90	90
Zenith dist.	59 27 42 S.	59 27 46 S.	59 27 49 S.
Declination	8 38 16 N.	8 38 16 N.	8 38 16 N.
LATITUDE	50 49 26 S.	50 49 30 S.	50 49 33 S.

Ex. 2.—1876, April 28th, the observed Meridian Altitude of the Star Arcturus, bearing South, was 53° 26′ 0″, height of the eye 18 feet. Required the Latitude.

	Norie.	Bowditch.	Raper.
Obs. Alt.	53° 26′ 0″ S.	53° 26′ 0″ S.	53° 26′ 0″ S.
Dip.	— 4 4	— 4 11	— 4 10
	53 21 56	53 21 49	53 21 50
Refraction	— 42	— 43	— 44
True Alt.	53 21 14	53 21 6	53 21 6
	90	90	90
Zenith dist.	36 38 46 N.	36 38 54 N.	36 38 54 N.
Declination	19 49 29 N.	19 49 29 N.	19 49 29 N.
LATITUDE	56 28 15 N.	56 28 23 N.	56 28 23 N.

Ex. 3. 1876, November 29th. The observed Meridian Altitude of the Star δ Corvi, bearing South, was 17° 14′ 30″, height of the eye 22 feet. Required the Latitude.

Ex. 4.—1876, July 11th. The observed Meridian Altitude of the Star α Persei, bearing North, was 38° 22′ 20″, height of the eye 12 feet Required the Latitude.

Ex. 5.—1876, December 18th. The observed Meridian Altitude of the Star γ[1] Leonis, bearing North, was 45° 45′ 45″, height of the eye 16 feet. Required the Latitude.

Ex. 6.—1876, June 20th. The observed Meridian Altitude of the Star β^1 Scorpii, bearing South, was 29° 12′ 50″, height of the eye 12 feet. Required the Latitude.

Ex. 7.—1876, February 27th. The observed Meridian Altitude of the Star α Gruis, bearing South was 31° 16′ 40″, height of the eye 13 feet. Required the Latitude.

Ex. 8.—1876, October 25th. The observed Meridian Altitude of the Star α Ophiuchi, bearing South, was 59° 30′ 30″, height of the eye 10 feet. Required the Latitude.

Ex. 9.—1876, August 26th. The observed Meridian Altitude of the Star Sirius, bearing South was 35° 50′ 20″ height of the eye 14 feet. Required the Latitude.

Ex. 10.—1876, February 2nd. The observed Meridian Altitude of the Star Achernar, bearing South, was 63° 33′ 40″, height of the eye 17 feet. Required the Latitude.

Ex. 11.—1876, August 15th. The observed Meridian Altitude of the Star Procyon, bearing North, was 52° 10′ 15″, height of the eye 16 feet. Required the Latitude.

Ex, 12.—1876, November 8th. The observed Meridian Altitude of the Star δ Orionis, bearing North, was 89° 20′ 30″, height of the eye 15 feet. Required the Latitude.

Ex. 13.—1876, April 7th. The observed Meridian Altitude of the Star Canopus, bearing South, was 43° 32′ 0″ height of the eye 12 feet. Required the Latitude.

Ex. 14.—1876, January 5th. The observed Meridian Altitude of the Star Algenib, bearing South, was 60° 14′ 40″, height of the eye 20 feet. Required the latitude.

Ex. 15.—1876, May 28th. The observed Meridian Altitude of the Star Spica, bearing South, was 51° 33′ 0″, height of the eye 18 feet. Required the latitude.

TO FIND THE TIME OF HIGH WATER.

AT A STANDARD PORT.

92. In the Admiralty Tide Tables the Times of High Water are given for each day of the year at twenty-four ports, the names of which are enumerated in the index of that book; these ports are called "Standard Ports" because they are used as bases from which the times of high water at other ports may be found. If the time of high water at a Standard Port be desired, it is only necessary to find the given port in the proper month, and there, opposite the given date, in the morning and afternoon columns, will be found the A. M. and P. M. tides required. Where the mark —— occurs, it shews that there is but one tide during that day; no high water, therefore, takes place in the morning or afternoon in which the mark appears.

Ex. 1.—1875, March 7th. Find the time of High Water at North Shields. A. M. and P. M.

$3^h\ 8^m$ A. M. $3^h\ 26^m$ P. M.

Ex. 2.—1875, July 28th. Find the time of High Water at Galway A. M. and P. M.

No A. M. $0^h\ 30^m$ P. M.

On the dates given, find the times of High Water at the following places:

Ex. 3—1875, June 12th, at Kingston.
Ex. 4—1875, February 19th, at Harwich.
Ex. 5—1875, April 27th, at Thurso.

WHEN THE GIVEN PORT IS NOT A STANDARD PORT.

93. Look out the port in the Table of Tidal Constants, and opposite will be given a "Standard Port for Reference", together with a Constant for time, which is to be applied according to the following rules:

94. When the Constant is additive.—At the given port, take out the morning tide on the given day, and add the constant to it, then:

(**a**) If the sum is less than 12^h it will be your A. M. Tide; in this case, take out the afternoon tide of the given day, and having added the constant to it, the sum if less than 12^h will be your P. M. Tide; but if the sum exceeds 12^h there will be *no P. M. Tide*, because the tide resulting will be that of the next morning.

(**b**) But if in adding the morning tide and the constant together, the sum goes over 12^h, take 12^h from it, and the remainder is your P. M. Tide; now take the afternoon's tide of *the day before*, and after adding the constant to it, if the sum exceeds 12^h, then what is over 12^h will be your A. M. Tide; but if the sum does not reach 12^h, it remains the afternoon tide of the day before, and there is *no A. M. Tide* on your day.

(c) In any case where the mark — occurs, take out the tide preceding it, and if after adding the constant the sum exceeds 12^h, what is over 12^h will be your tide, but if the sum is under 12^h then there is *no tide*.

Ex. 6—1875, March 7th; find the A. M. and P. M. tides at Scarborough.

Sunderland, March 7th A. M.	$3^h\ 7^m$	March 7th P. M.	$3^h\ 26^m$
Constant	+ 49		+ 49
HIGH WATER AT SCARBOROUGH	3 56 A. M.		4 15 P. M.

Ex. 7—1875, August 23rd; find the A. M. and P. M. tides at Wexford.

Waterford, August 23rd A. M.	$9^h\ 10^m$	August 23rd P. M.	$9^h\ 31^m$
Constant	+ 2 1		+ 2 1
H. W. AT WEXFORD	11 11 A. M.		11 32 P. M.

Ex. 8—1875, April 4th; find the A. M. and P. M. tides at Crinan.

Greenock, April 4th A. M.	$10^h\ 32^m$	April 3rd P. M.	$10^h\ 10^m$
	+ 4 41		+ 4 41
	15 13		14 51
	12 0		12 0
H. W. AT CRINAN	3 13 P. M.		2 51 A. M.

Ex. 9.—1875, April 10th; find the A. M. and P. M. tides at Lerwick.

Thurso April 10th A. M.	$11^h\ 8^m$	April 9th P. M.	$10^h\ 43^m$
Constant	+ 2 2		+ 2 2
H. W. AT LERWICK.	1 10 P. M.		0 45 A. M.

95. General Rule for Additive Constants.—When the sum of the constant and the tide taken from the Tables is less than 12^h, it remains a tide of the same name as that used; but where the sum exceeds 12^h, the time over 12^h will be a tide of *the name following* that taken out, consequently, in such a case, you must take from the Tables the tide immediately preceding the one you require.

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At the undermentioned times and places find the times of High Water A. M. and P. M.

Ex. 10.	1875,	April	2nd	at	Glasgow.
" 11	"	May	5th	"	Port Carlisle.
" 12	"	April	14th	"	Jersey.
" 13	"	March	31st	"	Bordeaux.
" 14	"	April	16th	"	Crinan.
" 15	"	June	6th	"	Ramsey.
" 16	"	July	12th	"	Limerick.
" 17	"	January	16th	"	Exmouth.
" 18	"	June	20th	"	Ramsey.
" 19	"	January	22nd	"	Newhaven.
" 20	"	July	28th	"	Limerick.
" 21	"	May	6th	"	Annan Foot.
" 22	"	March	17th	"	Filey Bay.
" 23	"	February	4th	"	Chatham.
" 24	"	May	29th	"	Llanelly.
" 25	"	March	17th	"	Whitby.
" 26	"	June	18th	"	Strangford Quay.
" 27	"	January	8th	"	Shoreham.
" 28	"	April	30th	"	Jersey.
" 29	"	July	12th	"	Killybegs.
" 30	"	August	11th	"	New Ross.

96. When the Constant is Subtractive.—If the morning and afternoon tides of the day required, are greater than your constant, subtract the constant from them, and the remainders will be your A. M. and P. M. tides respectively.

97. But if the morning tide upon the given day is less than your constant, take out the afternoon tide, and :—

(**a**). If this afternoon tide is less than your constant, subtract your constant from it by borrowing 12^h, and the remainder will be your A. M. Tide; now take out the morning tide upon *the following day*, if it also is less than the constant, again borrow 12^h, and having subtracted your constant, the remainder will be your P. M. Tide; but if this morning tide is greater than the constant, there will be *no P. M. Tide.*

(**b**). If the afternoon tide of the given day is greater than the constant, subtract the constant from it, the remainder will be your P. M. Tide; and there will be *no A. M. Tide.*

(**c**) In any case where the mark — occurs, if the tide following is less than your constant, add 12^h to it, and subtract the constant from the sum, the remainder will be your tide; but if the tide following the mark is more than your constant, then there is *no tide.*

98. General rule for Subtractive Constants.—If you can subtract your constant from the tide *as it stands*, the remainder will be a tide of the same name as that taken from the Tables; but if you have to borrow 12^h to enable you to subtract your constant from the tide, then the tide resulting, will be the tide preceding that taken from the Tables, in this case, therefore, you must take from the Tables *the tide following* the one you require.

Ex. 31—1875, June 15th; find the A. M. and P. M. tides at Barmouth.

Holyhead	June 15th A. M.	$7^h\ 41^m$	June 15th P. M.	$8^h\ 2^m$
Constant		$-2\ 31$		$-2\ 31$
H. W. AT BARMOUTH		5 10 A. M.		5 31 P. M.

Ex. 32—January 19th; find the A. M. and P. M. tides at Southampton.

Portsmouth	Jan. 19th A. M.	$9^h\ 20^m$	January 19th P. M.	$9^h\ 54^m$
Constant		$-1\ 11$		$-1\ 11$
H. W. AT SOUTHAMPTON		8 9 A. M.		8 43 P. M.

Ex. 33—June 8th; find the A. M. and P. M. tides at Ballycastle.

Belfast	June 8th P. M.	$2^h\ 7^m$	June 9th A. M.	$2^h\ 36^m$
Constant		$-4\ 18$		$-4\ 18$
H. W. AT BALLYCASTLE		9 49 A. M.		10 18 P. M.

Ex. 34—August 8th; find the A. M. and P. M. tides at Aberystwyth.

Holyhead	August 8th P. M.	$2^h\ 29^m$	August 9th A. M.	$2^h\ 49^m$
Constant		$-2\ 40$		$-2\ 40$
H. W. AT ABERYSTWYTH		11 49 A. M.		No P. M.

On the dates given, find the times of High Water A. M. and P. M. at the undermentioned places.

Ex. 35	1875	May	9th	at	Beaumaris.
" 36	"	June	22nd	"	Arklow.

Ex.	37	1875	April	4th	at	Cromarty.
"	38	"	July	25th	"	Coleraine.
"	39	"	August	9th	"	Cardigan.
"	40	"	February	6th	"	Margate.
"	41	"	April	2nd	"	Gibraltar.
"	42	"	March	1st	"	Bridlington.
"	43	"	May	12th	"	Ilfracomb.
"	44	"	July	9th	"	Port Rush.
"	45	"	April	16th	"	Cromarty.
"	46	"	February	17th	"	London Docks.
"	47	"	January	1st	"	Penzance.
"	48	"	April	19th	"	Peterhead.
"	49	"	May	12th	"	Lundy Island.
"	50	"	February	6th	"	Helgoland.
"	51	"	May	14th	"	St. Ives.
"	52	"	January	11th	"	Christchurch.
"	53	"	August	26th	"	Castletownsend.
"	54	"	August	27th	"	Valentia Harbor.
"	55	"	August	11th	"	Bantry Harbor.

WHEN THE GIVEN PORT IS NOT IN THE UNITED KINGDOM.

99. Most ports adjacent to the British coast are specified in the Table of Tidal Constants; but if the given port is outside this range, take Brest as your Standard port of Reference, and compute the Constant by the following rule.

100. To find the Constant.—Get the difference of longitude between Brest (long. 4° 29′ W.) and the given place; find also the difference between the Moon's Transit on the given day and the one preceding it; with these two elements enter the proper Table (*Norie* Table XVI, *Bowditch* Table XXVIII, *Raper* Table 28) and their intersection will give the correction for the day's change in the Moon's transit over the meridian of the given place. In the Alphabetical List of Ports at the end of the Admirably Tide Tables, find the time of High Water, Full and Change, corresponding to the given port, and add to this the correction found above if the diff. long. is West, but subtract it if East. Now find the difference between this corrected time and the time of High Water, Full and Change, at Brest ($3^h\ 47^m$), the remainder will be the Constant, *additive* if the Full and Change at the given port is greater than that at Brest, but *subtractive* if it is less.

101. With the time of high water at Brest and the Constant found above, get out the times of high water by the usual rules.

Ex. 56.—1875, January 21st. Find the time of High Water A. M. and P. M. at Rio Janeiro in longitude 43° 9′ W.

Long. of Rio Janeiro	43° 9′ W.	Moon's Transit Jan. 21st	11h 34m
do Brest	4 29 W.	do Jan. 20th	10 32
Diff. of longitude	38 40	Transit difference (62m)	1 2

H. W. Full and Change at Rio Janeiro	3h 0m		
Correction for Moon's Transit	+ 7		
	3 7		
H. W. Full and Change at Brest	3 47		
Constant	− 0 40		− 0h 40 m
H. W. at Brest on Jan. 21st A. M.	3 21	Jan. 21st P. M.	3 45
H. W. at Rio Janeiro	2 41 A. M.		3 5 P. M.

Ex. 57.—1875, August 5th. Find the time of High Water A. M. and P. M. at Macao in longitude 113° 34′ E.

Longitude of Macao	113° 34′ E.	Moon's Transit Aug. 5th	3h 18m
do Brest	4 29 W.	do Aug. 4th	2 36
Diff. of longitude	118 3 E.	Transit difference	0 42

H. W. Full and Change at Macao	10h 0m		
Correction for Moon's Transit	− 14		
	9 46		
H. W. Full and Change at Brest	3 47		
Constant	+ 5 59		+ 5h 59m
H. W. at Brest on Aug. 5th A.M.	6 5	Aug. 4th P. M.	5 48
H. W. at Macao	0 4 P. M.		No. A. M.

On the dates given, find the times of High Water at the undermentioned places.

Ex. 58.	1875, Jan.	11th	at Quebec	in Long.	71° 16′ W
" 59	" April	1st	" Pictou N. S.	"	62 40 W
" 60	" July	2nd	" Parrsboro' N. S.	"	64 8 W
" 61	" March	11th	" Batavia	"	106 48 E
" 62	" June	18th	" Shanghai	"	121 29 E

Ex. 63.	1875,	Jan.	17th	at	Bencoolen	in Long.	102	13	E
" 64	"	Feb.	27th	"	Halifax N. S.	"	63	34	W
" 65	"	May	1st	"	Acapulca	"	99	52	W
" 66	"	Jan.	13th	"	Suez Bay	"	32	33	E
" 67	"	Aug.	12th	"	Tobago	"	60	27	W
" 68	"	April	15th	"	Hammerfest	"	28	42	E
" 69	"	July	3rd	"	Yokohama	"	129	52	E
" 70	"	Feb.	19th	"	Sydney Harbor C.B.	"	60	55	W
" 71	"	July	28th	"	Honoruru	"	157	51	W
" 72	"	March	23rd	"	St. John N. B.	"	66	2	W
" 73	"	May	28th	"	Texel	"	4	42	E
" 74	"	March	3rd	"	Magdalen Islands	"	62	2	W
" 75	"	Feb.	15th	"	Zanzibar	"	39	15	E
" 76	"	April	1st	"	Cape Pillar	"	148	0	E
" 77	"	June	28th	"	Nanaimo Harbor	"	123	55	W
" 78	"	May	16th	"	Melbourne	"	144	59	E
" 79	"	April	11th	"	Iquiqui Road	"	70	11	W
" 80	"	March	1st	"	Madras	"	80	16	E

DEVIATION OF THE COMPASS.

TO FORM A TABLE OF DEVIATIONS.

102. For this purpose, the bearings of some object are given, which have been taken by the Standard Compass, while the ship's head has been brought in succession upon not less than eight different points of the compass; generally, the four cardinal and the four mid-cardinal points.

103. To find the correct Magnetic Bearing.—See that all the bearings are made to reckon from the same point, which may be either the N. or S. point, as may be most convenient; in cases where they differ, this is done by subtracting each bearing, of the name contrary to that selected, from 180°; now, if the bearings all E. or all W. add them together; but if some are E. and others W. add up the Eastings and Westings separately and get the difference between the sums; divide this sum or difference, as the case may be, by the number of bearings observed, and the result may be taken as the Correct Magnetic Bearing, which will of course be named E. or W. the same as the largest of the above sums.

104. To find the Deviations.—Find the angle between the Correct Magnetic Bearing and the first Bearing by Standard Compass, which is done by adding them together if one is E. and the other W., but by getting their difference if they are both of the same name; this will give the Deviation corresponding to the direction of the ship's head when this bearing was taken, and now, by laying off the two bearings upon a rough compass, as in an Azimuth (65), the Deviation will be named E. if the Correct Magnetic Bearing falls to the right of the other, but W. if the contrary. In like manner, find the angle between the Correct Magnetic and each of the other bearings in succession, and with the Deviations resulting, the required Table can be completed.

Ex. 1.—The bearings of a church steeple which were taken from a ship by the Standard Compass, while her head was lying upon the points indicated, were as follows:—Ship's head at North, Bearing N. 44° 10′ E; at N. E., N. 32° 30′ E; at East, N. 30° 50′ E; at S. E., N. 35° 15′ E; at South, N. 47° 15′ E; at S. W., N. 59° 10′ E; at West, N. 64° 10′ E; at N. W., N. 59° 20′ E.

Ship's Head.	Bearings by Standard Compass	Deviation.
N.	N. 44 10′ E.	2° 25′ E.
N. E.	N. 32 30 E.	14 5 E.
E.	N. 30 50 E.	15 45 E.
S. E.	N. 35 15 E.	11 20 E.
S.	N. 47 15 E.	0 40 W.
S. W.	N. 59 10 E.	12 35 W.
W.	N. 64 10 E.	17 35 W.
N. W.	N. 59 20 E.	12 45 W.

8) 372 40

Correct Mag. Bearing N. 46 35 E.

Bearings	N. 44° 10′ E.	N. 32° 30′ E.	N. 30° 50′ E.	N. 35° 15′ E.
Cor. Mag.	N. 46 35 E.	N. 46 35 E.	N. 46 35 E.	N. 46 35 E.
Deviations	2 25 E.	14 5 E.	15 45 E.	11 20 E.
Bearings	N. 47° 15′ E.	N. 59° 10′ E.	N. 64° 10′ E.	N. 59° 20′ E.
Cor. Mag.	N. 46 35 E.	N. 46 35 E.	N. 46 35 E.	N. 46 35 E.
Deviations	0 40 W.	12 35 W.	17 35 W.	12 45 W.

Ex. 2. The bearing of an object by the Standard Compass with the Ship's head at North was S. 13° 5′ E.; at N. E., S. 33° 45′ E.; at East, S. 37° 10 E.; at S. E., S. 29° 30′ E.; at South, S. 17° 10′ E.; at S. W., S. 0° 45′ W.; at West, S. 8° 0′ W.; at N.W., . 1° 55′ W.

Ship's Head.	Bearings by Standard Compass.	Deviation.
N.	S. 13° 5′ E.	1° 55′ W.
N. E.	S. 33 45 E.	18 45 E.
E.	S. 37 10 E.	22 10 E.
S. E.	S. 29 30 E.	14 30 E.
S.	S. 17 10 E.	2 10 E.
S. W.	S. 0 45 W.	15 45 W.
W.	S. 8 0 W.	23 0 W.
N. W.	S. 1 55 W.	16 55 W.

S. 130 40 E.
S. 10 40 W.

8) 120 00

Cor. Mag. Bearing S. 15 0 E.

Ex. 3.—The bearings of an object by the Standard Compass with the Ship's head at North was N. 85° 10′ W.; at N. E., N. 67° 45′ W.; at East, N. 59° 20′ W.; at S. E., N. 63° 45′ W.; at South, N. 84° 30′ W.; at S. W., S. 72° 35′ W.; at West, S. 71° 0′ W.; at N. W., S. 79° 35′ W.

Ship's Head.	Bearings by Standard Compass.	Deviation.
N.	N. 85° 10′ W.	0° 30′ E.
N. E.	N. 67 45 W.	16 55 W.
E.	N. 59 20 W.	25 20 W.
S. E.	N. 63 45 W.	20 55 W.
S.	N. 84 30 W.	0 10 W.
S. W.	N. 107 25 W.	22 45 E.
W.	N. 109 00 W.	24 20 E.
N. W.	N. 100 25 W.	15 45 E.

8) 677 20

Cor. Mag. Bearing N. 84 40 W.

Ex. 4.—The bearings of an object by the Standard Compass with the Ship's head at North was S. 63° 30′ W.; at N. E. S 73° 50′ W; at East, S 79° 15′ W; at S E, S. 75° 0′ W; at South, S 64° 50′ W; at S W, S 53° 30′ W; at West, S 50° 45′ W; at N W, S 56° 0′ W.

Ex. 5—The bearings of an object by the Standard Compass with the ship's head at North was N 5° 40′ W; at N E, N 28° 50′ W; at East, N 30° 50′ W; at S E, N 23° 30′ W; at South, N 10° 50′ W; at S W, N 1° 40′ E; at West, N 9° 20′ E; at N W, N 4° 40′ E.

Ex. 6—The bearings of an object by the Standard Compass with the ship's head at North was S 34° 45′ E; at N E, S 49° 15′ E; at East, S 50° 20′ E; at S E, S 44° 0′ E; at South, S 31° 0′ E; at S W, S 18° 45′ E; at West, S 14° 15′ E; at N W, S 18° 30′ E.

Ex. 7—The bearings of an object by the Standard Compass with the ship's head at North was S 83° 45′ W: at N E, N. 76° 30′ W; at East, N 68° 45′ W; at S E, N 72° 15′ W; at South, N. 88° 30′ W; at S W, S 67° 30′ W; at West, S 62° 45′ W; at N W, S 71° 15′ W

Ex. 8—The bearings of an object by the Standard Compass with the ship's head at North was N 9° 0′ W; at N E, N 1° 45′ W; at East, N 2° 45′ E; at S E, North; at South, N 7° 30′ W; at S W. N 16° 45′ W; at West, N 18° 15′ W; at N W, N 17° 0′ W.

Ex. 9—The bearings of an object by the Standard Compass with the ship's head at North was S 74° 30′ W; at N E, S 53° 0′ W; at East, S 49° 40′ W; at S E, S 56° 10′ W; at South, S 78° 0′ W; at S W, N 82° 40′ W; at West, N 77° 30′ W; at N W, N 82° 0′ W.

105. To find the Correct Magnetic Course made good.—Express the given compass course in degrees, and as in a Day's Work, set it down as R. or L. of the N. or S. point from which it is reckoning (38). Place the Deviation corresponding to the course underneath, and mark it R if it is East but L if West; now if they are of the same name take their sum, but get their difference if of contrary names, and after changing the R or L of the result into E or W as in a Day's Work (38) it will be the Correct Magnetic Course required.

Ex. 10—Supposing you have steered the following courses by the Standard Compass, viz: East, N. W. and South, find the correct magnetic courses made, from the Deviation Table as given in Ex. 1.

Compass Courses,	E = S 90° 0' L	N W = N 45° 0' L	S = 0° 0'
Deviation	15 45 R	12 45 L	0 40 L
Magnetic Courses	S 74 15 E	N 57 45 W	S 0 40 E

Ex. 11.—Supposing you have steered the following courses by the Standard Compass, viz:— North, N. E. and S. E., find the correct magnetic courses made, from the Deviation Table as given in Ex. 2.

Ex. 12.—Supposing you have steered the following courses by the Standard Compass, viz:— West, South and N. W., find the correct magnetic courses made, from the Deviation Table as given in Ex. 3.

Ex. 13.— You have steered the following courses by the Standard Compass, viz:— N. E., S. E. and S. W., find the correct magnetic courses made, from the Deviation Table as given in Ex. 4.

Ex. 14.—The following courses have been steered by the Standard Compass, viz: East, N. W. and West, find the correct magnetic courses made, from the Deviation Table as given in Ex. 5.

Ex. 15.—The following courses have been steered by the Standard Compass, viz:—North, S. E. and South, find the correct magnetic courses made, from the Deviation Table as given in Ex. 6.

106. To correct Bearings.—Express the Bearing in degrees, and proceed in the same manner as directed in the proceeding rule (105) for correcting a course steered, except, that instead of using the Deviation corresponding to the given Bearing, you take the Deviation corresponding to *the course upon which the ship's head was lying* when the bearing was observed.

Ex. 16.—The bearings of two distant objects by the Standard Compass, with the ship's head at N. E., are S. W. and N. W., find the bearings correct magnetic, using the Deviation Table as given in Ex. 7.

Compass bearings	S. W. = S 45° 0' R	N. W. =	N 45° 0' L
Deviation	16 6 L		16 6 L
Magnetic bearings	S 28 54 W		N 61 6 W

Ex. 17.—The bearings of two distant objects by the Standard Compass, with the ship's head at S. E., are N. E. and West, find the bearings correct magnetic, using the Deviation Table as given in Ex. 8.

Ex. 18—With the Ship's head at East, the bearings of two distant objects by the Standard Compass are S. W. and South, find the bearings correct magnetic, using the Deviation Table as given in Ex. 9.

Ex. 19—With the Ship's head at North, the bearings of two distant objects by the Standard Compass are North and S. W., find the bearings correct magnetic, using the Deviation Table as given in Ex. 1.

Ex. 20—The bearings of two distant objects as taken by Standard Compass are West and N. E., the ship at the time steering due East, find the bearings correct magnetic, using the Deviation Table as given in Ex. 2.

Ex. 21—A vessel heading up N. E., finds the bearings of two distant objects to be West and South, as taken by her Standard Compass; find the bearings correct magnetic, the vessel's Deviation Table being the same as that given in Ex. 3.

107. To find the course to steer, by calculation.—As Deviation is applied to courses in the same way as Variation, it is clear, that to get a course *to steer*, Easterly deviation must be allowed to the *left* hand of the correct magnetic course and Westerly to the *right.*

108. Suppose for instance it is necessary to have the course to steer by compass to make good a N. E. course correct magnetic; then using the Table of Deviations given in Ex. 1 the operation would be as under :

N E	N 45° 0′ R
Deviation for N E	14 5 L
Approx. Course to steer	N 30 55 E = N E by N $\frac{1}{4}$ N

But a glance at the Table of Deviations will shew that the deviation for N. E. by N. $\frac{1}{4}$ N. is not the same as that for N. E., consequently should the vessel be put upon the former course, she would not make good the course required; a second operation therefore becomes necessary. Find the deviation corresponding to N. E. by N. $\frac{1}{4}$ N., which by interpolating between N. and N. E. will be found to be 10° 26′ E. and apply this to N. E. as before :—

N. E.	N 45 0 R
Deviation of N. E. by N. $\frac{1}{4}$ N.	10 26 L
Approx. Course to steer	N 34 34 E

There is still a difference of about 4° between this course and the one for which the deviation was calculated, and if the process is again repeated, the deviation for N. E. by N. will be found to be 11° 10′ and the final result :—

N. E.	N 45° 0′ R
Deviation for N. E. by N.	11 10 L
Course to steer	N 33 50 E = N E by N nearly.

Usually the second result is sufficiently accurate for all practical purposes, but even this is a somewhat tedious process, and the result is found in a far easier and simpler manner by a Graphic Method, the explanation of one of which follows.

NAPIER'S DIAGRAM.

109. This Diagram (see Plate VI) has a central line divided into 360°, and also into 32 points, consequently it represents the outer circle or rim of the compass card straightened out. At each point of the compass a dotted and a straight line intersect one another, and upon these lines the different deviations forming the curve are laid off.

110. To make a Curve of Deviation.—Having the deviations corresponding to not less than eight equi-distant points of the compass, prick off each of them upon the diagram as follows :—

Place a pair of parallel rulers upon a *dotted* line, and move them until they cut the direction of the ship's head, corresponding to the deviation to be laid off; now from any part of the central line, take off a distance equal to your deviation in a pair of dividers, and setting one foot upon your course, lay off the other against the rulers, to the right of the central line if your deviation is East, but to the left if it is West. Having in like manner pricked off all the Deviations, take a pencil, and draw such a curve as will pass as nearly as possible through these points; this may take two or three trials to accomplish, but when a satisfactory curve is obtained, it can then be drawn in ink.

111. To find the Deviation corresponding to any given Course.—Lay a pair of parallel rulers upon a dotted line, and move it until it cuts the central line at the given course; now with a pair of dividers measure the distance along the edge of the rulers between the central line and the curve, and this, read off by the scale of degrees upon any part of the central line, will be the Deviation, E. or W. as named at the head of the diagram.

112. To find a Course to Steer by the Diagram.—Place your parallel rulers upon a plain line, and move them until they cut the central line upon the course required to be made; now place one foot of a pair of dividers upon that point of the curve cut by the rulers, and following the direction in which the dotted lines run *inwards*, let the other foot of the dividers rest upon the central line, and this will shew the Course *to Steer* to make good the correct Magnetic Course given.

With the Curve and Deviations given in Plate VI find the courses to steer by the Standard Compass to make the following courses, correct magnetic:—

Ex. 22.—N 40° E; S 25° W; N 38° W.
" 23.—S 84 E; S 62 W; N 17 W.
" 24.—N 5 W; S 85 W; East.
" 25.—North; N 88 W; S 86 E.

113. To find the Correct Magnetic Course by the Diagram.—Lay your rulers parallel to a dotted line, and move them until they cut the given Course upon the central line; now place one foot of the dividers upon the point where the curve is cut by the rulers, and following the direction in which the plain lines pass *inwards*, let the other foot of the dividers fall upon the central line, and this when read off will given the Correct Magnetic Course desired.

EXAMINATION PAPERS.

SET No. 1.

1—Multiply 89·764 by 384·59 by common logarithms.
2—Divide 248·25 by 36·487 by common logarithms.

3—

Hours.	Courses	Knots.	10 ths.	Winds.	L'way.	Dev.	Remarks, &c.
1	S 36° W	9	5	N by W	8°	8° W	A point
2	. . .	8	6	. . .			in Lat. 38° 50′ S
3	. . .	8	9	. . .			Long. 20 13 E
4	. . .	9	–	. . .			bearing by Compass
5	S 75 W	10	2	N W by N	2	27 W	
6	. . .	10	6	. . .			S 78° E
7	. . .	10	5	. . .			Dist. 13 miles.
8	. . .	11	–	. . .			
9	N 23 E	10	5	Ditto	1	7 E	Variation 30° W.
10	. . .	10	5	. . .			
11	. . .	10	5	. . .			
12	. . .	10	–	. . .			
1	N 82 W	9	2	N N E	0	31 W	
2	. . .	9	5	. . .			
3	. . .	9	5	. . .			
4	. . .	9	5	. . .			
5	N 6 W	10	7	W N W	2	3 W	A current set
6	. . .	11	–	. . .			by compass
7	. . .	11	–	. . .			E. S. E.
3	. . .	11	–	. . .			16 miles from the
9	S 12 W	8	4	West	4	4 W	time the departure
10	. . .	9	6	. . .			was taken until the
11	. . .	9	2	. . .			end of the day.
12	. . .	9	–	. . .			

Correct the courses for Deviation, Variation and Leeway, and find the Course and Distance from the given Point, and the Latitude and Longitude in by inspection.

4—1876, August 1st. In longitude 50° 40′ E. The observed meridian altitude of the Sun's Lower Limb was 64° 32′ 15″ bearing South, index error + 1′ 5″, height of eye 12 feet. Required the latitude.

5—In latitude 36° 14′ N. the Departure made good was 4′·96. Required the Difference of Longitude by parallel sailing.

6—Required the course and distance from Cape Ray to Scatteri, by calculation on Mercator's principle.

Lat. of Cape Ray	47° 37′ N	Long. 59° 18′ W
Lat. of Scatteri	46 2 N	Long. 59 41 W

1—Find the time of High Water A. M. and P. M. at the following places :

1875, May 28th, at S. Ives G. B.

" July 3rd, at Nagasaki, in Long. 129° 52′ E.

2—1876. April 29th, At $5^h 0^m$ A. M. Appt. T. Ship in latitude 47° 12′ N., longitude 160° 12′ E. The Sun's Magnetic Amplitude was N. E. ¾ N. Required the True Amplitude and Error of the Compass, and supposing the Variation to be 4° 20′ E., required the Deviation of the Compass for that position of the Ship's head.

3—1876, November 12th, at $4^h 3^m$ P. M. Mean Time at Ship, in latitude 0° 12′ 16″ S., longitude 61° 57′ 30″ E. The observed altitude of the ⊙ was 23° 50′ 40″ height of eye 15 feet. Time by a Chronometer $1^h 27^m 5^s$ which was fast $1^h 2^m 21^s$ for mean noon at Greenwich on May 1st and on June 1st was fast for mean noon at Greenwich $1^h 7^m 0^s$. Required the Longitude by Chronometer.

1—1876, June 4th, Mean Time at Ship at $5^h 25^m$, in latitude 27° 39′ N., longitude 38° 16′ W. The Sun's bearing by Compass W. ¼ S., altitude $\bar{\odot}$ 18° 21′ 45″. Height of the eye 14 feet. Required the True Azimuth and Error of the Compass, and supposing the Variation to be 15° 36′ W., required the Deviation of the Compass for that position of the Ship's head.

2—1876, May 16th A. M. at Ship; latitude by account 31° 50′ S.; longitude 87° 54′ 35″ W. The observed altitude of the Sun's L. L. North of the observer was 38° 22′ 40″, height of eye 12 feet. Time by watch $10^h 33^m 55^s$ which had been found to be slow $1^h 2^m 18^s$ of apparent time at Ship. The difference of longitude made to the East was 14′¼ after the error upon Apparent Time at Ship was determined. Required the Latitude by the Reduction to the Meridian.

1—1876, November 12th. The observed Meridian Altitude of the Star δ Ophiuchi bearing North was 45° 26′ 0″, height of the eye 10 feet. Required the Latitude.

2—Deviation of the Compass.

(7) In the following table give the correct magnetic bearing of the distant object, and thence the deviation :

Ship's head by Standard Compass.	Bearing of distant object by Standard Compass.	Deviation required.
North	N. 38° 0′ W.	
N. E.	N. 16 30 W.	
East	N. 13 10 W.	
S. E.	N. 19 40 W.	
South	N. 41 30 W.	
S. W.	N. 60 50 W.	
West	N. 66 0 W.	
N. W.	N. 61 30 W.	

(8) With the deviation from the Curve at the end of the book, give the courses you would steer by the Standard Compass to make the following courses, correct magnetic.

Correct magnetic courses, N. N. E. ; N. 47 W.

(9) Supposing you have steered the following courses by the Standard Compass, find the correct magnetic courses made from the above deviation table.

Compass courses, N. E. ; South.

(10) You have taken the following bearings of two distant objects by your Standard Compass as above ; with the Ship's head at S. E., find the bearings, correct magnetic.

Compass bearings, West; North.

SET No. 2.

1—Multiply 682 by 543·21 by common logarithms.

2—Divide 73829 by 55·555 by common logarithms.

3—

Hours.	Courses	Knots.	10 ths.	Winds.	L'way.	Dev.	Remarks, &c.
1	S 20° E	8	4	E N E	6°	5° E	A point
2		8	6				in Lat. 60° 20' S
3		9	1				Long. 40 27 E
4		7	9				bearing by Com-
5	N 82 E	6	2	S E	6	13 E	pass
6		6	4				N 8° W.
7		4	5				Dist. 14 miles.
8		5	5				
9	S 68 E	6	–	S S W	11	19 E	Variation 37° W.
10		6	6				
11		6	5				
12		6	5				
1	S 34 E	7	–	S W	13	9 E	
2		7	–				
3		7	–				
4		7	5				
5	N 53 E	6	3	S E by E	9	8 E	A current set
6		7	4				by compass
7		8	2				N73°W
8		6	9				16 miles from the
9	S 8 W	7	5	E S E	3	2W	time the departure
10		7	5				was taken until
11		7	5				the end of the day.
12		7	2				

Correct the Courses for Deviation, Variation and Leeway, and find the course and distance from the given Point, and the Latitude and Longitude in by inspection.

4—1876, September 22nd. In longitude 60° 13′ 30″ W. The observed meridian altitude of the Sun's Lower Limb was 39° 19′ 0″ bearing South, index error – 0′ 26″, height of eye 19 feet. Required the latitude.

5—In latitude 18° 13′ S. the Departure made good was 14 miles. Required the Difference of Longitude by parallel sailing.

6—Required the course and distance from Panama to Hobarton, by calculation on Mercator's principle.

Lat. of Panama	8° 57′ S	Long.	79° 31′ E	
Lat. of Hobarton	42 54 S	Long.	147 22 E	

1—Find the time of High Water A. M. and P. M. at the following places :

1875, January 8th, at Southampton.

" February 20th, at Basrah Bar in long. 47° 40′ E.

2—1876, February 15th at 6^h 36^m A. M. Appt. T. Ship, in latitude 34° 14′ N., longitude 15° 36′ E. The Sun's Magnetic Amplitude was S. E. by E. ¾ E. Required the True Amplitude and Error of the Compass, and supposing the Variation to be 13° 0′ W. required the Deviation of the Compass for that position of the Ship's head.

3—1876, April 26th at 2^h 28^m P. M. mean time at Ship, in latitude 1° 56′ N. longitude 78° 53′ E. The observed altitude of the ☉ was 50° 55′ 40″, height of eye 26 feet. Time by a Chronometer 8^h 9^m 0^s which was slow for mean noon at Greenwhich 59^m 36^s on November 12th 1875 and on November 30th 1875 was slow 59^m 59^s for mean noon at Greenwich. Required the Longitude by Chronometer.

1—1876, August 18th Mean Time at Ship, at 10^h 35^m, in latitude 26° 15′ 21″ S., longitude, 93° 30′ W. The Sun's bearing by Compass N. by W., altitude ☉ 45° 10′ 30″. Height of the eye 18 feet. Required the True Azimuth and Error of the Compass, and supposing the Variation to be 13° 40′ E., required the Deviation of the Compass for that position of the Ship's head.

2—1876, April 15th P. M. at Ship; latitude by account 46° 45′ S., longitude 79° 30′ E. The observed altitude of the Sun's L. L. North of the observer was 32° 40′ 10″, height of eye 21 feet. Time by watch 7^h 18^m 46^s which had been found to be slow 5^h 14^m 12^s of apparent time at Ship. The difference of longitude made to the East was 15′·7 after the error upon Apparent Time at Ship was determined. Required the Latitude by the Reduction to the Meridian.

1—1876, December 30th. The observed Meridian Altitude of the Star of μ Geminorum bearing South was 58° 40′ 0″, height of the eye 10 feet. Required the Latitude.

2—Deviation of the Compass.

(7) In the following table give the correct magnetic bearing of the distant object and thence the deviation :

Ship's head by Standard Compass.	Bearing of distant object by Standard Compass.	Deviation required.
North.	S. 11° 5′ E.	
N. E.	S. 0 45 E.	
East.	S. 4 40 W.	
S. E.	S. 0 25 W.	
South.	S. 9 45 E.	
S. W.	S. 21 5 E.	
West.	S. 23 50 E.	
N. W.	S. 18 35 E.	

(8) With the deviation from the Curve at the end of the book, give the courses you would steer by the Standard Compass to make the following courses, correct magnetic.

Correct magnetic courses, S. 50′ W. ; South.

(9) Supposing you have steered the following courses by the Standard Compass, find the correct magnetic courses made from the above deviation table.

Compass Courses, West ; N. W.

(10). You have taken the following bearings of two distant objects by your Standard Compass as above, with the Ship's head at N. E.; find the bearings, correct magnetic.

Compass bearings, S. W. ; East.

SET No. 3.

1—Multiply 4674·2 by 96·732 by common logarithms.

2—Divide 746206 by 294·1 by common logarithms.

3—

Hours	Courses	Knots	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	S 50° E	6	8	N E by E	14°	8° E	A point
2		7	1				in Lat. 58° 15′ N
3		6	6				Long. 145 37 W
4		6	4				bearing by compass
5	S 45 E	6	–	Ditto.	17	7 E	N 89° W.
6		6	4				Dist. 27 miles.
7		6	5				
8		6	5				
9	North	5	4	E N E	11	1 W	Variation 30° E.
10		5	3				
11		5	8				
12		5	9				
1	N 45 W	7	2	N N E	8	13W	
2		7	5				
3		8	2				
4		8	7				
5	East	6	4	Ditto.	10	25 E	A current set by compass
6		6	9				N E by E.
7		6	6				15 miles from the
8		6	5				time the departure
9	N 67 W	7	4	North	6	29W	was taken to the
10		7	5				end of the day.
11		7	9				
12		8	–				

Correct the Courses for Deviation, Variation, and Leeway, and find the course and distance from the given Point, and the Latitude and Longitude by inspection.

4—1876, November 1st. In longitude 76° 0′ W. The observed meridian altitude of the Sun's Upper Limb was 80° 40′ 10″ bearing South, index error + 2° 30′, height of eye 22 feet Required the latitude.

5—In latitude 30° 19′ the Departure made good was 421 miles. Required the Difference of Longitude by parallel sailing.

6—Required the course and distance from Cape Finisterre to the Lizard, by calculation on Mercator's principle.

Lat. of C. Finisterre 42° 53′ N. Long. 9° 15′ W.
Lat. of Lizard 49° 58′ N. Long. 5° 12′ W.

1—Find the time of High Water A. M. and P. M. at the following places:—

1875 August 12th at Valentia Harbor.

" May 1st at Portland U. S.

2—1876, September 22nd at $6^h\ 0^m$ P. M. Appt. T. Ship, in latitude $37^\circ\ 12'$ N., longitude $0^\circ\ 13'\ 30''$ W. The Sun's Magnetic Amplitude was W. $4^\circ\ 20'$ S. Required the True Amplitude and Error of the Compass, and supposing the Variation to be $17^\circ\ 30'$ W. required the Deviation of the Compass for that position of the Ship's head.

3—1876, November 2nd at $8^h\ 44^m$ A. M. Mean Time at Ship, in latitude $38^\circ\ 0'$ N. longitude $64^\circ\ 5'$ W. The observed altitude of the $\bar{\odot}$ was $22^\circ\ 39'\ 20''$ eight of the eye 15 feet. Time by a Chronometer $11^h\ 16^m\ 42^s$ which was slow for mean noon at Greenwich $1^h\ 45^m\ 36^s$ on May 13th and on May 18th was slow $1^h\ 45^m\ 32^s$ for mean noon at Greenwich. Required the Longitude by Chronometer.

1—1876, March 29th Mean Time at Ship $4^h\ 6^m$, in latitude $28^\circ\ 20'$ S., longitude $80^\circ\ 45'$ E. The Sun's bearing by Compass W. 10° S., altitude $\underline{\odot}$ $21^\circ\ 45'\ 30''$. Height of the eye 22 feet. Required the True Azimuth and Error of the Compass, and supposing the Variation to be $10^\circ\ 30'$ E., required the Deviation of the Compass for that position of the Ship's head.

2—1876, August 14th A. M. at ship; latitude by account $15^\circ\ 40'$ S., longitude $47^\circ\ 36'$ W. The observed altitude of the Sun's L. L. North of the observer was $59^\circ\ 54'\ 40''$, height of eye 22 feet. Time by watch $2^h\ 49^m\ 7^s$ which had been found to be fast $2^h\ 48^m\ 51^s$ of apparent time at Ship. The difference of longitude made to the West was $48'{\cdot}6$ after the error upon Apparent Time at Ship was determined. Required the Latitude by the Reduction to the Meridian.

1—1876, February 24th. The observed Meridian Altitude of the Star Capella bearing South $89^\circ\ 53'\ 50''$, height of the eye 19 feet. Required the Latitude.

2—Deviation of the Compass.

(7) In the following table find the correct magnetic bearing of the distant object and thence the deviation :

Ship's Head by Standard Compass.	Bearing of distant object of Standard Compass.	Deviation required.
North.	N. 82° 15′ E.	
N E.	N. 61 35 E.	
East.	N. 58 10 E.	
S. E.	N. 65 50 E.	
South.	N. 78 10 E.	
S. W.	S. 83 55 E.	
West.	S. 76 40 E.	
N. W.	S. 82 45 E.	

(8) With the deviation from the Curve at the end of the book, give the courses you would steer by the Standard Compass, to make the following courses, correct magnetic.

Correct magnetic courses N. E. ½ N. ; S. 14° E.

(9) Supposing you have steered the following courses by the Standard Compass, find the correct magnetic courses made from the above deviation table.

Compass courses, S. E. ; N. E.

(10) You have taken the following bearings of two distant objects by your Standard Compass as above, with the Ship's head at East, find the bearings, correct magnetic.

Compass bearings, East ; N. W.

SET No. 4.

1—Multiply 28·4291 by 7·4395 by common logarithms.

2—Divide 384444 by 85 by common logarithms.

3—

Hours	Courses	Knots	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	N 40° W	9	4	N N E	8°	14°W	A point
2		7	9				in Lat. 52° 21′ S
3		8	2				Long. 82 35 W
4		7	7				bearing by compass
5	N 11 W	8	–	West	5	3 E	N 45° E.
6		8	–				
7		8	–				Dist. 21 miles.
8		8	–				
9	N 27 W	8	–	Ditto	11	12W	Variation 23° E.
10		8	6				
11		9	–				
12		9	–				
1	S 38 W	9	–	Ditto	8	7 W	
2		9	–				
3		9	7				
4		9	7				
5	N 36 W	10	–	W by S	5	15W	A current set }
6		10	–				by compass }
7		10	–				S 30° W.
8		10	8				33 miles from the
9	S 20 W	9	6	Ditto	11	12W	time the departure
10		9	5				was taken to the
11		9	3				end of the day.
12		9	–				

Correct the Courses for Deviation, Variation and Leeway, and find the course and distance from the given Point and the Latitude and Longitude in by inspection.

4—1876, February 12th. In longitude 130° 34′ W. The observed meridian altitude of the Sun's Lower Limb was 61° 13′ 20″ bearing North, index error – 1′ 20″, height of eye 10 feet. Required the latitude.

5—In latitude 57° 16′ the Departure made good was 846·2. Required the Difference of Longitude by parallel sailing.

6—Required the course and distance from Boston U. S. to Sable Island.

Lat. of Boston U. S.	42° 23′ N	Long. 71° 8′ W
Lat. of Sable Island	43 59 N	Long. 59 46 W

1—Find the time of High Water A. M. and P. M. at the following places :

1875, July 26th at Mellon.

" May 31st at Table Bay in Longitude 18° 25′ E.

2—1876, June 22nd at 8^h 29^m A. M. Appt. T. Ship, in latitude 54° 10′ S., longitude 14° 22′ W. The Sun's Magnetic Amplitude was N. E. ¼ E. Required the True Amplitude and Error of the Compass, and supposing the Variation to be 8° W. required the Deviation of the Compass for that position of the Ship's head.

3—1876, September 22nd at 7^h 53^m A. M. Mean Time at Ship, in latitude 18° 0′ N., longitude 150° 0′ W. The observed altitude of the ☉ was 28° 26′ 40″, height of the eye 14 feet. Time by a Chronometer 5^h 55^m 0^s which was slow for mean noon at Greenwich 1^m 14^s on September 2nd and on September 22nd was 1^m 34^s fast for mean noon at Greenwich. Required the Longitude by Chronometer.

1—1876, April 9th Mean Time at Ship, at 7^h 55^m A. M. in latitude 40° 10′ S., longitude 88° 0′ W. The Sun's bearing by Compass N. 60° E., altitude ☉ 15° 39′ 40″. Height of the eye 9 feet. Required the True Azimuth and Error of the Compass and supposing the Variation of the Compass to be 18° 15′ E., required the Deviation of the Compass for that position of the Ship's head.

2—1876, March 1st P. M. at ship, latitude by account 23° 28′ S. longitude 50° 5′ 45″ E. The observed altitude of the Sun's U. L. North of the observer was 74° 10′ 0″, height of eye 11 feet. Time by watch 8^h 47^m 50^s which had been found to be slow 3^h 18^m 22^s of apparent time at Ship. The difference of longitude made to the East was 17¾′ after the error upon Apparent Time at Ship was determined. Required the latitude by the Reduction to the Meridian.

1—1876, October 1st, The observed Meridian Altitude of the Star ζ Aquila bearing North was 24° 14′ 15″, height of the eye 11 feet. Required the Latitude.

2—Deviation of the Compass.

(7). In the following table give the correct magnetic bearing of the distant object aud thence the deviation :—

Ship's head by Standard Compass.	Bearing of distant object by Standard Compass.	Deviation required.
North.	S. 11° 30′ W.	
N. E.	S. 18 45 W.	
East.	S. 23 15 W.	
S. E.	S. 20 30 W.	
South.	S. 13 0 W.	
S. W.	S. 3 45 W.	
West.	S. 2 15 W.	
N. W.	S. 3 30 W.	

(8) With the deviation from the Curve at the end of the book, give the courses you would steer by the Standard Compass to make the following courses, correct magnetic.

Correct magnetic courses. W. ¾ N.; N. 62° E.

(9). Supposing you have steered the following courses by the Standard Compass, find the correct magnetic courses made from the above deviation table.

Compass courses, South ; S. W.

(10). You have take the following bearings of two distant objects by your Standard Compass as above, with the Ship's head at North, find the bearings, correct magnetic.

Compass bearings, S. E. ; West.

SET No.

1—Multiply 128·968 by 2243·8 by common logarithms.

2—Divide 296400 by 947·29 by common logarithms.

3—

Hours	Courses	Knots.	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	West	7	6	South	1 Pt.	27°W	A point
2		6	8				in Lat. 20° 16′ S
3		7	4				Long 23 23 W
4		8	–				bearing by compass
5	W N W	11	–	S W	1¼	21W	S E by E.
6		7	7				Dist. 21 miles.
7		6	9				
8		7	4				
9	N W	8	–	W S W	¼	15W	
10		8	–				
11		7	–				
12		6	4				
1	N N W	6	2	West	1	4 W	Variation 1¾ Pt. E
2		4	–				
3		4	–				
4		3	4				
5	S S W ½ W	3	2	Ditto	¾	3 E	A current set
6		3	–				by compass
7		3	–				S E.
8		3	–				17 miles from the
9	Up S W by S	1	–	Ditto	5	2 E	time the departure
10	Off S by E	1	–				was taken to the
11		1	–				end of the day.
12		1	–				

Correct the Courses for Deviation, Variation, and Leeway, and find the course and distance from the given Point, and the Latitude and Longitude in by inspection.

4—1876, December 1st. In longitude 67° 56′ E., the observed meridian altitude of the Sun's Lower Limb was 18° 48′ 10″, bearing South, index error—3′ 6″, height of eye 18 feet. Required the latitude.

5—In latitude 18° 11′ S. the Departure made good was 110 miles. Required the difference of Longitude by parallel sailing.

6—Required the course and distance from A. to B. by calculation on Mercator's principle.

Lat. of A. 51° 5′ N. Long. 10° 0′ W.
Lat. of B. 51 25 N. Long. 9 29 W.

1—Find the time of High Water A. M. and P. M at the following places :—

1875 July 11th, at Foynes Island.

" June 29th, at Dalhousie Harbor N. B. in long. 66° 22′ W.

2—1876, August 6th at 6^h 40^m A. M. Appt. T. Ship, in latitude 31° 21′ S., longitude 130° 10′ E. The Sun's Magnetic Amplitude was E. by N. $\frac{3}{4}$ N. Required the True Amplitude and Error of the Compass, and supposing the Variation to be 0° 0′ required the Deviation of the Compass for that position of the Ship's head.

3—1876, September 1st at 8^h 54^m A. M. Mean time at Ship, in latitude 13° 17′ 15″ N. longitude 5° 40′ W. The observed altitude of the ☉ was 44° 2′ 20″, height of eye 18 feet. Time by a Chronometer 9^h 24^m 42^s which was slow for mean noon at Greenwich 0^m 18^s on May 22nd and on June 8th was fast 1^m 2^s for mean noon at Greenwich. Required the Longitude by Chronometer.

1—1876, November 1st Mean Time at Ship, at 8^h 27^m A. M. in latitude 16° 40′ S., longitude 89° 3′ E. The Sun's bearing by Compass S. 85° E., altitude ☉ 43° 3′ 10″. Height of the eye 12 feet. Required the True Azimuth and Error of the Compass, and supposing the Variation to be 2° 30′ W. required the Deviation of the Compass for that position of the Ship's head.

2—1876, July 15th A. M. at ship; latitude by account 36° 50′ S. longitude 57° 2′ 30″ W. The observed altitude of the Sun's L. L. North of the observer was 31° 18′ 20″, height of the eye 21 feet. Time by watch 3^h 44^m 22^s which had been found to be fast 4^h 7^m 16^s of apparent time at ship. The difference of longitude made to the West was $11\frac{1}{4}$ after the error upon Apparent Time at Ship was determined. Required the Latitude by the Reduction to the Meridian.

1—1876, August 22nd the observed Meridian Altitude of the Star γ^1 Eridani bearing North was 57° 36′ 20″ height of the eye 12 feet. Required the Latitude.

2—Deviation of the Compass.

(7) In the following table given the correct magnetic bearing of the distant object and thence the deviation :

Ship's head by Standard Compass.	Bearing of distant object by Standard Compass.	Deviation required.
North.	S. 74° 40 E.	
N. E.	N. 82 10 E.	
East.	N. 80 10 E.	
S. E.	N. 87 30 E.	
South.	S. 79 50 E.	
S. W.	S. 67 20 E.	
West.	S. 59 40 E.	
N. W.	S. 64 20 E.	

(8) With the Deviation from the Curve at the end of the book, give the courses you would steer by the Standard Compass to make the following courses, correct magnetic.

Correct magnetic courses. West; E. by N. ½ N.

(9) Supposing you have steered the following courses by the Standard Compass, find the correct magnetic courses made from the above deviation table.

Compass courses, N. W.; East

(10) You have taken the following bearings of two distant objects by your Standard Compass as above; with the Ship's head at West, find the bearings, correct magnetic.

Compass bearings, N. E.; South.

SET No. 6.

1—Multiply 4742·9 by 200·02 by common logarithms.

2—Divide 345609 by 7·7870 by common logarithms.

3—

Hours	Courses	Knots	10 ths.	Winds	L'way.	Dev.	Remarks, &c.
1	E 11° N	8	2	N 11° E	8°	32°W	A point
2		9	–				in Lat. 30° 14′ S.
3		9	6				Long. 1 10 W.
4		9	2				bearing by compass
5	E 8 S	8	7	N 34 E	11	33W	S ½ E
6		8	4				Dist. 12 miles.
7		8	4				
8		8	7				
9	N 24 E	9	–	East	14	18W	Variation 25° W
10		9	–				
11		9	–				
12		9	4				
1	E 8 S	10	5	S 14 E	8	33W	
2		10	–				
3		9	5				
4		9	5				
5	S 11 E	8	2	S 55 W	3	6W	A current set
6		9	–				by compass
7		9	–				S W by W.
8		9	2				16 miles from the
9	S 67 E	10	–	Ditto	0	31W	time the departure
10		10	–				was taken to the
11		10	–				end of the day.
12		10	6				

Correct the Courses for Deviation, Variation and Leeway, and find the course and distance from the given point, and the Latitude and Longitude in by inspection.

4—1876, January 19th. In longitude 67° 30′ W. The observed meridian altitude of the Sun's Lower Limb was 49° 24′ 10″ bearing South, index error + 0′ 17″, height of eye 13 feet. Required the latitude.

5—Required the course and distance from A. to B. by calculation on Mercator's principle.

Lat. of A. 5° 37′ N. Long. 79° 36′ W.
Lat. of B. 31 18 S. Long. 126 15 E.

1—Find the time of High Water A. M. and P. M. at the following places:—

1875, April 5th, at Peterhead.

" August 1st, at Hobarton in Longitude 147 22 E.

2—1876, March 20th at 6^h 2^m A. M. Appt. T. Ship, in latitude 31^o 49', longitude 124^o 9' W. The Sun's Magnetic Amplitude was E. $\frac{3}{4}$ S. Required the True Amplitude and Error of the Compass, and supposing the Variation to be 8^o 35' E. required the Deviation of the Compass for that positon of the Ship's head.

3—1876, December 24th at 2^h 45^m P. M. Mean time at Ship, in latitude 0^o 0', longitude 57^o 21' E. The observed altitude of the $\overline{\odot}$ was 43^o 55' 0", height of the eye 17 feet. Time by a Chronometer 0^h 18^m 29^s which was fast for mean noon at Greenwich 1^h 15^m 22^s on December 31st 1875 and on February 3rd 1876 was 1^h 16^m 3^s fast for mean noon at Greenwich. Required the Longitude.

1—1876, May 21st Mean Time at Ship, at 6^h 0^m, in latitude 29^o 15' N., longitude 130^o 45' E. The Sun's bearing by Compass East, altitude $\underline{\odot}$ 10^o 21' 20". Height of the eye 12 feet. Required the True Azimuth and Error of the Compass, and supposing the Variation to be 2^o W., required the Deviation of the Compass for that position of the ship's head.

2—1876, March 20th A. M. at ship; latitude by account 49^o 35' S. longitude 51^o 0' W. The observed altitude of the Sun's L. L. North of the observer was 39^o 21' 30", height of eye 22 feet. Time by watch 11^h 12^m 42^s which had been found to be slow 4^m 30^s of apparent time at ship. The difference of longitude made to the East was 40'·5 after the error upon Apparent Time at Ship was determined. Required the Latitude by the Reduction to the Meridian.

1—1876, March 4th The observed Meridian Altitude of the Star β Orionis bearing South was 81^o 42' 40" height of the ey 26 feet. Required the Latitude.

2—Deviation of the Compass.

(7) In the following table give the correct magnetic bearing of the distant object and thence the Deviation :

Ship's head by Standard Compass.	Bearing of distant object by Standard Compass.	Deviation required.
North.	N. 11° 10′ W.	
N. E.	N. 22 50 W.	
East.	N. 24 30 W.	
S. E.	N. 20 5 W.	
South.	N. 8 5 W.	
S. W.	N. 3 50 E.	
West.	N. 8 50 E.	
N. W.	N. 4 0 E.	

(8.) With the deviation from the Curve at the end of the book give the courses you would steer by the Standard Compass to make the following courses, correct magnetic.

Correct magnetic courses. N. 82° W ; E. ½ S.

(9.) Supposing you have steered the following courses by the Standard Compass, find the correct magnetic courses made, from the above deviation table.

Compass courses, North ; S. E.

(10.) You have taken the following bearings of two distant objects by your Standard Compass as above ; with the Ship's head at S. W., find the bearings, correct magnetic.

Compass bearings, S. W. ; East.

THE SEXTANT.

TO READ THE SEXTANT.

114. Each long stroke upon the arc is a degree; each long stroke upon the vernier is a minute. Divide 60 by the number of divisions between the degrees on the arc of your sextant, this will tell you *what it cuts to*, that is, the value of each division; do the same with the divisions upon the vernier for the same purpose.

115. Now see where the zero of the vernier cuts on the arc, and read the value of the division immediately at its right hand; after which look carefully at the vernier and note which of its divisions makes a *straight line* with a division upon the arc, read the value of that division, and add it to what is shewn by the arc, the sum will be the angle measured by the sextant.

116. To read the Arc of Excess.—On the arc, read to the division to the left hand of the zero; now see where a division upon the vernier makes a straight line with one upon the arc as before, but in reading the value of this division you must count the number of minutes and seconds from *the left hand division of the vernier*, that is, you must reckon it backwards.

THE ADJUSTMENTS OF THE SEXTANT.

117. To set the Index Glass perpendicular to the Plane of the Sextant.

Place the vernier about the middle of the arc; hold the Sextant horizontally with the limb from you, and looking obliquely into the Index Glass, see if the arc reflected in it, and the true arc, as seen outside, appear in an unbroken line, if not, it is rectified by the screws at the back of the glass.

118. To set the Horizon Glass perpendicular to the Plane of the Sextant.

Place the Zero of the vernier to the Zero of the arc, hold the Sextant horizontally and see if the reflected and true horizons appear in the same straight line, if not, turn the upper screw upon the Horizon Glass until they do.

119. To set the Horizon Glass parallel to the Index Glass.—Place the Zero of the vernier to the Zero of the arc, hold the Sextant perpendicularly, and see if the true and reflected horizons appear in the same straight line, if not, turn the lower screw upon the Horizon Glass until they do.

120. To set the Axis of the Telescope parallel to the plane of the Sextant.—Screw on the inverting telescope, and by turning the eye piece makes two of the wires parallel to the plane of the

Sextant; then select two objects in the heavens (not less than 90° apart), and bring them in contact upon the wire nearest the plane of the Sextant, alter the position of the instrument a little, until they are made to appear upon the upper wire, then if the contact remains unaltered this adjustment is correct; but if the objects have separated, the inner end of the telescope droops towards the plane of the Sextant, and the upper screw upon the collar must be slackened and the lower one tightened; while if the objects overlap one another, the inner end of the telescope is elevated and the screws must be turned the reverse way.

TO FIND THE INDEX ERROR.

121. By the sun.—Place the zero of the vernier about 40 minutes to the right of the zero of the arc and bring the true and reflected suns in contact, marking the reading *off;* then place the zero of the vernier about 40 minutes to the left of the zero of the arc, and again bring the true and reflected suns in contact, call this reading *on.* Find the difference between the two readings, and divide it by 2, this will be the Index Error, additive if *off* is the greatest, but subtractive if it is the least.

Ex. 1—1876, May 19th. The following observations were taken by two sextants for the purpose of finding their respective errors

Reading *off*	32′ 20″	Reading *off*	29′ 50″
Reading *on*	31 00	Reading *on*	33 30
	2) 1 20		2) 3 40
Index error	+ 0 40	Index error	− 1 50

122. If the above observations have been taken correctly the sum of the readings *off* and *on* divided by 4, will be equal to the sun's semi-diameter, as given in the Nautical Almanac for the day on which the observations were taken.

Ex. 2.—Check the observations taken in Ex. 1 for Index Error.

Reading *off*	32′ 20″	Reading *off*	29′ 50″
Reading on	31 00	Reading *on*	33 30
	4) 63 20		4) 63 20
☉ Semi-diameter	15 50	☉ Semi-diameter	15 50

On May 19th the sun's semi-diameter as given in the Nautical Almanac is 15° 50′·1.

123. By the horizon.—Place the zero of the vernier to the zero of the arc, and bring the true and reflected horizons in one straight line, then what the sextant shows will be the Error, additive if the reading is *off* the arc, but subtractive if it is *on*.

MERCATOR'S CHART.

TO FIND THE LATITUDE AND LONGITUDE OF ANY PLACE.

124. To find the Latitude.—With the compasses measure the distance between the place and the nearest parallel of latitude; now place one foot of the compasses at the end of this parallel (in the margin of the chart,) and let the other foot rest upon the scale upon the same side of the parallel as the given place, this when read, will be its latitude.

125. To find the Longitude.—Measure the distance between the place and the nearest meridian, and take it to the scale lying at the end of your meridian, now in the same way as for the Latitude read what this will shew, and the result will be the Longitude.

Ex. 1.— Find the Lat. and Long. of West Point, Anticosti.
" 2.— " " Mount Desert Rock.
" 3.— " " Cape Race N. F. L.
" 4.— " " Cape Canso Light.
" 5.— " " Pictou Island Light.

TO FIND THE PLACE CORRESPONDING TO A GIVEN LATITUDE AND LONGITUDE.

126.—Place one foot of your compasses on the given lat. as shown by the scale, and measure the distance between it and the nearest parallel; take your parallel rulers and having placed the edge upon this parallel, move it in the direction of the given lat. until it is at the distance shewn by the compasses from the parallel; now taking your longitude upon the scale, measure the distance between it and the nearest meridian, and placing one foot of the compasses upon the same meridian and against the edge of the rulers, then, where the other foot falls against the edge (in the direction of the long.) will be the position required.

Give the soundings upon which the following Latitudes and Longitudes fall.

Ex. 6.—	Lat.	47°	8′ N.	Long.	57°	38′	W.
" 7.—	"	46	33 N.	"	61	34	W.
" 8.—	"	48	53 N.	"	61	20	W.
" 9—	"	46	17 N.	"	56	27	W.
" 10.—	"	45	17 N.	"	52	44	W.

TO FIND THE COURSE AND DISTANCE BETWEEN TWO PLACES.

127. To find the Course.—Lay your rulers so that the two places appear upon its edge, move the rulers to the centre of the compass and the point upon which it lies will be the course; if the compass is Magnetic the course found will be magnetic, but if True the course will also be true, and may be brought into the magnetic course by applying the variation the reverse way, that is, East to the *left* and West to the *right*.

128. To find the Distance.—If the distance is not too long, place a foot of the compasses upon each of the two places, and take them to the scale at the *latitude* side of the chart, and having placed them so that their centre will be over the middle latitude (roughly guessed) then the distance will be the number of miles spanned by the compasses: if however, the distance is too long to be taken at one stretch, find the rough middle latitude, and over this, on the scale, take as many miles in your compasses as you may find convenient, see how often this distance will go between the two places, and measure off the remainder, if any, and these distances taken together will be the distance required.

Find the Course and Distance between the following places.

Ex. 11.—	From	Scatteri	to	Cape Race.
" 12.—	"	St. Pauls	"	North Point P. E. I.
" 13.—	"	Miscou Light	"	Amherst, Magdalen Islands
" 14.—	"	Seal Island	"	Truro Light, Cape Cod.
" 15.—	"	Cape Rosier	"	Cape Ray.
" 16.—	"	Mount Desert	"	Seal Island.

" 17.— " Lat. 50° 5′ N. Long. 58° 56′ W. to Heath Point, Anticosti.

Ex. 18.— From Lat. 43° 10′ N. Long. 62° 27′ W. to Cape Ann.
" 19.— " Lat. 45° 47′ N. Long. 57° 4′ W. to St. Pauls Island, S. W. point.
" 20.— " Lat. 42° 24′ N. Long. 56° 18′ W. to Seal Island.

TO FIND THE POSITION OF THE SHIP BY CROSS BEARINGS.

129.—Lay off your bearings from the points given, and where the lines cut one another will be the position of the ship. If the chart has a True Compass only, the Variation and Deviation must be allowed to the compass bearings in the same way as in a Day's Work.

TO FIND THE POSITION OF THE SHIP BY TWO BEARINGS OF ONE OBJECT.

130. Lay off the bearings from the object observed; place your parallel rulers upon the course steered during the interval, and now with the distance run in your dividers, slide your rulers along the lines of bearings until one leg of the dividers falls upon each line, then the points indicated will be the positions of the ship when the bearings were taken. In finding your position by this method, you should sail on until you have altered the bearing of the object not less than three points.

TO FIND THE COURSE TO STEER IN A CURRENT.

131. Lay off in pencil the course it is required to make, have a dot anywhere upon this line and from this lay off the current; from the dot and along the line of current prick off the drift, and now having the rate of sailing in your compasses, place one foot *at the end of the drift* and mark where the other falls upon your line of bearing, lay the edge of your parallel rulers against these two marks, and having taken it to the compass, you will have the course required.

THE COMMERCIAL CODE OF SIGNALS.

132. Code Signal.—When this is hoisted under the Ensign it signifies that the vessel is using the Commercial Code, but if it is hoisted singly it is then used as an "answering pennant," denoting that the last signal has been understood.

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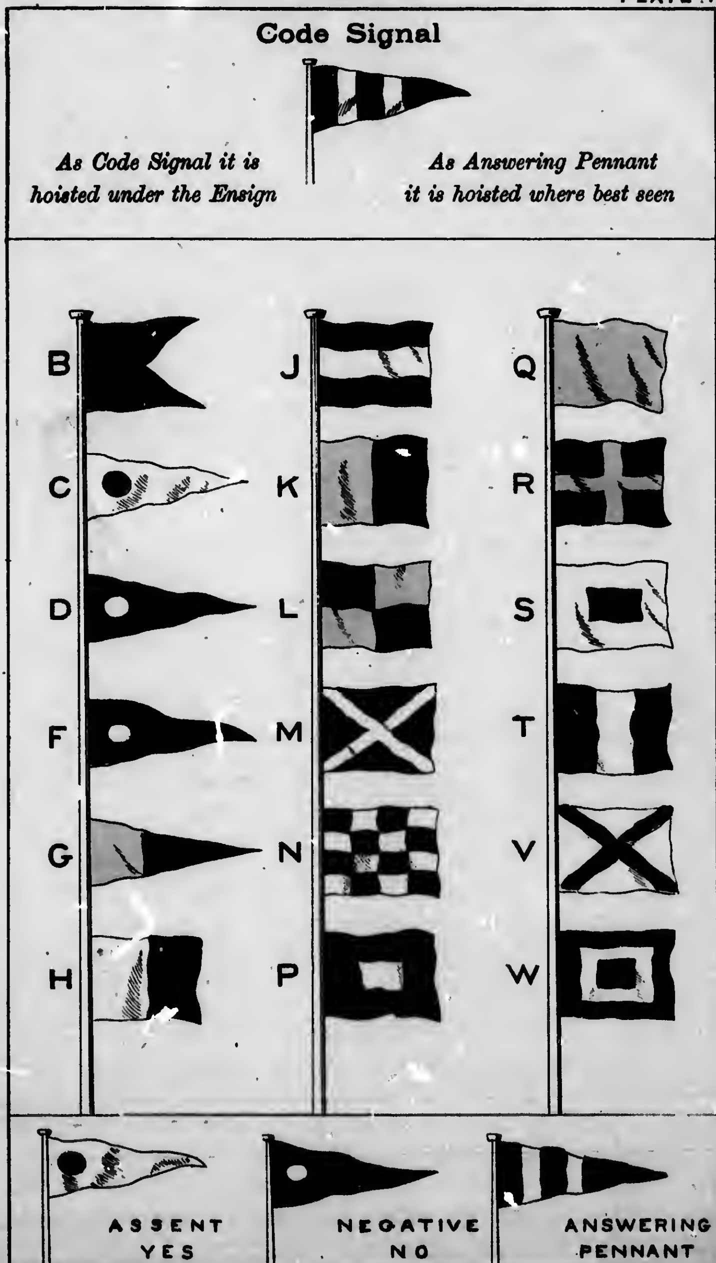
THE "COMMERCIAL CODE" OF SIGNALS

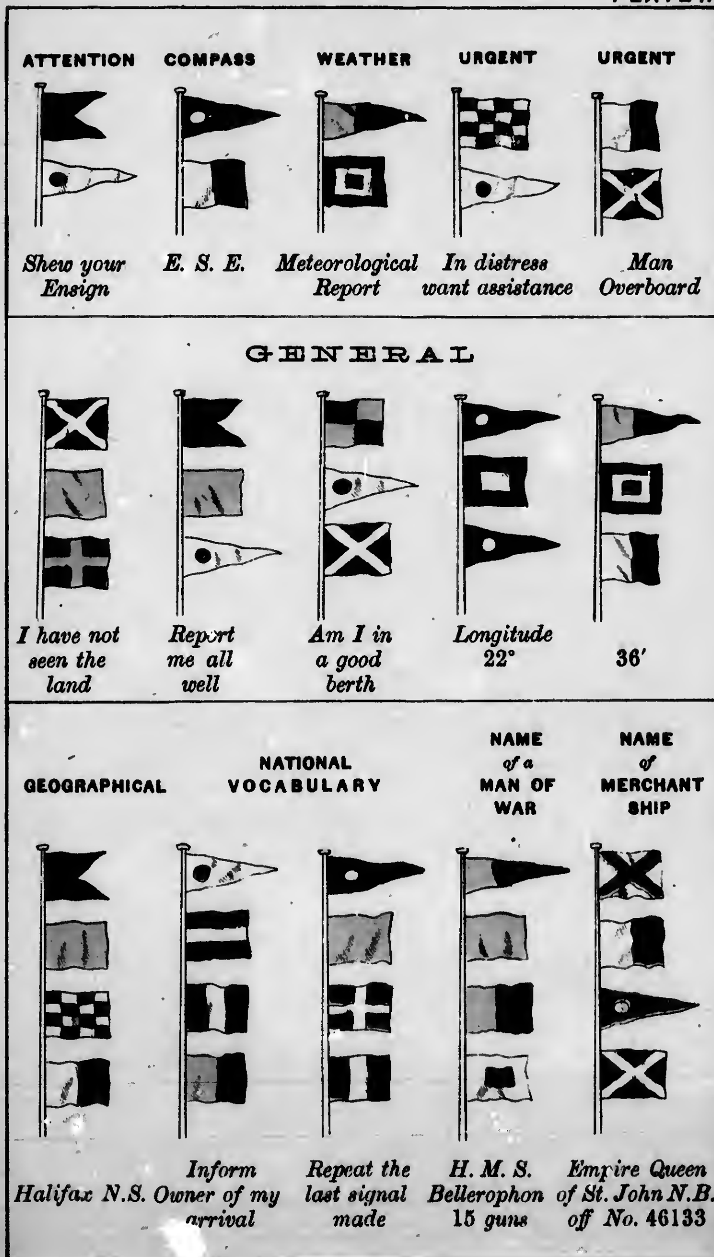
PLATE II



THE "COMMERCIAL CODE"

Examples

PLATE III



CLASSES OF SIGNALS.

133. Signals of a like nature have been grouped into classes, and as these classes are made by hoists distinguished one from the other by the number of flags shewn as well as the name or shape of the upper flag, you can, by this means, tell by the *form* of the signal the nature of the communication made, although of course. the *actual* meaning of the signal can only be ascertained by reference to the Code Book; the distinctive forms of these hoists are as under:—

134. One Flag Signals.

There are only two of these, C "yes," and D "no."

135. Two Flag Signals.

Burgee uppermost.—An "Attention Signal."

Ex. 1.—B. C.—Show your Ensign. (See Plate III.)

Pennant uppermost.—A "Compass Signal," except when the under flag is W in which case it is a "Meteorological Forecast" (or Weather Signal) mind this is the only case where the name or shape, of an under flag alters the *class* of the signal.

Ex. 2.—D H—E. S. E. (See Plate III.)

" 3.—G W—Meteorological report for to-morrow gives "Winds Variable" between the points (indicated) (See Plate III.)

Square flag uppermost.—An "Urgent or Distress Signal."

Ex. 4.—N C—In distress; want assistance. (See Plate III.)

" 5.—H M—Man overboard. "

136. Three Flag Signals.

Any hoist of three flags, no matter how made up, is a "General Signal."

Ex. 6.—M Q R—I have not seen the land. (See Plate III.)

" 7.—B Q C—Report me all well. "

" 8.—L C M—Am I in a good berth? "

" 9.—F P D—Longitude 22° "

" 10.—G W H—36 minutes. "

137. Four Flag Signals.

Burgee uppermost.—A "Geographical Signal."

Ex. 11.—B Q N H—Halifax, N. S. (See Plate III.)

Pennant C. D. or F. uppermost.—A "National Vocabulary Signal:" that is, signals to be used only when speaking your own countrymen. "Spelling Signals," which are used for spelling words or names not given in the Code Book come into this class as well, they all having C. uppermost.

Ex. 12.—C J T K—Inform owner of my arrival. (See Plate III.)

Ex. 13.—D Q R T—Repeat the last signal made. "

Pennant G. uppermost.—The " Name of a Man of War."

Ex. 14.—G Q K S—Bellerophon 15 Guns. (See Plate III.)

Square Flag uppermost.—The " Name of a Merchant Ship."

Ex. 15.—V H F M—Empire Queen of St. John N. B. Official Number 46133, Ton. 1174 (See Plate III).

READING SIGNALS.

138. By a Reference to the Code Book it will be seen that the Signals are arranged in Alphabetical order, (as in a Dictionary); they commence with the Attention Signals, and then after using up all the two flag hoists, proceed with the three flag, and then the four flag signals. The Geographical Signals are found at the end of Part I; Part II is taken up entirely with the Spelling, and National Vocabulary Signals. Names of Men of War and Merchant Ships are in a separate book.

Ex. 16.—Give the meaning of the signal			B Q C
" 17	"	"	D H Q
" 18	"	"	C L F T
" 19	"	"	C T
" 20	"	"	B K S
" 21	"	"	B H
" 22	"	"	C P B J
" 23	"	"	D N
" 24	"	"	S F P M
" 25	"	"	B Q M C
" 26	"	"	F P K —H B D
" 27	"	"	W N Q G
" 28	"	"	B Q P C
" 29	"	"	G R W-G T V-W B G
" 30	"	"	C L F D-C B F R-C O V N

TO MAKE A SIGNAL.

139. In Part II of the Code Book the *leading words* of phrases are arranged alphabetically; look out the one you want, and underneath will be found one or more sentences bearing upon this word, from which you can select the one which will suit you best, and alongside will be found the Signal corresponding. The names of places (to make a Geographical Signal) will be found at the end of Part II; to find a Ship's Signal Letters, enter the list in the separate book *with her official number.*

Give the Signal Letters corresponding to the following sentences:—

Ex. 31—I have sprung a leak.
" 32—Tack instantly.
" 33—You are in a very fair berth.
" 34—Quebec.
" 35—Keep on the starboard tack.
" 36—"Humming-bird" of Windsor N. S. Official Number 48462
" 37—N. by W. ½ W.
" 38—What is your Longitude, brought up to the present moment
" 39—6700.
" 40—You are in a dangerous or unsafe position.
" 41—Signal is annuled.
" 42—You will be aground at low water.
" 43—"Iona" of Pictou N. S. Official Number 43073.
" 44—Meteorological Report for to-day gives "Moderate Winds" in direction (*indicated*).
" 45—How much cable have you out.
" 46—Great risk in sending a boat.
" 47—5^h 43^m 27^s.
" 48—H. M. S. "Royal Alfred."
" 49—Longitude 17^o 29'.
" 50—John Smith.

DISTANT SIGNALS.

140. Distant Signals are used when, through fog or distance, the colors of the flags cannot be distinguished. The characteristic of one of these hoists is that there is always not less than one ball in it, consequently when a ball is seen in the formation of a signal, the *names* of the flags are not to be taken into consideration, you have simply to look *at their shape*, and notice them only as being either Square Flags or Pennants. In making a signal, the hoist representing each letter must be run up separately, so that for a General Signal, three distinct hoists would have to be made, and then a ball will be run up to show that the Signal is completed. When a mistake has been made, two balls are run up, this annuls the preceding hoists.

141. The following is an easy plan for committing the Distant Signals to memory. Learn them as they are placed below, that is, without attending to the balls :—

Pennant and Square Flag...	B J Q
Square Flag and Pennant....	C K R
Two Pennants	D L S
Two Square Flags............	F M T
One Pennant.....................	G N V
One Square Flag...............	H P W

Now when a signal is made, the group to which it belongs will immediately come to the recollection, and *then* by noticing the position of the ball, the actual signal will at once become known, because, if the ball is uppermost it will be the first letter of the group, if in the middle (or in the case of two balls, if they are divided) it will be the middle one, and the last one if the ball is at the bottom. Thus, suppose the signal made to be a pennant, ball and pennant, then the group to which two pennants belongs is D L S, and the ball being in the middle shews the signal to be L. If the signal had been two pennants and a ball, then the place of the ball would have given the signal as S.

142. Signification of Distant Signals when made singly, which will be indicated by the "*stop*" following each hoist.

B—Asks name of ship or signal station in sight.

C—Yes.

D—No.

F—Repeat signal, or hoist it in a more conspicuous place.

G—Cannot distinguish your Flags. Come nearer or make Distant Signals.

H—You may communicate by the Semaphore, if you please.

T—Stop, or bring to. Something important to communicate.

K—Have you any Telegrams or Despatches for me ?

L—Want a Pilot. Can I have one ?

M—Want a Tug. Can I have one ?

N—What is the Meteorological Forecast.

P—Calls attention to the Signal Station in sight.

Q—Vessel asks for orders by Telegraph from owner, Mr.——at——

R—Report me by Telegraph to my owner Mr.—— at ——

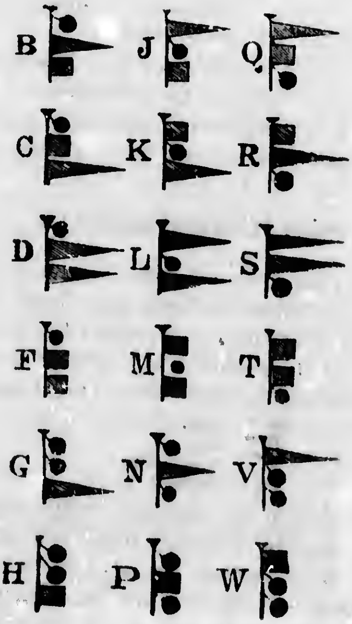
ALPHABET FOR COMPOSING DISTANT SIGNALS.

Preparatire  Answering.

and

Stop after each complete Signal.

Annul Signal.



The following Distant Signals composed of *Two Symbols* have the special specification indicated beneath.

You are running into danger.

Fire, or Leak. Want immediate assistance.

Short of Provisions. Starving.

Aground. Want immediate assistance.

S—Send the following message by Telegraph.
T—Send the following message, by the *Signal Letters* through the Telegraph.
V————————
W -————————

143. In addition to the above the following Distant Signals have the special signification indicated.

One Ball....................	Preparative, Answering, and "Stop" after each complete signal.
Two Balls..................	Annul Signal.
Ball and Pennant	You are running into danger.
Ball and Square Flag...	Fire or Leak. Want immediate assistance.
Pennant and Ball.........	Short of Provisions. Starving.
Square Flag and Ball...	Aground. Want immediate assistance.

SEMAPHORE SIGNALS.

144. These are made from the shore stations, arms in different positions being substituted for balls and flags; thus, taking the N. and S. line of the compass to represent the signal mast, then a square flag will be represented by an arm in the direction of N. E., a ball by one on the East line, and a pennant by one at S. E. Thus:

C 

Disc.
Ball.
Square Flag.
Pennant.

So that according to the position of the arms, you read the signal as balls, pennants, or square flags, and interpret them the same as if they were Distant Signals. As Semaphore Stations sometimes telegraph one another, you have only to pay attention to them when the disc at the top of the mast is turned towards you.

THE "COMMERCIAL CODE OF SIGNALS" VERSIFIED,

Now, as you read this lesson in rhyme,
Scan well each flag, 't is no waste of time :—
Just see if perchance I've made a mistake
In describing color, use, or shape :—
By doing thus, you'll keep from error,
And learning Flags will lose its terror.

When the Code Pennant in its stripes of white and red **Answering Pennant.**
Is seen flying quite alone,—say, at the mast head,
Then as the "Answering Pennant" it is intended
To say, " Your hoist is seen, and is comprehended."

But when under the broad Ensign it proudly flies, **Code Pennant.**
Then is quite changed its meaning, for it now implies
"On board this ship the Commercial Code is in use
For questions and answers, courtesy and abuse."

Should you think you know the Commercial Flags [at sight
Skip the following six verses, and you'll do right,—
When blues and reds, whites and yellows hold a levée,
You'll find with shapes and colors they're very heavy.

B is swallow-tailed, all red, 't is called the "Burgee;" **Code Flags.**
Next in order are Pennants four, C, D, F and G,
C has a red ball which from a white ground shows [clear,
D is of dark blue, with a white ball in its rear.

F shows a white ball in a field of bright red hue, **Code Flags.**
While G's in two parts, one yellow, the other blue;
Remember them well, for 't is an important part
They play in this very pretty Signalizing Art.

Each flag following now, perfectly square is its [shape :
H with one half red, the other white as snow-flake;
J in blue, white and blue, horizontally true ;
K in vertical halves of yellow and blue ;

L is quartered alternately yellow and blue;
M also blue, bears the white cross of St. Andrew;
Chequered blue and white, N shows as the wind [blows it;
P is the "Blue Peter," well each seaman knows it.

Q's the yellow flag that's hoisted in Quarantine;
On R's red ground St. George's yellow cross in seen;
S is a little blue square, with a big white border;
T the tricolor which keeps Frenchmen in order;

V is *all* white *except* a red cross: there's a bull
Quietly inserted to keep my line full;
W's a little red square bordered with white,
With a blue frame all round it to keep the parts tight.

But this Code has advantages left
Of which other Codes are quite bereft,
For by a glance at the hoist you guess
What a Signal intends to express.

C "Yes." Thus, if alone, Pennant C's flying,
Pleasant "Assent" 't is signifying;
D "No." But D's dark pennant singly waving,
Shows a stern "No" you now are braving.

Three kinds of hoists are of two flags made,
Each known by the upper Flag displayed,
Attention Signal. So when uppermost flies the "Burgee,"
An "Attention Signal" it will be.

Compass Signal. When a pennant is topmost bent,
A "Compass Bearing or Course." is meant,
Meteorological Forecast. Except when W is below
Tells how the wind's expected to blow.

Urgent Signal. But any square flag having the lead,
Shows danger, distress, or urgent need,
So quick with the book, and see what's there,
And bear a hand and relieve their care.

Now, of a very large class we'll treat :
Where *any* three flags the eye will meet,
"General Signals" they are really
For they treat of all things nearly.

General Signals.

Latitudes, longitudes, wants, wishes,
Everything's there, even to fishes ;
Thus you see if sought for with due care,
All things needful will be given there.

Four classes of four-flag hoists remain,
By their top flags distinguished again,
That where uppermost floats the Burgee
Names some port, place, river, land or sea.

Geographical Signal.

No Signal Book made can give all things—
The names of the Smiths, Browns and Tomkins,
So to spell at length with A, B, C,
Four flags having C atop 't will be.

Spelling Signal.

Where at the head C, D or F flies,
Each Nation its own meaning supplies ;
From English to English, then all's right,
But English to Dutch ! 't is nonsense quite.

National Vocabulary Signal.

Where above the whole, G floats wavy,
It names one of our brave old Navy,
Perhaps some big looming Iron-clad
That would send our foes "all to the bad."

Name of a Man of War.

Now for the last, but far from the least,
One Signal more before I have ceased :
Four flags, the square one being over,
Names a rich Merchant Ship or Rover.

Name of a Merchant Ship

Stop a moment, for it 's very needful
Of Distant Signals to be heedful ;
Colors now are of no importance,
But *shapes* rule letters in accordance.

Distant Signals.

Now, as in these signals, each letter
Is hoisted by itself, 't is better
Not to use this Code when you 're lazy,
But only just when things look hazy.

Preparatory Signals.

A single Ball at a vessel's peak
Implies "Prepare, I 'm going to speak;"
But after the hoists have upward run,
A single Ball tells "My Signal 's done."

Answering Signal.

Then, when his signal you comprehend,
A single Ball to your halliards bend;

Annul Signal

But if you see him two Balls flying,
To mend a mistake now he 's trying.

Now mind, to make these "Signals Distant,"
Two of each—Ball, Square Flag, Pennant,
Is all the bunting on deck required,
Now we want *shapes*, of colors we 're tired.

A Pennant and a Square Flag gives B, J or Q,
According to the way the Ball is seen by you;
Over the flags 'tis B, between them, it is J,
But Q is designated if it *under* lay.

A Square Flag and a Pennant 't is easy to show,
By Ball on the top, in the middle, or below,
Makes C, K or R; and so by the Balls places
Two Pennants in like fashion D, L or S is.

Again the Ball tells you which letter it will be
When two Square Flags signifies it's F. M or T:
One Pennant with *two* Balls will give G, N or V,
But with two Balls now a slight differencethere'll be.

The two Balls *on top* gives G, when *divided* it's N;
Both *below* 't is now V,—to this you must listen,
For then you 'll see how two Balls and a Flag will
[show
H, P or W, just according as these two Balls go.

Semaphore Signals.

Now that the Semaphores are fixed on land,
We 'll try their lingo to understand;
Quite easy of interpretation
You 'll find this kind of chatteration.

When from your sight the disc is hidden,
Some long-shore friend to gossip 's bidden;
But when the disc is to you abreast,
Your close attention is then in request.

It 's a Ball when the arm straight out lies,
But a Flag if upward it should rise;
A drooping Pennant will be expressed
When slanting downwards the arm's at rest.

Now, these moving arms translating,
Balls, Pennants, Flags, you now are making;
Read these hoists, as in the Distant Code,
And see, you 've conquered this other mode.

Now, having shorn these Flags of all their mysteries,
And given you fully their secret histories,
With an imaginative eye, pray see me now,
With the very utmost respect making my bow.

William C. Seaton.

MASTING AND RIGGING.

145. In the present day, when a vessel in port is either getting rigged for the first time, or is undergoing any extensive refit, the work is mostly carried on by a gang of riggers and consequently officers have but little opportunity of studying this branch of their profession. But independently of the great value a thorough knowledge of masting and rigging must have, in many situations in which an officer in charge may be placed, the Board of Examiners have made a familiarity with this subject, an essential part of their test of a man's fitness to hold a certificate of competency. In entering upon it here, it will be best, therefore, to begin at the beginning—let a vessel be supposed to be just off the stocks, and that she is lying at anchor in the stream, having her spars towing alongside all ready for getting aboard. In the situation in which the vessel is placed, it will be necessary to get up a pair of sheers with which to step the masts, consequently with this, work must commence.

THE SHEERS.

146. Selection of spars.—To get at the length of spar required, plumb the hold from the upper side of the mast hole to the keelson, and measuring from the heel, run this distance off upon the mainmast, now the length of the remaining part of the mast will give the hoist your sheers must have; to get this, you must choose a spar about a quarter longer than the required hoist, and see that it carries its size well up, and is free from spauls and flaws.

147. Taking in and Rigging.—Lay your spars alongside with their heels or butts forward, and if you are in a small vessel, you can sling skids over the side to keep the spars clear of the channels and then parbuckle them on board, letting their after ends rest upon a spar, placed athwart ship from rail to rail, and far enough forward to give the head of the sheers sufficient hoist for raising them. But if you are in a large ship, carrying topgallant bulwarks, the weight of the spars if parbuckled aboard, may possibly break them in, you had better therefore rig a couple of small derricks, in this way:—take a small spar, clove hitch the bight of a hawser round its smallest end to be used as guys and above this lash a good luff-tackle; now place the heel of the spar against the combings of the hatchway, close to a deck ringbolt, and catch a turn of a lashing through the ring, then take one part of the guy forward and the other aft. Hook the tackle to the side and raise the derrick, hauling the guys well taut, when it is high enough, unhook the tackle and overhaul it over the side; rig another derrick in precisely the same way.

When ready, lash a derrick tackle to each end of the sheer leg, and thus hoist these spars aboard, and launch them aft. Take your derricks aft., and lash the heads of them together so that they may form a small pair of sheers; when they are secured, with the derrick tackles hoist up the small ends of the masting sheers into the crutch of the derrick sheers and get their heels square. Lash the heads of the sheer legs together with a figure of eight lashing; having done this, open out the heels of the sheers and place each upon a good stout hardwood shoe. Secure your masting purchase over the lashing of the sheers, so, that one half the turns of the lashing will go over each horn of the sheers, and give it drift enough to let the block well clear. You can easily tell the upper from the lower block of this purchase, because the upper one should always be fitted with two long legs and a lashing eye, while the lower one has only an ordinary strop with a large eye at the lower part, through which to pass the lashing when securing it to the mast. Now having the upper block secured, get guys, by middling a couple of hawsers and making a clove hitch at the bight of each; place the hitch over the heels of the sheers and run them up rather over two-thirds of the distance from the heel to the lashing and there jamb them taut. Lash a good luff tackle to the foremost horn of the sheers, and call this the truss tackle; clap on a couple of tackles to each heel of the sheers, and let one of these lead forward and the other aft, these are called heel tackles.

148. Raising Sheers.— Rouse taut the after heel tackles; reeve the masting purchase (commencing with the middle sheave) and taking the lower block away forward, toggle it across the forehatch; now snatch the fall to a block toggled through the hawsepipe, take it to the windlass and heave away. As soon as the sheers are nearly erect, catch a slack turn with the after guys and fore heel tackles, also be prepared to steady taut the fore guys. Come up the purchase, and see if the block will plumb the masthole, if not, make it do so by slacking the necessary guys; after which, look round and see that your heel tackles and guys are hauled well taut and are properly secured.

149. Shifting sheers.—Although shifting or taking down sheers immediately after getting them up, does not fall into the natural order of events, yet it is taken here so that all work appertaining to the sheers may be kept together. Wet the deck on the fore side of the sheers so that the shoes may slip more easily. Ease away the after guys, until the head of the sheers is canted well forward; now haul away upon the fore heel tackles and when the sheers are nearly in the position required, take a turn with the after guys, and belay when the lower block plumbs the masthole.

150. Taking down sheers.—Get your sheers alongside the mast, and keep the topping tackle hooked on forward to prevent the heads of the sheers from falling aft.; send down the main purchase, lash each sheer leg to the mast head, cast off the head lashing and hoist each spar singly over the side.

TAKING IN A LOWER MAST.

151. In flush decked vessels, the mizenmast is the first spar taken in, because when all the masts are stepped, the sheers are then upon the fore side of the foremast and this latter spar can be used to support the head of the sheers, wh[illegible] they are canted over to take in the bowsprit. But in the case of vessels having a house abaft, so made, that there is not room enough for the sheers between it and the bulwarks, then the mainmast should be the first to be stepped, and by drooping the sheers aft, the mizenmast could be taken in, while the mainmast could then be used to take off the extra strain upon the sheers, which an operation of this nature would entail upon it; but in such a case, care must be taken to have the sheers of an extra length, for not only would the droop aft lessen their hoist, but they must be long enough to pass clear of the mainmast head, otherwise, you would have to take them down and re-rig them, to get them into position for taking in the foremast. Again, where a ship has a long topgallant forecastle, reaching well up to the foremast, then as this spar must necessarily be taken in on the fore side of the sheers, it must be taken in the first, so that there may be nothing in the way of transporting them aft. As in the following description of taking in masts, a particular case must be chosen, we will suppose that the vessel under our hands is flush decked.

152. Get the mizenmast alongside with its head aft and fore side up. Starting from the heel, measure off the depth of hold upon the mast, and lash the lower purchase block about two feet above this mark, using a narrow lashing with riding turns; make fast the truss tackle to the lower part of the cheeks; when ready, hoist on end, and as the mast-head appears above the rail, lash a couple of gantline blocks to the tenon. Continue heaving on end until the heel is very nearly over the rail, when a heel-tackle must be lashed on and taken away aft, upon the same side that the mast is coming in upon; steady it well taut, so that when the mast is free from the ship's side, it can be kept from swinging across the deck and perhaps knocking the sheer leg off its shoe. Having got the mast inboard, get it pointed to the partners, steadying well taut the truss tackle as it is being lowered away; when nearly upon the keelson, wipe the tenon dry and give it a coat of tar or white lead, after which the mast can be landed into its place. Shift the sheers forward (149) and take in the mainmast and then the foremast in the manner just described for the mizenmast.

TAKING IN A BOWSPRIT.

153. Having just taken in the foremast, the sheers are supposed to be upon the foreside of that mast. Dip over the truss tackle and take it forward, and it will now take the name of the topping tackle.

Take the masting purchase away aft and secure it in the fore hatchway, and by it ease away the heads of the sheers, at the same time rousing on the fore heel tackles, until, having got the sheers far enough forward to permit the head to plumb the fore part of the stem head, make fast the heels to the stanchions. Secure the fore guys aft, while the after ones should be taken to the foremast head and rove through two good top blocks (lashed one on each side of the mast), and then taken as far aft as the length of these guys will permit; after which, have the heel tackles, more especially the forward ones, steadied well taut. Get the bowsprit alongside with its head forward, and mark off upon it the length from its bed to the outside of the knightheads; sling or lash the lower purchase block about two or three feet outside this mark, according whether the stem projects much or little, that is to say, the lashing should come about a foot outside the stem head; make fast the topping tackle to the bees. Hoist away upon the spar, and when high enough, point it through the bowsprit port, top up upon the topping tackle and so launch it inboard, having a heel or bedding tackle, if necessary, to assist in rousing it aft. Should it happen that the vessel has a long forecastle deck, the head of the sheers may not be able to go far enough forward, to enable the bowsprit to be pointed into the port; in such a case, get a spar, having a tackle and guy upon its outer end, rigged out upon the side opposite to that upon which the bowsprit is being taken in; hook the inner block to the main purchase and heave it out until the bowsprit can be pointed. Again, where the head of the sheers cannot be thrown sufficiently forward, it may be impossible to heave the bowsprit up, it will then be best to rig a derrick upon the fore side of the sheers making the latter its principle support. Having the bowsprit bedded, unrig your sheers (150).

TAKING A MAST OUT.

154. The sheers for this purpose will have to be rigged similarly to that used for taking a mast in, but the spars will be sent up singly. Place the heel of one of the sheer legs opposite the mast to be taken out, and having set a hardwood shoe under it, secure it well, to prevent its slipping. Reeve a hawser through your top block, make it fast to the head of the sheer leg, and hoist away until you have get the spar against the mast, to which it will have to be temporarily secured; proceed in like manner with the other sheer leg and then lash the heads together with a figure of eight lashing, haul taut your fore and aft guys, rig the masting purchase and lash its lower block to the mast about a couple of feet above the deck. Now rig a belly gantline, thus: select two topblocks of sufficient swallow to take a small hawser and at about where the sheer guys are secured, lash one of these blocks to each of the sheer legs; reeve the end of the hawser through one of the topblocks, from forward aft, take it round the aft side of the mast and then through the block upon the opposite side, leading both parts well forward. The use of this latter gantline is, that it forms a parral for the mast to travel through, which prevents any injury being done to the deck or the mast combings, neither does it require the continual slacking of the truss tackle as the mast goes up on end. When the mast is clear for lifting, heave round upon the main purchase and when the heel of the mast is clear of the deck, lower away handsomely upon the truss tackle and belly gantline. It will be as well to leave the sheers standing until the new mast is taken in, when they can be sent down (150).

THE BOWSPRIT.

155. Gammoning.—In most vessels of the present day, the gammoning of a bowsprit consists merely of a band and screws, a fitting which presents no difficulty in its attachment. But if this is required to be rigged in the old style, take the gammoning chain and secure one end to the gammon port in the stem-head, then have it passed round the bowsprit, up to port and down to starboard, working outwards with the turns, and setting up each turn separately with a spanish windlass; when all the turns are passed frap them together. After this, set up the bobstays and bowsprit shrouds (167).

156. Cap.—To place the bowsprit cap, rig a triangle under the bows, by letting the inner ends of the spars rest upon the rail while the outer ends are slung to the bowsprit just in the wake of the cap tenon; now get a spar with a tackle attached to its head, secure its lower end to one of the spars forming the triangle, and pass a lashing where it comes up alongside the bees. Bring the cap in a boat under the bows, sling it, and hoisting it up, place it upon the tenon of the bowsprit. Should the cap be on deck, it can be eased out with a line.

FITTING RIGGING.

157. Cutting.—In the absence of any rigging plan, obtain the length of the starboard foremost shroud of each mast, thus: send a band aloft with a piece of houseline, let him take its end up through the top upon its starboard side and passing it round the fore part of the mast, place the end about the centre of the port side of the masthead; now take the other end of the line, and haul it taut down to the upper part of the lower deadeye, and this stretch of line will represent the length of the foremost swifter upon the starboard side. Lay off this length upon the rigging loft floor, or any other flat surface and drive in a spike at both of its extremities. Now give the shroud rope a good stretch and then flemish coil it round the spikes, after which cut the whole of the coil through at the point abreast of the inner end of the coil, and in this way will be got the length of each pair of shrouds for the mast whose measure has been taken; the inner fake being the starboard fore pair, the second inner one being the port pair, and so on in alternation until each pair of shrouds is named. If there should not be any place to coil the rope down in this manner, then taking the length of the starboard fore pair as a standard, the port fore pair will be longer than it by twice the diameter of the rope, the starboard second pair by four diameters, the port second pair by eight diameters, and so on doubling for every succeeding pair of shrouds.

158. Eyes.—The size of the eye of the starboard fore pair of shrouds, is one and a quarter times the size round of the masthead; and the eye upon each following pair of shrouds is two diameters of the rope, that is, two breadths of a seizing, greater than that upon the shroud preceding it.

159. Worming, parcelling and serving.—The shrouds being cut to their proper length, get them upon a slack stretch and proceed to worm them, this should be done with the lay of the rope. In parcelling, always commence with the part that will lie below and work upwards, thus: start upon the end part of the rope and finish at the crown, and following the same principle, in parcelling round the deadeye, commence at the centre and work outwards, towards the end on one side and the bight on the other Having completed the parcelling, get the rope well on the stretch and serve it against the lay of the rope.

160. Dead eyes.—Parcel round the score of the deadeye, then turn a kink with the sun if the rope is right handed, but against the sun if it should be left handed; now pass the throat seizing and afterwards the quarter and end seizings. Make a Matthew Walker knot at the end of the lanyard, and reeve it through the deadeye so that the knot shall come inside upon the hole in the upper deadeye nearest to the end of the shroud, this will be the fore hole upon the starboard side and the after hole upon the port side. But in reeving lanyards for new rigging, they should be rove full off the coil and cut when steadied taut by the single purchase, consequently they must then be rove back-handed, that is, starting from the after hole of the lower deadeye upon the starboard side, and the fore hole upon the port-side, the knot will be made when the line is passed through the last hole. This plan saves considerable waste of rope.

161. Marking shrouds.—When completed, shrouds are distinguished one from the other by their having a knotted tail put upon the centre of the eye; this tail has one knot upon the starboard fore pair of shrouds, two knots upon the port fore pair, three knots upon the starboard second pair, and so on, when it will be seen, that all the odd numbers of knots will be upon the starboard shrouds and the even numbers upon the port. The tails should be made of spunyarn for the fore and mizen rigging, but of houseline for the main.

162. Topmast rigging.—Measure from half way round the topmast head, at just above the hounds to the lower edge of the fid-hole and this will give half the length of the starboard foremast shrouds, increase this by two diameters of the rope and the length of the next pair will be arrived at, and by following the same rule of increase the length of each succeeding pair of shrouds will be found. The length of the starboard backstay will be from half way round the mast down to the lower dead eye, the port backstay will be twice the diameter of the rope longer. The size of the topmast rigging should be three-fifths that of the lower rigging, while the size of the backstays will be a quarter larger than the lower rigging.

163. Topgallant rigging.—No general rule can be given for the measurement of the topgallant rigging, so much depending upon the way it is set up. If upon the crosstree legs, then its length would be from the hounds to the heel of the topgallant mast; but if it sets up to a spider band round the topmast, then its length will be from half way round the topgallant masthead to a point lying one-third from the lower edge of the topmast crosstrees towards the upper edge of the lower cap.

SENDING UP THE TRESTLETREES.

164.—Having the fore ends of the masthead gantlines on deck, take out the after chock of the trestletrees and then stand them up deck on the fore side of the mast, with the fore part down and the under part leaning against the mast. Bend on the lines to the fore part, stopping them at intervals on their way up to the upper part of the trestletrees; now sway up and when the upper part of the trestletrees are above the cheeks, cut the upper stops and haul well taut, then the lower stops are to be cut and the trestletrees will launch gradually aft in their place; send up the after chock, let it into its place and bolt it.

GETTING TOPS OVER THE MASTHEAD.

165.—Taking the mizen top first, start by standing it upon the fore side of the mizenmast, with its fore rim on deck and the under part against the mast. Pass the fore ends of the masthead gantlines along the under side of the top, and make them fast, well apart, to the fore rim, stop them to each crosstree, closing them in as the upper part of the top is approached, so that when completed the lines will appear something like this **A**. Bend on tripping lines to the leg of each after crosstree and one also to the fore rim of the top, using in this latter case the after end of one of the gantlines from the mainmast; now sway up, and when the first stop is chock up to the block, cut it and steady taut all the tripping lines; in this way, cut each stop in succession until the lubbers hole is over the masthead, or if it only gets partially over it can be helped by keeping a good strain upon the after tripping lines and hauling in upon the fore ones. When the top is over the masthead, lower it into its place, after which send up and stop the bolsters; a coat of tar or white lead ought to be given the masthead in the wake of the top and bolsters. The main and fore tops are sent up in a similar manner, except that for the convenience of a masthead tripping line, it is customary to send them up upon the after side of their respective masts, when of course they will have to stand on deck upon their after edges, and the masthead tripping line must lead from aft and be bent on the after rim, while the other two lines are made fast to the fore ends of the crosstrees.

PLACING LOWER RIGGING.

166. Tar the masthead in the way of the rigging and cover the bolsters with well tarred canvass. On either side of the inner part of the middle crosstree, secure a single block with a good line rove through and bend it on to the starboard foremast shrouds, at about a third of the distance down from the eye; stop it also to the eye, well up. Sway up, and when the eye of the rigging is in hand, cut the stop, and haul again chock up, the men in the top at the same time guiding the eye of the shroud over the masthead and settling it well into its place. Each pair of shrouds is sent up in like manner. The shrouds being up, the stay is sent aloft, two gantlines being used, so that the legs of the stay may come up upon their respective sides of the masthead.

SETTING UP LOWER RIGGING.

167. Bobstays and Bowsprit-shrouds.—Having got some heavy weight slung to the end of the bowsprit, set these up with a luff upon luff. The double block of a luff-tackle is hooked to a strop upon the bobstay and the single block hooked to the lanyard; the fall is now led through a leading block on the bowsprit and coming in upon the forecastle, the other luff is put upon it. After the bobstay set up the bowsprit-shrouds.

168. Stay.—Get a slight pull on the rigging just sufficient to get it settled down upon the masthead. Proceed to set up the stay by getting a tackle on each side of the masthead, in a line with the stay; secure the lower blocks to the stay below the collar, heave well taut, and take in the slack of the collar by heaving in upon the turns of the eye lashing with a spanish windlass.

169. Shrouds.—Now having finished with the stay, get the lower rigging set up for a full due. It is customary to use a runner and tackle for this purpose, the tackle being attached to the masthead and the standing part of the runner to the rigging, while the single block of the runner is made fast to the lanyard, which latter should be well greased, so that it may slip easily through the holes of the deadeyes.

TOPMAST, LOWER CAP AND TOPMAST CROSSTREES.

170. Get the spar alongside with its head forward and the after part up. Lash a good topblock to the lower trestletrees, reeve the mast rope through it, from aft, forward, and then take it through the sheave of the topmast, carrying the end to the topmast head where it is secured with a clove hitch. The hauling part of the mast rope is racked to the standing part about one third down from the head, passing the two first turns round the mast to keep it from slipping; heave on end until the masthead is pointed through the trestletrees, when the clove hitch at the masthead is to be cast off and made fast to the lowermast head. Hoist the cap into the top and place it athwartships, so that its round hole is over the square hole of the trestletrees; the topmast is now hove up through the cap until the latter can be lashed to the topmast head; a spar with slue ropes is put into the fid-hole and then the topmast is swayed up until the under part of the cap is above the topmast head, when the topmast is slued round and lowered until the cap is fitted into its place. Now shift the block from the trestletrees to the lowermast head, cast off the racking and hoist on the topmast until three or four feet of it is above the lower cap. Lash a couple of gantlines on the topmast head, and making them fast to the fore part of the crosstrees, land the crosstrees upon the after part of the lower cap, with their after part down and the under side resting against the topmast, at the same time stopping the after horns loosely to the lower cap; have also a line from each of the after crosstrees to guide them in falling into their place. Now lower away the topmast and as it goes down the crosstrees will fall into place. Heave away upon the topmast until the crosstrees are clear of the lower cap, when the topmast is to be fitted with its rigging, by first placing the bolsters, then the rigging, starboard backstay, port backstay, topmast stays and lastly the jib stay and lift strops. Send the mast up into its place and fid it.

TOPGALLANT MAST.

171. Having sent the topgallant mast up, the general rule is to place the grommet on the masthead and then place, in the following order, the stay, rigging, backstays, lifts and jewel blocks; when this rule is deviated from, it is only when a fore and aft sail is set upon the stay, in which case the stay goes on last.

GETTING YARDS ALOFT.

172. Lower Yard.—Lay the lower yard alongside, with that yard-arm forward which will be of a different name to the side of the ship upon which it is taken in. Lash a good stout tackle to the topmast, just above the lower cap, overhaul it over the side and secure it to the lower block forward of the sling band, sway away and land it across the rail. Get a tackle from the lower stay and made it fast to the middle of the yard, hook on the lifts, and secure the yard-arms with a preventer brace (any line will do); now hoist away, keeping a good strain upon the stay tackle so that the arms of the truss may be kept clear of the mast; when high enough, secure the yard with the slings, truss it, peak it and hook on the brace pennants.

173. Topsail Yard.—This is sent aloft by a yard rope rove through the masthead sheave hole, which, after being made fast to the slings, is stopped to the quarter and yard arm. Heave it on end until the upper yard arm is above the cap, when the brace pennants and lifts are hooked on; cast off the yard-arm stop, the other yard-arm is then hoisted above the top and rigged, when the yard is lowered crossed and parralled. Should the topsail yard be a heavy one, a gun tackle purchase should be used for sending the yard aloft, securing the block to the slings of the yard, and when the yard is well above the cap, secure the lifts, then lower away and steady taut the braces.

174. Topgallant Yard.—Is sent aloft much in the same way as a light topsail yard, having also two stops, one on the upper quarter of the yard and the other on the yard-arm. When the yard-arm is hoisted above the crosstrees, cast off the yard arm stop and place the gear on in the following order; foot rope, brace, and then the lift, finally stopping the whole on the yard-arm.

175. In sending down topgallant yards, the main should be sent down on the starboard side, while the fore and mizen are sent down to port and so placed in the rigging.

STOWAGE.

176. Examination of hold.—Before going below, see that all the mast and pump coats are secure and in good condition. When in the hold, examine the limbers and see that there are neither dirt nor chips either there or in the well. Look to the iron fastenings in the wake of the channels; then under the deck and transom for leaks, also make sure that the ends of the chain are secured round the mast, close under the deck.

177. Dunnage.—Lay the dunnage athwartships. If the vessel is flat bottomed, she should carry about four inches more in the wings than on the floor; while if she is sharp bottomed, the greatest quantity of dunnage will be required amidships.

178. Arrangement of cargo.—In a general cargo place the heavy goods and those the least liable to injury at the bottom; the light goods should go in the upper tiers. Articles such as silks and perishable commodities of a like nature should be stowed away aft.

179. Bale goods.—Amidships stow them on their flats with their marks and numbers uppermost, but when in the wings let them be upon their edges, keeping them well off the side by dunnage.

180. Cotton.—For this cargo ballast will be necessary, the amount of course depending upon the build of the ship; but as sometimes as much as 20 tons per 100 tons register is requisite, care must be taken that a sufficient quantity be laid in. When the bales come on board, see that none are wet or even damp, for bales in such a condition get heated and would be liable to take fire during the voyage.

181. Iron, rails or bars.—Have the bottom well dunnaged, so that there may not be a risk of any claims for damage from sea water. With railway iron the first tiers are laid loosely fore and aft, until they rise an inch or so above the keelson, when having a good floor to work upon, lay the remaining rails diagonally and well apart, protecting the sides of the vessel by rails laid fore and aft, with their flanges against the skin. The last two tiers should be laid fore and aft, so that a platform may be made for shoreing it down, thus: get planks athwartships on the top of the iron, and place a sufficient number of shores between the planks and the deck beams, taking the precaution to cleat all the shores both to the planks and the beams.

182. Molasses.—Should the cargo consist wholly of molasses, it is advisable to commence the stowage amidships, alongside the pumpwell, working towards each end so as to have the breakage fore and aft. Do not take in over four heights; stow the casks bilge and contline, bung up and bilge free, with good beds well quoined off under the quarters. Have a vent hole at the side of the bung of each cask, otherwise the cask may burst from the fermentation during the voyage.

183. Petroleum. — In some ports it is customary to stow petroleum bilge and bilge, an exceedingly dangerous practice; and further, having as a consequence to carry a much larger proportion of dunnage, the ship cannot take any thing like the quantity of cargo she ought to.

184. Ore.—A vessel carrying this cargo, not only requires to have it stowed well up, but also that it should be kept at some considerable distance from her sides. The hold is prepared by building a good strong platform upon the keelson, bilge and sister keelson; a bulkhead is built upon both sides of this platform well secured with shores against the ship's side and the deck.

LLOYD'S RULES FOR THE STOWAGE OF MIXED CARGOES.

Prepared by HENRY C. CHAPMAN & Co., *Agent for Lloyds, Liverpool.*

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185. Owners, Commanders, and Mates of ships, are considered in law in the same situation as common carriers, it is therefore necessary that all due precautions be taken to receive and stow cargoes in good order, and deliver the same in like good order. The law holds the shipowner liable for the safe custody of the goods when properly and legally received on board in good order, and for the "delivery" to parties producing the bill of lading. The captain's blank bill of lading should be receipted by the warehouse keeper, or person authorised to receive the contents Goods are not unfrequently sent alongside in a damaged state, and letters of indemnity given to the captain by the shippers for signing in good order and condition; this is nothing more or less than conniving at fraud; fine goods are also often damaged in the ship's hold by lumpers, if permitted to use cotton hooks in handling bales. All goods must be received on board according to the custom of the port where the cargo is to be taken in; and the same custom will regulate the commencement of the responsibility of the master and owners.

186. Hemp, flax, wool, and cotton, should be dunnaged 9 inches on the floors, and the *upper part* of the bilge; the wing bales of the second tier kept 6 inches off the side at lower corner, and 2½ inches at the sides. Sand or damp gravel ballast to be covered with boards. Pumps to be frequently sounded and attended to. *Sharp bottomed ships one-third less dunnage in floor and bilges.* Avoid horn shavings as dunnage from Calcutta.

187. Oil, wines, beer, molasses, tar, &c., to be stowed bung up; to have good *cross beds* at the quarters (*and not to trust to hanging beds*); to be well chocked with wood, and allowed to stow 3 heights of pipes or butts, 4 heights of puncheons, and 6 heights of hogsheads or half-puncheons. All moist goods and liquids, such as salted hides, bales of bacon, butter, lard, grease, castor-oil, &c., should not be stowed too near "dry goods," whose nature is to absorb moisture. Shipowners have often to pay heavy damages for leakage in casks of molasses, arising from stowing too many heights without an intervening platform or 'twixt decks. From Bengal, goods also are frequently damaged by castor-oil.

188. Tea and flour, in barrels; flax, clover, and linseed, or rice, in tierces; coffee and cocoa, in bags; should always have 9 inches, at least, of good dunnage in the bottom, and 14 to the upper part of the bilges, with 2½ inches at the sides; allowed to stow 6 heights of tierces, and 8 heights of barrels. All ships above 600 tons should have 'twixt decks or platforms laid for these cargoes to ease the pressure—caulked 'twixt decks should have scuppers in the sides, and 2½ inches of dunnage laid athwartship, and not fore-and-aft ways, when in bags or sacks; and when in boxes or casks not less than 1 inch. Rice, from Calcutta, is not unfrequently damaged by indigo, for want of care in stowing.

189. Entire cargoes of sugar, saltpetre, and guano, in bags, must have the dunnage carefully attended to, as laid down for other goods. Timber ships are better without 'twixt decks if loading all timber or deals. Brown sugar to be kept separate from white sugar, and both kept from direct contact with saltpetre.

190. Pot and pearl-ashes, tobacco, bark, indigo, madders, gum, &c., whether in casks, cases, or bales, to be dunnaged in the bottom, and to the upper part of the bilges, at *least* 9 inches, and 2½ inches at the sides.

191. Miscellaneous goods, such as boxes of cheese, kegs and tubs of lard, or other small or slight-made packages, not intended for broken stowage, should be stowed by themselves, and dunnaged as other goods.

192. Barrels of provisions and tallow casks, allowed to stow 6 heights. All metals should be stowed under, and separated from, goods liable to be damaged by contact.

193. All manufactured goods, also dry hides, bales of silk, or other valuable articles, should have 2½ inches of dunnage against the side, to preserve a water-course. Bundles of sheet-iron, rods, pigs of copper or iron, or any rough hard substance, should not be allowed to come in contact with bales or bags, or any soft packages liable to be chafed. When mats can be procured, they should be used at the sides for silk, tea, &c.

194. Tar turpentine, rosin, &c., to have flat beds of wood under the quarters, of an inch thick, and allowed to stow 6 heights.

195. Very frequent and serious loss falls on Merchants on the upper part of cargoes, particularly in vessels that bring wheat, corn, tobacco, oil-cake, &c., arising from vapour damage imbibed by wheat, flour, or other goods, stowed in the same vessel with turpentine or other strongscented articles; the shippers are to blame for such negligence, for not making due inquiry before shipping.

196. Ships laden with full cargoes of coal, bound round Cape Horn or Cape of Good Hope, to be provided with approved ventilators, as a preventative against ignition.

NOTE.—Shippers abroad, when thep know that their cargoes will be stowed properly, will give a preference, and at higher rates, to such commanders of ships at will undertake to guarantee the dunnage. The American shipowners, in the stowage of mixed cargoes in large ships, have, from experience, discovered what "pressure" flour barrels, provision casks, &c., will bear, and so avoid reclamations for damage if otherwise properly stowed; hence, in large ships above 600 tons, with dimensions exceeding in length 4½ times the beam, and 21 feet depth of hold, orlop decks will come into general use, so as to relieve the pressure, by dividing a ship's hold like a warehouse, into stories. A large ship, called the ' Liverpool," which left New-York in December last, with an entire cargo of flour, has never since been heard of; it is supposed the lower tier of barrels gave way under the pressure, and the cargo having got loose, shifted in a gale of wind, and capsized the vessel. Ship's cargoes for Insurance, will also become a matter of special agreement between merchant and ship-owner, and merchant underwriters, and the premiums vary according to the dunnage agreement. The stowage and dunnage must stand A1, and is often of more importance than the class of the vessel, as experience has proved. When ships are chartered for a lump sum, the draught of water should be limited, as it not unfrequently happens that brokers insert a clause that coals are not to be considered as dead weight, in order to fill the ship up in a case of goods falling short, to make up the chartered freight. All packages, bales, and cases, not weighing more than 25 cwt. to the cubic ton measurement, are designated as light freight.—*Lloyd's May*, 1851.

MONTREAL, &c.,—STOWAGE OF GRAIN CARGOES

Lloyd's instructions to Masters and Mates.

197. No ship exceeding 400 tons register can be entirely loaded with grain in bulk; and all exceeding 400 tons register may take two thirds ot the cargo of grain in bulk, and one third in bags, or rolling freight instead thereof. In the latter case, the grain in bulk should be stowed 6 inches, but not more above the beams, to allow for settling.

198. When ships take wheat, corn, &c., in bulk, it must be stowed in sections or "bins" (not to contain more than 12,000 bushels each), to be lined with thoroughly seasoned boards, grain tight, not less than 10 inches from the flat of the floor, and from 14 to 16 inches in the bilges graduated to the sides, which must be clapboard lined to the deck. Care must be taken to preserve a water-course under the lining. Good shifting boards, secured to the stanchions, extending at least 6 feet downwards and fitted tight to the deck. The stanchions not to be removed, but firmly secured. No loose grain to be stowed in the extreme ends, and no admixture of other goods. Pumps and masts cased and covered with mats and canvas, made thoroughly grain tight, with sufficient space in the well to admit the passage of a man-hole from the deck, or by a clear passage from the 'tween decks aft. Mats to be used for covering knees, keelsons, and stanchions, if required, but not for lining or covering the sides.

199. Grain, when stowed in bags, must be dunnaged not less than 10 inches on the floor, 14 to 16 inches on the bilges, 3 inches on sides up to the deck; between decks the dunnage must be laid athwartships, at least 2 inches from the deck. Shifting plank extending at least 4 feet from deck beams downwards, secured to stanchions. The dunnage in the hold must be entirely covered with boards and sails, or masts, graintight.

200. All bulk or loose grain must be taken in bins prepared for that purpose.

201. For dunnaging, deals are preferable to anything else. They should be laid fore-and-aft, about 3 inches apart, the second tier over the spaces of the first tier, the third tier over the spaces of the second, and so on. Staves or other materials generally used for dunnage to be placed so as to give free course for the water to reach the pumps. The dunnage should be raised from 10 to 12 inches from the floor, and in the bilges from 14 to 16 inches, according to the build of the ship and the discretion of the Inspector. Flat-floored wall-sided ships should be fitted with bilge pumps.

202. The studs for the bulkheads should be made of three-inch deals, placed about 2 feet apart, and firmly secured at the top and bottom, and properly braced and cleeted on the lining and to the beams (or deck), to resist the pressure of the grain.

203. The studs for the bulkheads forwards, and after bulkheads for ships not exceeding 10 feet depth of hold, must be 4 by 6 inches in size, and of 1 entire piece; of a greater depth than 16 feet, they must be 4 by 8 inches. They must be set 20 inches apart from centre to centre, firmly secured at the top and bottom, and properly braced and cleeted on the ceiling and deck, to resist the pressure of the grain.

204. The sides above the turn of the bilge must be lined on one-inch battens after the manner of clapboarding.

205. Shifting planks 2 inches thick must extend to the deck on each side of the stanchions, fitted tight under and between the beams and carlins, and extending not less than 6 feet downwards; care must be taken that the stanchions are well secured on both ends. In no case can single boards be substituted for plank, and the shifting boards must be shored from sides, midway between the stanchions.

206. Materials for bins must be perfectly seasoned; unseasoned lumber must not be used where it will come in contact with the grain. Water-tanks, whether of wood or iron, must be cased with wood to prevent damage from sweat or leakage. And all ships with grain in bulk ought to have feeders and ventilators.

207. It must be seen that the grain is well trimmed up between the beams, and the space between the beams completely filled.

208. When ships are chartered, the draught of water should be limited, and provision made for loading under inspection.

209. The load draught must be regulated by the depth of the hold, allowing 3 inches to every foot depth of hold, measured from lowest line of sheer of deck amidships to the water, when upright. Ships having an additional deck put on after construction, the depth of hold to be measured from original deck.

210. Ships loading grain complying strictly with the above rules, lined and loaded under the supervision of the surveyor appointed by Lloyd's agent, will be entitled to a certificate to that effect.

211. Applications for supervision will have to be made in writing, and a fee of 10 dollars charged for such supervision and certificate.

212. To secure the yards for lifting heavy weights.—Brace the main yard forward so as to plumb the gangway, then peak and untruss it. Lower the yard about half way down and lash it to the mast, keeping the truss arms clear. Get a spar up and down on the after side of the yard, resting its heel on a good shoe just inside the waterways. Lash the purchase block upon the yard, outside the upright spar. If the weight to be taken in is so heavy that additional precautions may be considered advisable, have a spar, as a preventer from the lowermast head to the yard outside the upright spar. Sling skids up and down the side. Now rig the midship purchase; get a spar on the fore side of the main hatch, attach guys to it which leading to both mastheads pass through blocks on deck again; to the head of this spar secure the purchase intended to be used, together with a guy provided with a tackle, so that the head of the spar may be brought into any position desired.

BENDING SAILS.

213. Courses.—See that the head cringles are well parcelled, the buntline holes leathered, the midship stop in its place and the reeftackles in good order. This done, stretch the sail across the deck, with the clews aft and the buntline holes and leech line cringles forward; clinch the buntlines and leechlines to the sail; reeve or hook on clewgarnets, sheets and tacks; mouse all hooks. Stop the midship part of the headrope to the inner buntlines, and the outer headrope and earing to the leechline; sway up, made fast the midship stop, haul out the earings, bend the robands and furl the sail.

214. Topsail.—Get a sail rope from the masthead with which to send the sail aloft. Open out the sail and see everything is secure, chafes protected, reeftackle blocks, &c., all right. Bend the sail rope round the sail on one side of the midship stop; sway up to the yard and bend the midship stop, reeve the reeftackles and clewlines, shackle on the sheets and haul up on the buntlines; haul out the earings, keeping the head cringle well up on the yard; pass the robands, see that all the reef earings are in the sail and then furl it.

215. Topsail in bad weather.— Where the maintopsail has blown away and it is desirable to bend another, get the sail rope and weather reeftackle rove and overhauled down on deck. Make the sail up by the foot, leaving the buntline holes, reeftackle blocks and clew out clear. Tie the third reefpoints over the foot of the sail, after which tie up the second and then the first reefs, finally, stopping the head with rope yarns. Bend on the sail rope and reeftackle on one side of the midship stop; sway up to the yard and make fast the midship stop, reeve the reeftackles and clewlines, clench on the buntlines and shackle on the sheets. When the gear is bent, haul out on the reeftackles on both sides and bend the head of the sail; after which reeve the first reef-earings, haul out and cast off the first reefpoints and so follow on until all the reefs are taken in; then, if necessary the sail can be set.

216. Topgallant sail.—This is sent aloft in much the same way as a topsail.

217. Royals.—Are generally bent on deck before the yard is sent aloft.

218. Jib or Staysail.—Get the luff of the sail so made up that all the eyelet holes will be free for bending. Overhaul the halliards and downhaul, and bend them round the head of the sail about a foot inside the luff; bend a line to the clewcringle. Sway up on the halliards, haul out on the downhaul until the sail is boomended, then hook or lash the tack to the sail and bend the hanks. When bent, clinch the halliards to the sail, reeve the downhaul through a couple of the upper hanks and clinch it; now secure the pendants to the sail and furl it.

219. Spanker, Mizen or Trysail.—Stretch it out upon deck and make it up, leaving the head and luff eyelet holes out; if the sail has brails, seize them to the after leech of the sail. Get a line from the rim of the top, bend it on to the sail and sway it to the jaws of the gaff. Bend the head of the sail first to the hoop and then the jackstay. If the sail travels up and down the mast on hoops, it is better to lower the gaff and get it bent on deck.

MAKING SAIL.

220. To set a Course (Main).—Loose the sail, overhaul the gear, board the main tack; haul taut the weather lift and aft with the sheet; haul out the bowline.

221. To set a Topsail or other square sail.—Cast off the yard arm gaskets and then the bunt, let fall the sail, overhaul the buntlines, and haul home first the lee and then the weather sheet. Hoist away on the yard and trim by the braces.

222. Spanker or Mizen.—Loose the sail. Overhaul the lee topping lift, man the foot outhaul, let go the brails, ease away the tripping line and haul out. Let go the downhaul and throat brails and haul away upon the head outhaul. When set, trim the gaff by the vangs and the boom by the sheet; steady taut the boom guys.

223. To set a Jib or Staysail.—Loose the sail, haul aft the lee sheet, let go the downhaul and hoist away upon the halliards; when the weather leech of the sail is taut, belay and trim aft the sheet.

224. To set a lower (three-cornered) studdingsail.—The boom being rigged out and secured, bend on the inner halliards to the inner cringle and the outer halliards halfway out on the yard. See the tripping line is made fast to the outer yard-arm and that the end of the sheet is secure. Hoist on the inner halliards until the sail is halfway up, then clap on the outer halliards, boom end the sail, sway up taut the inner halliards, and trim down the sheet.

225. Topmast studdingsail.—Bend the halliards outside the middle of the yard, hitch the downhaul over the inner yard-arm, and see that its outer part is clear, bend on the tack, secure the ends of the downhaul and the sheet. Make up the downhaul with a slip bend and then hoist away; when about two-thirds up the leech of the topsail, break the hitch on the downhaul, haul out the tack and hoist up; trim down the sheet.

TRIMMING YARDS.

226. Closehauled.—The lower yards should be braced sharp up, and each weather yard arm kept abaft the one below it; that is, the lower yard being sharp up, the topsail weather yard arm should be kept in a quarter of a point abaft the lower yard arm, the topgallant weather yard arm a quarter of a point on the aft side of the topsail yard, and so on; but as in a sea way a vessel's yards require a little play, they should never in such a case be braced too sharply up.

227. Windabeam or quarterly.—The head yards should be braced a little more forward than the after yards.

228. Wind hauling.—Should the wind haul aft, the after yards should be trimmed first; but if the wind shifts forward, then trim the head yards first. The crossjack yard is always trimmed with the main.

TAKING IN SAIL.

229. To take in a Course.—Slack off a foot or so of the lee sheet and haul taut the lifts; man the weather gear, unreeve the bowline, ease away the tack and haul close up; now haul up the lee side and furl the sail.

230. Reefed foresail or mainsail.—Start the lee clew, now haul up the weather side and take in the lee side afterwards.

231. Closed reefed Topsail.—Round in on the weather braces to spill the sail and steady taut the lower lifts. Slack the lee sheet; man the weather gear, ease off the weather sheet and haul up the weather clewlines and buntlines; after which, haul up to leeward and furl the sail.

232. To take in a Topgallantsail.—Let go the lee brace, lower away on the halliards at the same time hauling down on the clewlines. When the yard is down on the lifts, steady taut the braces, start the lee sheet, and haul upon the lee clewline and buntline. When these are up, haul up on the weather clew and stow the sail. Supposing that in a squall, after having started the halliards, the yards will not come down, slack up the sheets and clap on the clewlines, this in all probability will relieve the parrel and allow the yard to come down.

233. To take in a Mizen or Spanker.—Supposing it to be fitted with a standing gaff; man the head downhaul and lee brails, let go the head outhaul; now haul down and brail in the head of the sail. This done, trip up the foot of the sail, brail it in and make fast.

234. To take in a Jib.—Let go the halliards and haul away upon the downhaul; when the sail is nearly down, let go the sheet and haul close down. Send hands out to furl, and as they gather in the canvass haul taut the weather sheet.

235. Studdingsails in a squall.—To save the booms, let go the topmast studdingsail tack and outer halliards; should the sails make too much noise, trip the inner halliards two blocks and haul taut the topmast studdingsail downhaul. If a topmast studdingsail tack should part and with the surge carry away the sheet, the best plan to get hold of the sail is to luff the ship to a little, and as she comes to the wind, let go the halliards, when the sail will naturally fall across the topmast stay. Send a hand aloft with a line to the topsail yard arm, let him make a bowline round the halliards and throw it down on deck afore all; when it is in hand, put the ship right before the wind, then hoist up on the halliards and haul down on the line. The sail being now handed, keep the ship to on her course again.

REEFS.

236. Taking a reef in the Topsails.—Round in on the weather brace and lower away on the halliards, some hands taking in the slack of the reeftackles as the yard comes down. When the yard is down on the lifts, steady the braces so as to keep the sail spilled; haul out the weather reeftackle first, and then the lee one; haul taut the buntlines. Send the hands aloft, the first man laying out to the weather earing, the second to the lee one. Haul out to windward first, keeping the dog's ear well upon the yard, after which, haul out to leeward; tie the points and lay off the yard, one man remaining in the top to overhaul the reeftackles, etc.

237. Topsail reef-earings and reef points.—In passing the reef earings, the first and second should be passed from forward over the top of the yard and down aft through the cringle; the third reef-earing is passed in the opposite direction, that is to say, up aft, over the yard and down forward through the cringle. In tying the points of the third reef, the band should be kept as nearly as possible to the centre of the under part of the yard. Reef points should be whipped and fitted to the sail according to the reef to which they severally belong; in this way, the third reef points have three whippings and are sewn into the sail with the shortest leg aft; the points for the second reef have two whippings and they are sewn in with the longest leg aft, while the first reef points have only one whipping and are sewn into the sail with equal legs.

238. To close reef the topsail.—Brace bye the yard to spill the sail, lower away the yard, haul out the reeftackles while slacking up the sheets; when the reeftackles are up, haul the buntlines well taut, steady the yard by the braces, lay aloft and take in the reef. When this is in, haul home the sheets, hoist on the halliards so that the strain may be taken off the lifts and then trim the yard.

239. To reef a course.—Start the lee sheet a little. Haul up the weather and then the lee side of the sail; haul out the reeftackles, taking the weather side first. Now lay aloft and take in the reef in a similar manner to that in which the last reef of a topsail is taken in. In some vessels there are not any reef points in the courses, in such cases, it is usual to lace the reef band to the yard with a marling hitch, having the hitch on the fore side; this plan has its advantages, but it takes a long time to get the sail reefed.

240. Shaking out reefs in a topsail.—Settle the halliards, haul out the reeftackles, haul taut the buntlines and steady the braces. Lay aloft and cast off the points, commencing amidships and working outwards to each yardarm, taking care to tie afresh the other reef, if any. When all the points are cast off, ease away both earings at the same time, otherwise, if one is eased off before the other there is a risk of splitting the sail. Make fast the reef-earing through the cringle of the sail above the reef and let out by a long bowline. Lay in off the yard, overhaul the reeftackles and buntlines, then hoist away upon the yard and trim by the braces.

241. To let out the reef in a course.—Slack up the sheet and tack, haul taut the clewgarnets and buntlines, haul out the reeftackles. Cast off the points, starting amidships and working outwards, after which, cast off the earing, overhaul the gear, board the tack, aft the sheet and haul out the bowline, etc.

HANDLING A SHIP.

242. To tack Ship.—Keep the vessel full for stays, and while she is gathering way, let go all gear such as clewgarnets, buntlines or leechlines; lay down the braces clear for running and get the tacks and sheets out of their beckets. All being ready, gradually ease down the helm, and give the word—HELM'S A'LEE—let go the head sheets and fore sheet, and as the sails lift—RAISE TACKS AND SHEETS—upon which the fore and main tack, together with the main sheet, are let go and overhauled. When the vessel has come up within a point of the wind—MAINSAIL HAUL—this directs the main and crossjack yards to be swung, down main tack and aft main sheet. Unless working short tacks, immediately the main tack is down, haul taut the weather main lift before the bowline is hauled out, and at a similar time do the same with the fore tack. Right the helm. As the main topsail begins to fill—FOREBOWLINE, LET GO AND HAUL—down fore tack, aft fore sheet and head sheets. In a strong breeze, care should be taken that the weather braces should be *eased* off when the head yards are swung, so that the yard may be prevented from swinging up and endangering the truss of the lower yard, or the parrel of the topsail yard. Should the vessel fall off very much in stays, 'vast bracing the fore yard and keep the head sheets flowing; and further, should the vessel carry her headway well round, it will be unnecessary to entirely reverse the helm when the head yards are being swung.

243. Tacking in a light wind or against a short chop of a sea.—Having put the helm a'lee, let the head sails run down; when the foretopsail lifts, check in the weather fore braces, and keep the fore tack and fore sheet aboard, so that all the sail forward may be pressing on the bow. When the wind is on the opposite bow, haul the main yard; after which, follow on the same as when tacking under ordinary circumstances.

244. Missing stays.—Supposing that the mainsail has been hauled and the helm reversed; then shift the helm back as before for sternboard and get the main yard swung round again. As she falls off once more, trim down the after canvass, and then when she has got weigh enough upon her, try her again. This is of course supposing that the vessel has plenty of room; where it is otherwise, and it is imperative to get upon the other tack without loss of time, then she must be brought round upon her heel by boxhauling her, as given in the following paragraph.

245. Boxhauling.—Suppose the vessel is lying head to wind, with the after yards swung and the helm reversed for sternway. Square the after yards, brail up the after canvass, haul the foreyard round abox and haul over the head sheets to windward. Tend the after braces as she falls off before the wind, so that the after canvass may be kept on the shake as long as possible. In this way, when she gets before the wind, the after yards will be braced sharp up on the other tack; now square the head yards and shift the helm when she gathers headway; while she is coming to, keep the foreyard shaking as much as possible. Set the head sails as she comes to the wind.

246. Wearing.—Brail up the spanker. Up helm, square in the after yards, and as she falls off before the wind proceed as directed in boxhauling (245). If it is desirable to wear her short round, luff her up a little to deaden her way, before running her off.

247. Wearing in heavy weather.—Suppose the canvass has been reduced to a close reefed maintopsail and fore topmast staysail. Put the helm up and square in the mainyard to shiver the topsail; if she refuses to pay off, loose the lee side of the foresail and haul aft the sheet. When before the wind, haul up the clew of the foresail, shift over the topmast staysail sheet and having the hands at the lee main braces, watch for a smooth sea to round her to, when this presents itself, brace up the main yard and down helm.

248. Wearing by a drag.—Get a hawser up and pass the end outside all, from the lee bow along the lee side, round the stern, and bring it in to windward on the weather quarter. Make the hawser fast to a spar large enough to float it and pay out from the weather quarter. When about forty fathoms are out, take a turn, and the vessel being now hung by the stern will necessarily pay off; as she gets before the wind, let slip the hawser from the weather quarter; as the lee side faces the wind, let slip the stop from the lee quarter, and as she is now held forward, the ship must round to, head to wind. This may be found useful where a vessel having lost her spars, lies in the trough of the sea.

249. Laying to. — Supposing that in wearing as given for heavy weather, it was intended to lay her to, then when before the wind and having the clew of the foresail hauled up, together with the topmast staysail sheet shifted over, man the lee main and maintopsail braces. As soon as a smooth presents itself, down with the helm, brace up the main yard, and swing the fore yard so that the wind will blow directly along the yard. Should it be blowing so hard that it is impossible to present any sail to it, spread some canvass in the mizen rigging, and should that prove useless, then it will be necessary to construct a drag.

250. Laying to with a drag.—Get a spar and bend a hawser round the middle, spiking the bend to the spar. So as to be enabled to recover the spar, before launching get a small line bent on to the end of it, bring the bight of the line to the bend of the hawser and stop it there with a split ropeyarn. Now launch the spar overboard, and as the hawser is paying out, take a few loose turns with the small line round the hawser, so that in hauling in the hawser, the spar is brought in end on by means of the small line. Pay out to about fifty fathoms and secure it abreast the fore channels, if the vessel now lays well, this will be all that will be necessary, but should she fall off and the reverse too much, it can be remedied by getting a couple of good stout bridles on the hawser, in this way—take a good line and bend it on the hawser outside of all, and get it led aft; now have another line made fast in the same way and take it forward. Pay out another fifteen or twenty fathoms of hawser and steady taut both lines; should she fall off she would immediately get hung by the head, and come to again; on the contrary, should she come to, the after line will keep her in check. So managed a vessel should lay well, but she may be expected to roll heavily.

251. Broached to.—If while running with the wind quarterly the vessel should broach to, trim the head yards forward and up with the helm, keeping the mainyard nearly square. It is not a bad plan when running with the wind quarterly, to have the head yards carried a little more forward than the after yards, but while this considerably lessons the risk of broaching to, yet, if the vessel steers badly, it has the disadvantage of causing her to swing off more. When scudding with a quarterly wind, the fore-topmast staysail should always be kept hoisted.

252. Caught aback.—If caught aback by a sudden shift of wind, put the helm up, flatten in the head sheets and brail in the after canvass. If she still refuses to pay off and is gathering sternway, reverse the helm, haul round the fore yard abox and the head sheets to windward. But if caught aback in a squall, let go the topsail halliards, for as the vessel is almost certain to get sternway, the canvass should be reduced as soon as possible. In shifting the helm for a sternboard *it should never be put hard over.*

253. Caught in a squall.—Should a vessel, by the wind and with all sail set, be caught in a squall at night and thrown upon her beam ends, her rudder may not act, and when the halliards are let go it is very probable that the yards will not come down. In such a case, let go the lee sheets, this will immediately ease the parrels of the yards and allow them to run down, thereby relieving the ship at once; of two evils choose the least, therefore it is better to risk losing your canvass than your masts, and indeed many a fine ship with her crew is lost, by endeavouring to clew up their sails, instead of spilling them and letting them come down at once. If caught in a squall with the wind quarterly and studdingsails set, trim the foreyard first, so that the studdingsails may be kept quiet.

ANCHORAGE.

GETTING UNDER WEIGH.

254. With plenty of room.—See that all the gear about the deck is secured, boats in, steering gear in good working order, compasses all right, anchor gear all ready for use, the hand lead convenient, and the side and masthead lights to hand. Suppose the vessel is laying with one anchor down and that it is desired to get under weigh upon the starboard tack; heave in short and as the shackles come in, examine them and see that the marks

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are not worn off. * Cast off the topsails, sheet home and masthead them, brace up the after yards with the port braces and the head yards with the starboard braces. Get the jib and staysail ready for hoisting, the after canvass set and the helm to port. Man the windlass and trip the anchor. Immediately the anchor is off the ground and the vessel begins to fall off to port, run the jib up, and if necessary stand by to fill the fore yard. Heave the anchor up, cat and fish it. Set the courses and the other requisite sails. If it is not necessary to have head reach on the vessel, it is as well to let the head yards remain until the anchor is catted and fished.

255. In a crowded harbor.—It would be as well to hang on to some friendly vessel until the anchor is catted; then when ready for making sail, slip or let go the hawser by which she is hanging on.

256. With a vessel or other obstruction in the way.—A square rigged vessel when getting under weigh will make a stern board first, therefore it is better to cast her towards anything laying in her way. Suppose, for instance, there is a vessel well down on either quarter, then cant towards her when getting away.

257. From a lee shore.—A vessel laying at single anchor in an open roadstead, with the wind blowing on to the shore, taking in cargo, always lays with buoys and slip ropes on her cable, and consequently has little difficulty in getting away at any moment. But suppose that your vessel has run in for shelter, and the wind hauling round, she is caught upon a lee shore; assume that she is laying to her anchor with a range of sixty fathoms. From the quarter, pass a hawser away forward, outside all, and make it fast to the chain. Now loose the topsails, courses, and fore and aft canvass; sheet home the topsails, and brace up the after yards for the tack upon which it is intended to get away, but the head-yards will have to be braced slightly abox. Set the after canvass and jibs. Ease away the chain until the maintopsail fills, then brace round the fore yard; when it fills, slip the chain and cut the hawser. It is advisable to buoy the end of the hawser as well as the chain, so that it may be picked up the more readily. Now suppose you have run in again to pick up your anchor. While approaching the roadstead, get a boat out and coil a hawser into her. Sail to windward of the

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* **Shackles.**—The way in which these are usually marked is to have a piece of spunyarn round the pin, putting one knot in it for fifteen fathoms, two knots at thirty fathoms, and so on, giving an extra knot for every additional fifteen fathoms. Instead of this, some have adopted white rings painted upon the bow of the shackle, but as these are very liable to get worn off, it can hardly be thought an improvement upon the other plan. The pins should never be of iron, which if rusted in become immovable, but they should be made of wood, leather or lead, so that they can be bored out if necessary.

buoy and when abreast of it, let slip the boat, which at once proceeds to the buoy and gets hold of the end of the hawser, to which the end of the one in the boat is bent on. The boat now returns to the ship, paying out her hawser as she goes; the ship in the mean time shortening sail and tacking to close in with the boat. When the boat is alongside, get the end of the hawser aboard and run it in until you are abreast of the buoy on the chain; pick it up and pass the end in through the hawsepipe, and heave it in: when the end of the chain is on board, shackle it on and heave up the anchor.

COMING TO AN ANCHOR.

258. Selecting a berth.—Care should be taken that in bringing up, you do not lie in the wake of another vessel; for should she drive down upon you, you have not only to stand to your own damages, but are responsible for any that may occur to her. Had you not come to in her wake, no such accident could have taken place.

259. Bringing up at single anchor.—Get the anchors off the rail, the working anchor a-cockbill and the shank painter and stopper of the second anchor ready to let go at a moment's notice; have the squares of the windlass down, norman riding chocks shipped, and the range overhauled on *both* sides; see that the halliards, braces and all running gear, are down ready for use Having a light breeze, reduce canvass by taking in royals and topgallant sails and haul up the courses. When close to your proposed anchorage lower away the foretopsail, haul down the jib and round her to. As the ship comes head to wind, let the fore and main yards run square, and as soon as the vessel gets sternway, let go the anchor. Pay out the chain, then clew up and furl all snug. Should the wind be at all fresh, it would be advisable to clew up the foretopsail instead of merely lowering it down.

260. Coming to in a tideway.—If the wind is blowing against the tide, reduce the canvass until the tide takes, but it is advisable to retain such canvass on the ship as will keep her under control should the anchor not take hold. If the wind is blowing with the tide, round her to, with nearly all the after available canvass set, say, the main and mizen topsails, spanker and after staysails. In this case, it is not necessary to wait until the vessel has lost the whole of her headway, because the tide will make the anchor take hold.

261. Coming to with both anchors.—Reduce the canvass to as little as possible, leaving her only enough to give her barely headway. Suppose it is intended to drop the starboard anchor first. Overhaul a range of forty-five fathoms of the starboard chain, while on the port there should be from fifteen to twenty fathoms, let these ranges be stoppered to ringbolts with spunyarn, or anything else which can be cut in a moment. Get the remainder of the cables ranged on deck and having selected the position of the anchorage, down helm and drop the starboard anchor; immediately this is upon the bottom, right the helm, so as to sheer the vessel away from her anchor, when the forty-five fathoms have run out, let go the other one and pay this out also to forty-five fathoms; now veer away upon both chains and when sufficient cable is out furl all sails.

RIDING OUT A GALE.

262. At single anchor with a long scope.—Both practice and theory have so completely demolished the old usage of riding with an open hawse, that it is hardly necessary to enter upon the subject here. It is apparent that when a ship is riding at anchor, that the more chain that is out, the more nearly the strain is brought upon the anchor in the line of its greatest resistance, that is, parallel with the bottom. Not only has it this advantage, but in a heavy gale, she would under these circumstances have a long range of chain clear of the bottom, this would act upon her as a spring and ease her from those heavy jerks which are so liable to capsize the windlass. A long scope, with the second anchor dropped about ten to fifteen fathoms ahead of the ship, will enable her to ride out a very heavy gale, for by dropping the second anchor just ahead, it prevents the vessel shearing about, which is a very common cause of anchors coming home. If there is plenty of sea room, the end of the second chain can be shackled on to the first, thereby giving the advantage of an additional scope. When riding out a gale, it is a very good plan to ease the windlass by having a spring bent on its fore side, and after passing over the top of it let the line be secured away aft, well parcelling the spring in the wake of the windlass. Now pay out just sufficient of the chain to allow the spring to take a little of the strain. In South Eastern African ports this is a necessity, and consequently all traders there are furnished with a coir hawser for the purpose.

263. Cutting away the masts.—Supposing the gale rises to such a height that it becomes necessary to cut away the masts to save the ship from driving on shore; then the foremast and bowsprit should be the first to go, for the after masts act much the same as the tail upon a wind-vane, and will keep the vessel head to wind. If it should be determined to spare the bowsprit, rig the jibboom close in, for situated as this spar is, the wind which strikes upon it, acts as a lever in shearing her about. Now having to cut the masts away, suppose that it is desirable to throw the masts over on the port side. Commence upon the port side of the foremast and cut about two-thirds of the way through; after which, cut away all the rigging on the starboard side except the foremast swifter; station hands ready to cut away the head stays and foremast shroud at the moment required. Now deepen the cut in the mast until the remaining part of the latter has been sufficiently weakened, then as the ship rolls to port, cut away the stays and swifter and the mast is immediately over the side; cut away the port rigging and let the wreck go clear of the ship. The mainmast should be the next to go, and will be cut away in a similar manner; the mizen mast should be left to the very last extremity, as it assists materially in keeping the vessel steady.

TENDING A SHIP AT SINGLE ANCHOR.

264. Wind quarterly.—The vessel should be steered to windward of her anchor and the yards pointed to the wind. Laying in this way will make the wind, helm and tide, all act against the chain and thus keep the vessel steady at her anchor. It is generally understood, that the helm affects the course of a ship by making her head move to the same side as the blade of the rudder is turned; but although the vessel's course is certainly altered in the direction specified, yet the above generally received idea as to how it is done, is an erroneous one, although to the eye following the apparent motion of the ship, it has all the authority of a self-evident truth. Now in the above position of a vessel at anchor, the helm is put down, consequently the blade of the rudder coming upon the weather side, the tide runs against it and pushes the stern away to leeward, and will continue to do so until the fore part of the ship breaks the effect of the current upon the rudder, when everything else being equal, the vessel remains in that position. Now having shewn how the rudder acts, it will be seen, that as the stern goes over to leeward, her lee bow presents itself to the tide and consequently the ship turns herself as upon a pivot, the wind and helm acting upon the weather quarter and the tide upon the lee bow, all therefore acting so that the chain may be kept taut.

265. Wind abeam.—The shear should be to leeward, head yards pointed to the wind and after yards laid aback; this will tail her free from her anchor at slack water.

266. Wind on the bow.—The whole of the yards should be pointed to the wind, and a shear given to windward to ease the chain.

267. Riding windrode.—This is when the wind is stronger than the tide and is very a ticklish position. First see upon which side the chain grows; say for instance that the chain grows away down upon the port quarter, then the after yards should be braced up by the port braces, head yards square, and, if possible, set the spanker, so that by pressing her quarter to leeward the tide may strike on the port bow. If when the yards are braced in this manner, the vessel should slew broadside on, there will be no danger of her fouling her anchor; should she slew with her head to port, the head yards can be braced aback, and if with her head to starboard, the foreyard can be filled and a staysail run up if necessary, so that she may be kept clear from her anchor.

ACCIDENTS.

268. Weather brace and parrel of maintopgallant yard carried away.—While a vessel is by the wind, the parrel of the maintopgallant yard is carried away, and with the surge forward, it snaps the weather brace. Now it must be borne in mind, that the weather brace and the lee sheet command a square sail, and so having lost one of these, we must turn our attention to the other. Let go the lee brace and start the lee sheet, which will cause the weather yard arm to fly in aft. Stand by to lower the yard as the sail comes aback, hauling in the weather clewline as the yard comes down. When the yard is down on the lift, have a hand aloft to pass a small lashing round the tye and the mast, so that the yard may be secured to the latter. Now get a preventer brace on the weather yard arm, by making a bowline knot round the weather topgallant lift at the masthead and letting it slip down to the yard arm, throw the other end on deck, outside all, and leading it aft, steady taut.

269. Parrel carried away while running.—Brace the yard bye and lower it, keeping the ship with the wind on the quarter, so as to shiver the sail and bring the yard to the mast. Hands must now be sent aloft to secure the yard to the mast while the sail is shivering.

270. Parrel of the maintopsail yard carried away.—Suppose it an old fashioned topsail, and to be double reefed, for it is more likely to be carried away so than when mastheaded, the parrel being then to a great extent relieved by the tye. First haul up the clews of the mainsail; round in on the weather main brace and thereby throw the sail to the mast. Get the mast in the rolling chocks of the yard, steady taut the weather maintopsail brace and fit a temporary parrel.

271. Truss of the lower yard carried away.—Get a couple of good sized top blocks, whose swallow is sufficiently large to take a small hawser; lash them to the lowermast just above the truss band. Reeve the ends of the hawser through them, take the port end over to the starboard side and make it fast to the yard outside the truss band; in a similar way, take the starboard end over and secure it to the port side of the yard; the bight of the hawser leads down on deck abaft the mast. Now to each of its parts clap on a good luff tackle and haul taut. In bracing up the yard it will be necessary to slack the lee tackle, so that the weather quarter of the yard may be allowed to go forward.

272. Lanyards of rigging carried away.—These will of course be on the weather side, therefore, down with the helm and bring the vessel upon the other tack. If circumstances will not allow this, or if sailing with the wind large, up helm and thus bring the wind upon the opposite side; now reeve new lanyards and set up afresh.

273. Bobstays carried away.—This usually occurs when the vessel is being driven against a head sea. Upon the supposition that there is plenty of sea room, together with favorable weather, take in the after fore and aft canvass, up helm, and run the vessel before the wind, after which the bowsprit may be secured by one of the following methods.

(**a**). If there is plenty of steeve in the spar and the hawsepipes are well down, get the end of a stream chain out through the hawsepipe and make it fast round the bowsprit end; take the other end of the chain out through the hawsepipe and secure it also to the bowsprit; now take the inboard parts of the chain to the windlass, first settling in the slack of each separately so that they shall bear an equal strain, heave round and set them both up taut.

(**b**). If the bowsprit has but little steeve and the hawsepipes are well up, get the ends of the chain out through the hawsepipes and secured to the bowsprit as described in (*a*), now have a martingale rigged under the bowsprit, clove hitch the chain round its lower end and heave taut.

(**c**). Get a good strong tackle and lash its fall part under the outer end of the bowsprit. Pass out the end of a stream chain through the bow pipe, take it round the bows outside all and pass it inboard again through the opposite pipe; this chain will be used as bridle. Take another piece of chain which is just about long enough to reach from the head rail to the fore foot, and to one of its ends hook on the lower block of the tackle which is secured to the bowsprit, then shackle the other end on to the chain bridle where it crosses the middle of the cutwater. Now let the bridle slip, and when it falls under the fore foot, haul it taut and well secure it, then clap on to the tackle and set up the new bobstay. In this manner a long stay will be obtained, which, reaching from the bowsprit end to the fore foot, will prove a sufficient support for any spar. Should the bobstays carry away while beating out of harbor, it would be advisable to run back again and repair damages.

274. Bowsprit sprung.—Fish it with small spars and chain lashings, wedging off the lashing after it has been hove in well taut.

275. Bowsprit carried away.—The first immediate necessity is to secure the foremast. Take in the after fore and aft canvass, check the lee fore braces, square the mainyard and get the vessel before the wind. Get tackles from the foremast head and hook them to strops toggled through the hawsepipes, or should they be plugged, get a large strop round the fore part of the cutwater and bring the other part up between the knightheads; having the tackles hooked, set them well taut. The bowsprit being of course alongside, get hold of the topmast stays and unreeve them from the bees; get tackles on them and hook the tackles to the strop which is made fast round the cutwater, and having set them up, the topmast will be secured. The next thing to be done is to get the wreck hung up alongside. First get hold of both parts of the jib stay, lash them together, and with the strop so formed and a tackle from the masthead, hoist up the jibboom. This being secured, try to get the bight of a hawser round the bowsprit end, form a bowline knot in it, and let it run down and jam on the bowsprit; take the hawser away forward, place it in the warping chock and from thence to the windlass; now heave away until the spar is lifted out of the water, when the bobstays, bowsprit shrouds, etc., can be cast off. All the gear being detached, try to drive off the lower cap and save the jibboom, so that it may be used for a jury bowsprit. When this is done, reeve the jibboom in the vacant place, securing the heel in the bowsprit bed, and fit with a gammoning, bobstay and bowsprit shrouds. The fore and foretopmast stays will have to be set up to a strop fitted round the cutwater and in between the knightheads. If additional strength is required to the temporary bowsprit, another spar can be lashed to it with chains.

276. Lower trestletrees sprung.—Secure the heel of the topmast by passing turns of chain through the sheave hole in the topmast heel and up over the cap. When sufficient turns have been taken, frap all together.

277. Cap or Mast-tenon decayed.—When from any cause the cap becomes insecure, a spanish cap should be made. This consists of a number of turns of chain passed round both masts, just under the cap; frap them together between the doublings of the mast and wedge them off if necessary. This is also applicable to a bowsprit cap.

278. Lower masthead sprung.—A large spar should be lashed up and down on the aft side of the mast, well securing it with chain lashings and wedges.

279. Lower yard sprung.—Fish it by lashing small spars with chain to the yard, wedging the lashing off well. If the defect is at the yardarm, a preventer lift should be fitted to the yard.

280. Topmast carried away.—Say it is a foretopmast and the vessel is by the wind. Up with the helm and square the mainyard, so that the wreck may be brought to the weather side. As the wind comes on the opposite side brace up the mainyard, and so let the vessel lay abox, the fore yard not being in a position to be swung, in consequence of the wreck which is hanging on to the fore side of it. Send a large topblock and a small hawser in the top; lash the block to the lowermast head, and when rove, overhaul the hawser down on the fore side of the fore sail and bend it on to the middle of the topsail yard; unparrel the yard and send it down across the forecastle. Now bend on the hawser to the upper part of the topmast and raise it enough to slacken the topmast rigging; send a second line down on the fore side of the sail, reeve it in the sheave hole in the heel of the topgallant mast, steady it taut, come up the topgallant rigging, free the topgallant mast of the topmast crosstrees and lower them on deck. Raise the wrecked topmast high enough to permit the crosstrees, rigging, backstays, etc., to be taken off the masthead, and they had better be hoisted into the top and placed over the cap, really for going on end again. Now if no spare topmast is to hand, cut a fid hole in the upper half (masthead half) of the broken spar, send it on end and rig it. Take kinks in the rigging and backstays, securing each kink with two lashings. Set up the gear, send the topsail yard aloft with the sail bent on, take two reefs in the latter and set it, for half a loaf is better than no bread. The topgallant mast may be sent on end and the topgallant sail set. If the jib is found to be too long in the leech, use a long tack lashing, which will remedy as much of the defect as is possible.

RUDDER DAMAGED OR LOST.

281. Steering by sails.—If it should be desirable to steer a vessel on a wind by her sails, brace the fore yard sharp up and let the after yards be checked in about a point and a half. It will then be seen that as the vessel comes up to the wind, the after canvass will be on the shake, and the ship having nothing but her head sail upon her, will naturally fall off until she is met by the after canvass, which will check and bring her to the wind.

282. Rudder stock carried away.—If this is carried away above the woodlock so that the lower part of the rudder is left in place, get a lanyard rope middled and clovehitched to the crown of a kedge, whose stock must be unshipped. Bend a hawser to the ring of the kedge and another to its fluke, and lead the hawsers away forward one on each side of the ship. By the rope at its crown, lower the kedge over the stern until it is halfway down the remaining portion of the rudder, then haul forward on the fore guys or hawsers, until the after end of the rudder is hooked fast by the fluke of the anchor. Upon each side of the vessel forward, rig out a spar, having the block of a tackle lashed on

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to it, the other block of each tackle is then made fast to the fore end of the guy which is upon its own side of the ship, and by getting leading blocks, the falls of the tackles may be brought to the barrel of the wheel, and the vessel steered by their means with very little trouble.

283. Temporary steering apparatus.—With the rudder gone, no matter how it occurs, some plan must be adopted whereby the vessel can be steered. Collect the following articles :—an empty water cask, a pair of chain water cask slings, a spar of sufficient length that when laid from rail to rail it will project well over on both sides, and a couple of topblocks. Lash one of the topblocks to each end of the spar and place it across the rail, a little on the fore side of the wheel, securing it there, and having guys leading forward from its ends, of necessary. Sling the water cask with the chain slings, placing them over each end and racking the rings to the standing part, now frap or snake them together. Bend on the hawser to the ring of the water cask slings, get the cask over the stern, ond pay out about twenty fathoms on the hawser. Get about sixty fathoms of lanyard rope, pass turns of it round the barrel of the wheel taking care to leave equal ends, each of which is then rove through one of the blocks at the end of the spar. Make both ends fast to the hawser, which latter is then paid out until both parts of the lanyard rope are nearly taut. Make the hawser fast amidships, and this apparatus, which can be rigged in an hour is ready for service.

284. Making a Jury Rudder.—Look up the following materials :— a spare topmast, a quantity of small chain, some stuff for bolting, and several short lengths of a stout spar with which to form the body of the rudder. Ascertain the length of the rudder stock by running a small spar down the rudder trunk until it comes upon one of the draft figures upon the sternpost; mark the spar where it comes level with the rail and add this length to the draft of water measured from, and this will give the length of stock required. Cut two holes in the rudder stock, one about three feet from the heel and the other at what will be about five feet down from the lower edge of the rudder trunk. Now, make and bolt the frame together, plank up the sides, leaving space at the heel in which to place the ballast. Reeve the chains through the two mortice holes in the rudder stock, and take the heel chains forward, outside of all, to the fore side of the main channels, and those at the upper part of the stock in through the mizen chains, in both cases bringing the port chain to the starboard side of the vessel and *vice versa.* Get a rope down through the rudder trunk, and after bringing it aboard again over the stern, make it fast to the rudder head. If it should be a matter of doubt, whether the ballast will be sufficient to sink the rudder when thrown overboard, drive a staple or a timber dog into each side of the heel of the rudder, reeve the end of a lanyard rope through each, and afterwards make the ends fast to the rudder head; to the bight of this rope sling a kedge, crown up, and have a good rope bent on to its ring which (leaving a good slack) is to be taken forward. Launch the rudder over to windward and haul in on the head rope and lee heel chain, until the head of the rudder is got into the rudder trunk; directly it is entered, clap on to all the chains and get the rudder up and down. When this has been got into its place, cast off one of the ends of the lanyard holding the kedge, which immediately frees itself and swings away forward and is taken aboard; unreeve the lanyard rope. Although the rudder is now in its place, it will be necessary to rig a purchase to prevent it from jumping up; this can be done by placing a plank or spar right over the rudder head, securing it to the rail at both sides. Ship a tiller in the fid hole, reeve the wheel ropes and take them to the barrel of the wheel.

VESSEL ASHORE—CARRYING OUT AN ANCHOR.

285. Vessel broadside on.—Suppose a vessel in stays has touched upon a sandbank and is now broadside on, it thus becomes necessary to get an anchor out by which to warp her off. First thing, get all the yards pointed to the wind, haul up the courses, let go the topgallant halliards and run down the jibs. Have the largest boat taken to the lee side of the ship, and lower into her the stream anchor and hawser, together with a buoyrope and buoy for the anchor. Run away with the boat right to windward, drop the anchor and bring the hawser back to the vessel's lee bow, pass the end aboard and commence to heave the ship off. When her head begins to cant towards the anchor, assist her if possible with the foretopsail. Having hove the vessel off to her anchor, drop the bower and heave up the stream anchor. Doubtless it will be necessary to have another fleet of hawser, before the vessel is in a safe position.

286. Vessel stem on.—It now becomes necessary to carry out the bower anchor and say ninety fathoms of chain; now, first, let it be supposed there is no boat aboard large enough for the work. Run away the kedge with a guesswarp. Hang the anchor to the cathead, crown up. Get two boats alongside, and lay a couple of good stout spars right across the gunwales of the two boats, one forward and the other aft; now, leaving a good space between the two boats, lash the spars to the thwarts. Get the boats under the cathead, lower the anchor down so that the stock comes between the boats, and secure the ring to the after spar; now lower away until the crown of the anchor is to hand, when it is to be lashed to the foremast spar. Take in as much chain as the boats will carry, then unshackle, haul out by the guesswarp and drop the anchor. As the boats are being brought back to the ship, pay out the chain as far as it will go, buoying the end to the smaller of the two boats; now cast off the spars connecting the boats, and send the larger one back for the remainder of the chain, or as much as she can carry. Proceed in this manner until the whole of the chain required is paid out. But if there is a boat large enough to carry the anchor out by herself, then sling it to the boat's stern, crown up; pass the chain away forward under the boat's bottom and secure the bight. Now stow as much chain in her bows as the boat will carry, haul her out by the guesswarp until in the position selected for dropping the anchor, when the boat is to be slewed round, stern on, and the anchor dropped. The chain in the boat is to be paid out and the end buoyed by a small boat, while the large boat returns for more chain, as before described. When enough chain has been paid out, take the end in through the stern pipes, clap strong purchases upon it and heave away. When the vessel is hove off to her anchor, let her swing round to the kedge and fleet the chain cable forward to the hawsepipe; the anchor can then be hove up if necessary.

MAKING A RAFT.

287. If it becomes necessary to desert a vessel after having lost all the boats, a raft may be rigged, which if securely lashed together, would allow a crew to spend time enough upon it to enable them to make some considerable distance. Get three topmast studdingsail booms, or any other such spars, square their heels and lash their other ends rather loosely together, nailing or spiking the turns when passed, so that they cannot possibly come adrift. Now stand the spars upon their heels and open them out as far as the head lashing will allow, so as to make a tripod or three legged stand. Lash a spar, low down, from leg to leg on each side. Now starting parallel with any one of these spars, lash some others to the remaining two; they must be placed wide enough apart to allow about one-third of the bilge of a puncheon to lay between them; there ought to be room enough in the longest space to admit three puncheons end on to one another, there would then be place in the middle compartment for two puncheons and one in the next. Having placed the puncheons in their places, bung up, lash short spars over them to prevent their being washed out, and if planking is at hand a temporary deck may be laid over this; a few lines passed round above this for bulworks, would make things safer. The centre puncheon of the three in the first tier may be filled with fresh water, so that the misery of thirst may be provided against for some time. A sail can easily be rigged, and by having a rowlock over the three cask tier, in the after part of the raft, it can be steered very readily by an oar.

RULE OF THE ROAD.

VESSEL'S LIGHTS.

288. Sailing Vessels carry a RED light upon the *port* side, and a GREEN light upon the *starboard* side; each light is visible ten points round the horizon, that is, from right ahead to two points abaft the beam, and in clear weather should be seen when about two miles off. As small vessels in bad weather cannot always carry these lights in their proper places, they are allowed to keep them on deck, on their respective sides, ready for instant use.

289 Steam Vessels have in addition to the above lights, a BRIGHT mast-head light, visible twenty points round the horizon, that is, through the whole range of the side lights, and if clear, it should be seen about five miles distant.

290. Steam Vessels when towing other ships have TWO BRIGHT mast-head lights, instead of one; they are carried vertically.

291. Steam Vessels under sail only are to be considered as sailing vessels.

292. Steam Vessels laying Telegraphic cables carry TWO RED lights, not less than three feet apart, upon their foremast head while by day they shew two black balls similarly placed.

293. Fishing Vessels and open boats if they do not carry the ordinary lights of a sailing vessel, must have a lantern with a green slide on the one side and a red one upon the other, so that upon the approach of other vessels, they may be enabled to shew the light proper to the side upon which the vessel is approaching. Fishing Vessels laying to their nets must exhibit a BRIGHT mast-head light, and if they consider it advisable, they may also use a Flare-up in addition. On the French coast, Fishing Vessels laying to their nets must use TWO BRIGHT mast-head lights, not less than three feet apart.

294. Pilot Vessels will only carry a BRIGHT light at the mast-head, visible all round the horizon; but they will also be required to exhibit a flare-up light every fifteen minutes.

295. Vessels at anchor shall exhibit where best seen, but not exceeding twenty feet from the deck, a BRIGHT light visible all round the horizon.

296. A Vessel's movements as shewn by her lights.—(a) If the two lights of a sailing vessel, or the three lights of a steam vessel, are visible, such vessel is bearing down upon you end on.

(b) If the *Red* light of a vessel is seen upon the Port bow, she is *passing* you to port; but if it is seen upon the Starboard bow, she is *crossing* you to port.

(c) If the *Green* light of a vessel is seen upon the Starboard bow, she is *passing* you to starboard; but if it is seen upon your Port bow, she is crossing you to starboard.

FOG SIGNALS.

Sailing vessels shall use a fog-horn when under weigh, otherwise, a bell.

Steam vessels shall use a steam whistle when under steam. The whistle must be placed before the funnel, not less than eight feet from the deck. If she is under sail only, the same rule applies as if she were a sailing vessel. These signals must be made not less than every five minutes.

PILOTAGE SIGNALS.

299. Vessels requiring a Pilot will in the day-time hoist at the fore, the Jack or other *National Color* usually worn by Merchant Ships, having round it a white border one fifth of the breadth of the flag, or they will hoist the Commercial Code Signal P T. At night a blue light every fifteen minutes, or a bright white light flashed or shewn at short or frequent intervals, just above the bulwarks for about a minute at a time.

DISTRESS SIGNALS.

300. In the Day-time the following signals numbered 1, 2 and 3, when used or displayed together or separately shall be deemed to be signals of distress in the day-time :

1. A Gun fired at intervals of about a minute.
2. The Commercial Code Signal of distress indicated by N C.
3. The Distant Signal, consisting of a square flag, having either above or below it, a ball or anything resembling a ball. (The Ensign, Union down, has been advisedly omitted, because many foreign flags are the same whether right side or wrong side up; and because it is hoped that all these proposed signals may become international.)

301. At Night the following signals, numbered 1, 2, 3 and 4, when used or displayed together, or separately, shall be deemed to be signals of distress at night :—

1. A Gun fired at intervals of about a minute.
2. Flames on the ship (as from a burning tar barrel, oil barrel, &c.)
3. Rockets of any color or description, fired *one at a time*, at intervals of about *five* minutes

4. Blue lights burned one at a time, at intervals of about *five* minutes.

302. THE ARTICLES OF THE MERCHANT SHIPPING ACT, GIVING THE STEERING AND SAILING RULES.

Two Sailing Ships meeting.

Art. 11. If two Sailing Ships are meeting End on or nearly End * on so as to involve Risk of Collision, the Helms of both shall be put to Port, so that each may pass on the Port Side of the other.

Two Sailing Ships crossing.

Art. 12. When two Sailing Ships are crossing so as to involve Risk of Collision, then, if they have the Wind on different Sides, the Ship with the Wind on the Port Side shall keep out of the Way of the Ship with the Wind on the Starboard Side; except in the Case in which the Ship with the Wind on the Port Side is close hauled and the other Ship free, in which Case the latter Ship shall keep out of the Way; but if they have the Wind on the same Side, or if One of them has the Wind aft, the Ship which is to windward shall keep out of the Way of the Ship which is to leeward.

Two Ships under Steam meeting.

Art. 13. If Two Ships under Steam are meeting End on or nearly End on * so as to involve Risk of Collision, the Helms of both shall be put to Port, so that each may pass on the Port Side of the other.

Two Ships under Steam crossing.

Art. 14. If Two Ships under Steam are crossing so as to involve Risk of Collision, the Ship which has the other on her own Starboard Side shall keep out of the Way of the other.

Sailing Ship and Ship under Steam

Art. 15. If Two Ships, one of which is a Sailing Ship, and the other a Steam Ship, are proceeding in such Directions as to involve Risk of Collision, the Steam Ship shall keep out of the Way of the Sailing Ship.

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* The only Cases in which Articles 11 and 13 apply, are when ships are meeting End on, or nearly End on, *in such a manner as to involve risk of collision*; in other words, in cases in which *by day* each ship sees the masts of the other in a line or nearly in a line with her own; and *by night* to cases in which each ship is in such a position as to see both the side lights of the other.

Ships under Steam to slacken Speed. Art. 16. Every Steam Ship, when approaching another Ship so as to involve Risk of Collision, shall slacken her Speed, or, if necessary, stop and reverse; and every Steam Ship shall, when in a Fog, go at a moderate speed.

Vessels overtaking other Vessels. Art. 17. Every Vessel overtaking any other Vessel shall keep out of the Way of the said last-mentioned Vessel.

Construction of Articles 12, 14, 15, and 17. Art. 18. Where by the above Rules One of Two Ships is to keep out of the Way, the other shall keep her Course, subject to the Qualifications contained in the following Article.

Proviso to save special Cases. Art. 19. In obeying and construing these Rules, due regard must be had to all Dangers of Navigation; and due regard must also be had to any special Circumstances which may exist in any particular Case, rendering a Departure from the above Rules necessary in order to avoid immediate Danger.

No Ship, under any Circumstances, to neglect proper Precautions. Art. 20. Nothing in these Rules shall exonerate any Ship, or the Owner, or Master, or Crew thereof, from the Consequences of any Neglect to carry Lights or Signals, or of any Neglect to keep a proper Look-out, or of the Neglect of any Precaution which may be required by the ordinary Practice of Seamen, or by the special Circumstances of the Case.

Art. 11. Si deux navires à voiles se rencontrent courant l'un sur l'autre, directement ou à-peu-près, et qu'il y ait risque d'abordage, tous deux viennent sur tribord, pour passer à bâbord l'un de l'autre.

Art. 12. Lorsque deux navires à voiles font des routes qui se croisent et les exposent à un abordage, s'ils ont des amures différentes, le navire qui a les amures à bâbord manœuvre de manière à ne pas gêner la route de celui qui a le vent de tribord; toutefois, dans le cas où le bâtiment qui a les amures à bâbord est au plus près, tandis que l'autre a du largue, celui-ci doit manœuvrer de manière à ne pas gêner le bâtiment qui est au plus près. Mais, si l'un des deux est vent arrière ou s'ils ont le vent du même bord, le navire qui est vent arrière ou qui aperçoit l'autre sous le vent manœuvre pour ne pas gêner la route de ce dernier navire.

Art. 13. Si deux navires sous vapeur se rencontrent courant l'un sur l'autre, directement ou à-peu-près, et qu'il y ait risque d'abordage, tous deux viennent sur tribord, pour passer à bâbord l'un de l'autre.

Art. 14. Si deux navires sous vapeur font des routes qui se croisent et les exposent à s'aborder, celui qui voit l'autre par tribord manœuvre de manière à ne pas gêner la route de ce navire.

Art. 15. Si deux navires, l'un à voiles, l'autre sous vapeur, font des routes qui les exposent à s'aborder, le navire sous vapeur manœuvre de manière à ne pas gêner la route du navire à voiles.

Art. 16. Tout navire sous vapeur, qui approche un autre navire de manière qu'il y ait risque d'abordage, doit diminuer sa vitesse ou stopper et marcher en arrière, s'il est nécessaire. Tout navire sous vapeur doit, en temps de brume, avoir une vitesse modérée.

Art. 17. Tout navire qui en dépasse un autre gouverne de manière à ne pas gêner la route de ce navire.

Art. 18. Lorsque, par suite des règles qui précèdent, l'un des deux bâtiments doit manœuvrer de manière à ne pas gêner l'autre, celui-ci doit néanmoins subordonner sa manœuvre aux règles énoncées à l'article suivant.

Art. 19. En se conformant aux règles qui précèdent, les navires doivent tenir compte de tous les dangers de la navigation. Ils auront égard aux circonstances particulières qui peuvent rendre nécessaire une dérogation à ces règles, afin de parer à un péril immédiat.

Art. 20. Rien dans les règles ci-dessus ne saurait affranchir un navire, quel qu'il soit, ses armateurs, son capitaine ou son équipage, des conséquences d'une omission de porter des feux ou signaux, d'un défaut de surveillance convenable, ou, enfin, d'une négligence quelconque des précautions commandées par la pratique ordinaire de la navigation ou par les circonstances particulières de la situation.

REMARKS UPON THE STEERING AND SAILING RULES.

303. As detailed in (296) the position and color of the light seen, shews, not only whether the vessel to which it belongs is passing or crossing you, but it also points out the s de upon which she will pass in the one case, or towards which she will cross your bows in the other. Knowing this then, it ought to be a very simple matter for you to determine what course to adopt to avoid danger. But a very erroneous idea has unfortunately become prevalent among seamen, which is, that in all cases, where a green light is seen the helm must be put to starboard, or to port for a red light. Now this generalisation of the rule is only half true. for while the way in which the helm is to be put, if altered at all, is right, the "in all cases" is decidedly wrong, as it will be endeavored to make evident. In the practical comprehension of the rule of the road, the main fact to be borne in mind is, that the rule of the road at night *is exactly the same as it is by day;* but as in the day a vessel's course is at once manifest, at night, it is very often otherwise, and consequently lights are borne, which while they give notice of the approach of the vessel, also indicate, as above laid down, the direction in which she is approaching. This being understood, then, if two vessels are crossing one another, the one will see a red and the other a green light; it is plain, that if the one which sees a red light ports, while the other starboards because he sees a green one, that a collision is almost inevitable; while on the contrary, if they had governed themselves by the rule of the road, and *one* had stood on, while the other put her helm so as to keep clear, an accident would have been impossible. A few examples will be given of the leading cases of vessels eeting under risk of collision, which while shewing what ought to be done to avoid danger, has also (except in the first example) special reference to exposing the error of *always* putting the helm according to the light seen.

Ex. 1. In Plate V Fig. 1 is given an illustration of two vessels meeting end on; here the vessels are in full view of both each others lights, and according to Article 11 the helms of both are put to port, and they go clear of one another as shewn by the dotted ships.

Ex. 2. In the position given in plate V Fig. 2 it will be seen that.

A sees a green light upon her port bow
B sees a red light upon her starboard bow

both alter their helms :—

A starboards } and collide.
B ports }

Both vessels being closehauled, as A is upon the starboard tack she keeps her course (Article 12) and B ports.

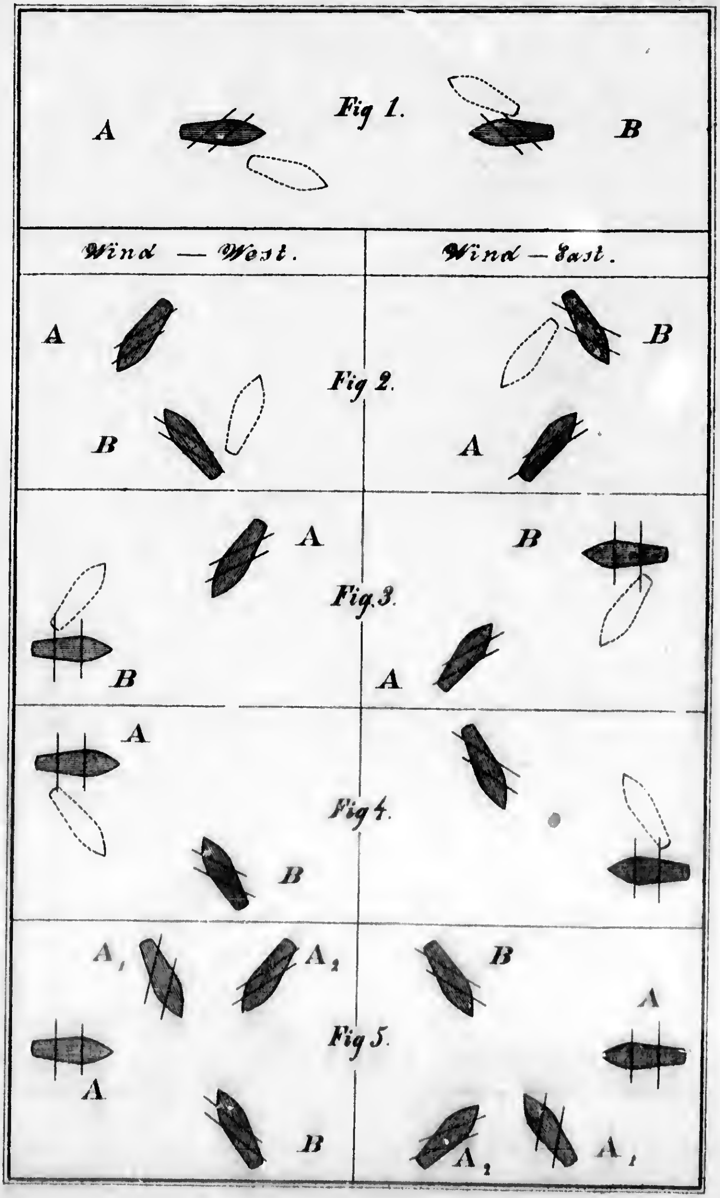
Ex. 3. In Fig. 3.

A sees a red light upon the starboard bow
B sees a green light upon the port bow

Rule of the Road.

Examples.

PLATE V.



both vessels shift their helms :—

A ports } and collide.
B starboards }

There is no difficulty here, A is on the starboard tack and under all circumstances would stand on; B is free and starboards.

Ex. 4. In Fig. 4.

A sees a red light upon the starboard bow
B sees a green light upon the port bow

both vessels alter their course.

A ports } and collide.
B starboards }

This is a case which requires some consideration; B is upon the port tack and consequently if the approaching vessel is close hauled, B has to give way, but, on the other hand, if A is going free, as in Fig. 4, B stands on and A gets out of the way. Now upon an examination of Figs. 4 and 5 it is seen, that as long as B sees A upon his weather bow, A is going free and consequently the responsibility of keeping out of collision rests with the latter. If however A is seen at A_1 she is right ahead and both vessels port; if she is to the southward of A_1 then she appears upon B's lee bow, and consequently although A will not be closehauled until in the position of A_2 yet B must be all ready to starboard if A stands on and gets broader upon her lee bow.

304. In the case of a steamer crossing a sailing vessel with risk of collision, as the steamer is supposed to have a fair wind she gets out of the way of the sailing vessel, which latter keeps her course. When two steamers are crossing one another, then as it is only the one which sees the other upon her own starboard side that moves (Article 14), it follows, that under such circumstances, the steamer which sees a red light upon her starboard side, ports her helm, the other not seeing a red light, keeping her course.

HEADS OF EXAMINATION

In Regulations respecting Lights and Fog Signals and in the Steering and Sailing Rules.

1.—What light or lights are required by the regulations to be exhibited by sailing vessels at anchor in a roadstead or fairway?

A.—One light only, viz., a white light.

2.—What light or lights are required by the regulations to be exhibited by steam ships in a roadstead or fairway at anchor.

A.—The same as for sailing vessels.

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3.—Where is the anchor light to be exhibited ?

A.—Where it can best be seen. It must of course be placed where there is the least possible chance of obstruction from spars, ropes, &c., &c.

4.—To what height may the anchor light be hoisted ?

A.—It may be exhibited at a height of 20 feet above the deck, but not higher.

5.—What is the description of the lantern containing the anchor light required by the regulations ?

A.—Globular.

6.—In what direction or directions must the anchor light show ?

A.—It must show a clear, uniform, and unbroken light, visible all round the horizon.

7.—At what distance must it be visible ?

A.—At least one mile.

8—What is the number of lights required by the regulations to be carried by sailing ships when under weigh at night ?

A.—Two.

9.—Of what colour are these lights, and how are they to be placed on board the ship ?

A.—A green light on the starboard side, and a red light on the port side.

10.—What description of light must be shown from the sides of sailing vessels under weigh ; and over how many points of the compass, and in what directions, and how far, are they required to show ?

A.—Each light must be so constructed as to show an uniform and unbroken light over an arc of the horizon of 10 points of the compass ; so fixed as to throw the light from right ahead to two points abaft the beam on the starboard and port sides respectively ; and of such a character as to be visible on a dark night, with a clear atmosphere, at a distance of at least two miles.

11.—What lights are they to carry when being towed at night ?

A.—The same.

12.—Are the side lights required to be fitted with screens ; and if so, on what side, and of what length, and how ?

A.—Yes, on the inboard side ; at least three feet in length, measuring forward from the light. They are to be so fitted as to prevent the coloured lights from being seen across the bows.

13.—What is the number of lights required by the regulations to be carried by steam ships when under steam at night ?

A.—Three lights.

14.—Of what colour are these lights, and how are they to be placed on board the ship ?

A.—White at the fore-mast head, green on the starboard side, and red on the port side.

15.—Over how many points of the compass, in what direction, and how far, is the fore mast-head light of a steamer required to show ?

A.—Over 20 points, viz., from right ahead to two points abaft the beam on both sides. It must be of such a character as to be visible on a dark night, with a clear atmosphere, at a distance of at least five miles.

16.—Are they required to be fitted with screens ; and if so, on which side, and of what length ?

A.—The green and red lights are to be fitted with screens on the inboard side, extending at least three feet forward from the light, as in the case of sailing vessels.

17.—Over how many points of the compass, in what directions, and how far, are the coloured side lights of steamers required to show ?

A.—Each light must be so constructed as to show an uniform and unbroken light over an arc of the horizon of 10 points of the compass, so fixed as to throw the light from right ahead to two points abaft the beam on the starboard and port sides respectively, and of such a character as to be visible on a dark night with a clear atmosphere at a distance of at least two miles.

18.—What description of lights are steamers required by the regulations to carry when they are not under steam, but under sail only ?

A.—Side lights only, the same as sailing vessels.

19.—What exceptional lights are to be carried by small sailing vessels in certain cases ?

A.—Whenever, as in the case of small vessels during bad weather, the green and red lights cannot be fixed, these lights shall be kept on deck, on their respective sides of the vessel, ready for instant exhibition, and shall, on the approach of or to other vessels, be exhibited on their respective sides in sufficient time to prevent collision, in such manner as to make them most visible, and so that the green light shall not be seen on the port side, nor the red light on the starboard side.

To make the use of these portable lights more certain and easy, the lanterns containing them shall each be painted outside with the colour of the light they respectively contain, and shall be provided with suitable screens.

21.—What description of light are sailing pilot vessels required to carry ?

A.—Sailing pilot vessels are not to carry coloured side lights, but a white light like an anchor light, and to burn a flare up every 15 minutes.

22.—What lights are open boats and fishing boats required to carry ?

A.—Open fishing boats and other open boats shall not be required to carry the side lights required for other vessels; but shall, if they do not carry such lights, carry a lantern having a green slide on the one side and a red slide on the other side; and on the approach of or to other vessels, such lantern shall be exhibited in sufficient time to prevent collision, so that the green light shall not be seen on the port side, nor the red light on the starboard side.

Fishing vessels and open boats when at anchor, or attached to their nets and stationary, shall exhibit a bright white light.

23.—May open boats use a flare up ?

A.—Yes, if considered expedient.

24.—Is the flare up to be shown by open boats instead of or in addition to the lantern with the coloured slides ?

A—The flare up must be in addition to the lantern with the two coloured slides.

25.—What lights are steam ships required to carry when towing other ships ?

A.—Steam ships, when towing other ships, shall carry two bright white mast-head lights vertically, in addition to their side lights, so as to distinguish them from other steam ships. Each of these mast-head lights shall be of the same construction and character as the mast-head lights which other steam ships are required to carry.

26.—Are sailing vessels required to use any signals when at anchor or when sailing in thick weather or in a fog; and if so, what are they ?

A.—Yes; a fog horn and a bell.

27.—When is each sort of signal to be used ?

A.—The fog horn is to be sounded when under weigh in a fog, and the bell when in a fog and not under weigh.

28.—How often are the fog signals of sailing vessels to be sounded ?

A.—As often as necessary, but every five minutes at least.

29.—Are steam ships required to use any signals in a fog or in thick weather; and if so, what are they ?

A.—Yes, a steam whistle and a bell.

30.—When is each signal to be used ?

A.—The steam whistle to be sounded when under weigh, and the bell when not under weigh.

31.—How often are the fog signals of steamers to be sounded ?

A.—As often as necessary, but every five minutes at least.

32.—At what height above the deck is the steam whistle to be placed ; and where ?

A.—Not less than eight feet above the deck. Before the funnel.

33.—What other precaution is to be observed by steamers when steaming in a fog ?

A.—The regulations require that steam ships in a fog shall go at a moderate speed.

34.—What precaution is to be taken by steamers approaching another vessel ?

A.—If there is risk of collision, the steamer is to slacken speed, or if necessary stop and reverse.

35.—If you see a white light alone, what does it denote as regards the ship carrying it ?

A.—It denotes the presence of a vessel at anchor, or a pilot vessel, or a fishing vessel attached to her nets ; or it may be the foremast-head light of a vessel, under steam, with her side lights not within sight on account of distance, fog, &c.

36.—If you see a green or a red light without a white-light, or both a green and a red light without a white light, is the vessel carrying the light or lights seen, a vessel under steam or a vessel under sail ?

A.—A vessel under sail.

37.—How do you know ?

A.—Because there is no white light at the foremast-head.

38.—If you see a white light over a coloured light, is the vessel a vessel under sail or a vessel under steam ?

A.—A vessel under steam. The mast-head light denotes that the vessel is under steam.

[The Examiner will then take one model of a vessel, which he will place on the table, and call it A, He will then take the mast or stand with a white and a red ball on it, and place it at the other end of the table, and call it B.

The Examiner should be careful that the model of one vessel only is used when the questions numbered 39 to 49 are asked.]

39.—A is a steamer going north, seeing a white light and a red light ahead at B. Are A and the vessel showing the two lights B meeting end on or nearly end on, or is B passing A, or is B crossing the path of A, and in what direction; and how do you know?

A.—Passing to port, because if I see a red light ahead I know that the head of the vessel carrying that red light must be pointing away in some direction to my own port or left hand. The ships showing the red light has her port or left side more or less open open to A.

40.—If A is going north, within what points of the compass must the vessel B showing the white and red lights be steering?

A.—B must be going from a little W. of S. to W. N. W.

41.—How do you know this?

A.—Because, the screens being properly fitted, I could not see the red light of B at all with the vessel's head in any other direction.

42.—Is the steamer A to starboard, or to port, or to keep on?

A.—To do neither suddenly, but, if anything, to port a little.

43.—Why?

A.—To bring the red light of A to the red light of the stranger B.

[The Examiner should then explain that if the steamer A starboards she will run across the path of the vessel carrying the lights B, because the vessel showing the red light must be passing to port.]

[The Examiner should now substitute the mast with the white ball and green ball for the mast with the white ball and red ball. One ship only is still to be used.]

44.—A is a steamer going north, and seeing a white and green light ahead. Are A and B meeting, or is B passing A, or is B crossing the course of A, and in what direction; and how do you know?

A.—B is passing to starboard of A, because if I see a green light ahead I know that the head of the vessel carrying that green light must be pointing away in some direction to my starboard or right hand. The ship showing the green light has her right or starboard side more or less open to me.

45.—As A is going north, within what points of the compass must the vessel showing the white and green lights be steering?

A.—B must be going from a little E. of South to E. N. E.

46.—How do you know?

A.—Because, the screens being properly fitted, I cannot see the green light at all with the vessel's head in any other direction.

47.—Is the steamer A to starboard, or to port?

A.—To do neither suddenly, but, if necessary, to starboard.

48.—And why?

A.—To show her green light to the stranger's green light. There can be no danger of collision when the green of one vessel is opposed to the green light of another.

49.—What would be the result if you ported to a green light ahead?

A.—I should probably run right across the path of the vessel carrying the green light.

[The examiner should then explain that A must not port, because as the vessel showing the white and green lights B must be passing to starboard, A would run across the path of B by porting.]

[The examiner should now place the models of two steamers on the table meeting end on. One he should call A, and the other B.]

50.—If a steamer A sees the *three* lights of another steamer B ahead or nearly ahead, are the two steamers meeting, passing, or crossing?

A.—Meeting end on, or nearly end on.

51.—Do the regulations expressly require the helm of a ship to be put to port in any case; and if so, when?

A.—Yes; in the case of two steamers or two sailing vessels meeting end on, or nearly end on.

52.—Do they expressly require the helm of a ship to be put to port in any other case; and if so, in what other?

A.—No. The use of the port helm is not in any other case expressly required by the regulations.

[The Examiner should then explain that the only case in which port-helm is mentioned in the regulations is in Articles 11 and 13 for two ships meeting end on, or nearly end on.]

53.—If you port to a green light ahead, or anywhere on your starboard bow, and if you get into collision by doing so, do you consider that the regulations are in fault?

A.—No, because the regulations do not expressly require me to port in such a case, and because by porting I know that I should probably and almost certainly run across the other vessel's path, or run into her.

[The Examiner should see the candidate put the models in the positions indicated by the questions 54 and following.]

54.—If a steamer A sees another steamer's red light B on her own starboard side, are the steamers meeting, passing, or crossing; and how do you know?

A.—Crossing, because the red light of one is opposed to the green light of the other: and whenever a green light is opposed to a red light, or a red light to a green light, the ships carrying the lights are crossing ships.

55.—Is A to stand on; and if not, why not?

A.—A has the othe vessel B on her own starboard side. A knows she is crossing he course of B because she sees the red light of B on her (A's) own starboard side. A also knows she must get out of the way of B, because Article 14 expressly requires that the steamer that has the other on her own starboard side shall keep out of the way of the other.

56.—Is A to starboard or to port in such a case?

A.—A must do what is right so as to get herself out of the way of B; she must starboard if necessary, or port if necessary; and she must stop and reverse if necessary.

57.—If A gets into collision by porting, will it be because she is acting on any rule?

A.—No; the rule does not require her to port. If she ports, and gets into collision by porting, it is not the fault of any rule.

58.—If a steamer A sees the green light of another steamer B on her own (A's own) port bow, are the two steamers meeting, passing, or crossing; and how do you know?

A.—Crossing, because the green light of one ship is shown to the red light of the other.

59.—What is A to do, and why?

A.—By the rule contained in Article 18 of the Regulations, A is required to keep her course, subject only to the qualification that due regard must be had to all dangers of navigation; and that due regard must also be had to any special circumstances which may exist in any particular case, rendering a departure from that rule necessary in order to avoid immediate danger. The crossing ship B on A's port side must get out of the way of A, because A is on B's starboard side.

60.—A, a steamer, sees the green light of another steamer, B, a point on her, A's, port bow. Is there any regulation requiring A to port in such a case, and if so, where is it to be found?

A.—There is not any.

61.—Are steam ships to get out of the way of sailing ships?

A.—If a steamer and a sailing ship are proceeding in such direction as to involve risk of collision, the steamer is to get out of the way of the sailing ship.

62.—What is to be done by A, whether a steamer or sailing ship, if overtaking B?

A.—A is to keep out of the way of B.

63.—When by the rules one of two ships is required to keep out of the way of the other, what is the other to do?

A.—To keep her course.

64.—Is there any qualification or exception to this ?

A.—Yes. Due regard must be had to all dangers of navigation, and to any special circumstances which may exist in any particular case to avoid immediate danger.

65.—Is there any general direction in the steering and sailing rules ; and if so, what is it ?

A.—Yes, it is this : that nothing in the rules shall exonerate any ship, or the owner, master, or crew thereof, for the consequences of any neglect to carry lights or signals, or of any neglect to keep a proper look-out, or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

66.—Can you repeat article (——) of the regulations. I refer to the article containing the rule for (——) ?

[The Examiner should repeat this question, naming a different article each time.]

67.—What does the Act of Parliament provide as to the obligation of owners and masters in obeying the regulations respecting lights, fog signals, and steering and sailing ?

A.—Section 27 of "the Merchant Shipping Act Amendment Act, 1862," provides that owners and masters shall be bound to obey the regulations, and it also provides that in case of wilful default by the master or owner he shall be deemed to be guilty of a misdemeanor for each infringement.

68.—What do breaches of the regulations imply ?

A—If an accident happens through non-observance of the regulations, it implies wilful default on the part of the person in charge of the deck at the time, unless it is shown to the satisfaction of the court hearing the case that the special circumstances of the case rendered a departure fron the rules necessary.

69.—If collision ensues from a breach of the regulations, who is to be deemed in fault for the collision ?

A.—The person by whom the regulations are infringed, unless the court hearing the case decides to the contrary.

70.—Do the regulations apply to sea-going ships in harbours and in rivers ?

A.—Yes unless there is any rule to the contrary made by a competent authority.

71.—Do they apply to British ships only ?

A.—No, to foreign ships as well.

72.—When did the present regulations come into operation ?

A.—On 1st June 1863.

73.—Do you know where the present regulations are to be found?

A.—Yes in "the Merchant Shipping Act Amendment Act, 1862," and the order in Council of the 9th January 1863. Copies are given away on application to the Board of Trade.

74.—Is one ship bound to assist another in case of collision?

A.—Yes.

75.—What is the penalty for default?

A.—If the master or person in charge of the ship fails to render assistance without reasonable excuse, the collision is, in absence of proof to the contrary, to be deemed to be caused by his wrongful act, neglect, or default.

76.—Is there any other penalty attached to not rendering assistance?

A.—Yes. If it is afterwards proved that he did not render assistance, his certificate may be cancelled or suspended by the court investigating the case.

77.—Is it not expected that you should understand the regulations before you take charge of the deck of a ship?

A.—It is.

78.—Why?

A.—If I do not understand them and am guilty of default, the consequence will be very serious to me.

79.—What would be a serious offence?

A.—To cause a collision by porting the helm when not required to port by the regulations and without due consideration.

AN EXAMPLE VOYAGE.

We are laying at anchor, ready for sea, in a harbor the entrance of which opens out between E. by S. and S. E. by S., the wind is S. by W., a nice working breeze. Having made all the necessary preparations for a start we get under weigh (254). The harbor being cleared and a sufficient offing made to lay upon our course, which is due West and therefore upon the opposite tack, we call the hands up, and put the ship about (242). When she comes head to wind, she refuses stays, but having overcome that difficulty, (244) she is got upon her course. As the vessel is known to be in the vicinity of shoals, extra care is taken and a good look-out is kept for any changes in the color of the water or for a sea of a broken or irregular character, but in spite of all she grounds upon a sand bank. The pumps are at once sounded with good results, and there not being much sea on, there is every prospect of her being got off, so preparations are immediately made to carry out an anchor (285,286) and eventually she is hove off all right. The ship now carries a fair wind for some time and makes a good run towards her destined port; but in course of time, the wind freshening a good deal makes it necessary to take in the topgallant sails (232) and as the wind still continues to increase we take a reef in the maintopsail (236). The weather now begins to look dirty so we hand the mainsail and jib (229,234) and as we are evidently in for a gale we take in the spanker (233) then close reef the topsails (238) and reef the foresail (239). Blowing hard, weather very heavy and threatening; take in the foresail (230) and fore topsail (231) and lay her to (249.) Wind still increasing, and the main topsail is blown away, the ship falls into the trough of the sea, and as it is blowing too hard to shew any canvass, we must wear her and lay her to under a drag (248. 250). This being done the hands are set about bending a new maintopsail (215); the drag is then hauled in and the close reefed maintopsail set. The weather shewing signs of moderating we set the close reefed foretopsail and reefed foresail. The wind going down, we set to work to shake out the reefs in the topsails (240) and foresail (241) and as the weather continues to lighten up, we set the jib (223), topgallant sails (220) and spanker (222). The wind draws aft (228) with a moderate breeze and the topmast (225) and lower (224) studdingsails are set. The wind now shifts forward (228) and the studdingsails are hauled down; it being reported that one or two of the lanyards of the main rigging have parted, measures are taken to reeve others (272). Dark masses of cloud appear away to leeward, and the sea becomes more and more heavy and irregular; a cyclone has evidently passed over here very recently. The sea is running in every direction and the ship labors very heavily; and at a moment when she has driven against a very heavy lump of a sea, word is passed that she has carried away her bobstay and the hands are at once set to repair damages (273). This has hardly been accomplished before the parrel of the main topgallant yard is carried away together with the weather brace (268); a temporary parrel having been fitted and a new brace rove and the ship having passed out of the track of the revolving storm, makes good weather of it and sights her port. The signal is make for a pilot (299) but no notice being taken of it, it is decided, being well accustomed to the place, to take the vessel in without one, and we proceed to get every thing ready for anchoring (259). As we get close in, we select a berth (248), shorten sail and bring up at single anchor (259) in due course. Having to wait some days in the stream, in a tideway, before we can get alongside the wharf, we take all necessary precautions to keep her steady at her anchor (264 to 267).

LOG LINE.

305. The length of a knot is found by multiplying the number of feet in a nautical mile (6080,) by the number of seconds run by the glass, and dividing the product by the number of seconds in an hour (3600).

After allowing a sufficient length of line as *stray line* (generally from 15 to 20 fathoms), the log line is marked as follows:

The Marks.—End of stray line, a piece of rag; one knot, a piece of leather; two knots has two knots; three knots has three knots, and so on, and between each, a single knot is placed for the intervening half knot. These marks correspond to the long glass, and they signify their double for the short glass.

Ex. Find the length of knot to correspond with a 28^s glass.

$$
\begin{array}{rrl}
 & 6080 & \\
 & 28 & \\
\hline
 & 48640 & \\
 & 12160 & \\
\hline
3600\,) & 170240 & (\,47\text{ ft.} \\
 & 14400 & \\
\hline
 & 26240 & \\
 & 25200 & \\
\hline
 & 1040 & \\
 & 12 & \\
\hline
3600\,) & 12480 & (\,3\text{ in.} \\
 & 10800 & \\
\hline
 & 1680 & \\
\hline
\end{array}
$$

Length of knot 47 ft. $3\frac{1}{2}$ in (nearly).

LEAD LINE.

306. In the hand lead line, there are nine marks and eleven deeps; the marks are as follows:

Two fathoms,	**leather with two tails**	**Thirteen fathoms,**	**blue rag, *bunting***
Three "	**leather with three tails**	**Fifteen "**	**white rag, *cotton***
Five "	**white rag, *cotton***	**Seventeen "**	**red rag, *bunting***
Seven "	**red rag, *bunting***	**Twenty "**	**two knots**
Ten "	**leather with a hole in it**		

In the deep sea lead line, every ten fathoms additional to the above is marked with an additional knot, until it is 100 fathoms, this is marked with a piece of bunting; 110 by a piece of leather; 120 by two knots, and then go on increasing, one knot, as before, for every additional ten fathoms; each five fathoms between these marks will be shewn by a single knot.

In calling the soundings, if it is a mark, as at ten fathoms, it will be given *by the mark ten;* if eleven fathoms, *by the deep eleven;* if a $\frac{1}{4}$ or $\frac{1}{2}$ fathom more than a mark or deep, as at $10\frac{1}{4}$ or $11\frac{1}{2}$ fathoms, then *and a quarter ten* or *and a half eleven;* but if it is $\frac{3}{4}$ more than a mark or deep, such as $4\frac{3}{4}$ fathoms, it will be called a *quarter less five.*

MASTER'S DOCUMENTS, &C.

307. A Charter Party is an agreement by which the ship is hired either for a certain period or to perform a certain voyage; and to prevent disputes the following portions of it should be clearly specified:—

- **The description of the Voyage.**
- **The number of Lay Days, and whether they are working or running days.**
- **The amount of Demurrage, (this is claimed daily; and on Saturday for Sunday).**
- **The amount of freight, when and where it is to be paid, also if it is to be paid in Foreign Money, some arrangement should be made with reference to the rate of exchange.**
- **The amount of Penalty for non-performance.**

308. A Bill of Lading is a receipt for certain specified goods in a given order and condition; it is also an agreement to carry those goods to a certain port for a given rate of freight. Three are usually signed, two of which are stamped; one of these is for the shipper, and the other for the consignee; the unstamped copy is held by the master.

309. A Manifest is a document headed by the description of the ship and voyage, and contains a detailed account of the cargo with the marks and numbers, the weight or measurement of the goods, and the names of the shippers and consignees.

310. Invoice is an account which contains a description of certain goods, together with their value and the particulars of any further charges which have been incurred thereon.

311. A Bottomry Bond is a document whereby the ship becomes security for money borrowed to put her in seaworthy condition. The Bond is payable when the ship arrives at her port of destination, therefore, should the vessel be lost, the bond is cancelled. If through further damage the vessel has to put into another port for repairs, and money is again borrowed upon Bottomry, the second bond is payable first, because it is considered that without the additional outlay the ship would not have completed her voyage, and consequently the first bond would have been lost. When about to raise money upon Bottomry it is usual to advertise what is required, and then to accept the lowest interest offered.

312. Protests are noted when the Master anticipates damage to his cargo through bad weather, or other causes beyond his control. Within twenty-four hours of his arrival, he goes before a Notary Public if in a home port, or a British Consul in a foreign port, and protests against being held responsible for such damage; if damage has happened he is now in a position to make his claim upon the Underwriters by having his protest extended, which latter must be done within six months.

313. Surveys are held when damage has occurred to Ship or Cargo. In many ports persons are officially appointed to hold them, but where such is not the case, and it is the Ship which has to be surveyed, then two Shipmasters or Shipwrights are generally called in, and they give in writing a detailed account of the damage which has taken place, and in case these damages have been made good, a Certificate to that effect should be obtained from the Surveyors. When it is Cargo that is damaged, two Merchants who by trade are competent to give a judgment, are the best persons to hold the survey.

314. A Survey of Hatches is held by one Shipmaster, who gives a Certificate that the hatches were properly battened down and secured.

315. Lloyd's Agent is a person employed by the Underwriters to see that Ships are well found, and also to report to them upon any claims made for damage. He has no control over the Master.

316. The Official Log Book contains a list of the Crew, with their characters for seamanship and conduct, together with the account of all misdemeanors or finable offences committed by them; in these latter cases, the entry detailing the offence must be signed by the Master, and also by the Mate or one of the crew; it must be read over to the offender, and after his reply (if any) is taken down, a statement of this having been done must also be attested in the same manner. An entry in regard to the death of a seaman must be made, by giving the cause of his death, with an account of his wages, and also of each article of his effects sold. A list of other logable events, not so likely to occur as the above, are given in the Directions to be found in every Official Log Book. This book, together with the wages and effects of all deceased seamen, must be delivered to the Shipping Master within twenty-four hours of the ship's arrival into port.

HINTS TO SHIPMASTERS.

The following are extracts from the general instructions issued to shipmasters at London, Liverpool and Sunderland, and are reproduced here in consequence of the practical value of the advice they contain.

Official log to be kept by the captain and every occurrence of moment to be inserted, duly attested by the signatures of the chief and second officers. Important entries to be further certified by the signature of carpenter and one of the crew, if necessary.

You must on no account omit to *keep your lead going* whenever near the land,—nor forget to keep a *good look-out.* We believe one half of the casualties at sea arise from neglect of these two most important matters. The relieving officer of the night watches should muster his own watch and station his look-outs fifteen minutes after the watch is called. The names of the look-outs should be stated in the ship's log.

We beg your closest attention to the stowage and dunnage of the cargoes—both at home and abroad, as in case of improper stowage or deficient dunnage, your own wages, and your mate's, will be liable for the loss in consequence; and we wish to observe that no advantage of freight or stowage can compensate for the evil of leaving out any of the 'twixt deck stanchions during the voyage. We can never admit it as an excuse that you trusted these things to your officers, they are of sufficient importance to merit your own personal superintendance.

It is desirable that you should retain your officers and carpenter until your return home.

You must avoid the infliction by yourself or officers of corporal punishment on your crew, particularly on your apprentices, whom you will always mess apart from the rest of your crew, and instruct as much as you can in your profession.

You will take care your carpenter keeps all the upper works of your ship free from chafe or appearance of injury, making him pay particular attention to the caulking of the topsides, gunwales, waterways, stanchions, bitts, knightheads, &c., as these places are most liable to leaks, and vessels require particular care in dunnaging in this vicinity.

In the event of your loading a cargo liable to steam or "sweat," you must take care your ventilators FORE AND AFT are kept open, by every opportunity and means in your power, to allow a draught through the ship.

You must keep a ship's disbursement book, and post it daily, and whenever you leave any port abroad, where you have spent any money on account of the ship, you must leave a copy of your disbursements behind you to come by the next conveyance, so that, should anything happen to you or the vessel, her accounts can be made up.

On arriving at any port abroad, your first letter should contain a sketch of your passage, with any particulars you think may be of interest to us.

We trust you will always keep up a proper state of discipline amongst your crew, which is not only conducive to the interests of the vessel, but to the comfort of all on board.

You will carefully superintend the keeping of the vessel's log book, into which the whole of the day's work must be entered, including the dead reckoning, latitude by observations, longitude by chronometer and lunar observations, whenever taken; you will also take care that all casualties are carefully noted.

Sails, at all times, to be kept well aired, and repaired when necessary.

Never leave any port without being properly victualled and equipped for your intended voyage, in order that you may not have occasion to put back or touch at any intermediate port, which can only be justified by circumstances of extreme necessity.

When discharging cargo, never allow anything to go from the ship without consignees' or captain's order to first officer.

Forecastle to be kept clean and well ventilated. We suggest that the crew may be allowed one afternoon per week for scrubbing their clothes. [An experienced master suggests that the bedding of the crew should, in fine weather, be taken out and aired frequently, and that in the event of the serious illness of any member of the crew at sea, accommodation should be provided aft in a cabin if possible, so as to ensure careful attention, and to avoid the discouraging influence on the other seamen. That divine service be performed at least once on the Sabbath at sea. In harbour in foreign ports, he deprecates the system of ship to ship visiting on the Sabbath, and prefers that the ship's boats be used only for the purpose of taking the men to and from the Bethel ship, or any church on shore. The apprentices or other lads to be encouraged in their religious duties, and all unnecessary Sunday labour to be avoided.]

Listings to be removed, and coal-hole, fore and after peaks, and limbers to be well cleaned out, at every opportunity. We attach the utmost importance to this duty.

Protests and surveys to be all in order, in event of damage to ship or cargo. The latter to be surveyed before leaving the vessel, claims being often made upon the ship even weeks after the cargo is in the warehouse.

Bills of lading never to be signed for weight or contents unless you have personal knowledge of same being correct.

Immediately on your return, we require to be furnished with vouchers and accounts for the voyage, to be kept in consignees' accounts current, portage bill. log, and expenditure books, statement of condition of hull, sails, rigging, and spars, *with a list of all stores remaining on board.*

If ever you should unfortunately be in any difficulty with your ship, that it became necessary to procure or take assistance either by steam or manual service, be cool and collected, act with firmness, and make every endeavour to arrange the terms (either in writing or in presence of third parties) upon which your engagements are made. Claims for salvage often arise when, by a little foresight and presence of mind, an agreement might be entered into which would prevent any dispute.

If possible, never give away the consignment of your ship, but reserve it.

In running down the Trades, you will as usual shift your sails, repairing such as require it; the same may apply to your homeward passage, as all sails have to be repaired on board. *On arrival at your port of discharge never neglect to note your protest immediately.* Then make arrangements for discharging your cargo, and give notice when ready to do so.

Hold a survey on your hatches before opening them, and at the same time get a Certificate of Survey from the Surveyor: for should it so happen that any cargo turns out damaged, and you have not obtained such certificate, it may cost considerably more, and occasion far more difficulty to get than it would otherwise.

Should any cargo be damaged, get a certificate to that effect as above.

Get receipts for all your cargo at time of delivery.

Having discharged outward cargo, give notice, in writing, of being ready to load homeward cargo. On the expiration of your lay days, give notice in writing of same, (inserting a copy thereof in ship's log book) and then claim demurrage.

Should your claim for demurrage not be paid before sailing, get your charter party endorsed as to the number of days occupied in loading, and if the consignee refuses to do so, go to the British Consul, or a notary, and note a protest of his refusal.

Always get copies of your protests and surveys.

Should you engage cargo at one port and have to fill up at others, you must, before signing bills of lading at first port, insert the clause of "*vià such and such port or ports*," neglect of this will made the ship liable for all losses consequent on a deviation from the direct voyage from port of loading to port of discharge.

In case of ship being open for charter, and you should not, on your arrival, find letters enclosing homeward charter, do not appear to be over anxious about a freight, but state that you expect instructions from your owners by next mail, and in the mean time make yourself thoroughly acquainted with every thing offering in the freight market. However much you may desire to return to one port in preference to another, conceal your wishes on this point, as otherwise by your openly stating a particular wish to your consignee to return to London or Liverpool rather than any other port, may, and very frequently does, occasion a considerable loss to the ship. Always endeavour to keep consignment of vessel open in this country.

In Fixing ship. 1st Take care to have stamped charters and bills of lading. They can be got stamped within 14 days after date, without payment of any penalty, and at the head office in London, within one month after date on payment of £10 penalty. After a month they cannot be got stamped at all.

2nd Let no charterer sign as agent unless he states for whom he is agent. A man of straw, or a foreigner, may be the principal.

3rd When a foreigner is the principal, try to get the agent, who effects the charter, to make himself liable as principal, and to sign the charter without adding the word agent.

4th If freight is not payable in cash on delivery, take care that the bills are to be "*approved bills*," and not charterer's bills, as in the latter case, the shipowner cannot hold the cargo for his freight, even though the charterer was notoriously insolvent. If a charterer objects to the stipulation for "approved bills," he is generally not safe, and his charter should not be taken.

5th In stating days allowed the merchant, it is proper to say "running days," or "working days," according to the intention. "Days" means "working days," and Sundays and holidays do not count until the ship is on demurrage. After that time all days count.

6th In bills of lading of a ship to consignees in England from consignors abroad, have a clause inserted—"consignees paying freight and *demurrage*," if you wish to have a remedy for your demurrage.

In loading. 1st Enter the ship at the custom-house. The days count from entry at the custom-house and being ready to load.

It is however proper to give notice to the merchant, of arrival and being ready to load; and it is generally better to do this in writing, as it is more easily proved in case of need.

Enter in the log-book the day of arrival at the port of loading and entering at the custom-house. Also enter a copy of the notice given to the merchant. Also enter in the log-book the day loading is completed.

N. B. The signature of the master to the entries in the log, as well as that of the mate is very useful in case of dispute. If the master be owner or part owner, the entries should be signed by the mate, and the second mate, carpenter, or eldest apprentice.

If the merchant's correspondent abroad is willing to give a certificate on the back of the charter or bill of lading, of the correct number of days expended in loading, get him to do so, but do not on any account allow him to certify a smaller number of days than were really spent. Rather do without his certificate, as it is not at all necessary to have it.

In case the merchant's correspondent at port of loading should refuse to furnish a cargo, the master should, on the expiration of the lay days allowed by charter, protest against the merchant, and he is then at liberty to return in ballast to his chartered port of discharge, and has a right to his full freight. The better plan, however, is to take the best freight he can get for his chartered port of discharge, and claim the deficiency of the freight from the merchant. It is improper to wait the demurrage days, unless required so to do by the merchant.

In discharging. Enter ship at custom house.

Give notice to merchant of being ready to unload.

Make similar entries in the log-book of entering ship at custom-house, of notice given to the merchant, and of the day the dis-charging is completed, and let them be signed as before directed in the case of loading, by the master and mate, or if the master be an owner, then by the mate, and the second mate, carpenter, or eldest apprentice.

If you are chartered, but have signed bills of lading, to a consignee, before you part with the cargo, the consignee should produce the endorsed bill of lading. He should also undertake for payment of freight according to bills of lading, particularly if you have any doubt of your charterer's solvency.

It is doubted whether the owner of a *chartered* ship can recover his freight from a consignee who has once go hold of the cargo, without giving an express undertaking to pay; and it is said the only remedy is against *the charterer*.

N. B. You cannot hold the cargo for demurrage, and only for freight in terms of charter party or bill of lading.

Payment of freight. When an advance of freight is to be paid, make it payable on signing bills of lading, and not on the sailing of the ship. When foreign money is to be paid, make it at current rate of exchange. When bills are to be given, have them good and approved bills, and not charterer's acceptance. Do not make the freight payable two months, or any time after the delivery of the cargo, but either "during delivery," or "on delivery."

The following mode of payment of freight is objectionable. "The freight is to be paid on the quantity delivered, by an approved bill on London at three months' date from the delivery to the charterers of a certificate, signed by the consignees, of the right and true delivery of the whole cargo, agreeable to bills of lading; or in cash, under discount, at charterers' option."

Instructions to masters. It cannot be too clearly understood that the payment of freight depends very much on the care that the master bestows on the cargo, and that he is bound to deliver it in the same good order and condition in which it was received, (the act of God, dangers of the seas, &c. &c., excepted.) Owners have often had large sums to pay for damage to cargo, arising from the following causes, which with ordinary care might have been prevented:—

Runs not being clear.

Dunnage not being good and sufficient.

Ship not being properly matted out.

Pump-well, mast-cases, bulkheads, shifting boards, and chain locker not being substantial and secure.

Neglected air ports, by which cargo reaches the pumps and chokes them.

Leaky ports.

Coverings of hatchways and coatings of masts being insufficient or imperfect.

Inattention to the pumps. Attend the pumps carefully, and enter in each day's log, "pumps carefully attended."

Improper stowage, a point to which too much attention cannot be given.

Cutting timber or deals, and breaking open packages for stowage beyond what is provided for by the charter, the usages of the trade, or without the written consent of the charterer or shipper, and deck load being carried over a perishable cargo.

Rats, mice, or other vermin.

It is recommended for all captains to examine the mast-cases, pump-well and chain trunks, and to have the dunnage laid under their own inspection, before taking in cargo.

No master should consent to vary the terms of his charter, or alter his voyage, without the greatest caution, and then only with the charterer himself, or his agent, having his written consent, which written consent ought to be given up to the master before making the alteration, otherwise the charterer will be discharged from the contract, and the owner liable to an action for breach of contract. If there be a telegraph, it would be better for the master to refer to his owner for instructions.

SURVEYS. A ship having received damage, or touched the ground, before arriving at her port of loading, ought to be surveyed and a certificate of her sea-worthiness, in duplicate, obtained before taking on board cargo; the master to send one by post to his owner, and retain the other on board for his own use.

A ship putting into an intermediate port for repairs, the master must have a certificate of survey on the damage received and the ship's sea-worthiness before leaving. If the cargo be a perishable one, and there is a reason to think it is damaged, it will be necessary to have a survey on it, and obtain a certificate that it is or has been put into proper condition for its passage to the port of destination.

'reight cannot be claimed on damaged cargo sold at an intermediate port, hence it is always better to put it into the best condition possible, and bring it on. In most cases of survey abroad, it will be proper to have the certificate in duplicate, attested by the consul or other public functionary; one to be sent to the owner by post, the other retained on board for the master's use.

It will be proper to have a survey of the hatches and dunnage at the port of discharge; and when hatches are opened, to take samples; at a port of call, get a certificate from the merchant's agent that they were in order when opened.

When you call at one port for orders to discharge or load at another, ask for your orders in writing, and take care of them, they will be useful in case of dispute.

BILL OF LADING. Never be induced to sign bills of lading before the goods are on board, or without the mate's receipt being given up or cancelled, or without first carefully reading them over, and c nparing one with the other, not only to see that they are alike, and that the quantity of goods and rate of freight are correct, but that nothing is inserted contrary to the fact on the charter party, if there be one.

Do not sign bills of lading for a less freight than what is in the charter party, but say—freight, demurrage, and all other conditions, as per charter.

Insert the correct number of days consumed in loading, on the margin of the bill of lading, but do not have a smaller number certified than were really spent; rather do without it.

Interest and insurance on money advanced, and address commission paid at port of loading, ought to be endorsed on the bills of lading. This is a receipt which the receivers of the cargo cannot dispute.

Qualify your risk by adding "quantity and quality unknown, not accountable for leakage, breakage, rust, or injury by vermin," or whatever else you think will suit the goods you have on board.

If it be attempted to ship goods in a damaged or improper condition, give the shipper notice in writing, and if he fail to replace them with sound, say—"shipped in a damaged condition," or "shipped in improper condition."

If the shipper refuse to allow the above qualification, and you find it necessary to protest on this or any other account connected with the bill of lading, say—"signed under protest"

Before signing bills of lading, enter deck load at shipper's or charterer's risk, even if provided for in charter or otherwise.

Deliver your cargo to no one unless he produce one of the bills of lading which you have previously signed, properly en dorsed.

Before signing bills of lading in a foreign language, they ought to be translated. Many of them omit the usual exceptions, "the Act of God, the Queen's Enemies," &c., and have objectionable clauses in them. Where they cannot be translated, it will be proper to add, "freight and all other conditions, as per charter party, and anything contrary thereto to be void."

Bill of lading, when there is no charter party, should say, "consignee paying freight, demurrage, and all other charges;" also, "goods to be taken from alongside at consignee's expense and risk."

In England, it is customary in the case of ships loading general cargoes for abroad, to sign bills of lading for freight paid in advance, but not to receive it for a month or six weeks after the sailing of the vessel. In this case, say "nevertheless the owners to have a lien on the goods for freight until paid."

A master of a ship, on signing a bill of lading, ought clearly to understand he is only required to give a receipt for the cargo; not to enter into a second agreement. hence the necessity of referring to the charter party in the bill of lading for "freight and conditions," the bill of lading being the last document signed.

Always keep on good terms with your charterers, shippers, and consignees; do anything you can to oblige them consistent with your duty to your owners.

INSTRUCTIONS FOR USING THE

MORTAR AND ROCKET APPARATUS.

In the event of your vessel stranding within a short distance of the United Kingdom, and the lives of the crew being placed in danger, assistance will, if possible, be rendered from the shore in the following manner, namely:

1. A rocket or shot with a thin line attached will be fired across your vessel. Get hold of this line as soon as you can; and when you have secured it, let one of the crew be separated from the rest, and, if in the day time, wave his hat or his hand, or a flag or handkerchief; or, if at night, let a rocket, a blue light or a gun be fired, or let a light be displayed over the side of the ship and be again concealed, as a signal to those on shore.

2. When you see one of the men on shore, separated from the rest wave a Red flag (or if at night show a Red light), and then conceal it, you are to haul upon the rocket line until you get a tailed block with an endless fall rove through it.

3. Make the tail of the block fast to the mast about 15 feet above the deck, or if your masts are gone, to the *highest secure* part of the vessel. When the tail block is made fast, and the rocket line unbent from the whip, let one of the crew, separated from the rest, make the signal required by Article 1 above.

4. As soon as the signal is seen on shore a hawser will be bent to the whip line, and will be hauled off to the ship by those on shore.

5. When the hawser is got on board, the crew should at once make it fast to the same part of the ship as the tailed block is made fast to, only about 18 inches higher, taking care that there are no turns of the whip line round the hawser.

6. When the hawser has been made fast on board, the signal directed to be made in Article 1 above, is to be repeated.

7. The men on shore will then pull the hawser taut, and by means of the whip line will haul off to the ship a sling, cot or life-buoy, into which the person to be hauled ashore is to get and be made fast. When he is in and secure, one of the crew must be separated from the rest, and again signal to the shore, as directed in Article 1 above. The people on shore will then haul the person in the sling to the shore, and, when he is landed, will haul back the empty sling to the ship for others. This operation will be repeated until all persons are hauled ashore from the wrecked vessel.

8. It may sometimes happen that the state of the weather and the condition of the ship will not admit of a hawser being set up; in such cases a sling or life-buoy will be hauled off instead, and the ship-wrecked persons will be hauled through the surf, instead of along a hawser.

Masters and crews of stranded vessels should bear in mind that SUCCESS in landing them, in a great measure DEPENDS UPON THEIR COOLNESS AND ATTENTION TO THE RULES HERE LAID DOWN; and that by attending to them many lives are annually saved by the mortar and rocket apparatus on the coast of the United Kingdom.

The system of signaling must be strictly adhered to; and all women, children, passengers and helpless persons should be landed before the crew of the ship.

EXAMINATION PAPERS.

ADJUSTMENTS OF THE SEXTANT.

The applicant will answer in writing, on a sheet of paper which will be given him by the Examiner, all the following questions, numbering his answers with the numbers corresponding to the questions.

1. What is the first adjustment of the sextant?

To set the Index glass perpendicular to the plane of the sextant.

2. How do you make that adjustment?

Place the vernier about the middle of the arc; hold the sextant horizontally with the limb from you, and looking obliquely into the index glass, see if the arc reflected in it, and the true arc as seen outside, appear in an unbroken line; if not, it is rectified by the screws at the back of the glass..

3. What is the second adjustment?

To set the Horizon glass perpendicular to the plane of the sextant.

4. Describe how you make that adjustment?

Place the zero of the vernier to the zero of the arc, hold the sextant horizontally and see if the reflected and true horizons appear in the same straight line, if not, turn the proper screw until they do.

5. What is the third adjustment?

To set the Horizon Glass parallel to the Index Glass.

6. How do you made the third adjustment?

Place the zero of the vernier to the zero of the arc, hold the sextant perpendicularly and see if the true and reflected horizons appear in the same straight line, if not, turn the proper screw until they do.

7. In the absence of a screw how would you proceed?

Find the index error.

8. How would you find the index error by the horizon.

Place the zero of the vernier to the zero of the arc, and bring the true and reflected horizons in one straight line, then what the sextant shews will be the Index Error.

9. How is it to be applied ?

It will be additive if the reading is off the arc, but subtractive if it is on.

10. Place the index at error of minutes to be added, change it, and leave it.

NOTE.—The examiner will see that it is correct.

11. The examiner will then place the zero of the vernier on the arc, not near any of the marked divisions, and the candidate will read it.

NOTE.—In all cases the applicant will name or otherwise point out the screws used in the various adjustments. (117 to 120).

12. How do you find the Index Error by the sun.

By measuring the Sun's diameter both on and off the arc, then half the difference of the two readings will be the index error (121).

13. How is the same applied ?

Additive if the reading off is the greatest, but subtractive if it is the least.

14. What proof have you that those measurements or angles have been taken with tolerable accuracy ?

The sum of the two measurements, divided by 4, should be equal to the Sun's semidiameter as given in the Nautical Almanac for the day on which the observations were taken.

CHART.

The applicant will be required to answer in writing, on a sheet of paper which will be given him by the examiner, all the following questions according to the grade of certificate required, numbering his answer with the numbers corresponding with those on the question paper.

1. A strange chart being placed before you, what should be your special care to determine, before you answer any questions concerning it, or attempt to make any use of it ?

See if it is a British Chart by ascertaining if its longitude is reckoned from the meridian of Greenwich, also whether the compasses engraved upon it are true or magnetic.

2. How are you to ascertain that in our British Charts ?

The North point of a true compass is marked by a star and is drawn parallel to a meridian. The line bearing the North point of a magnetic compass makes an angle E. or W. of a meridian equal to the variation.

3. Describe how you would find the course by the chart between any two places A and B ?

Lay the edge of the parallel rulers upon A and B, move the rulers to the centre of the nearest compass which will then shew the course required, magnetic or true as per chart.

4. Supposing there to be points of variation at the first-named place, what would the course be magnetic, the true course being about ?

I would shape my course to the right for Westerly variation, to the left for Easterly.

5. How would you measure the distance between these two or any other two places on the chart?

By using a pair of dividers, take the space between the two places to the graduated meridian, which if the middle latitude is the centre of the scale used, will give the distance required.

6. Why would you measure it in that particular manner?

Because the distance between the parallels is increased towards the poles, in order to compensate for the expansion of the meridian difference.

The above comprises all the questions on the chart that are put to first Mates.

In addition to the above the Masters are required to answer :—

7. What do you understand those small numbers to indicate that you see placed about the chart?

Soundings, generally in fathoms.

8. At what time of the tide?

Low water ordinary spring tides.

9. What are you required to know in order that you may compare the depths obtained by your lead line on board with the depths marked upon the chart?

The time from high water and the half range of tide at ship. With these, Table B in the Admiralty Tide Tables will give a correction to be applied to the half mean spring range of the place, the result being the rise of tide at the time of sounding.

10. What do the Roman numerals indicate that are occasionally seen near the coast, and in harbors?

The time of high water full and change.

11. How would you find the time of high water at any place, the Admiralty Tide Tables not being at hand, nor any other special tables available?

By adding 48 minutes for every day since full and change.

All the above questions should be answered, but this does not preclude the Examiner from putting any other questions of a practical character, or which the local circumstances of the port may require.

DEVIATION OF THE COMPASS.

[The candidate is to answer correctly at least eight of such of the following questions as are marked with a cross by the examiner. The examiner will not mark less than 12.]

1. What do you mean by Deviation of the Compass?

It is an error of the Compass caused by the magnetic action of the iron in the ship or cargo upon the needle.

2. How do you determine the deviation (a) when in port and (b) when at sea?

(*a*) By reciprocal bearings.

Let the ship lie with her head upon any point of the compass; now, take a compass on shore, and let the observers on board and on shore take the bearings of one another; reverse the bearing taken from the shore, and the difference between it and the bearing taken from the ship will be the deviation corresponding to the direction of the ship's head. Proceed in like manner with the ship's head on the remaining points of the compass.

(*b*) By astronomical bearings.

Take the bearing of the Sun and by computing the True Azimuth find the error of the compass, then the difference between this and the Variation, as found from a chart of Equal Variations, would be the Deviation for the direction of the ship's head when the bearing was observed. Now take like observations with the ship's head upon not less than each cardinal point of the Compass, and also upon the courses lying half way between them.

3. Having determined the deviation with the ship's head on the various points of the compass, how do you know when it is Easterly and when Westerly?

It will be Easterly, if when laid off upon the compass the correct magnetic bearing is to the right of the one taken from the ship, but Westerly if the contrary.

4. Why is it necessary, in order to ascertain the deviations, to bring the ship's head in more than one direction?

Because every change in the course brings the iron in the ship into a different relative position with regard to the compass needle.

5. For accuracy what is the least number of points to which the ship's head should be brought?

Eight.

The four cardinal and the four mid-cardinal points are the best.

6. How would you find the deviation when sailing along a well known coast?

When the reciprocal bearings of two well defined objects, such as lighthouse towers, are known, bring them in one, and the difference between the observed and given bearings will be the deviation for the direction of the ship's head when such bearings were observed.

For the questions 7, 8 and 9 see the article upon Deviation page 96.

11. Name some suitable objects by which you could readily obtain the deviation of the Compass when sailing along the coasts of the English Channel?

The Lizard, Portland and the South Foreland Lights.

12. Do you expect the Deviation to change, if so, state under what circumstances?

It will change rapidly for a time after launching, also through any considerable change of latitude, any alteration in the position of the Compass, or the quantity or place of the iron on board.

13. How often is it advisable to test the accuracy of your table of deviations?

At every convenient opportunity.

More particularly in a new ship; and also after having made any considerable change of latitude, or after having stood upon the same tack any length of time.

14. State briefly what you have to guard against in selecting a position for the compass?

That it should be removed as far as practicable from all iron stanchions, deck beams, smoke stacks, or other disturbing influences of a like character.

15. The compasses of iron ships are more or less affected by what is termed the heeling error; on what courses does this error vanish, and on what courses is it the greatest?

It vanishes at the East or West points, and is greatest about North or South.

16. State to which side of the ship—in the majority of cases— is the north point of the compass drawn in the Northern Hemisphere, and what effect has it on the assumed position of the ship when she is steering on northerly, and also on southerly courses?

The north end of the needle is drawn to windward, and consequently when steering to the northward the ship makes a more weatherly course than that indicated by the compass, while on southerly courses she is to leeward of her apparent course.

17. The effect being as you state, on what courses would you keep away, and on what courses would you keep closer to the wind in order to make good a given compass course?

I should keep away upon northerly courses, but keep closer to the wind on southerly courses.

18. Does the same rule hold good in both Hemispheres with regard to the heeling error?

No, with few exceptions the rule which holds good in the

Northern Hemisphere must be reversed to apply to the Southern.

19. Your steering compass having a large error, how would your proceed to correct that compass by compensating magnets and soft iron, so as to reduce the error between manageable limits.

Make a mark upon the deck exactly under the centre of the compass and draw two chalk lines through it, one fore and aft, and the other athwartships. Get the ship perfectly upright and lay her head N. or S. correct magnetic. Now place a magnetic bar athwartship, with its centre on the fore and aft line, and the N. or marked end pointing to starboard if the N. end of the needle is drawn to starboard, and *vice versa.* Still keeping the centre upon the fore and aft line, move the bar to or from the compass until the ship's head is N. or S. by compass. Then place her head E. or W. correct magnetic and set a bar fore and aft with its marked end aft if the needle is drawn towards the stern and *vice versa* ; move the centre of the bar along the athwartship line, until the ship's head lays E. or W. by compass. Next lay her head upon either of the 4 point courses, correct magnetic, and place a box of soft iron at each side of the binnacle, level with the needle. Use more or less iron in these boxes until the compass agrees with the known direction of her head. This last adjustment is permanent, but the other two will require supervision, and therefore the magnets should be so fixed that they may be shifted for this purpose during the voyage. The magnets should be from 10 to 18 inches in length, their breadth one-tenth their length and their thickness one-fourth their breadth. They should not be placed nearer than twice their length to the compass needle.

DEFINITIONS IN NAVIGATION AND NAUTICAL ASTRONOMY.

The candidate is to write a short definition against so many of the following terms as may be marked with a cross by the Examiner. The examiner will not mark less than 10. The writing should be clear, and the spelling should not be disregarded.

A Plane is a perfectly flat and even surface *without depth* ; this surface may be supposed to lie in any given direction, and then all objects which are upon this surface are said to be in that plane.

A Great Circle is a circle whose plane passes through the centre of the sphere ; it therefore divides the latter into two equal parts, and is the largest circle there can be drawn upon a Globe.

A Small Circle is a circle whose plane does not pass through the centre of the sphere, consequently it divides the sphere into unequal parts.

Def. 1. **The Equator** is a great circle equi-distant from the poles.

It divides the earth into the Northern and Southern Hemispheres.

Def. 2. **The Poles** are the extremities of the earth's axis.

The one which lies upon the same side of the equator as the Dominion is called the North Pole, while the other is termed the South Pole.

Def. 3. **A Meridian** is a great circle which passes through the Poles.

It is one of the two lines which define the position of any spot upon the earth.

Def. 4. **The Ecliptic** is a great circle showing the apparent path of the sun in the heavens.

This apparent movement of the sun amongst the stars is caused by the motion of the earth in its orbit.

Def. 5. **The Tropics** are two small circles parallel to the equator, each cutting a vertex of the ecliptic.

There is always a point between these two circles where the sun is vertical. That one which lies to the Northward of the equator is called the Tropic of Cancer, while the other is the Tropic of Capricorn.

Def. 6. **Latitude** is the arch of a meridian intercepted between any given place and the equator.

It is reckoned from the equator towards the poles, and is named North or South, the same as the pole towards which it is reckoned.

Def. 7. **Parallels of Latitude** are small circles parallel to the equator.

It is the intersection of a parallel of latitude with a meridian at any given point which defines the position of that point upon the face of the Globe.

Def. 8. **Longitude** is the arch of the equator intercepted between what is called the First Meridian and the meridian passing through any given place.

Any meridian may be made the First Meridian, many nations using that which passes through their respective Capitals, but most maritime nations have adopted the English First Meridian, which is the one which passes through the Observatory at Greenwich. Long. is reckoned from 0° at the First Meridian to 180°, where it meets the other (or inferior) part of the First Meridian; and is named East, if, when looking towards the North, it is reckoned to the right of the First Meridian, but West if the contrary.

Def. 9. **The Visible Horizon** is the circle in the open sea, formed by the limit of vision.

It will expand with an increased elevation of the eye above the level of the sea, and contract as the eye approaches the surface.

Def. 10. **The Sensible Horizon** is a plane which passing through the eye of the observer, is parallel with the visible horizon.

Def. 11. **The Rational Horizon** is the plane which passes through the centre of the earth parallel to the visible horizon.

Def. 12. **The Artificial Horizon and its uses.** The artificial horizon is a small shallow trough containing quicksilver. It is used when there is no visible horizon, for the purpose of measuring the altitude of an object

As the angle taken is the *angle of reflecti en*, it is double the actual altitude, and must therefore be halved after the error of the sextant has been applied to it.

Def. 13. **True Course of a Ship** is the angle contained between the ship's head and the TRUE meridian.

It is therefore the compass course corrected for all its errors.

Def. 14. **Magnetic Course** is the angle contained between the ship's head and the *Correct Magnetic* meridian.

Is in error by the amount of the deviation.

Def. 15. **Compass Course** is the angle contained between the ship's head and the meridian, as shown by her compass.

Consequently it is in error by the amount of the variation, deviation and leeway.

Def. 16. **Variation of the Compass** is the angle between the true and magnetic meridians.

Every place has its own variation, and this again is also subject to a slow change in its amount. The variation of the compass is caused by the true and magnetic poles not being located in the same place, and the change which is always taking place in its amount appears to arise from a slow movement of the magnetic round the true pole.

Def. 17. **Deviation of the Compass** is the angle between the correct magnetic meridian and that shown by the compass.

Def. 18. **The Error of the Compass** is the combined effects of both variation and deviation upon a ship's compass.

As the variation is affected by a change of place, and the deviation, in addition, by any alteration in the direction of the ship's head, it is evident that the error of the compass found in the amplitudes or azimuths by getting the angle between the true and compass bearings of the sun, can only be used when in about the same locality, and with the ship lying upon the same course as when the compass bearing was taken.

Def. 19. **Leeway** is the angle formed by the ship's keel with her actual course through the water.

It is caused by the action of the wind upon a ship's side, which gives her a lateral as well as a progressive motion.

Def. 20. **The Meridian Altitude of a Celestial object** is its altitude when upon the meridian of the place of observation.

Def. 21. **Azimuth** is the angle contained between the North or South Pole and the vertical circle passing through the object.

It is called the true or magnetic azimuth, according whether the angle is reckoned from the true or magnetic pole. The azimuth found by computation is true.

Def. 22. **Amplitude** is the angle contained between the East or

West point of the horizon and an object in the act of rising or setting.

It is called the true or magnetic amplitude according whether the angle is reckoned from the true or magnetic East or West point of the horizon; the amplitude found by calculation is true.

Def. 23. **Declination** is the angular distance of any heavenly body North or South of the celestial equator.

Def. 24. **Polar Distance** is the angular distance of any celestial object from the pole of the observer.

Def. 25. **Right Ascension** is the arc of the Celestial Equator contained between the First Point of Aries and the Circle of Declination passing through any given heavenly body.

It is expressed in time, and is reckoned Westward from the First Point of Aries in continuation right through the whole circle, that is, from 0h. to 24h. The First Point of Aries is that point in the Celestial Equator which is crossed by the Sun in March.

Def. 26. **Dip** is the angle contained between the *sensible* horizon and a line drawn from the eye of the observer to any point in the *visible* horizon.

As the visible horizon expands or contracts with any increase or decrease of the height of the observer's eye above the level of the sea, it follows that the dip of the horizon is regulated by the height of the eye.

Def. 27. **Refraction** is the amount by which the altitude of a heavenly body is increased by the effect of the earth's atmosphere.

The rays of light which form the image of an object, while forcing their way through our atmosphere, get more or less bent downwards from their proper straight line, and as an object is seen in the same direction as that with which the ray enters the eye, its having been curved downward from its true direction will naturally give the object an apparent altitude greater than really belongs to it

Def. 28. **Parallax** is a correction additive to an altitude to make it equal to what it would have been, supposing it had been observed from the centre of the earth.

Def. 29. **Semi-diameter** is the half of the apparent diameter of a heavenly body.

Def. 30. **Augmentation of the Moon's Semi-diameter** is the increase of the apparent semi-diameter of the Moon, caused by the place of the observer getting closer to that body while she is rising from the horizon to the zenith.

When the Moon is in the zenith, the observer is immediately underneath, and consequently at his shortest distance from her; but as the Moon sets (a motion due to the rotation of the earth eastward), the place of the observer is gradually removed from the moon, until when that body is in the horizon, it is plain that the observer has increased his distance from her by the length of the earth's radius; and the moon's distance from us is not so great but that this amount has an appreciable effect upon her apparent size.

Def. 31. **Observed Altitude** is the angular distance of any heavenly body from the horizon as shown by a sextant.

Def. 32. **Apparent Altitude** is the angular distance of an object from the sensible horzon.

It is found by applying the index error and dip to its observed altitude.

Def. 33. **True Altitude** is the apparent altitude of an object corrected for refraction and parallax.

Def. 34. **Zenith Distance** is the angular distance of an object from that point in the heavens immediately over the observer.

It is found by subtracting the true altitude from 90°

Def. 35. **Vertical Circles** are great circles passing through the Zenith.

They are consequently perpendicular to the horizon.

Def. 36. **Prime Vertical** is that vertical circle which is at right angles to the Celestial Meridian.

Therefore any object upon the Prime Vertical must bear due East or West.

Def. 37. **Civil Time** is the ordinary way of reckoning time on shore.

The civil day is contained between two following midnights; it is 24 h. long, and is divided into two parts of 12 h. each; the first is called A. M. or *ante meridian*, the second P. M., or *post meridian*.

Def. 38. **Astronomical Time** is the interval of time from the preceding noon.

The astronomical day commences at noon of the civil day of the same date, and closes at the noon following; astronomical time is reckoned consecutively up to 24h.

Def. 39. **Sidereal Time** is the time elapsed since the preceding transit of the first point of Aries.

Def. 40. **Mean Time** is time as shown by an ordinary clock.

The interval between following transits of the sun is not regular, *a mean sun* therefore has been imagined, which moving at one uniform rate is supposed to make the circuit of the Celestial Equator in the same time, exactly, that the sun requires to pass through the Ecliptic.

Def. 41. **Apparent Time** is the time elapsed since the preceding transit of the true sun.

Def. 42. **Equation of Time.** — The interval of time between Mean and Apparent time.

Def. 43. **Hour Angle of a Celestial object.** — The angle contained between it and the Celestial Meridian.

Def. 44. **Complement of an Arc or Angle.**—The difference between it and 90°.

Def. 45. **Supplement of an Arc or Angle.**—The difference between it and 180°.

LEADING LIGHTS.

ENGLISH CHANNEL.

Bishop Rock	1 F.	
St. Agnes	1 R.	Every minute.
Seven Stones, Lt. V.	2 F.	
Longships	1 F.	*Red* towards the land.
Wolf	1 R.	Every thirty seconds. *Red* and *White* alternately.
Lizard	2 F.	These lights will shortly be altered to *Electric*.
Eddystone	1 F.	
Start Point	2 R.	Every minute.
Portland Bill	2 F.	
Shambles Lt. V.	1 F.	
Needles	1 F.	
St. Catherines	1 F.	
Warner Lt. V.	1 R.	Every minute.
Nab Lt. V.	2 F.	
Owers Lt. V.	1 R.	Every thirty seconds, twice *White* and once *Red*.
Beachey Head	1 R.	Every two minutes. Light visible for 15 seconds.
Royal Sovereign Shoals Lt. V.	1 R.	Every minute, three flashes in quick succession.
Dungeness	1 F.	Electric.
Varne Shoal Lt. V.	1 R.	Every twenty seconds. *Red.*
South Foreland	2 F.	Electric.
East Goodwin Lt. V.	1 R.	Every fifteen seconds. *Green.*
South Sand Head Lt. V.	1 F.	
Gull Stream Lt. V.	1 R.	Every twenty seconds.
North Sand Head Lt. V.	3 F.	Triangular.
North Foreland	1 F.	
Ushant, East end	1 F.	
Casquets	3 R.	Every twenty seconds. Triangular.
Alderney Island	2 F.	*Red.*
Cape de la Hague	1 F.	
Cape Barfleur	1 R.	Every thirty seconds.
Cape Grisnez	1 R.	Every thirty seconds.
Calais	1 F.	Flash every four minutes.

ST. GEORGE'S CHANNEL.

Skelligs	1 F.	
Calf Rock	1 F.	Flash every fifteen seconds.
Fastnet	1 R.	Every minute.
Kinsale	1 F.	
Daunts Rock Lt. V.	1. F.	*Red.*

Roche Point	1 R. *Red*, every minute. 1 F.
Ballycotton	1 F. Flash every ten seconds.
Minehead	1 R. Every minute. Light visible for 50 seconds.
Waterford (Hook)	1 F.
Saltees Lt. V.	2 F.
Tuskar	1 R. Every minute. Twice *white* and once *Red*.
Lucifer Shoals Lt. V.	1 F. *Red.*
Blackwater Bank Lt. V.	1 F.
South Arklow Lt. V.	1 R. Every thirty seconds.
North Arklow Lt. V.	2 F.
Wicklow	1 R. Every thirteen seconds. Light visible for 10 seconds.
Codling Bank Lt. V.	1 R. Every twenty seconds. *Red.*
Kish Lt. V.	1 R. Every minute.
Bailey (Howth(	1F.
Rockabill	1 F. Flash every twelve seconds.
Carlingford	2 F.
Chicken Rock	1 R. Every thirty seconds.
Great Orme Head	1 F.
Point Lynus	1 R. Every ten seconds. Light visible for 8 seconds.
Skerries	2 F. One *White* and the other *Red*.
South Stack	1 R. Every two minutes.
Caernarvon Bay Lt. V.	1 R. Every twenty seconds. Twice *White* and once *Red*.
Bardsey	1 F.
Cardigan Bay Lt. V.	1 R. Every thirty seconds. *Red.*
South Bishop	1 R. Every twenty seconds.
Smalls	1 F.

BAY OF FUNDY.

Cape Sable	1 R. Every forty seconds. Light visible for 15 seconds.
Seal Island	1 F.
Cape Fourcher.	1 R. Every one minute and three quarters. Light visible one minute and a quarter.
Cape St. Mary	1 R. Every thirty seconds. *Red* and *White* alternately.
Briar Island	1 F.
Grand Passage	2 F. Horizontal.
Petit Passage (Boar's Head)	1 R. Every minute. *Red* and *White* alternately.
Point Prim	F.
Marshall Cove	F. Vertical.

Margaretsville	2 F.	*Red.*
Black Rock	1 F.	
Horton Bluff	1 F.	
Burntcoat Head	1 F.	
Parrsboro'	1 F.	
Apple River	1 F.	
Cape Enrage	1 F.	
Grindstone Island	1 F.	
Quaco	1 R.	Every twenty seconds.
Cape Spencer	1 R.	Every forty five seconds. *Red* and *White* alternately.
Partridge Island	1 F.	
Point Lepreau	2 F.	Vertical.
Whitehead (Bliss Island)	1 F.	*Red.*
Wolf Island	1 R.	Every minute and a half.
Campobello Island	1 F.	
Port S. Andrew	1 F.	
Grand Maman (Swallow Tail)	1 F.	
Gannet Rock	1 F.	Flash every four and a half seconds.
Machias Seal Island	2 F.	
West Quoddy Head	1 F.	
Little River	1 F.	Flash every ninety seconds.
Moose Peak	1 R.	Every thirty seconds.
Nash's Island	1 F.	*Red.*
Petit Manan	1 F.	Flash every two minutes.
Mount Desert Rock	1 F.	
Bakers Island	1 F.	Flash every ninety seconds.
Bears Island	1 F.	

NOVA SCOTIA-EAST COAST.

Scatterie Island	1 R.	Every ninety seconds. Light visible for one minute.
Louisburg	1 F.	
Green Island	1 F.	*Red.*
Cape La Ronde	1 F.	
Sydney Harbour	1 F.	*Red.*
Cape Causo	2 F.	Vertical.
Hart Island	1 F.	*Red.*
North Canso	1 F.	
White Head Island	1 R.	Every twenty seconds.
Green Island (Guysboro')	1 F.	
Liscomb Island	1 R.	Every two minutes. *Red* and *White* alternately.
Beaver Island	1 R.	Every two minutes.
Egg Island	1 R.	Every minute. *Red* and *White* alternately.
Sable Island, East end	1 F.	

Sable Island, West end	1 R.	Every three minutes. Light visible for a minute and a half, during which time there will be a flash every half minute.
Devil Island	1 F.	*Red* to seaward.
Mullin's Point	1 F.	
Chebucto Head	1 R.	Every minute.
Sambro	1 F.	
Mahone Bay	1 F.	*Red.*
Chester	1 F.	
Cross Island	1 R.	Every minute.
	1 F.	
Shelbourne Harbor	1 F.	
Green Island (Margaret's Bay)	1 R.	Every ninety seconds. *Red* and *White* alternately.
Lunenburg	1 F.	
West Iron Bound Island	1 R.	Every thirty seconds
Port Medway	1 F.	
Liverpool	1 R.	Every two minutes.
Little Hope Island	1 R.	Every minute. *Red.*
Port Hebert	1 F.	*Red.*
Ragged Island Harbor	1 F.	*Red.*
Shelbourne Harbor	2 F.	Vertical.
Negro Island	1 R.	Every minute. *Red* and *White* alternately.
Barrington	1 F.	*Red.*
Barrington Bay L. V.	1 F.	
Carters Island	1 F.	*Red.*
Cape Sable	1 R.	Every forty seconds. Light visible for 15 seconds
Tusket River	2 F.	Horizontal.
Seal Island	1 F.	

THE ST. LAWRENCE.

Belle Isle	1 F.	
Amour Point	1 F.	
Cape Norman N. F. L.	1 R.	Every two minutes
Point Rich "	1 F.	Flash every fifteen second
Cape Ray "	1 F.	Flash every ten seconds
St. Paul Island N. E point	1 F.	
St. Paul Island S. W. point	1 R.	Every minute
Bird Rocks	1 F.	
Entry Island	1 F.	*Red.*
Amherst Island	1 R.	Every thirty seconds. *Red* and *White* alternately.
Etang du Nord	1 R.	
Cape Despair	1 R.	Every half minute.
Percé Roadstead	1 F.	

Cape Gaspé	1 F.	*Red.*
Cape Rosier	1 F.	
Anticosti Island :		
East end	1 F.	
South Point	1 F.	Flash every twenty seconds.
S. W. point	1 R.	Every minute.
West point	1 F.	
Cape Magdalen	1 R.	Every two minutes. *Red* and *White* alternately.
Egg Island	1 R.	Every ninety seconds.
Matane	1 F.	*Red.*
Cape Chatte	1 R.	Every thirty seconds.
Point des Monts	1 F.	
Little Metis Point	1 R.	Every minute.
Manicouagan Lt. V.	2 F.	
Father Point	1 F.	
Port Neuf	1 F.	
Biquette Island	1 R.	Every two minutes.
Red Island Reef Lt. V.	2 F.	
Red Islet	1 F.	*Red.*
Lark Islet	1 F.	
Green Island	1 F.	
Brandy Pots	1 F.	
Long Pilgrims	1 F.	
Kamouraska	1 F.	
Lower Traverse Lt. V.	2 F.	
Upper Traverse Lt. V.	2 F.	
Stone Pillar	1 R.	Every ninety seconds.
Crane Island	1 F.	
Belle Chasse	1 F.	
St. John, Island of Orleans	1 R.	Every thirty seconds.
Point St. Lawrence, do.	1 F.	
Monté du Lac	1 F.	
St. Antoine	1 F.	
St. Croix	1 F.	
Port Neuf	2 F.	

LAKE ONTARIO.

Snake Island.	1 F	*Red.*
Simcoe or Gage	1 F	
Pigeon Island	1 R.	Every seventy seconds.
Outer Drake or False Rocks.	1 F	
Point Pleasant	1 F	
Point Peter	1 R.	Every hundred seconds.
Salmon or Wicked Point	1 F	*Red.*
Telegraph Island	1 F	
Scotch Bonnet or Egg Island	1 F	

Presqu' Isle:		
East point	1 F.	
On hill inshore	2 F.	
Cobourg	1 F.	
Peter Rock or Gull Island	1 F.	
Port Hope	1 F.	*Red* facing South. *White* facing East and West.
Darlington	1 F.	
Pickering or Liverpool	1 F.	
Gibraltar Point	1 F.	
Toronto	2 F.	
Port Credit	1 F.	
Oakville	1 F.	
Burlington Bay	2 F.	
Dalhousie Harbor	1 R.	
Fox Island	1 F.	

ELEMENTS FROM THE NAUTICAL ALMANAC.

JANUARY, 1876.

Day of the month.	Page I. AT APPARENT NOON. The Sun's. Apparent Declination	Var. in 1 hour.	Equation of Time *to be added to Apparent Time.*	Var. in 1 hour.	Page II. AT MEAN NOON. The Sun's. Apparent Declination.	Semi-diameter	Page XX. Day of the year.
	° ′ ″	″	m s	s	° ′ ″	′ ″	
1	S. 23 2 36.4	12.05	3 38.54	1.190	S. 23 2 37.1	16 18.2	0
2	22 57 33.5	13.20	4 6.92	1.175	22 57 34.4	16 18.2	1
3	22 52 3.1	14.34	4 34.94	1.159	22 52 4.2	16 18.2	2
4	22 46 5.4	15.47	5 2.56	1.142	22 46 6.7	16 18.2	3
5	22 39 40.6	16.59	5 29.76	1.124	22 39 42.1	16 18.2	4
6	22 32 48.9	17.71	5 56.49	1.104	22 32 50.6	16 18.2	5
7	22 25 30.5	18.82	6 22.75	1.084	22 25 32.5	16 18.2	6
8	22 17 45.7	19.91	6 48.50	1.062	22 17 48.0	16 18.1	7
9	22 9 34.7	21.00	7 13.72	1.039	22 9 37.2	16 18.1	8
10	22 0 57.7	22.08	7 38.39	1.016	22 1 0.5	16 18.1	9
11	21 51 55.0	23.14	8 2.49	0.992	21 51 58.1	16 18.0	10
12	21 42 26.9	24.19	8 26.00	0.967	21 42 30.3	16 18.0	11
13	21 32 33.6	25.24	8 48.91	0.941	21 32 37.3	16 17.9	12
14	21 22 15.2	26.28	9 11.19	0.915	21 22 19.2	16 17.8	13
15	21 11 32.2	27.30	9 32.83	0.888	21 11 36.5	16 17.8	14
16	21 0 24.8	28.31	9 53.81	0.860	21 0 29.4	16 17.7	15
17	20 48 53.2	29.31	10 14.12	0.832	20 48 58.2	16 17.6	16
18	20 36 57.8	30.30	10 33.76	0.803	20 37 3.2	16 17.5	17
19	20 24 38.9	31.27	10 52.69	0.774	20 24 44.6	16 17.4	18
20	20 11 56.9	32.23	11 10.89	0.744	20 12 2.9	16 17.3	19
21	19 58 52.1	33.17	11 28.37	0.713	19 58 58.5	16 17.2	20
22	19 45 24.8	34.10	11 45.10	0.681	19 45 31.5	16 17.1	21
23	19 31 35.5	35.01	12 1.08	0.649	19 31 42.5	16 17.0	22
24	19 17 24.5	35.90	12 16.28	0.617	19 17 31.8	16 16.9	23
25	19 2 52.1	36.79	12 30.69	0.584	19 2 59.7	16 16.8	24
26	18 47 58.7	37.65	12 44.30	0.550	18 48 6.7	16 16.7	25
27	18 32 44.9	38.50	12 57.10	0.516	18 32 53.2	16 16.6	26
28	18 17 10.9	39.33	13 9.08	0.482	18 17 19.5	16 16.4	27
29	18 1 17.2	40.14	13 20.24	0.447	18 1 26.1	16 16.3	28
30	17 45 4.1	40.94	13 30.56	0.413	17 45 13.3	16 16.2	29
31	17 28 32.1	41.72	13 40.05	0.378	17 28 41.6	16 16.0	30
32	S. 17 11 41.6	42.48	13 48.69	0.343	S. 17 11 51.4	16 15.9	31

FEBRUARY 1876.

Day of the month.	Page I. AT APPARENT NOON. The Sun's. *Apparent* Declination.	Var. in 1 hour.	Equation of Time *to be added to Apparent Time.*	Var. in 1 hour.	Page II. AT MEAN NOON. The Sun's. *Apparent* Declination.	Semi-diameter.	Page XX. Days of the year.
	° ′ ″	″	m s	s	° ′ ″	′ ″	
1	S. 17 11 41.6	42.48	13 48.69	0.343	S. 17 11 51.4	16 15.9	31
2	16 54 33.1	43.22	13 56.50	0.308	16 54 43.1	16 15.7	32
3	16 37 6.9	43.95	14 3.47	0.273	16 37 17.2	16 15.6	33
4	16 19 23.5	44.66	14 9.60	0.238	16 19 34.0	16 15.4	34
5	16 1 23.3	45.35	14 14.89	0.203	16 1 34.0	16 15.3	35
6	15 43 6.7	46.02	14 19.35	0.169	15 43 17.7	16 15.1	36
7	15 24 34.2	46.68	14 22.99	0.135	15 24 45.4	16 15.0	37
8	15 5 46.1	47.32	14 25.81	0.101	15 5 57.[illegible]	16 14.8	38
9	14 46 42.8	47.94	14 27.85	0.068	14 46 5[illegible].4	16 14.6	39
10	14 27 24.8	48.55	14 29.06	0.035	14 27 36.5	16 14.4	40
11	14 7 52.4	49.14	14 29.51	0.003	14 8 4.3	16 14.2	41
12	13 48 5.9	49.72	14 29.19	0.029	13 48 17.9	16 14.0	42
13	13 28 5.8	50.28	14 28.12	0.060	13 28 17.9	16 13.8	43
14	13 7 52.4	50.82	14 26.31	0.091	13 8 4.7	16 13.6	44
15	12 47 26.2	51.35	14 23.77	0.120	12 47 38.5	16 13.4	45
16	12 26 47.5	51.86	14 20.53	0.150	12 26 59.9	16 13.2	46
17	12 5 56.8	52.36	14 16.58	0.179	12 6 9.2	16 13.0	47
18	11 44 54.4	52.83	14 11.95	0.207	11 45 6.9	16 12.8	48
19	11 23 40.8	53.29	14 6.64	0.235	11 23 53.4	16 12.6	49
20	11 2 16.5	53.73	14 0.67	0.262	11 2 29.0	16 12.4	50
21	10 40 41.7	54.15	13 54.05	0.289	10 40 54.3	16 12.1	51
22	10 18 57.1	54.56	13 46.78	0.316	10 19 9.6	1[illegible] 11.9	52
23	9 57 2.9	54.95	13 38.88	0.342	9 57 15.4	16 11.7	53
24	9 34 59.6	55.32	13 30.37	0.367	9 35 12.0	16 11.5	54
25	9 12 47.6	55.67	13 21.26	0.392	9 13 0.0	16 11.2	55
26	8 50 27.1	56.00	13 11.57	0.416	8 50 39.7	16 11.0	56
27	8 27 59.4	56.32	13 1.29	0.440	8 28 11.6	16 10.7	57
28	8 5 24.0	56.62	12 50.45	0.463	8 5 36.1	16 10.5	58
29	7 42 41.6	56.90	12 39.07	0.485	7 42 53.6	16 10.3	59
30	7 19 52.6	57.17	12 27.16	0.507	7 20 4.5	16 10.0	60

MARCH, 1876.

Day of the month.	Page I. AT APPARENT NOON. The Sun's Apparent Declination.	Page I. The Sun's Var. in 1 hour.	Equation of Time *to be added to Apparent Time.*	Var. in 1 hour.	Page II. AT MEAN NOON. The Sun's Apparent Declination.	Page II. The Sun's Semi-diameter.	Page XX Day of the year.
	° ′ ″	″	m s	s	° ′ ″	′ ″	
1	S. 7 19 52.6	57.17	12 27.16	0.507	S. 7 20 4.5	16 10.0	60
2	6 56 57.6	57.41	12 14.74	0.528	6 57 9.3	16 9.8	61
3	6 33 56.8	57.64	12 1.82	0.548	6 34 8.3	16 9.6	62
4	6 10 50.7	57.86	11 48.42	0.568	6 11 2.1	16 9.3	63
5	5 47 39.6	58.05	11 34.57	0.586	5 47 50.8	16 9.1	64
6	5 24 24.1	58.23	11 20.28	0.604	5 24 35.1	16 8.8	65
7	5 1 4.4	58.40	11 5.57	0.621	5 1 15.2	16 8.6	66
8	4 37 40.9	58.55	10 50.46	0.637	4 37 51.4	16 8.3	67
9	4 14 13.9	58.69	10 34.98	0.652	4 14 24.2	16 8.0	68
10	3 50 43.8	58.81	10 19.15	0.666	3 50 53.9	16 7.8	69
11	3 27 10.9	58.92	10 3.00	0.679	3 27 20.8	16 7.5	70
12	3 3 35.6	59.02	9 46.56	0.691	3 3 45.2	16 7.2	71
13	2 39 58.1	59.10	9 29.84	0.702	2 40 7.5	16 7.0	72
14	2 16 19.0	59.16	9 12.87	0.712	2 16 28.1	16 6.7	73
15	1 52 38.4	59.21	8 55.67	0.721	1 52 47.3	16 6.4	74
16	1 28 56.8	59.25	8 38.27	0.729	1 29 5.4	16 6.2	75
17	1 5 14.5	59.27	8 20.69	0.736	1 5 22.7	16 5.9	76
18	0 41 31.9	59.28	8 2.94	0.742	0 41 39.8	16 5.6	77
19	S. 0 17 49.3	59.27	7 45.05	0.748	S. 0 17 56.9	16 5.3	78
20	N. 0 5 52.9	59.24	7 27.03	0.753	N. 0 5 45.5	16 5.0	79
21	0 29 34.3	59.20	7 8.91	0.757	0 29 27.2	16 4.8	80
22	0 53 14.5	59.14	6 50.70	0.760	0 53 7.7	16 4.5	81
23	1 16 53.2	59.07	6 32.41	0.763	1 16 46.7	16 4.2	82
24	1 40 29.9	58.98	6 14.08	0.765	1 40 23.8	16 3.9	83
25	2 4 4.4	58.88	5 55.71	0.766	2 3 58.6	16 3.6	84
26	2 27 36.2	58.76	5 37.33	0.766	2 27 30.7	16 3.4	85
27	2 51 4.9	58.62	5 18.95	0.766	2 50 59.7	16 3.1	86
28	3 14 30.2	58.47	5 0.58	0.765	3 14 25.3	16 2.8	87
29	3 37 51.7	58.31	4 42.25	0.763	3 37 47.1	16 2.6	88
30	4 1 9.0	58.13	4 23.97	0.760	4 1 4.7	16 2.3	89
31	4 24 21.7	57.93	4 5.76	0.757	4 24 17.7	16 2.0	90
32	N. 4 47 29.5	57.71	3 47.63	0.753	N. 4 47 25.8	16 1.7	91

APRIL, 1876.

Day of the Month.	Page I. AT APPARENT NOON. The Sun's Apparent Declination.	Var. in 1 hour.	Equation of Time *to be added to* / *subt. from* Apparent Time.	Var. in 1 hour.	Page II. AT MEAN NOON. The Sun's Apparent Declination.	Semi-diameter.	Page XX. Day of the year
	° ′ ″	″	m s	s	° ′ ″	′ ″	
1	N. 4 47 29.5	57.71	3 47.63	0.753	N. 4 47 25.8	16 1.7	91
2	5 10 32.0	57.49	3 29.60	0.749	5 10 28.6	16 1.5	92
3	5 33 28.9	57.25	3 11.69	0.743	5 33 25.8	16 1.2	93
4	5 56 19.8	56.99	2 53.92	0.737	5 56 17.0	16 0.9	94
5	6 19 4.4	56.72	2 36.30	0.730	6 19 1.9	16 0.6	95
6	6 41 42.4	56.44	2 18.87	0.722	6 41 40.2	16 0.4	96
7	7 4 13.5	56.15	2 1.64	0.713	7 4 11.6	16 0.1	97
8	7 26 37.4	55.84	1 44.63	0.703	7 26 35.8	15 59.8	68
9	7 48 53.8	55.52	1 27.88	0.692	7 48 52.5	15 59.6	99
10	8 11 2.4	55.19	1 11.39	0.681	8 11 1.3	15 59.3	100
11	8 33 2.8	54.84	0 55.19	0.669	8 33 2.0	15 59.0	101
12	8 54 54.8	54.48	0 39.30	0.655	8 54 54.2	15 58.7	102
13	9 16 38.0	54.11	0 23.74	0.641	9 16 37.7	15 58.5	103
14	9 38 12.1	53.73	0 8.52	0.627	9 38 12.0	15 58.2	104
15	9 59 36.8	53.33	0 6.34	0.611	9 59 36.9	15 57.9	105
16	10 20 51.8	52.91	0 20.82	0.595	10 20 52.1	15 57.6	106
17	10 41 56.6	52.48	0 34.91	0.579	10 41 57.1	15 57.4	107
18	11 2 51.0	52.04	0 48.60	0.561	11 2 51.7	15 57.1	108
19	11 23 34.6	51.59	1 1.86	0.543	11 23 35.5	15 56.8	109
20	11 44 7.1	51.12	1 14.69	0.525	11 44 8.[illegible]	15 56.6	110
21	12 4 28.1	50.63	1 27.08	0.507	12 4 29.3	15 56.3	111
22	12 24 37.3	50.13	1 39.01	0.487	12 24 38.7	15 56.1	112
23	12 44 34.3	49.61	1 50.47	0.468	12 44 35.8	15 55.8	113
24	13 4 18.8	49.08	2 1.43	0.448	13 4 20.5	15 55.5	114
25	13 23 50.4	48.54	2 11.97	0.428	13 23 52.2	15 55.3	115
26	13 43 8.8	47.98	2 21.98	0.407	13 43 10.7	15 55.0	116
27	14 2 13.6	47.41	2 31.50	0.386	14 2 15.6	15 54.8	117
28	14 21 4.5	46.82	2 40.53	0.366	14 21 6.6	15 54.6	118
29	14 39 41.2	46.22	2 49.06	0.345	14 39 43.3	15 54.3	119
30	14 58 3.2	45.61	2 57.08	0.323	14 58 5.4	15 54.1	120
31	N. 15 16 10.3	44.98	3 4.58	0.302	N. 15 16 12.6	15 53.9	121

MAY, 1876.

Day of the month.	Page I. AT APPARENT NOON. The Sun's *Apparent* Declination.	Var. in 1 hour.	Equation of Time *to be subtracted from Apparent Time.*	Var. in 1 hour.	Page II. AT MEAN NOON. The Sun's *Apparent* Declination.	Semi-diameter.	Page XX. Day of the year.
	° ′ ″	″	m s	s	° ′ ″	′ ″	
1	N. 15 16 10.3	44.98	3 4.58	0.302	N. 15 16 12.6	15 53.9	121
2	15 34 2.2	44.34	3 11.57	0.280	15 34 4.6	15 53.7	122
3	15 51 38.6	43.69	3 18.03	0.258	15 51 41.0	15 53.4	123
4	16 8 59.2	43.02	3 23.95	0.235	[illegible] 9 1.6	15 53.2	124
5	16 26 3.7	42.34	3 29.33	0.212	[illegible] 6.1	15 53.0	125
6	16 42 51.7	41.66	3 34.15	0.189	[illegible] 42 54.2	15 52.8	126
7	16 59 23.2	40.96	3 38.41	0.166	16 59 25.6	15 52.5	127
8	17 15 37.7	40.25	3 42.11	0.142	17 15 40.1	15 52.3	128
9	17 31 35.0	39.52	3 45.23	0.118	17 31 37.5	15 52.1	129
10	17 47 14.8	38.79	3 47.76	0.094	17 47 17.3	15 51.9	130
11	18 2 36.9	38.05	3 49.72	0.069	18 2 39.3	15 51.7	131
12	18 17 41.0	37.29	3 51.09	0.045	18 17 43.4	15 51.5	132
13	18 32 26.7	36.52	3 51.88	0.021	18 32 29.0	15 51.3	133
14	18 46 53.8	35.73	3 52.08	0.004	18 46 56.1	15 51.1	134
15	19 1 1.9	34.94	3 51.69	0.028	19 1 1.2	15 50.9	135
16	19 14 51.0	34.14	3 50.72	0.052	19 14 53.2	15 50.7	136
17	19 28 20.6	33.32	3 49.17	0.076	19 28 22.7	15 50.5	137
18	19 41 30.4	32.49	3 47.05	0.100	19 41 32.5	15 50.3	138
19	19 54 20.3	31.65	3 44.36	0.124	19 54 22.[illegible]	[illegible]	139
20	20 6 49.8	30.80	3 41.10	0.148	20 6 51.[illegible]	[illegible]	140
21	20 18 58.8	29.94	3 37.28	0.171	20 19 [illegible]	[illegible]	141
22	20 30 47.0	29.07	3 32.91	0.193	20 30 48.7	15 49.5	142
23	20 42 14.1	28.19	3 28.01	0.215	20 42 15.8	15 49.4	143
24	20 53 19.9	27.29	3 22.60	0.236	20 53 21.5	15 49.2	144
25	21 4 4.1	26.39	3 16.68	0.256	21 4 5.6	15 49.0	145
26	21 14 26.5	25.48	3 10.29	0.276	21 14 27.9	15 48.9	146
27	21 24 26.9	24.55	3 3.43	0.295	21 24 28.2	15 48.7	147
28	21 34 5.0	23.62	2 56.12	0.314	21 34 6.2	15 48.6	148
29	21 43 20.6	22.68	2 48.38	0.331	21 43 21.7	15 48.5	149
30	21 52 13.6	21.73	2 40.23	0.348	21 52 14.5	15 48.3	150
31	22 0 43.7	20.77	2 31.67	0.365	22 0 44.6	15 48.2	151
32	N. 22 8 50.8	19.81	2 22.73	0.380	N. 22 8 51.6	15 48.1	152

JUNE, 1876.

Day of the month.	Page I. AT APPARENT NOON. The Sun's Apparent Declination.	Var. in 1 hour.	Equation of Time *to be subt. from* / *added to Apparent Time.*	Var. in 1 hour.	Page II. AT MEAN NOON. The Sun's Apparent Declination.	Semi-diameter.	Page XX. Day of the year.
	° ′ ″	″	m s	s	° ′ ″	′ ″	
1	N. 22 8 50.8	19.81	2 22.73	0.380	N. 22 8 51.6	15 48.1	152
2	22 16 34.7	18.84	2 13.41	0.396	22 16 35.4	15 47.9	153
3	22 23 55.3	17.87	2 3.73	0.411	22 23 56.0	15 47.8	154
4	22 30 52.5	16.89	1 53.71	0.425	22 30 53.1	15 47.7	155
5	22 37 26.1	15.90	1 43.35	0.438	22 37 26.6	15 47.6	156
6	22 43 35.9	14.91	1 32.68	0.451	22 43 36.3	15 47.5	157
7	22 49 21.9	13.92	1 21.71	0.463	22 49 22.2	15 47.4	158
8	22 54 44.0	12.92	1 10.45	0.475	22 54 44.2	15 47.2	159
9	22 59 42.0	11.91	0 58.93	0.485	22 59 42.1	15 47.1	160
10	23 4 15.7	10.90	0 47.17	0.495	23 4 15.9	15 47.0	161
11	23 8 25.2	9.89	0 35.17	0.504	23 8 25.3	15 46.9	162
12	23 12 10.3	8.87	0 22.96	0.512	23 12 10.4	15 46.8	163
13	23 15 30.9	7.85	0 10.57	0.520	23 15 31.0	15 46.7	164
14	23 18 27.0	6.82	0 1.99	0.526	23 18 27.6	15 46.7	165
15	23 20 58.4	5.79	0 14.69	0.532	23 20 58.4	15 46.6	166
16	23 23 5.1	4.76	0 27.52	0.537	23 23 5.1	15 46.5	167
17	23 24 47.0	3.73	0 40.46	0.541	23 24 47.0	15 46.4	168
18	23 26 4.1	2.70	0 53.48	0.543	23 26 4.1	15 46.4	169
19	23 26 56.4	1.66	1 6.55	0.545	23 26 56.4	15 46.3	170
20	23 27 23.9	0.63	1 19.65	0.546	23 27 23.9	15 46.2	171
21	23 27 26.5	0.41	1 32.75	0.545	23 27 26.5	15 46.2	172
22	23 27 4.2	1.44	1 45.82	0.543	23 27 4.3	15 46.1	173
23	23 26 17.1	2.48	1 58.82	0.540	23 26 17.2	15 46.1	174
24	23 25 5.2	3.51	2 11.72	0.535	23 25 5.4	15 46.1	175
25	23 23 28.6	4.54	2 24.50	0.529	23 23 28.8	15 46.0	176
26	23 21 27.2	5.57	2 37.13	0.523	23 21 27.5	15 46.0	177
27	23 19 [illegible]	6.59	2 49.59	0.515	23 19 1.5	15 46.0	178
28	23 16 10.7	7.61	3 1.84	0.506	23 16 11.0	15 46.0	179
29	23 12 55.7	8.64	3 13.87	0.496	23 12 56.1	15 46.0	180
30	23 9 16.[illegible]	9.65	3 25.67	0.486	23 9 16.8	15 46.0	181
31	N. 23 5 12.5	10.66	3 37.20	0.475	N. 23 5 13.2	15 46.0	182

JULY, 1876.

Day of the month.	Page I. AT APPARENT NOON. The Sun's. *Apparent* Declination.	Var. in 1 hour.	Equation of Time *to be added to Apparent Time.*	Var. in 1 hour.	Page II. AT MEAN NOON. The Sun's. *Apparent.* Declination.	Semi-diameter.	Day of the year.
	° ′ ″	′	m s	s	° ′ ″	′ ″	
1	N. 23 5 12.5	10.66	3 37.20	0.475	N. 23 5 13.2	15 46.0	182
2	23 0 44.7	11.66	3 48.46	0.463	23 0 45.4	15 46.0	183
3	22 55 52.8	12.66	3 59.42	0.450	22 55 53.6	15 46.0	184
4	22 50 37.0	13.65	4 10.66	0.436	22 50 38.0	15 46.0	185
5	22 44 57.4	14.64	4 20.37	0.422	22 44 58.5	15 46.0	186
6	22 38 54.2	15.62	4 30.34	0.407	22 38 55.3	15 46.0	187
7	22 32 27.5	16.60	4 39.93	0.392	22 32 28.7	15 46.0	188
8	22 25 37.4	17.57	4 49.14	0.376	22 25 38.8	15 46.0	189
9	22 18 24.1	18.54	4 57.96	0.359	22 18 25.6	15 46.1	190
10	22 10 47.7	19.49	5 6.37	0.342	22 10 49.4	15 46.1	191
11	22 2 48.5	20.44	5 14.36	0.324	22 2 50.3	15 46.1	192
12	21 54 26.5	21.39	5 21.91	0.305	21 54 28.4	13 46.2	193
13	21 45 41.9	22.32	5 29.01	0.286	21 45 44.0	15 46.2	194
14	21 36 35.0	23.25	5 35.65	0.267	21 36 37.2	15 46.3	195
15	21 27 5.9	24.17	5 41.82	0.247	21 27 8.2	15 46.3	196
16	21 17 14.8	25.08	5 47.51	0.227	21 17 17.2	15 46.4	197
17	21 7 1.9	25.99	5 52.71	0.206	21 7 4.5	15 46.4	198
18	20 56 27.5	26.88	5 57.39	0.184	20 56 30.2	15 46.5	199
19	20 45 31.8	27.76	6 1.55	0.162	20 45 34.6	15 46.6	200
20	20 34 15.1	28.63	6 5.16	0.139	20 34 18.0	15 46.6	201
21	20 22 37.5	29.49	6 8.22	0.116	20 22 40.5	15 46.7	202
22	20 10 39.4	30.34	6 10.71	0.092	20 10 42.6	15 46.8	203
23	19 58 21.1	31.18	6 12.61	0.067	19 58 24.4	15 46.9	204
24	19 45 42.9	32.00	6 13.91	0.042	19 45 46.2	15 47.0	205
25	19 32 44.9	32.82	6 14.61	0.016	19 32 48.3	15 47.1	206
26	19 19 27.5	33.63	6 14.70	0.009	19 19 31.0	15 47.2	257
27	19 5 50.9	34.42	6 14.18	0.035	19 5 54.5	15 47.3	208
28	18 51 55.5	35.20	6 13.04	0.060	18 51 59.2	15 47.4	209
29	18 37 41.5	35.96	6 11.28	0.086	18 37 45.3	15 47.5	210
30	18 23 0.3	36.72	6 8.90	0.112	18 23 13.1	15 47.7	211
31	18 8 19.1	37.46	6 5.91	0.137	18 8 22.9	15 47.8	212
32	N. 17 53 11.1	38.20	6 2.30	0.163	N. 17 53 15.0	15 47.9	213

AUGUST 1876.

Days of the month.	Page I. AT APPARENT NOON. The Sun's Apparent Declination.	The Sun's Var. in 1 hour.	Equation of Time to be added to subt. from Apparent Time.	Var. in 1 hour.	Page II AT MEAN MOON. The Sun's Apparent Declination	The Sun's Semi-diameter.	Page XX Days of the year.
	° ′ ″	″	m s	s	° ′ ″	′ ″	
1	N 17 53 11.1	38.20	6 2.30	0.163	N. 17 53 15.0	15 47.9	213
2	17 37 45 7	38.91	5 58.07	0.189	17 37 49.6	15 48.1	214
3	17 22 3 3	39.62	5 53 23	0.214	17 22 7.2	15 48.2	215
4	17 6 3 9	40.32	5 47.79	0.239	17 6 7.8	15 48.3	216
5	16 49 48.0	41.00	5 41.74	0.264	16 49 51.9	15 48.5	217
6	16 33 15.8	41.68	5 35.10	0.289	16 33 19.7	15 48.6	218
7	16 16 27.6	42.34	5 27.87	0.313	16 16 31.5	15 48.8	219
8	15 59 23.7	42.99	5 20 06	0.337	15 59 27.5	15 48.9	220
9	15 42 4 2	43.63	5 11.69	0.361	15 42 8.0	15 49.1	221
10	15 24 29 6	44.25	5 2.75	0.384	15 24 33.3	15 49.3	222
11	15 6 40.1	44.87	4 53 27	0.406	15 6 43.8	15 49.4	223
12	14 48 36.0	45.47	4 43.24	0.428	14 48 39.6	15 49 6	224
13	14 30 17.5	46.06	4 32.69	0.450	14 30 21.0	15 49.7	225
14	14 11 45.1	46.64	4 21.62	0.472	14 11 48.5	15 49.9	226
15	13 52 59.0	47.20	4 10.03	0.493	13 53 2.2	15 50.1	227
16	13 33 59.4	47.75	3 57.94	0.514	13 34 2.6	15 50.3	228
17	13 14 46.9	48.29	3 45 35	0.535	13 14 49.9	15 50.4	229
18	12 55 21.7	48.81	3 32.26	0.556	12 55 24.6	15 50.6	230
19	12 35 44.1	49.32	3 18.68	0.576	12 35 46.8	15 50.8	231
20	12 15 54.5	49.81	3 4.62	0.596	12 15 57.1	15 51.0	232
21	11 55 53.3	50.29	2 50.09	0.615	11 55 55.7	15 51.2	233
22	11 35 40.8	50.75	2 35.09	0.634	12 35 43.0	15 51.4	234
23	11 15 17.3	51.20	2 19.64	0.653	11 15 19.3	15 51.6	235
24	10 54 43 1	51.64	2 3.75	0.671	10 54 44.9	15 51.9	236
25	10 33 58.7	52.06	1 47.43	0.688	10 34 0.3	15 52.1	237
26	10 13 4.4	52.46	1 30.71	0.705	10 13 5.7	15 52 3	238
27	9 52 0 4	52.86	1 13.58	0.722	9 52 1.4	15 52.5	239
28	9 30 47.0	53.24	0 56.07	0.737	9 30 47.9	15 52.8	240
29	9 9 24.7	53.61	0 38.19	0.752	9 9 25.3	15 53.0	241
30	8 47 53.8	53.96	0 19.97	0.766	8 47 54.1	15 53.2	242
31	8 26 14.4	54.31	0 1.41	0.780	8 26 14.4	15 53.4	243
32	N. 8 4 27 0	54.64	0 17.46	0.793	N. 8 4 26.8	15 53.7	244

SEPTEMBER, 1876.

Day of the month.	Page I. AT APPARENT NOON.				Page II. AT MEAN NOON.		Page XX.
	THE SUN'S.		Equation of Time *to be substracted from Apparent Time.*	Var. in 1 hour.	THE SUN'S		Day of the year.
	Apparent Declination.	Var. in 1 hour.			*Apparent* Declination.	Semi-diameter.	
	° ′ ″	″	m s		° ′ ″	′ ″	
1	N. 8 4 27.0	54.64	0 17.46	0.793	N. 8 4 26.8	15 53.7	244
2	7 42 31.9	54.95	0 36.63	0.805	7 42 31.4	15 53.9	245
3	7 20 29.4	55.25	0 56.08	0.815	7 20 28.5	15 54.2	246
4	6 58 19.7	55.55	1 15.77	0.825	6 58 18.5	15 54.4	247
5	6 36 3.2	55.83	1 35.70	0.835	6 36 1.7	15 54.6	248
6	6 13 40.1	56.09	1 55.84	0.843	6 13 38.2	15 54.9	249
7	5 51 10.7	56 35	2 16.16	0.850	5 51 8.5	15 55.1	250
8	5 28 35.3	56.59	2 36.65	0.857	5 28 32.9	15 55.4	251
9	5 5 54.3	56.82	2 57.29	0.862	5 5 51.5	15 55.6	252
10	4 43 7.9	57.04	3 18.04	0.867	4 43 4.8	15 55.9	253
11	4 20 16.5	57.24	3 38.89	0.871	4 20 13.0	15 56.1	254
12	3 57 20.3	57.43	3 59.83	0.874	3 57 16.5	15 56.4	255
13	3 34 19.8	57.60	4 20.84	0.876	3 34 15.7	15 56.6	256
14	3 11 15.3	57.76	4 41.89	0.878	3 11 10.8	15 56.9	257
15	2 48 7.1	57.91	5 2.98	0.879	2 48 2.2	15 57.1	258
16	2 24 55.6	58.04	5 24.09	0.879	2 24 50.4	15 57.4	259
17	2 1 41.2	58.15	5 45.15	0.879	2 1 35.6	15 57.6	260
18	1 38 24.2	58.25	6 6.28	0.878	1 38 18.3	15 57.9	261
19	1 15 5.0	58.34	6 27.33	0.876	1 14 58.7	15 58.2	262
20	0 51 44.0	58.41	6 48.33	0.874	0 51 37.3	15 58.4	263
21	0 28 21.4	58.46	7 9.26	0.870	0 28 14.5	15 58.7	264
22	N. 0 4 57.8	58.50	7 30.10	0.866	N. 0 4 50.5	15 59.0	265
23	S. 0 18 26.6	58.53	7 50.84	0.861	S. 0 18 34.3	15 59.3	266
24	0 41 51.4	58.54	8 11.45	0.856	0 41 59.4	15 59.5	267
25	1 5 16.3	58.53	8 31.92	0.849	1 5 24.6	15 59.8	268
26	1 28 40.9	58.51	8 52.22	0.842	1 28 49.5	16 0.1	269
27	1 52 4.8	58.48	9 12.34	0.834	1 52 13.8	16 0.4	270
28	2 15 27.8	58.43	9 32.26	0.825	2 15 37.1	16 0.7	271
29	2 38 49.4	58.37	9 51.95	0.815	2 38 59.0	16 1.0	272
30	3 2 9.4	58.29	10 11.40	0.805	3 2 19.3	16 1.2	273
31	S. 3 25 27.4	58.20	10 30.57	0.793	S. 3 25 37.6	16 1.5	274

OCTOBER, 1876.

Day of the month.	Page I. AT APPARENT NOON. The Sun's. Apparent Declination.	Var. in 1 hour.	Equation of Time *to be subtracted from Apparent Time.*	Var. in 1 hour.	Page II. AT MEAN NOON. The Sun's. Apparent Declination.	Semi-diameter.	Day of the year.
	° ′ ″	″	m s	s	° ′ ″	′ ″	
1	S. 3 25 27.4	58.20	10 30.57	0.793	S. 3 25 37.6	16 1.5	274
2	3 48 43.1	58.10	10 49 45	0.780	3 48 53.5	16 1.8	275
3	4 11 56.1	57.98	11 8.02	0 766	4 12 6.8	16 2.1	276
4	4 35 6.1	57.85	11 26.24	0.751	4 35 17.2	16 2.3	277
5	4 58 12.9	57.70	11 44.09	0.736	4 58 24.2	16 2.6	278
6	5 21 16.0	57.55	12 1.55	0.719	5 21 27.6	16 2.9	279
[illegible]	5 44 15.2	57.38	12 18.59	0 701	5 44 27.0	16 3.2	280
8	6 7 10.1	57.19	12 35.19	0.682	6 7 22.1	16 3.5	281
9	6 30 0.4	56.99	12 51.34	0.663	6 30 12.6	16 3.7	282
10	6 52 45.6	56.77	13 7.01	0.643	6 52 58.0	16 4.0	283
11	7 15 25.4	56.54	13 22.18	0.622	7 15 38.0	16 4.3	284
12	7 37 59.5	56.29	13 36.84	0.600	7 38 12.3	16 4.5	285
13	8 0 27.3	56.02	13 50.97	0.577	8 0 40.3	16 4.8	286
14	8 22 48.6	55.74	14 4.54	0.554	8 23 1 6	16 5.1	287
15	8 45 2.8	55.44	14 17.55	0.530	8 45 16.0	16 5.3	288
16	9 7 9.6	55.12	14 29.98	0.506	9 7 22.9	16 5.6	289
17	9 29 8.6	54.78	14 41.82	0.481	9 29 22.0	16 5.9	290
18	9 50 59.3	54.43	14 53.05	0.455	9 51 12.8	16 6.2	291
19	10 12 41.4	54.06	15 3.66	0.429	10 12 55.0	16 6.4	292
20	10 34 14.4	53.68	15 13.63	0.402	10 34 28.1	16 6.7	293
21	10 55 38 0	53.28	15 22.96	0.375	10 55 51.7	16 7.0	294
22	11 16 51.7	52.86	15 31.63	0.347	11 17 5.4	16 7.2	295
23	11 37 55.1	52.42	15 39.62	0.319	11 38 8.8	15 7.5	296
24	11 58 47.8	51.97	15 46.93	0 290	11 59 1.5	16 7.8	297
25	12 19 29.4	51.49	15 53.55	0.261	12 19 43.1	16 8.1	298
26	12 39 59.5	51.01	15 59.46	0.231	12 40 13 1	16 8.3	299
27	13 0 17.7	50.50	16 4.65	0.201	13 0 31.2	16 8.6	300
28	13 20 23.6	49.98	16 9.10	0.170	13 20 37.1	16 8.8	301
29	13 40 16.9	49.45	16 12.81	0.139	13 40 30.2	16 9.1	302
30	13 59 57.1	48.89	16 15.75	0.107	14 0 10.3	16 9.4	303
31	14 19 23.8	48.32	16 17.92	0.074	14 19 36.9	16 9.6	304
32	S. 14 38 36.7	47.74	16 19.29	0.040	S. 14 38 49.7	16 9.9	305

NOVEMBER, 1876.

Day of the month.	Page I. AT APPARENT NOON. The Sun's. *Apparent* Declination.	Page I. The Sun's. Var. in 1 hour.	Equation of Time *to be substracted from Apparent Time*.	Var. in 1 hour.	Page II. AT MEAN NOON. The Sun's. *Apparent* Declination.	Page II. The Sun's. Semi-diameter.	Page XX. Day of the year.
	° ′ ″	″	m s		° ′ ″	′ ″	
1	S. 14 38 36.7	47.74	16 19.29	0.040	S. 14 38 49.7	16 9.9	305
2	14 57 35.4	47.14	16 19.86	0.007	14 57 48.2	16 10.1	306
3	15 16 19.5	46.53	16 19.61	0.027	15 16 32.2	16 10.4	307
4	15 34 48.7	45.90	16 18.54	0.062	15 35 1.2	16 10.6	308
5	15 53 2.6	45.25	16 16.63	0.097	15 53 14.8	16 10.8	209
6	16 11 0.7	44.59	16 13.87	0.133	16 11 12.8	16 11.1	310
7	16 28 42.7	43.90	16 10.25	0.169	16 28 54.5	16 11.3	311
8	16 46 8.1	43.21	16 5.77	0.205	16 46 19.7	16 11.5	312
9	17 3 16.6	42.49	16 0.43	0.241	17 3 28.0	16 11.7	313
10	17 20 7.7	41.76	15 54.22	0.277	17 20 18.8	16 12.0	314
11	17 36 41.0	41.01	15 47.14	0.313	17 36 51.7	16 12.2	315
12	17 52 56.0	40.24	15 39.20	0.349	17 53 6.5	16 12.4	316
13	18 8 52.4	39.45	15 30.39	0.385	18 9 2.6	16 12.6	317
14	18 24 29.7	38.65	15 20.71	0.421	18 24 39.6	16 12.8	318
15	18 39 47.5	37.83	15 10.19	0.456	18 39 57.1	16 13.0	319
16	18 54 45.5	36.99	14 58.82	0.491	18 54 54.7	16 13.2	320
17	19 9 23.2	36.14	14 46.61	0.526	19 9 32.1	16 13.4	321
18	19 23 40.2	35.27	14 33.57	0.560	19 23 48.8	16 13.6	322
19	19 37 36.2	34.39	14 19.71	0.594	19 37 44.4	16 13.8	323
20	19 51 10.8	33.49	14 5.05	0.627	19 51 18.6	16 14.0	324
21	20 4 23.5	32.57	13 49.60	0.660	20 4 31.0	16 14.2	325
22	20 17 14.1	31.64	13 33.37	0.692	20 17 21.2	16 14.4	326
23	20 29 42.2	30.69	13 16.37	0.724	20 29 49.0	16 14.6	327
24	20 41 47.4	29.73	12 58.62	0.755	20 41 53.8	16 14.8	328
25	20 53 29.4	28.76	12 40.14	0.785	20 53 35.4	16 15.0	329
26	21 4 47.8	27.77	12 20.93	0.815	21 4 53.5	16 15.2	330
27	21 15 42.4	26.77	12 1.01	0.844	21 15 47.8	16 15.3	331
28	21 26 12.9	25.76	11 40.40	0.873	21 26 17.9	16 15.5	332
29	21 36 18.9	24.74	11 19.11	0.901	21 36 23.6	16 15.7	333
30	21 46 0.2	23.70	10 57.16	0.928	21 46 4.6	16 15.8	334
31	S. 21 55 16.6	22.66	10 34.56	0.955	S. 21 55 20.6	16 16.0	335

DECEMBER, 1876.

Day of the month.	Page I. AT APPARENT NOON. The Sun's. Apparent Declination.	Var. in 1 hour.	Equation of Time *to be subt. from* / *added to Apparent Time.*	Var. in 1 hour.	Page II. AT MEAN NOON. The Sun's. Apparent Declination.	Semi-diameter.	Page XX. Day of the year.
	° ′ ″		m s	s	° ′ ″	′ ″	
1	S. 21 55 16.6	22.66	10 34.56	0.955	S. 21 55 20.6	16 16.0	335
2	22 4 7.8	21.60	10 11.32	0.981	22 4 11.4	16 16.1	336
3	22 12 33.4	20.53	9 47.47	1.006	22 12 36.7	16 16.3	337
4	22 20 33.3	19.45	9 23.03	1.030	22 20 36.3	16 16.4	338
5	22 28 7.2	18.37	8 58.02	1.054	22 28 10.0	16 16.5	339
6	22 35 14.9	17 27	8 32.46	1.076	22 35 17.4	16 16.6	340
7	22 41 56.1	16.16	8 6.38	1.097	22 41 58.3	16 16.7	341
8	22 48 10.5	15.04	7 39.79	1.118	22 48 12.4	16 16.8	342
9	22 53 57.9	13.91	7 12.73	1.137	22 53 59.6	16 17.0	343
10	22 59 18.2	12.78	6 45.23	1.154	22 59 19.7	16 17.1	344
11	23 4 11.2	11.64	6 17.32	1.171	23 4 12.4	16 17.2	345
12	23 8 36.7	10.48	5 49.03	1.186	23 8 37.7	16 17.3	346
13	23 12 34.4	9.33	5 20.40	1.200	23 12 35.3	16 17.4	347
14	23 16 4.4	8.17	4 51.45	1.212	23 16 5.1	16 17.4	348
15	23 19 6.5	7.00	4 22.24	1.222	23 19 7.0	16 17.5	349
16	23 21 40.5	5.83	3 52.79	1.231	23 21 40.9	16 17.6	350
17	23 23 46.4	4.66	3 23.14	1.239	23 23 46.7	16 17.7	351
18	23 25 24.1	3.48	2 53.34	1.244	23 25 24.3	16 17.7	352
19	23 26 33.6	2.31	2 23.42	1.248	23 26 33.7	16 17.8	353
20	23 27 14.8	1.13	1 53.42	1.251	23 27 14.8	16 17.9	354
21	23 27 27.6	0.06	1 23.37	1.252	23 27 27.6	16 18.0	355
22	23 27 12.0	1.24	0 53.31	1.252	23 27 12.0	16 18.0	356
23	23 26 28.1	2.42	0 23.28	1.250	23 26 28.1	16 18.1	357
24	23 25 15.9	3.60	0 6.68	1.246	23 25 15.9	16 18.1	358
25	23 23 35.5	4.77	0 36.55	1.242	23 23 35.5	16 18.2	359
26	23 21 26.8	5.95	1 6.29	1.236	23 21 26.9	16 18.2	360
27	23 18 50.0	7.12	1 35.87	1.229	23 18 50.2	16 18.3	361
28	23 15 45.1	8.29	2 5.26	1.220	23 15 45.4	16 18.2	362
29	23 12 12.3	9.45	2 34.43	1.210	23 12 12.7	16 18.3	363
30	23 8 11.6	10.60	3 3.35	1.199	23 8 12.2	16 18.3	364
31	23 3 43.3	11.75	3 31.99	1.187	23 3 44.0	16 18.3	365
32	S. 22 58 47.4	12.90	4 0.32	1.174	S. 22 58 48.2	16 18.3	366

APPARENT PLACES OF STARS 1876.

AT UPPER TRANSIT AT GREENWICH.

γ Pegasi. (*Algenib*)

Date.	Dec. *North.*	
	14° 29′	
Jan. 1	41.7″	
11	40.9	*0.8″*
21	40.0	*0.9*
31	39.1	*0.9*

α Eridani. (*Achernar*)

Date.	Dec. *South.*	
	57° 51′	
Jan. 11	75.7″	
21	75.4	*0.3″*
31	74.6	*0.8*
Feb. 10	73.2	*1.4*

α Persei.

Date.	Dec. *North.*	
	49° 25′	
July 9	6.9″	
19	7.3	*0.4″*
29	8.0	*0.7*
Aug. 8	9.0	*1.0*

γ^1 Eridani.

Date.	Dec. *South.*	
	13° 51′	
Aug. 8	21.1″	
18	19.8	*1.3″*
28	18.8	*1.0*
Sept. 7	18.2	*0.6*

α Aurigæ. (*Capella*)

Date.	Dec. *North.*	
	45° 52′	
Feb. 10	26.8″	
20	27.3	*0.5″*
Mar. 1	27.5	*0.2*
11	27.4	*0.1*

β Orionis. (*Rigel*)

Date.	Dec. *South.*	
	8° 20′	
Feb. 10	47.5″	
20	48.1	*0.6″*
Mar. 1	48.5	*0.4*
11	48.6	*0.1*

δ Orionis.

Date.	Dec. *South.*	
	0° 23′	
Nov. 6	16.9″	
16	18.1	*1.2″*
26	19.5	*1.4*
Dec. 6	20.9	*1.4*

μ Geminorum.

Date.	Dec. *North.*	
	22° 34′	
Dec. 6	36.1″	
16	35.9	*0.2″*
26	35.8	*0.1*
36	35.7	*0.1*

α Argus. (*Canopus*)

Date.	Dec. *South.*	
	52° 37′	
Mar. 21	53.7″	
31	53.7	*0.0″*
Apr. 10	53.1	*0.6*
20	52.1	*1.0*

α Canis Majoris. (*Sirius*)

Date.	Dec. *South.*	
	16° 32′	
Aug. 8	36.1″	
18	34.6	*1.5″*
28	33.4	*1.2*
Sept. 7	32.5	*0.9*

α Canis Minoris. (*Procyon*)

Date.	Dec. *North.*	
	5° 32′	
Aug. 8	34.6″	
18	35.0	*0.4″*
28	35.3	*0.3*
Sept. 7	35.4	*0.1*

π Leonis.

Date.	Dec. *North.*	
	8° 37′	
July 9	76.4″	
19	76.7	*0.5″*
29	76.9	*0.2*
Aug. 8	77.0	*0.1*

APPARENT PLACES OF STARS 1876.

AT UPPER TRANSIT AT GREENWICH.

γ^1 Leonis.

Date.	Dec. *North.*	
	20° 27′	
Dec. 6	45.1″	
		1.7″
16	43.4	
		1.5
26	41.9	
		1.3
36	40.6	

ε Corvi.

Date.	Dec. *South.*	
	21° 55′	
Nov. 16	56.5″	
		1.2″
26	57.7	
		1.5
Dec. 6	59.2	
		1.9
16	61.1	

α Virginis. (*Spica*)

Date.	Dec. *South.*	
	10° 30′	
April 30	65.2″	
		0.1″
May 10	65.3	
		0.0
20	65.3	
		0.2
30	65.1	

α Bootis. (*Arcturus*)

Date.	Dec. *North.*	
	19° 49′	
Apr. 10	26.4″	
		1.3″
20	27.7	
		1.5
30	29.2	
		1.6
May 10	30.8	

β^1 Scorpii.

Date.	Dec. *South.*	
	19° 27′	
June 9	67.8″	
		0.0″
19	67.8	
		0.0
29	67.8	
		0.0
July 9	67.8	

δ Ophiuchi.

Date.	Dec. *South.*	
	3° 22′	
Nov. 6	35.0″	
		1.0″
16	36.0	
		1.3
26	37.3	
		1.4
Dec. 6	38.7	

α Ophiuchi.

Date.	Dec. *North.*	
	12° 38′	
Oct. 7	66.7″	
		0.7″
17	66.0	
		1.0
27	65.0	
		1.3
Nov. 6	63.7	

ζ Aquilæ.

Date.	Dec. *North.*	
	13° 40′	
Sept. 7	56.5″	
		0.6″
17	57.1	
		0.4
27	57.5	
		0.1
Oct. 7	57.6	

α Gruis.

Date.	Dec. *South.*	
	47″ 33′	
Feb. 10	46.3″	
		2.6″
20	43.7	
		2.6
Mar. 1	41.1	
		2.6
11	38.5	

ELEMENTS FROM THE ADMIRALTY TIDE TABLES.

JANUARY, 1875.

Week Day.	Month Day.	Moon's Transit.		Brest.				Devonport.				Portsmouth.				Dover.			
				Morn.		Aft.		Morn.		Aft.		Morn.		Aft.		Morn.		Aft.	
		H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
F.	1	7 m	4	10	33	11	7	—		0	1	5	54	6	23	5	27	5	53
S.	2	7	46	11	41	—		0	32	1	5	6	55	7	28	6	22	6	54
S.	3	8	30	0	14	0	45	1	38	2	10	8	1	8	34	7	27	8	0
M.	4	9	17	1	13	1	40	2	41	3	9	9	4	9	31	8	29	8	55
Tu.	5	10	8	2	2	2	24	3	37	4	4	[illegible]	55	10	19	9	18	9	41
W.	6	11	2	2	45	3	5	4	29	4	[illegible]	[illegible]	40	11	1	10	4	10	27
Th.	7	11	58	3	25	3	45	5	14	5	[illegible]	[illegible]	21	11	41	10	49	11	11
F.	8	0 a	53	4	5	4	25	5	55	6	[illegible]	—		0	1	11	33	11	55
S.	9	1	47	4	45	5	4	6	37	6	56	0	22	0	43	—		0	17
S.	10	2	38	5	24	5	44	7	14	7	33	1	4	1	24	0	38	1	0
M.	11	3	26	6	4	6	24	7	52	8	12	1	45	2	5	1	22	1	44
Tu.	12	4	13	6	45	7	6	8	34	8	54	2	25	2	46	2	5	2	27
W.	13	5	0	7	30	7	54	9	15	9	38	3	7	3	30	2	49	3	11
Th.	14	5	47	8	18	8	42	10	1	10	26	3	53	4	16	3	34	3	57
F.	15	6	37	9	8	9	37	10	51	11	19	4	39	5	4	4	20	4	43
S.	16	7	30	10	12	10	50	11	49	—		5	31	6	5	5	8	5	38
S.	17	8	28	11	31	—		0	26	1	3	6	39	7	19	6	9	6	45
M.	18	9	29	0	14	0	54	1	40	2	17	8	1	8	44	7	27	8	9
Tu.	19	10	32	1	29	2	0	2	55	3	35	9	20	9	54	8	44	9	17
W.	20	11	34	2	30	2	56	4	10	4	40	10	25	10	52	9	48	10	17
Th.	21	morn.		3	21	3	45	5	8	5	34	11	17	11	41	10	45	11	11
F.	22	0	32	4	8	4	30	5	58	6	22	—		0	4	11	37	12	[illegible]
S.	23	1	25	4	50	5	10	6	44	7	5	0	27	0	49	—		0	23
S.	24	2	13	5	28	5	46	7	23	7	41	1	10	1	29	0	44	1	5
M.	25	2	57	6	4	6	22	7	58	8	15	1	47	2	5	1	25	1	44
Tu.	26	3	39	6	40	6	57	8	32	8	48	2	23	2	41	2	3	2	21
W.	27	4	19	7	13	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	58	3	14	2	39	2	56
Th.	28	4	59	7	48	8	6	9	32	9	49	3	30	3	47	3	11	3	28
F.	29	5	40	8	26	8	47	10	6	10	26	4	4	4	23	3	45	4	4
S.	30	6	23	9	14	9	45	10	47	11	11	4	44	5	9	4	23	4	47
S.	31	7	9	10	21	11	2	11	42	—		5	38	6	13	5	13	5	44

FEBRUARY, 1875.

Week Day.	Month Day.	Moon's Transit.		BREST.				SHEERNESS.				LONDON.				HARWICH.			
				Morn.		Aft.		Morn.		Aft.		Morn.		Aft.		Morn.		Aft.	
		H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
M.	1	7 m	58	11	44	—	—	8	3	8	43	9	15	9	58	7	10	7	51
Tu.	2	8	51	0	25	1	3	9	23	10	3	10	42	11	22	8	31	9	10
W.	3	9	46	1	37	2	5	10	40	11	12	11	59	—	—	9	47	10	10
Th.	4	10	42	2	30	2	52	11	40	—	—	0	29	0	56	10	50	11	14
F.	5	11	37	3	12	3	32	0	3	0	24	1	21	1	44	11	36	11	58
S.	6	0 a	30	3	52	4	12	0	45	1	5	2	4	2	25	—	—	0	18
S.	7	1	20	4	32	4	50	1	25	1	44	2	44	3	4	0	38	0	57
M.	8	2	9	5	8	5	27	2	4	2	22	3	23	3	40	1	16	1	35
Tu.	9	2	57	5	46	6	5	2	40	2	58	3	59	4	17	1	54	2	13
W.	10	3	45	6	24	6	44	3	16	3	34	4	36	4	55	2	32	2	52
Th.	11	4	34	7	4	7	25	3	54	4	14	5	14	5	33	3	12	3	32
F.	12	5	26	7	47	8	10	4	35	4	56	5	54	6	14	3	52	4	12
S.	13	6	22	8	36	9	4	5	17	5	42	6	35	6	59	4	33	4	55
S.	14	7	21	9	39	10	21	6	9	6	41	7	26	7	57	5	22	5	50
M.	15	8	22	11	10	—	—	7	19	8	3	8	35	9	17	6	25	7	10
Tu.	16	9	23	0	2	0	48	8	51	9	40	10	6	10	58	7	59	8	48
W.	17	10	21	1	29	2	2	10	25	11	4	11	45	—	—	9	32	10	12
Th.	18	11	15	2	30	2	53	11	36	—	—	0	22	0	53	10	46	11	14
F.	19	morn.		3	15	3	35	0	3	0	26	1	22	1	47	11	38	—	—
S.	20	0	4	3	55	4	13	0	48	1	8	2	9	2	29	0	1	0	21
S.	21	0	50	4	31	4	48	1	28	1	45	2	47	3	6	0	40	0	58
M.	22	1	33	5	4	5	20	2	2	2	19	3	24	3	40	1	16	1	33
Tu.	23	2	14	5	36	5	51	2	36	2	52	3	55	4	11	1	50	2	6
W.	24	2	54	6	4	6	19	3	6	3	20	4	27	4	41	2	22	2	38
Th.	25	3	35	6	34	6	49	3	34	3	49	4	56	5	11	2	52	3	7
F.	26	4	17	7	4	7	20	4	4	4	19	5	25	5	40	3	22	3	37
S.	27	5	1	7	38	7	57	4	34	4	50	5	56	6	13	3	51	4	6
S.	28	5	49	8	20	8	46	5	8	5	29	6	30	6	50	4	23	4	43

MARCH, 1875.

Week Day.	Month Day.	Moon's Transit.		BREST.				HULL.				SUNDERLAND.				NORTH SHIELDS.			
				Morn.		Aft.		Morn.		Aft.		Morn.		Aft.		Morn.		Aft.	
		H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
M.	1	6 m	40	9	21	10	4	—		0	8	8	55	9	32	9	4	9	44
Tu.	2	7	33	10	53	11	41	0	45	1	25	10	15	11	1	10	27	11	13
W.	3	8	28	—		0	27	2	9	2	52	11	45	—		11	58	—	
Th.	4	9	23	1	8	1	41	3	33	4	13	0	25	1	4	0	39	1	17
F.	5	10	17	2	7	2	20	4	45	5	9	1	35	2	0	1	46	2	9
S.	6	11	9	2	50	3	10	5	30	5	51	2	25	2	47	2	30	2	50
S.	7	11	59	3	29	3	48	6	11	6	32	3	7	3	26	3	8	3	26
M.	8	0 a	48	4	7	4	26	6	51	7	10	3	44	4	2	3	44	4	2
Tu.	9	1	37	4	44	5	3	7	29	7	48	4	20	4	38	4	21	4	40
W.	10	2	28	5	22	5	41	8	7	8	26	4	57	5	16	4	59	5	19
Th.	11	3	20	6	0	6	20	8	45	9	4	5	36	5	56	5	39	5	59
F.	12	4	16	6	40	7	0	9	25	9	46	6	17	6	38	6	20	6	41
S.	13	5	16	7	23	7	48	10	7	10	29	7	0	7	25	7	2	7	26
S.	14	6	17	8	15	8	46	10	55	11	28	7	50	8	20	7	54	8	25
M.	15	7	18	9	26	10	14	—		0	6	8	54	9	36	9	2	9	48
Tu.	16	8	16	11	9	—		0	50	1	34	10	25	11	16	10	37	11	28
W.	17	9	10	0	2	0	46	2	24	3	10	—		0	3	—		0	17
Th.	18	10	0	1	24	1	54	3	51	4	29	0	43	1	19	0	56	1	31
F.	19	10	40	2	17	2	37	4	57	5	19	1	47	2	11	1	57	2	18
S.	20	11	29	2	56	3	13	5	38	5	57	2	33	2	55	2	37	2	56
S.	21	morn.		3	30	3	47	6	15	6	33	3	11	3	27	3	12	3	28
M.	22	0	10	4	3	4	18	6	51	7	7	3	43	3	59	3	43	3	59
Tu.	23	0	50	4	33	4	48	7	22	7	37	4	13	4	27	4	14	4	29
W.	24	1	31	5	2	5	16	7	52	8	7	4	42	4	56	4	44	4	59
Th.	25	2	12	5	30	5	44	8	21	8	35	5	10	5	25	5	14	5	29
F.	26	2	56	5	58	6	13	8	49	9	4	5	40	5	55	5	44	5	59
S.	27	3	42	6	29	6	45	9	10	9	35	6	10	6	27	6	14	6	30
S.	28	4	31	7	4	7	24	9	51	10	10	6	46	7	6	6	48	7	7
M	29	5	23	7	46	8	12	10	30	10	57	7	26	7	50	7	29	7	55
Tu.	30	6	16	8	45	9	25	11	28	—		8	18	8	53	8	25	9	3
W	31	7	10	10	13	11	4	0	7	0	49	9	36	10	23	9	48	10	35

APRIL, 1875.

Week Day.	Month Day.	Moon's Transit.		BREST.				LEITH.				THURSO.				GREENOCK.			
				Morn.		Aft.		Morn.		Aft.		Morn.		Aft.		Morn.		Aft.	
		H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
Th.	1	8 m	3	11	53	—		10	17	11	1	4	16	5	2	7	19	8	5
F.	2	8	55	0	34	1	8	11	37	—		5	39	6	11	8	46	9	21
S.	3	9	45	1	34	1	56	0	10	0	32	6	34	6	52	9	47	10	10
S.	4	10	35	2	17	2	37	0	52	1	12	7	10	7	26	10	32	10	54
M.	5	11	24	2	57	3	16	1	32	1	52	7	42	8	0	11	16	11	37
Tu.	6	0 a	14	3	35	3	55	2	11	2	30	8	18	8	36	11	58	—	
W.	7	1	8	4	15	4	35	2	48	3	6	8	54	9	14	0	18	0	38
Th.	8	2	4	4	55	5	15	3	25	3	46	9	35	9	57	[illegible]	59	1	21
F.	9	3	4	5	36	5	58	4	7	4	29	10	19	10	43	1	42	2	3
S.	10	4	7	6	21	6	44	4	52	5	16	11	8	11	33	2	24	2	46
S.	11	5	10	7	7	7	35	5	41	6	7	11	59	—		3	9	3	32
M.	12	6	11	8	7	8	42	6	36	7	12	0	28	1	4	3	57	4	29
Tu.	13	7	7	9	23	10	11	7	53	8	38	1	44	[illegible]	30	5	3	5	43
W.	14	7	58	11	0	11	47	9	28	10	13	3	23	4	12	6	29	7	15
Th.	15	8	45	—		0	26	10	54	11	29	4	55	5	31	7	59	8	38
F.	16	9	28	0	58	1	26	12	0	—		6	1	6	26	9	10	9	39
S.	17	10	9	1	49	2	9	0	24	0	45	6	45	7	3	10	2	10	24
S.	18	10	49	2	27	2	43	1	4	1	22	7	17	7	31	10	43	11	1
M.	19	11	29	2	59	3	15	1	38	1	54	7	45	7	59	11	19	11	26
Tu.	20	morn.		3	31	3	46	2	10	2	26	8	14	8	28	11	53	—	
W.	21	0	10	4	2	4	17	2	40	2	55	8	43	8	57	0	9	0	25
Th.	22	0	53	4	32	4	46	3	9	3	23	9	12	9	27	0	41	0	57
F.	23	1	38	5	0	5	16	3	38	3	53	9	42	9	58	1	13	1	27
S.	24	2	26	5	32	5	48	4	8	4	25	10	15	10	32	1	42	1	58
S.	25	3	17	6	4	6	22	4	42	4	59	10	50	11	11	2	14	2	31
M.	26	4	9	6	41	7	3	5	19	5	40	11	32	11	54	2	48	3	6
Tu.	27	5	2	7	27	7	54	6	3	6	28	—		0	20	3	26	3	49
W.	28	5	54	8	25	9	2	6	59	7	35	0	50	1	26	4	16	4	46
Th.	29	6	45	9	45	10	29	8	16	9	0	2	7	2	54	5	22	6	4
F.	30	7	34	11	11	11	50	9	46	10	22	3	42	4	22	6	46	7	25

MAY, 1875.

Week Day.	Month Day.	Moon's Transit.		BREST.				LIVERPOOL.				PEMBROKE.				WESTON-SUPER-MARE.			
				Morn.		Aft.		Morn.		Aft.		Morn.		Aft.		Morn.		Aft.	
		H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
S.	1	8 m	23	—		0	21	7	31	8	3	1	51	2	26	2	24	2	57
S.	2	9	10	0	49	1	17	8	28	8	53	2	56	3	25	3	30	4	3
M.	3	9	59	1	39	2	0	9	15	9	35	3	52	4	16	4	31	4	56
Tu.	4	10	51	2	21	2	42	9	35	10	15	4	40	5	4	5	21	5	46
W.	5	11	46	3	3	3	26	10	38	11	1	5	28	5	52	6	10	6	34
Th.	6	0 a	46	3	49	4	12	11	24	11	47	6	15	6	38	6	58	7	32
F.	7	1	49	4	35	4	58	—		0	10	7	1	7	23	7	45	8	7
S.	8	2	55	5	21	5	44	0	34	0	58	7	47	8	12	8	30	8	53
S.	9	3	59	6	9	6	35	1	21	1	45	8	37	9	2	9	15	9	38
M.	10	4	59	7	1	7	31	2	10	2	36	9	27	9	52	10	0	10	22
Tu.	11	5	54	8	1	8	34	3	4	3	33	10	19	10	48	10	46	11	15
W.	12	6	43	9	8	9	49	4	9	4	46	11	17	11	51	11	48	—	
Th.	13	7	27	10	29	11	6	5	30	6	12	—		0	26	0	27	1	5
F.	14	8	9	11	46	—		6	50	7	22	1	4	1	40	1	41	2	14
S.	15	8	49	0	12	0	39	7	52	8	19	2	15	2	45	2	47	3	19
S.	16	9	29	1	5	1	28	8	42	9	4	3	13	3	38	3	48	4	16
M.	17	10	9	1	48	2	7	9	24	9	42	4	1	4	23	4	41	5	3
Tu.	18	10	51	2	25	2	42	9	59	10	16	4	44	5	4	5	25	5	45
W.	19	11	36	2	59	3	17	10	34	10	52	5	24	5	43	6	5	6	25
Th.	20	morn.		3	34	3	51	11	9	11	26	6	0	6	17	6	43	7	0
F.	21	0	23	4	8	4	24	11	43	12	0	6	34	6	51	7	17	7	34
S.	22	1	13	4	40	4	57	—		0	17	7	7	7	24	7	50	8	7
S.	23	2	5	5	14	5	31	0	34	0	51	7	41	7	58	8	24	8	40
M.	24	2	58	5	49	6	8	1	8	1	25	8	16	8	36	8	56	9	14
Tu.	25	3	50	6	30	6	52	1	44	2	5	8	57	9	18	9	32	9	52
W.	26	4	40	7	18	7	44	2	27	2	52	9	41	10	4	10	12	10	32
Th.	27	5	29	8	12	8	43	3	17	3	46	10	29	10	55	10	57	11	24
F.	28	6	16	9	14	9	49	4	18	4	52	11	21	11	51	11	54	—	
S.	29	7	2	10	23	10	59	5	30	6	6	—		0	22	0	27	1	0
S.	30	7	49	11	32	—		6	42	7	14	0	56	1	31	1	33	2	5
M.	31	8	37	0	1	0	29	7	42	8	9	2	5	2	35	2	37	3	9

JUNE, 1875.

Week Day.	Month Day.	Moon's Transit.		Brest.				Holyhead.				Kingstown.				Belfast.			
				Morn.		Aft.		Morn.		Aft.		Morn		Aft.		Morn.		Aft.	
		H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
Tu.	1	9 m	29	0	57	1	24	7	31	7	56	8	22	8	50	8	4	8	29
W.	2	10	26	1	50	1	15	8	20	8	45	9	18	9	45	8	54	9	20
Th.	3	11	27	2	40	3	5	9	9	9	34	10	8	10	31	9	45	10	10
F.	4	0 a	33	3	31	3	57	9	59	10	23	10	56	11	21	10	35	11	0
S.	5	1	40	4	23	4	48	10	46	11	10	11	47	—		11	24	11	48
S.	6	2	44	5	13	5	38	11	35	—		0	13	0	39	—		0	13
M.	7	3	43	6	4	6	30	0	3	0	31	1	6	1	33	0	41	1	9
Tu.	8	4	36	6	56	7	22	0	59	1	27	2	0	2	27	1	38	2	7
W.	9	5	23	7	48	8	15	1	55	2	23	2	54	3	21	2	36	3	5
Th.	10	6	7	8	42	9	10	2	52	3	23	3	50	4	22	3	34	4	4
F.	11	6	48	9	38	10	10	3	55	4	27	4	54	5	22	4	34	5	3
S.	12	7	28	10	41	11	12	5	0	5	30	5	50	6	18	5	32	6	0
S.	13	8	8	11	43	—		5	58	6	25	6	45	7	12	6	28	6	57
M.	14	8	49	0	14	0	41	6	52	7	17	7	39	8	6	7	25	7	51
Tu.	15	9	33	1	7	1	30	7	41	8	2	8	32	8	56	8	15	8	36
W.	16	10	19	1	51	2	12	8	23	8	43	9	19	9	41	8	57	9	17
Th.	17	11	9	2	32	2	52	9	2	9	21	10	1	10	19	9	37	9	56
F.	18	morn.		3	11	3	30	9	33	9	58	10	36	10	55	10	15	10	34
S.	19	0	1	3	49	4	8	10	17	10	34	11	14	11	32	10	53	11	11
S.	20	0	53	4	26	4	44	10	50	11	6	11	50	—		11	28	11	44
M.	21	1	46	5	2	5	20	11	24	11	43	0	9	0	28	—		0	3
Tu.	22	2	37	5	39	6	0	—		0	4	0	47	1	7	0	22	0	43
W.	23	3	27	6	21	6	42	0	27	0	50	1	29	1	51	1	5	1	28
Th.	24	4	13	7	4	7	27	1	13	1	37	2	13	2	37	1	52	2	17
F.	25	4	59	7	51	8	16	2	1	2	26	3	1	3	25	2	43	3	9
S.	26	5	44	8	44	9	12	2	54	3	24	3	52	4	23	3	36	4	5
S.	27	6	30	9	40	10	12	3	56	4	28	4	54	5	24	4	35	5	5
M.	28	7	10	10	44	11	18	5	1	5	32	5	53	6	21	5	35	6	4
Tu.	29	8	11	11	53	—		6	3	6	32	6	50	7	20	6	34	7	5
W.	30	9	9	0	25	0	57	7	1	7	31	7	50	8	22	7	35	8	5

JULY, 1875.

Week Day.	Month Day.	Moon's Transit.		Brest.				Londonderry.				Sligo Bay.				Galway.			
				Morn.		Aft.		Morn.		Aft.		Morn.		Aft.		Morn.		Aft.	
		H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
Th.	1	10 m	12	1	29	1	59	5	47	6	15	3	6	3	33	2	20	2	50
F.	2	11	18	2	29	2	57	6	44	7	13	4	0	4	27	3	19	3	47
S.	3	0 a	24	3	24	3	51	7	43	8	8	4	56	5	23	4	15	4	41
S.	4	1	26	4	18	4	43	8	33	8	55	5	49	6	13	5	7	5	33
M.	5	2	23	5	6	5	29	9	17	9	39	6	37	7	1	5	58	6	22
Tu.	6	3	14	5	51	6	13	10	1	10	22	7	24	7	46	6	45	7	8
W.	7	4	0	6	35	6	56	10	44	11	6	8	7	8	29	7	30	7	53
Th.	8	4	43	7	18	7	40	11	32	12	0	8	51	9	15	8	15	8	38
F.	9	5	24	8	2	8	23	—		0	29	9	41	10	7	9	1	9	23
S.	10	6	5	8	45	9	8	0	59	1	29	10	34	11	2	9	46	10	11
S.	11	6	46	9	34	10	3	2	1	2	33	11	31	12	0	10	38	11	9
M.	12	7	29	10	35	11	8	3	4	3	33	—		0	29	11	40	—	
Tu.	13	8	15	11	42	—		4	0	4	27	0	58	1	30	0	11	0	42
W.	14	9	3	0	18	0	51	4	53	5	19	2	2	2	35	1	14	1	45
Th.	15	9	54	1	20	1	49	5	42	6	5	3	1	3	25	2	11	2	37
F.	16	10	47	2	11	2	33	6	27	6	49	3	45	4	5	3	1	3	24
S.	17	11	41	2	54	3	14	7	11	7	32	4	25	4	45	3	45	4	5
S.	18	morn.		3	34	3	54	7	53	8	12	5	6	5	26	4	25	4	45
M.	19	0	33	4	14	4	32	8	30	8	47	5	46	6	4	5	4	5	23
Tu.	20	1	23	4	50	5	8	9	2	9	18	6	20	6	38	5	41	5	59
W.	21	2	12	5	26	5	44	9	36	9	54	6	57	7	16	6	18	6	38
Th.	22	2	58	6	4	6	24	10	12	10	32	7	36	7	56	6	58	7	18
F.	23	3	43	6	44	7	4	10	53	11	15	8	16	8	38	7	40	8	2
S.	24	4	28	7	26	7	48	11	41	—		9	0	9	24	8	24	8	46
S.	25	5	15	8	11	8	36	0	9	0	41	9	52	10	23	9	11	9	36
M.	26	6	5	9	3	9	32	1	16	1	51	10	55	11	28	10	5	10	36
Tu.	27	6	59	10	5	10	46	2	30	3	6	—		0	2	11	10	11	50
W.	28	7	58	11	29	—		3	42	4	17	0	39	1	18	—		0	30
Th.	29	9	1	0	13	0	51	4	49	5	18	1	58	2	34	1	10	1	45
F.	30	10	6	1	27	1	58	5	46	6	14	3	5	3	33	2	17	2	48
S.	31	11	9	2	28	2	56	6	43	7	12	4	0	4	27	3	19	3	47

AUGUST, 1875.

Week Day.	Month Day.	Moon's Transit.		BREST.				HOLYHEAD.				QUEENSTOWN.				WATERFORD.			
				Morn.		Aft.		Morn.		Aft.		Morn.		Aft		Morn.		Aft.	
		H.	M.	H	M.	H	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.	H.	M.
S.	1	0 a	8	3	22	3	46	9	50	10	14	4	36	5	1	4	58	5	23
M.	2	1	2	4	9	4	31	10	34	10	54	5	25	5	49	5	46	6	8
Tu.	3	1	51	4	51	5	11	11	13	11	33	6	9	6	29	6	29	6	50
W.	4	2	36	5	30	5	48	11	53	——		6	49	7	7	7	11	7	28
Th.	5	3	18	6	5	6	23	0	13	0	32	7	24	7	42	7	45	8	2
F.	6	4	0	6	41	6	59	0	52	1	11	8	0	8	16	8	19	8	35
S.	7	4	41	7	17	7	35	1	30	1	49	8	32	8	48	8	50	9	5
S.	8	5	24	7	53	8	11	2	9	2	29	9	5	9	22	9	20	9	36
M.	9	6	9	8	34	8	59	2	49	3	14	9	41	10	4	9	58	10	25
Tu.	10	6	56	9	27	10	3	3	44	4	16	10	31	11	7	10	53	11	27
W.	11	7	46	10	45	11	28	4	53	5	33	11	46	——		——		0	3
Th.	12	8	38	——		0	11	6	12	6	51	0	27	1	9	0	40	1	19
Fr.	13	9	32	0	48	1	22	7	25	7	57	1	49	2	26	1	57	2	35
S.	14	10	25	1	52	2	16	8	24	8	47	2	57	3	24	3	10	3	39
S.	15	11	17	2	38	2	57	9	9	9	27	3	49	4	10	4	7	4	29
M.	16	morn.		3	16	3	35	9	45	10	3	4	30	4	50	4	51	5	13
Tu.	17	0	6	3	54	4	12	10	21	10	38	5	9	5	28	5	32	5	50
W.	18	0	54	4	30	4	47	10	53	11	9	5	48	6	5	6	8	6	26
Th.	19	1	40	5	5	5	23	11	26	11	45	6	23	6	41	6	44	7	2
F.	20	2	26	5	40	5	58	——		0	5	6	59	7	17	7	20	7	38
S.	21	3	13	6	16	6	36	0	25	0	45	7	35	7	55	7	56	8	14
S.	22	4	2	6	56	7	17	1	5	1	27	8	14	8	32	8	32	8	51
M.	23	4	55	7	41	8	5	1	50	2	15	8	53	9	17	9	10	9	31
Tu.	24	5	52	8	33	9	4	2	41	3	13	9	41	10	9	9	57	10	30
W.	25	6	52	9	43	10	30	3	49	4	32	10	47	11	32	11	9	11	51
Th.	26	7	55	11	21	——		5	20	6	6	——		0	21	——		0	34
F.	27	8	57	0	10	0	54	6	49	7	29	1	8	1	56	1	18	2	4
S.	28	9	57	1	30	2	0	8	3	8	32	2	35	3	7	2	46	3	22
S.	29	10	52	2	26	2	50	8	56	9	19	3	36	4	2	3	54	4	22
M.	30	11	42	3	12	3	34	9	41	10	2	4	26	4	48	4	49	5	11
Tu.	31	0 a	28	3	53	4	11	10	19	10	36	5	8	5	27	5	29	5	47

TABLE OF TIDAL CONSTANTS.

NAME OF PORT.	Constants. Time. H. M.	Constants. Height. Ft. In.	Standard Port for Reference.
Bantry Harbor	— 1 14	— 1 7	Queenstown
Valentia Harbor	— 1 19	— 0 8	"
Limerick, R. Shannon	+ 1 45	+ 1 9	Galway
Mellon, "	+ 1 26		"
Foynes Island, "	+ 1 0	+ 0 7	"
Killybegs	+ 0 13		Sligo
Coleraine	— 1 37	— 1 6	Londonderry
Port Rush	— 1 53	— 2 6	"
Ballycastle Bay	— 4 18		Belfast
Lough. Strangford, Quay	+ 1 21		Kingstown
Arklow	— 2 25		"
Wexford	+ 2 1	— 7 4	Waterford
New Ross	+ 0 44	+ 0	"
Castletownsend	— 0 40	— 1 0	Queenstown
St. Ives	— 2 10		Weston-super-mare
Lundy Island	— 1 39		"
Ilfracombe	— 1 12		"
Llanelly	+ 0 4		Pembroke
Cardigan	— 3 10		Holyhead
Aberystwyth	— 2 40	— 3 0	"
Barmouth	— 2 31		"
Beaumaris	— 0 51	— 4 7	Liverpool
Annan Foot	+ 0 33		"
Port Carlisle	+ 0 47		"
Ramsey	+ 1 1	+ 3 3	Holyhead
Glasgow	+ 1 17		Greenock
Crinan	+ 4 41		"
Lerwick	+ 2 2		Thurso
Cromarty	— 2 21		Leith
Peterhead	— 1 43		"
Whitby	+ 0 23		Sunderland
Scarborough	+ 0 49	+ 1 5	"
Filey Bay	+ 0 58		"
Bridlington	— 1 50		Hull
Chatham	+ 0 34		Sheerness
London Docks	— 0 5	— 0 0	London
Margate	— 2 18		"
Newhaven	+ 0 39		Dover
Shoreham	+ 0 22	— 1 2	"
Southampton	— 1 11		Portsmouth
Christchurch	— 2 41		"
Exmouth	+ 0 38		Devonport
Penzance	— 1 13		"
Gibraltar	— 1 27		Brest
Bordeaux	+ 3 3		"
Jersey (St. Helier)	+ 2 38		"
Helgoland	— 0 33	— 2 10	Harwich

Time of High Water on Full and Change days at the following places, arranged alphabetically, with the Rise of the Tide at Springs and Neaps.

PLACE.	High Water Full and Change.	Rise.	
		Springs.	Neaps.
	H. M.	ft.	ft.
Acapulco, Mexico, W. Coast	3 6	1¼	
Basrah (Bar) Persian Gulf	noon		
Batavia, Java	10 0	2	
Bencoolen, Sumatra	6 0	3–5	
Brest, France	3 47	19	13¾
Dalhousie Harbour, G. St. Lawrence	3 10	9	
Halifax, Nova Scotia	7 49	6	5
Hammerfest, Norway	1 10	9	
Hobarton, Tasmania	8 15	4½	3½
Honoruru, Sandwich Islands	4 0	2	
Iquiqui Road, Peru	8 45	5	
John St., Bay of Fundy	11 21	27	23
Macao, China, E. Coast	10 0	6½	
Madras Road, Coromandel Coast	7 34	3½	
Magdalen Islands, G. St. Lawrence	8 20	3	2
Melbourne, Australia, S. C.	2 48		
Nagasaki Bay, Japan	7 15	9	7½
Nanaimo Harbor, G. of Georgia, Vancouver Id.	5 0	14	
Parsboro, Bay of Fundy	0 17	43	37½
Pictou Harbor, Nova Scotia	10 0	6	4
Pillar Cape, Tasmania	1 0	6	
Portland, United States	11 25	10	8¾
Quebec, R. St. Lawrence	6 38	18	13
Rio Janeiro, Brazil	3 0	4	3
Shanghai, Yang-tse-Kiang, China, E. Coast	0 40	10	7
Suez Bay (head of Gulf) Red Sea	11 0	7	4
Sydney Harbor, Cape Breton	9 0	5	4
Table Bay, Africa, W. Coast	2 40	5	3¼
Texel, (outside shoals) Netherlands	6 30	4	3½
Tobago, Caribbean Sea	3 0	4	2
Yoko-hama, Yedo Bay, Japan	6 0	6¼	4¼
Zanzibar, Africa, E. C.	4 15	15	10

ANSWERS TO EXERCISES.

These Exercises are worked by the Tables of Norie, Bowditch and Raper; but the answer by Norie will cover that of either of the two other Tables where the solutions agree; where they disagree, separate answers will be given.

MULTIPLICATION BY LOGARITHMS.

	Norie		Norie.	Bowditch.
Ex. 4.—	18·679	Ex. 10.—	38550·09	38551
" 5.—	268·00	" 11.—	1251717	1251735
" 6.—	239·41	" 12.—	1000000	
" 7.—	10905·5	" 13.—	13372	13373
" 8.—	18779·2	" 14.—	2859809	2859812
" 9.—	18627	" 15.—	34300	

	Norie.	Bowditch.
Ex. 16.—	77511	77510
" 17.—	·5016	
" 18.—	·000003258	
" 19.—	161·94	
" 20.—	380·4	380·5

DIVISION BY LOGARITHMS.

	Norie.		Norie.	Bowditch.
Ex. 4.—	626·57	Ex. 13.—	·7136	
" 5.—	31·852	" 14.—	87338	87340
" 6.—	18·852	" 15.—	·05171	
" 7.—	7·4538	" 16.—	6798	
" 8.—	7486·4	" 17.—	91·91	
" 9.—	3453·4	" 18.—	·0001025	
" 10.—	30394	" 19.—	·08773	
" 11.—	21·32	" 20.—	6·672	
" 12.—	21·19			

PARALLEL SAILING.

Ex. 2.—	198·1	Ex. 6.—	324·1	Ex. 10.—	69·84
" 3.—	76·73	" 7.—	39·00	" 11.—	57·31
" 4.—	19·16	" 8.—	161·4	" 12.—	140·2
" 5.—	12·93	" 9.—	329		

COURSE AND DISTANCE BY MERCATOR.

	COURSE.	DIST.		COURSE.	DIST.
Ex. 3.—	N. 73° 12′ E.	460·2	Ex. 10.—	S. 51° 32′ E.	6525

ERRATA.

Page 242—Logarithms. Ex. 4—Answer 18 678.
" 243—Day's Work. Ex. 6.—Distance 91′.
" 244— " Ex. 9.—Departure course, S. 80° E.; Course S. 65° E Dist. 66½′. Long. in 147° 30′ W.
" 245—Mer. Alt. of the Sun. Ex. 8.—The Lat. should be named S.
" Ex. 11.—Latitude 40° 19′ 17″ N.
" 246.—Greenwich Date. Ex. 9.—G. A. T. May 1st. $4^h\ 0^m\ 0^s$.
Amplitude. Ex. 7.—Declination, 22^s 37′ 20″.
" 248.—Azimuth. Ex. 14.—Raper, True Azimuth N. 49° 57′ W.
" 250.—Chronometer. Ex. 13.—G. M. T. March $25^d\ 5^h\ 14^m\ 1^s$.
" 252.—Star. Ex. 14.—Bowditch, Latitude, 6° 5′ 27″ S.
Tides. Ex. 23.—No A. M. $0^h\ 14^m$ P. M.
" 253.— " Ex. 50.—$11^h\ 45^m$ A. M. No P. M.
" 255.—Set No. 1 Day's Work.—Longitude in 19° 30′ E.
" 256.— " Deviation.—The names of the Deviation as given should be reversed.
" Correct Mag. Courses, N. 21° 51′ E; S. 1° 51′ W.
" Cor Mag. Bearings S. 70° 1′ W; N. 19° 59′ W.
Set No. 2. Deviation—Course to steer, S. 67° W.
" 258—Set No. 4. Deviation—Course to steer, N. 48 E.

current course N. 40° E. 18′; N. 27° E. 32′·9; N. 43° E. 38′·3; N. 47° E. 42′·8; N. 41° E. 35′·5; N. 10° W. 32′·7; N. 15° E. 29′·5.
Diff. lat. 201′·8; **departure** 110′·1.

COURSE N. 29° E. DISTANCE 231; LAT. IN 36° 4′ N. LONG. IN 24° 57′ W.

ANSWERS TO EXERCISES.

Ex. 2.— 198·1	Ex. 6.— 324·1	Ex. 10.— 69·84
" 3.— 76·73	" 7.— 39·00	" 11.— 57·31
" 4.— 19·16	" 8.— 161·4	" 12.— 140·2
" 5.— 12·93	" 9.— 329	

COURSE AND DISTANCE BY MERCATOR.

	COURSE.	DIST.		COURSE.	DIST.
Ex. 3.—	N. 73° 12′ E.	460·2	Ex. 10.—	S. 51° 32′ E.	6525
" 4.—	S. 13 44 W.	4443	" 11.—	S. 48 16 W.	6460
" 5.—	N. 49 54 E.	3732	" 12.—	N. 63 59 E.	6935
" 6.—	S. 49 18 W.	1107	" 13.—	N. 88 4 W.	10493
" 7.—	S. 87 10 E.	6029	" 14.—	S. 70 12 E.	8098
" 8.—	S. 68 17 W.	502·7	" 15.—	N. 56 11 E.	10362
" 9.—	S. 66 44 W.	1230			

CORRECTING COURSES.

Ex. 5.—	N. 77° E.	Ex. 9.—	N. 34° E.	Ex. 13.—	S. 87° W.
" 6.—	N. 67 W.	" 10.—	S. 39 W.	" 14.—	N. 64 W.
" 7.—	S. 88 E.	" 11.—	S. 83 E.	" 15.—	S. 7 W.
" 8.—	S. 83 W.	" 12.—	N. 88 E.		

DAY'S WORK.

Ex. 4.—**Corrected Courses.**—Dep. Course, North 14′·5; Current Course S. 26° W., 23′; N. 22° W., 22′; N. 14° W., 24′·8; N.45° W., 24′·2; N. 64° W., 22′·5; N. 8° W., 21′·5; S. 38°W., 25′·5. **Diff. lat.** 66′·5; **departure** 80′·3.

Course N. 50° W. Distance 105. Lat. in 51° 8′ S. Long. in 178° 38′ E.

Ex. 5. — **Corrected Courses.** — Dep. Course S 30° W. 11′; N. 36° E. 18′·9; S. 13° W. 19′·5; S. 17° W. 20′·7; N. 58° E. 18′; East 16′·8; S. 18° W. 17′·9. **Diff. lat.** 40′·5; **departure** 21′·7.

Course S. 28° E., Distance 46′; Lat. in 44° 27′ S; Long. in 90° 0′E.

Ex. 6.—**Corrected Courses.**—Dep. course, West 9′; Current course, South 14′; S. 56° E. 19′·7; N. 54° W. 19′·3; S. 8° W. 20′·8; S. 39° W. 24·9; S. 24° E. 25·1; S. 69° W. 20·6. **Diff. lat.** 84′·0; **departure** 35′·9.

Course S. 23° W. Distance 93′; Lat. in 34° 2′ N.; Long. in 9° 26 E.

Ex. 7.—**Corrected Courses.** —Current course S. 79° E. 21′; N. 22° W. 15′·8; N. 13° W. 18′·5; N. 63° W. 19′·8; N. 80° W. 18′·2; N. 56° E. 16·2; N. 41° E. 17·7. **Diff. lat.** 63′·4; **departure** 0′·0.

Course. North Dist. 63′·4; Lat. in 0° 17′ N. Long. in 36° 24′ W.

Ex 8.—**Corrected Courses.**—Departure course N. 4° E. 14′; current course N. 40° E. 18′; N. 27° E. 32′·9; N. 43° E. 38′·3; N. 47° E. 42′·8; N. 41° E. 35′·5; N. 10° W. 32′·7; N. 15° E. 29′·5. **Diff. lat.** 201′·8; **departure** 110′·1.

Course N. 29° E. Distance 231; Lat. in 36° 4′ N. Long. in 24° 57′W.

Ex. 9.—**Corrected Courses.**—Departure course S. 80° W. 10′; Current course S. 32° E., 27′; N. 37° W. 32·9; S. 18° E., 32′·5; N. 73° W., 27′·2; S. 59° E., 26; N. 88° E., 24·7; N. 77° E. 25′·5; **Diff. lat.** 28′·0; **departure** 40·7.

COURSE S. 56° E. DIST. 49; LAT. IN 37° 42′ N. LONG IN 147° 55′ W.

Ex. 10.—**Diff. lat.** 56.0; **departure** 145′·9.

COURSE N. 69° W. DISTANCE 156′; LAT. IN 45° 26′ N. LONG. IN 28° 45′ W.

Ex. 11.—**Dif. lat.** 42′·8; **departure** 103′·2.

COURSE N. 67° E. DISTANCE 112′; LAT. IN 47° 39′ S. LONG. IN 97° 00′ E.

Ex. 12.—**Diff. lat.** 47′·5; **departure** 146′·9.

COURSE S. 72° E. DISTANCE 154′; LAT. IN 47° 22′ N. LONG. IN 26° 10′ W.

Ex. 13.—**Diff. lat.** 100′·0; **departure** 90′·2.

COURSE S. 42° E. DISTANCE 135′; LAT. IN 33° 55′ N. LONG. IN 1° 3′ E.

Ex. 14.—**Diff. lat.** 201·7; **departure** 0·0.

COURSE. North DISTANCE 201·7; LAT. IN 40° 53′ S. LONG. IN 104° 10′ E.

Ex. 15.—**Diff. lat.** 65·9; **departure** 111·0.

COURSE S. 59° W. DISTANCE 130′; LAT. IN 29° 6′ N. LONG. IN 178° 22′ E.

MERIDIAN ALTITUDE OF THE SUN.

Ex. 3.—Green. App. Time, April 25d 16h 44m 0s. True declination 13° 37′ 21″ N.

Norie	True Altitude	52° 23′ 22″ N.	Latitude	23° 59′ 17″ S.
Bowditch	" "	52 23 16 N.	"	23 59 23 S.
Raper	" "	52 23 15 N.	"	23 59 24 S.

Ex. 4.—Green. App. Time, July 10d 16h 34m 20s. True declination 22° 5′ 24″ N.

Norie	True Altitude	18° 54′ 3″ N.	Latitude	49° 0′ 33″ S.
Bowditch	" "	18 53 54 N.	"	49 0 42 S.
Raper	" "	18 53 57 N.	"	49 0 39 S.

Ex. 5.—Green. App. Time, Nov. 7d 23h 12m 56s. True declination 16° 45′ 41″ S.

Norie	True Altitude	73° 29′ 58″ S.	Latitude	0° 15′ 39″ S.
Bowditch	" "	73 29 52 S.	"	0 15 33 S.
Raper	" "	73 29 48 S.	"	0 15 29 S.

Ex. 6.—Green. App. Time, Mar. $27^d\ 0^h\ 33^m\ 28^s$. True declination 2° 51′ 40″ N.

Norie	True Altitude	32° 35′ 11″ S.	Latitude	60° 16′ 29″ N.
Bowditch	" "	32 35 4 S.	"	60 16 36 N.
Raper	" "	32 35 6 S.	"	60 16 34 N.

Ex. 7.—Green. App. Time, Sept. $22^d\ 17^h\ 2^m\ 40^s$. True declination 0° 11′ 37″ S.

Norie	True Altitude	18° 25′ 9″ N.	Latitude	71° 46′ 28″ S.
Bowditch	" "	18 24 59 N.	"	71 46 38 S.
Raper	" "	18 24 56 N.	"	71 46 41 S.

Ex. 8.—Green. App. Time, Jan. $24^d\ 4^h\ 53^m\ 12^s$. True declination 19° 14′ 29″ S.

Norie	True Altitude	90° 7′ 58″ N.	Latitude	19° 6′ 31″ N.
Bowditch	" "	90 7 53 N.	"	19 6 36 N.
Raper	" "	90 7 54 N.	"	19 6 35 N.

Ex. 9.—Green. App. Time, July $4^d\ 8^h\ 55^m\ 12^s$. True declination 22° 48′ 36″ N.

Norie	True Altitude	51° 27′ 12″ S.	Latitude	61° 21′ 24″ N.
Bowditch	" "	51 27 7 S.	"	61 21 29 N.
Raper	" "	51 27 8 S.	"	61 21 28 N.

Ex. 10.—Green. App. Time, Mar. $19^d\ 21^h\ 48^m\ 48^s$. True declination 0° 3′ 43″ N.

Norie	True Altitude	39° 37′ 53″ S.	Latitude	50° 25′ 50″ N.
Bowditch	" "	39 37 47 S.	"	50 25 56 N.
Raper	" "	39 37 51 S.	"	50 25 52 N.

Ex. 11.—Green. App. Time, Sept. $22^d\ 5^h\ 5^m\ 38^s$. True declination 0° 0′ 0″.

Norie	True Altitude	49° 40′ 43″ S.	Latitude	40° 19′ 17″ N.
Bowditch	" "	49 40 34 S.	"	40 19 26 N.
Raper	" "	49 40 39 S.	"	40 19 21 N.

Ex. 12.—Green. App. Time, May $15^d\ 1^h\ 7^m\ 0^s$. True declination 19° 1′ 40″ N.

Norie	True Altitude	38° 32′ 52″ N.	"	32° 25′ 28″ S.
Bowditch	" "	38 32 44 N.	"	32 25 36 S.
Raper	" "	38 32 42 N.	"	32 25 38 S.

Ex. 13.—Green. App. Time, Mar. $19^d\ 22_h\ 23^m\ 0^s$ True declination 0° 4′ 19″ N.

Norie	True altitude	38° 56′ 11″ S.	Latitude	51° 8′ 8″ N.
Bowditch	" "	38 56 6 S.	"	51 8 13 N.
Raper	" "	38 55 59 S.	"	51 8 20 N.

Ex. 14.—Green. App. Time, June $28^d\ 13^h\ 16^m\ 40^s$ True declination $23°\ 14'\ 30''$ N.

Norie	True altitude 71° 13′ 11″ N.	Latitude 4° 27′ 41″ N.
Bowditch	" " 71 13 5 N.	" 4 27 35 N.
Raper	" " 71 13 1 N.	" 4 27 31 N.

Ex. 15.—Green App. Time, Feb. $29^d\ 20^h\ 20^m\ 20^s$ True declination 7° 23′ 27″ S.

Norie	True Altitude 62° 16′ 13″ S.	Latitude 20° 20′ 20″ N.
Bowditch	" " 62 16 6 S.	" 20 20 27 N.
Raper	" " 62 16 9 S.	" 20 20 24 N.

GREENWICH DATE.

	d h m s		d h m s
Ex. 3.—G. A. T. Feb.	2 8 42 28	Ex. 7.—G. M. T. Apr.	28 23 4 0
" 4.—G. A. T. Oct.	11 14 38 43	" 8.—G. M. T. July	8 17 21 35
" 5.—G. M. T. Aug.	20 18 45 4	" 9.—G. A. T. Apr.	30 4 0 0
" 6.—G. A. T. Mar.	15 18 52 14	" 10.—G. M. T. Nov.	30 21 21 21

AMPLITUDE.

	Green. Date.	True decl.	True Amp.	Error.	Dev.
	d h m s	° ′ ″	° ′	° ′	° ′
Ex. 2.—Nov.	9 23 4 4	17 19 39 S.	W. 18 1 S.	32 5 W.	30 41 W.
" 3.—Apr.	15 10 36 12	10 9 2 N.	W. 11 2 N.	7 32 E.	5 24 W.
" 4.—Oct.	30 5 28 0	14 4 26 S.	E. 24 31 S.	15 51 E.	3 26 W.
" 5.—Feb.	7 23 2 4	15 6 40 S.	W. 19 11 S.	23 51 W.	15 51 W.
" 6.—July	1 17 59 32	23 2 1 N.	E. 58 33 N.	49 3 W.	11 12 E.
" 7.—Jan.	5 8 31 56	22 27 20 S.	W. 22 52 S.	19 19 E.	26 19 E.

" 8.—	True amplitude	W. 3° 59′ S.	Deviation	18° 31′ E.
" 9.—	"	E. 0 36 N.	"	8 23 W.
" 10.—	"	West	"	4 33 E.
" 11.—	"	W. 50 27 S.	"	21 33 E.
" 12.—	"	E. 61 7 N.	"	15 53 E.
" 13.—	"	W. 50 12 S.	"	24 3 E.
" 14.—	"	E. 15 4 N.	"	3 56 W.
" 15.—	"	W. 20 34 N.	"	8 44 E.

AZIMUTH.

Ex. 3.—Green. Mean Time, Jan. $27^d\ 21^h\ 47^m\ 4^s$. Polar distance 71° 41′ 6″.

	° ′ ″		° ′ ″	° ′	° ′
Norie	Rem. 5 39 3	T. Az.	N 95 38 W	Er. 8 38 W	Dev. 17 16 W.
Bowditch	" 5 39 6	"		"	
Raper	" 5 39 6	"	N 95 39 W	" 8 39 W	" 17 17 W.

Ex. 4.—Green. Mean Time, Feb. 25_d 4^h 8^m 44^s. Polar distance 99° 9′ 12″.

		° ′ ″		° ′		° ′		° ′
Norie	Rem.	26 36 38	T. Az.	S 68 50 E	Er.	1 29 E	Dev.	5 45 W.
Bowditch	"	26 36 41	"		"		"	
Raper	"	26 36 43	"	S 68 52 E	"	1 27 E	"	5 47 W.

Ex. 5.—Green. Mean Time, Sept. 22_d 4_h 58^m 27^s. Polar distance 89° 59′ 58″.

		° ′ ″		° ′		° ′		° ′
Norie	Rem.	22 42 1	T. Az.	N 80 36 E	Er.	20 44 W	Dev.	[illegible] W.
Bowditch	"	22 42 3	"		"		"	
Raper	"	22 42 7	"	N 80 37 E	"	20 43 W	"	[illegible] 43 W.

Ex. 6.—Green. Mean Time, Sept. 30^d 22^h 43^m 16^s. True declination 3° 24′ 22″ S.

		° ′ ″		° ′		° ′		° ′
Norie	Rem.	32 2 36	T. Az.	S. 82 30 W.	Er.	23 0 W.	Dev.	25 0 W.
Bowditch	"	32 2 40	"	"				
Raper	"	32 2 42	"	S. 82 30½ W.				

Ex. 7.—Green. Mean Time, Dec. 19^d 21^h 38^m 28^s. Time declination 23° 27′ 24″ S.

		° ′ ″		° ′		° ′		° ′
Norie	Rem.	0 23 53	T. Az.	N. 122 10 E.	Er.	6 30 E.	Dev.	20 0 W.
Raper	"	0 23 48	"	N. 122 7 E.	"	6 27 E.	"	20 3 W.

Ex. 8.—Green. Mean Time, Feb. 11^d 21^h 49^m 0^s. True declination 13° 50′ 13″ S.

		° ′ ″		° ′		° ′		° ′
Norie	Rem.	7 5 44	T. Az.	N. 88 12 W.	Er.	29 8 W.	Dev.	19 38 W.
Bowditch	"	7 5 47	"	N. 88 13 W.	"	29 9 W.	"	19 39 W.
Raper	"	7 5 46	"	N. 88 13 W.	"	29 9 W.	"	19 39 W.

Ex. 9.—Green. Mean Time, Nov. 14^d 5^h 15^m 56^s. True declination 18° 28′ 5″ S.

		° ′ ″		° ′		° ′		° ′
Norie	Rem.	24 40 32	T. Az.	S. 45 58 W.	Er.	44 2 W.	Dev.	9 2 W.
Bowditch	"	24 40 36	"	S. 46 2 W.	"	43 58 W.	"	8 58 W.
Raper	"	24 40 37	"	S. 46 0 W.	"	44 0 W.	"	9 0 W.

		Norie.	**Bowditch.**	**Raper.**
		° ′ ″	° ′ ″	° ′ ″
Ex. 10.—	Remainder	11 11 35	11 11 39	11 11 37
	True Azimuth	S. 64 22 E.	S. 64 22 E.	S. 64 22 E.
	Deviation	3 18 E.	3 18 E.	3 18 E.
Ex. 11.—	Remainder	44 52 52	44 52 57	44 52 57
	True Azimuth	N. 64 16 W.		N. 64 15 W.
	Deviation	17 4 E		17 5 E.

Ex. 12.—Daily rate 4″·4. Acc. rate 12^m 27^s Green. Mean Time Apr. 30^d 18^h 0^m 0^s.

Norie	Rem. 53° 8′ 49″	A. T. S.	30^d 18^h 52^m 53^s	Long. 12° 27′ 30″ E
Bowditch	" 53 8 52	"	30 18 52 52·5	
Raper	" 53 8 51	"	30 18 52 53	

Ex. 13.—Green. Mean Time Mar. 25^d 5^h 41^m 1^s.

Norie	Rem. 51° 7′ 29″	A. T. S.	25^d 4^h 4^m 8^s	Long.	16° 0′ 15″ W
Bowditch	" 51 7 31	"	25 4 4 9	"	16 0 0 W
Raper	" 51 7 33	"	25 4 4 9	"	16 0 0 W

Ex. 14.—Green. Mean Time May 19^d 19^h 19^m 19^s.

Norie	Rem. 17° 29′ 16″	A. T. S.	20$_d$ 2^h 17^m 56^s	Long.	103° 43′ 45″ E
Bowditch	" 17 29 20	"	20 2 17 57	"	103 44 0 E
Raper	" 17 29 17	"	20 2 17 56	"	103 43 45 E

Ex. 15.—Green Mean Time Oct. 28^d 1^h 52^m 27^s.

Norie	Rem. 20° 15′ 47″	A. T. S.	27^d 21^h 33^m 13^s	Long.	68° 50′ 45″ W
Bowditch	" 20 15 49				
Raper	" 20 15 51				

Ex. 16.—Green Mean Time June 27^d 0^h 0^m 0^s.

Norie	Rem. 10° 4′ 21″	A. T. S.	26^d 22^h 56^m 10^s	Long.	15° 15′ 0″ W
Bowditch	" 10 4 25	"	26 22 56 9	"	15 15 15 W
Raper	" 10 4 26	"	26 22 56 9	"	15 15 15 W

		Norie.	**Bowditch.**	**Raper.**
Ex. 17.—	Remainder	51° 3′ 29″	51° 3′ 32″	51° 3′ 31″
	Longitude	166 59 15 E	166 59 15 E	166 59 15 E
Ex. 18.—	Remainder	32 22 47	32 22 50	32 22 48
	Longitude	73 32 45 E	73 33 0 E	73 32 45 E
Ex. 19.—	Remainder	58 13 9	58 13 11	58 13 15
	Longitude	173 43 45 E		173 44 0 E
Ex. 20.—	Remainder	53 52 56	53 53 0	53 53 1
	Longitude	0 34 45 W		0 35 0 W
Ex. 21.—	Remainder	7 58 16	7 58 19	7 58 18
	Longitude	37 18 0 E		
Ex. 22.—	Remainder	23 56 38	23 56 42	23 56 42
	Longitude	180 0 0 W	179 59 45 E	179 59 45 E
Ex. 23.—	Remainder	38 15 8	38 15 11	38 15 12
	Longitude	0 0 0	0 0 0	0 0 15 E
Ex. 24.—	Remainder	70 59 50	70 59 53	70 59 53
	Longitude	178 3 30 W	178 3 0 W	178 3 15 W

	Norie	Bowditch	Raper
Ex. 25.—Remainder	62 2 26	62 2 28	62 2 29
Longitude	145 5 45 E	145 6 0 E	145 6 0 E

EX. MERIDIAN.

Ex. 3. — Hour Angle 33^m 53^s. Green. App. Time, May 14^d 3^h 59^m 3^s. 1st Aug. 11′ 42″. 2nd Aug. 29′ 57″.

	Norie	Bowditch	Raper
Latitude	66° 54′ 20″ N.	66° 54′ 26″ N.	66° 54′ 27″ N.

Ex. 4.—Hour Angle 19° 56′. Green. App. Time, Mar. 25^d 1^h 0^m 0^s 1st Aug. 0′ 28″. 2nd Aug. 15′ 28″.

	Norie	Bowditch	Raper
Latitude	41° 44′ 1″ N.	41° 44′ 8″ N.	41° 44′ 2″ N.

Ex. 5.—Hour Angle 37^m 44^s. Green. App. Time, May 10^d 0^h 37^m 32^s 1st Aug. 13′ 50″. 2nd Aug. 28′ 13″.

	Norie	Bowditch	Raper
Latitude	37° 49′ 21″ S.	37° 49′ 28″ S.	37° 49′ 33″ S.

Ex. 6. — Hour Angle 32^m 16^s. Green. App. Time, June 28_d 16^h 16^m 16^s. 1st. Aug. 12′ 22″. 2nd Aug. 16′ 13″.

	Norie	Bowditch	Raper
Latitude	36° 48′ 11″ S.	36° 48′ 18″ S.	36° 48′ 25″ S.

Ex. 7.—Green. App. Time, Dec. 15^d 5^h 19^m 42^s.

	Norie	Bowditch	Raper
Latitude	53° 49′ 59″ S.	53° 50′ 5″ S.	53° 50′ 5″ S.

Ex. 8.—Green. App. Time, Nov. 23^d 5^h 49^m 0^s.

	Norie	Bowdlcth	Raper
Latitude	28° 56′ 16″ N.	28° 56′ 22″ N.	28° 56′ 21″ N.

Ex. 9.—Green. App. Time, Aug. 4^d 18_h 40^m 48^s.

	Norie	Bowditch	Raper
Latitude	47° 9′ 46″ S.	47° 9′ 51″ S.	47° 9′ 58″ S.

Ex. 10.—Green. App. Time, Jan. 28^d 11^h 0^m 2^s.

	Norie	Bowditch	Raper
Latitude	47° 37′ 33″ N.	47° 37′ 41″ N.	47° 37 41″ N.

Ex. 11.—Green. App. Time, Feb. 29^d 22^h 59^m 46^s.

	Norie	Bowditch	Raper
Latitude	42° 17′ 38″ S.	42° 17′ 45″ S.	42° 17′ 45″ S.

Ex. 12.—Green. App. Time, Sept. 22^d 5^h 5^m 38^s.

	Norie	Bowditch	Raper
Latitude	39° 18′ 1″ N.	39° 18′ 7″ N.	39° 18′ 7″ N.

Ex. 13.—Green. App. Time, Oct. $11^d\ 8^h\ 15^m\ 2^s$.

	Norie	Bowditch	Raper
Latitude	31° 16′ 31″ S.	31° 16′ 35″ S.	31° 16′ 40″ S.

Ex. 14.—Green. App. Time, Jan. $25^d\ 9^h\ 0^m\ 48^s$.

	Norie	Bowditch	Raper
Latitude	18° 26′ 37″ N.	18° 26′ 43″ N.	18° 26′ 45″ N.

Ex. 15.—Green. App. Time, Nov. $4^d\ 18^h\ 11^m\ 15^s$.

	Norie	Bowditch	Raper
Latitude	46° 16′ 58″ N.	46° 17′ 1″ N.	46° 17′ 8″ N.

MERIDIAN ALTITUDE OF A STAR.

		Norie	Bowditch	Raper
Ex. 3.—	Latitude	50° 57′ 5″ N	50° 57′ 14″ N.	50° 57′ 11″ N.
" 4.—	"	2 17 4 S.	2 17 11 S.	2 17 6 S.
" 5.—	"	23 51 18 S.	23 51 23 S.	23 51 28 S.
" 6.—	"	41 24 3 N.	41 24 10 N.	41 24 7 N.
" 7.—	"	11 14 39 N.	11 14 47 N.	11 14 46 N.
" 8.—	"	43 12 11 N.	43 12 16 N.	43 12 20 N.
" 9.—	"	37 42 2 N.	37 42 6 N.	37 42 7 N.
" 10.—	"	31 21 30 S.	31 21 23 S.	31 21 20 S.
" 11.—	"	32 21 44 S.	32 21 51 S.	32 21 56 S
" 12.—	"	1 6 30 S.	1 6 37 S.	1 6 38 S.
" 13.—	"	6 5 34 S.	6 52 7 S.	6 5 30 S.
" 14.—	"	44 19 52 N.	44 19 59 N.	44 19 56 N.
" 15.—	"	28 0 44 N.	28 0 52 N.	28 0 52 N.

TIDES.

	A. M.	P. M.		A. M.	P. M.
	h. m.	h. m.		h. m.	h. m.
Ex. 1—	3 8	3 26	Ex. 13—	0 28	1 16
" 2—	No. A. M.	0 30	" 14—	1 19	1 51
" 3—	5 50	6 18	" 15—	0 11	0 36
" 4—	11 38	No. P. M.	" 16—	0 54	1 25
" 5—	No. A. M.	0 20	" 17—	No. A. M.	0 27
" 6—	3 56	4 15	" 18—	11 51	No. P. M.
" 7—	11 11	11 32	" 19—	No. A. M.	0 16
" 8—	2 51	3 13	" 20—	1 35	2 15
" 9—	0 45	1 10	" 21—	11 57	No. P. M.
" 10—	10 3	10 38	" 22—	0 14	1 1
" 11—	11 25	11 48	" 23—	No. A. M.	14
" 12—	0 49	1 38	" 24—	No. A. M.	0 26

	A. M. h. m.	P. M. h. m.		A. M. h. m.	P. M. h. m.
Ex. 25—	No. A. M.	0 26	Ex. 41—	11 41	No. P. M.
" 26—	11 57	No. P. M.	" 42—	10 18	10 55
" 27—	11 55	No. P. M.	" 43—	10 36	11 15
" 28—	1 7	1 49	" 44—	10 36	11 6
" 29—	0 13	0 42	" 45—	9 39	10 3
" 30—	0 11	0 47	" 46—	11 40	No. P. M.
" 31—	5 10	5 31	" 47—	10 48	11 19
" 32—	8 9	8 43	" 48—	No. A. M.	0 11
" 33—	9 49	10 18	" 49—	10 9	10 48
" 34—	11 49	No. P. M.	" 50—	11 45	No. A. M.
" 35—	0 30	0 54	" 51—	No. A. M.	0 4
" 36—	10 42	11 4	" 52—	11 24	11 44
" 37—	10 51	11 11	" 53—	11 41	No. P. M.
" 38—	11 4	11 39	" 54—	No. A. M.	0 37
" 39—	No. A. M.	0 4	" 55—	10 32	11 13
" 40—	No. A. M.	0 7			

	Norie and Raper. A. M. h. m.	Norie and Raper. P. M. h. m.	Bowditch. A. M. h. m.	Bowditch. P. M. h. m.
Ex. 56—	2 41	3 5		
" 57—	No. A. M.	0 4		
" 58—	9 4	9 24		
" 59—	5 25	6 14	5 26	6 15
" 60—	11 38	No. P. M.		
" 61—	11 58	No. P. M.	11 57	No. P. M.
" 62—	No. A. M.	0 6		
" 63—	0 47	1 28	0 46	1 27
" 64—	11 47	No P. M.		
" 65—	11 53	No P. M.		
" 66—	2 14	2 38		
" 67—	11 32	No P. M.		
" 68—	9 45	10 17		
" 69—	5 13	5 40	5 12	5 39
" 70—	8 36	8 56		
" 71—	No A. M.	0 6	No A. M.	0 7
" 72—	No A. M.	0 13	No A. M.	0 14
" 73—	11 56	No P. M.		
" 74—	4 23	5 9		

	Norie and Raper. A. M. h. m.	Norie and Raper. P. M. h. m.	Bowditch. A. M. h. m.	Bowditch. P. M. h. m.
" 75—	11 31	No P. M.		
" 76—	8 44	9 25		
" 77—	No A. M.	0 12	No A. M.	0 13
" 78—	No A. M.	0 13	No A. M.	0 12
" 79—	No A. M.	0 16	No A. M.	0 17
" 80—	0 21	0 56		

DEVIATION OF THE COMPASS.

Ex. 1—Cor. Mag. Bearing N. 46° 35′ E. Ship's head, North, Dev. 2° 25′ E.; N. E., 14° 5′ E.; East, 15° 45′ E.; S. E., 11° 20′ E.; South, 0° 40′ W.; S. W., 12° 35′ W.; West, 17° 35′ W.; N. W., 12° 45′ W.

Ex. 2—Cor. Mag. Bearing S. 15° 0′ E. Ship's head, North, Dev. 1° 55′ W.; N. E., 18° 45′ E.; East, 22° 10′ E.; S E., 14° 30′ E.; South, 2° 10′ E.; S. W., 15° 45′ W.; West, 23° 0′ W.; N. W., 16° 55′ W.

Ex. 3—Cor. Mag. Bearing N. 84° 40′ W. Ship's head, North, Dev. 0° 30′ E.; N. E. 16° 55′ W.; East, 25° 20′ W.; S. E., 20° 55′ W. South, 0° 10′ E.; S. W., 22° 45′ E.; West, 24° 20′ E.; N. W., 15° 45′ E.

Ex. 4—Cor. Mag. Bearing S. 64° 35′ W. Ship's head, North, Dev. 1° 5′ E.; N. E., 9° 15′ W.; East, 14° 40′ W.; S. E., 10° 25′ W.; South, 0° 15′ W.; S. W., 11° 5′ E.; West, 13° 50′ E.; N. W., 8° 35′ E.

Ex. 5—Cor. Mag. Bearing N. 10° 30′ W. Ship's head North. Dev. 4° 50′ W.; N. E., 18° 20′ E.; East, 20° 20′ E.; S. E., 13° 0′ E.; South, 0° 20′ E.; S. W., 12° 10′ W.; West. 19° 50′ W.; N. W., 15° 10′ W.

Ex. 6—Cor. Mag. Bearing S. 32° 36′ E. Ship's head, North. Dev. 2° 9′ E.; N. E. 16° 39′ E.; East, 17° 44′ E.; S. E., 11° 24′ E.; South, 1° 36′ W.; S. W., 13° 51′ W.; West. 18° 21′ W.; N. W., 14° 6′ W.

Ex. 7—Ship's head, North. Dev. 3° 39′ E.; N. E., 16° 6′ W.; East, 23° 51′ W.; S. E., 20° 21′ W.; South, 4° 6′ W.; S. W., 19° 54′ E.; West, 24° 39′ E.; N. W. 16° 9′ E.

Ex. 8—Ship's heod North. Dev. 0° 34′ E.; N. E. 6° 41′ W.; East, 11° 11′ W.; S. E., 8° 26′ W.; South, 0′ 56′ W.; S.W., 8° 19′ E.; West, 9° 49′ E.; N. W., 8° 34′ E.

Ex. 9—Ship's head North, Dev. 1° 39′ E.; N. E. 23° 9′ E.; East 26° 29′ E.; S. E., 19° 59′ E.; South, 1° 51′ W.; S.W., 21° 11′ W.; West 26° 21′ W.; N. W., 21° 51′ W.

Ex. 10—Comp. Courses.	S. 74° 15′ E.;	N. 57° 45′ W.;	S. 0° 40′ E.	
11— "	N. 1 55 W.;	N. 63 45 E.;	S. 30 30 E.	
12— "	N. 65 40 W.;	S. 0 10 E.;	N. 29 15 W.	
13— "	N. 35 45 E.;	S. 55 25 E.;	S. 56 5 W.	
14— "	S. 69 40 E.;	N. 60 10 W.;	S. 70 10 W.	
15— "	N. 2 9 E.;	S. 33 36 E.;	S. 1 36 E.	
16—Mag. Bearings.	S. 28 54 W.;	N. 61 6 W.		
17— "	N. 36 34 E.;	S. 81 34 W.		
18— "	S. 71 29 W.;	S. 26 29 W.		
19— "	N. 2 25 E.;	S. 47 25 W.		
20— "	N. 67 50 W.;	N. 67 10 E.		
21— "	S. 73 5 W.;	S. 16 55 E.		
22—Mag. Courses.	N. 29° E.;	S. 35° W.;	N. 29° W.	
23— "	N. 80 E.;	S. 81 W.;	N. 13 W.	
24— "	N. 5 W.;	N. 78 W.;	N. 74 E.	
25— "	N. 2 W.;	N. 71 W.;	N. 78 E.	

SET No. 1.

Logarithms.—	Product	34522	
	Quotient	6·804	
Day's Work.—	Course S. 27° W. Distance 74 miles. Latitude in 39° 56′ S. Longitude in 20° 56′ E.		
Mer. Altitude.—	Latitude	Norie	43° 10′ 1″ N.
	"	Bowditch	43 10 8 N.
	"	Raper	43 10 3 N.
Parallel Sailing.—	Difference of longitude 6·149 miles.		
Mercator.—	Course S. 9° 24′ W. Distance 96·29 miles.		
Tides.—	St. Ives	$9^h 44^m$ A. M.	$10^h 17^m$ P. M.
	Nagasaki	6 28 "	6 55 "
Amplitude.—	Deviation	27° 35′ E.	
Chronometer.—	Longitude	Norie	61° 57′ 45″ E.
	"	Raper	61 58 0 E.
Azimuth.—	Deviation	34° 59′ E.	
Ex-Meridian.—	Latitude	Norie	31° 50′ 16″ S.
	"	Bowditch	31 50 23 S.
	"	Raper	31 50 18 S.
Star.—	Latitude	Norie	48° 0′ 34″ S.

	Latitude.	Bowditch 48 0 40 S.
	"	Raper 48 0 44 S.

Deviation.—North, 1° 39′ E.; N. E., 23° 9′ E.; East, 26° 29′ E.;
S. E., 19 59 E.; South, 1 51 W.; S.W., 21 11 W;
West, 26 21 W.; N.W. 21 51 W.
Courses to steer, N. 14½′ E.; N. 36° W.
Correct Mag. Courses N. 68° 9′ E.; S. 1° 51′ E.
Correct Mag. Bearings N. 70 1 W.; N. 19 59 E.

SET No. 2.

Logarithms.—	Product	Norie	370469 Bowditch 370467
	Quotient	"	1329
Day's Work.—	Course S. 76° E. Distance 114 miles. Latitude in 60° 49′ S. Longitude 44° 15′ E.		
Mer. Altitude.—	Latitude	Norie	50° 31′ 45″ N.
	"	Bowditch	50 31 51 N.
	"	Raper	50 31 51 N.
Parallel Sailing.—	Difference of longitude 14·75 miles.		
Mercator.—	Course S. 60° 22′ E. Distance 4120		
Tides.—	Southampton	10h 50m A. M.	11h 11m P. M.
	Busrah Bar	No A. M.	0 1 "
Amplitude.—	Deviation	3° 20′ E.	
Chronometer.—	Longitude	Norie	78° 52′ 45″ E.
	"	Bowditch	78 53 0 E.
	"	Raper	78 53 0 E.
Azimuth.—	Deviation	Norie	29° 5′ E.
		Raper	29 6 E.
Ex-Meridian.—	Latitude	Norie	46° 43′ 22″ S.
	"	Bowditch	46 43 29 S.
	"	Raper	46 43 27 S.
Star.—	Latitude	Norie	53° 58′ 13″ N.
	"	Bowditch	53 58 17 N.
	"	Raper	53 58 21 N.

Deviation.—North, 1° 5′ E.; N. E., 9° 15′ W.; East, 14° 40′ W.;
S. E., 10 25 W.; South, 0 15 W.; S. W. 11 5 E.;
West 13 50 E.; N. W. 8 35 E.;
Courses to steer, S. 67° E.; S. 1° W.
Correct Mag. Courses N. 76° 10′ W.; N. 36° 25′ W.
Correct Mag. Bearings S. 35 45 W.; N. 80 45 E.

SET No. 3.

Logarithms.—	Product	Norie 452146	Bowditch 452150	
	Quotient	" 2537		
Day's Work.—	Course S. 2° E. Distance 34 miles. Latitude in 57° 40′ N. Longitude in 145° 34′ W.			
Mer. Altitude.—	Latitude	Norie	5° 4′ 32″ S.	
	"	Bowditch	5 4 26 S.	
	"	Raper	5 4 32 S.	
Parallel Sailing.—	Difference of longitude 487·7.			
Mercator.—	Course N. 21° 30′ E. Distance 456·8.			
Tides.—	Valentia Harbor	11^h 50^m A. M.	No P. M.	
	Portland U. S.	7 37	" 8^h 8^m P. M.	
Amplitude.—	Deviation 21° 49′ E.			
Chronometer.—	Longitude	Norie	64° 4′ 15″ W.	
	"	Bowditch	64 4 30 W.	
	"	Raper	64 4 45 W.	
Azimuth.—	Deviation	16° 36′ E.		
Ex-Meridian.—	Latitude	Norie	15° 44′ 38″ S.	
	"	Bowditch	15 44 45 S.	
	"	Raper	15 44 39 S.	
Star.—	Latitude	Norie	46 2 48 N.	
	"	Bowditch	46 2 54 N.	
	"	Raper	46 2 52 N.	

Deviation.— North, 1° 55′ W.; N. E., 18° 45′ E.; East, 22° 10′ E.
S. E., 14 30 E.; South, 2 10 E.; S.W., 15 45 W.
West, 23 0 W.; N.W., 16 55 W.
Courses to steer, N. 28° E.; S. 19° E.
Correct magnetic courses S. 30° 30′ E.; N. 63° 45′ E.
Correct magnetic bearing S. 67 50 E.; N. 22 50 W.

SET No. 4.

Logarithms.—	Product	211.5		
	Quotient	4523		
Day's Work.—	Course N. 73° W. Distance 117 miles. Latitude in 51° 46′ S. Longitude in 85° 37′ W.			
Mer. Altitude.—	Latitude	Norie	42° 16′ 8″ S.	
	"	Bowditch	42 16 14 S.	
	"	Raper	42 16 17 S.	
Parallel Sailing.—	Difference of longitude 1565 miles.			
Mercator.—	Course N. 79° 8′ E. Distance 509.2 miles.			

Tides.—	Mellon	$11^h\ 31^m$ A. M.		No P. M.
	Table Bay	11 19	“	11 47 P. M.
Amplitude.—	Deviation 7° 22′ E.			
Chronometer.—	Longitude 150° 0′ 0″ W.			
Azimuth.—	Deviation 13° 23′ W.			
Ex-Meridian.—	Latitude	Norie	23° 26′ 22″	S.
	“	Bowditch	23 26 28	S.
	“	Raper	23 26 27	S.
Star.—	Latitude	Norie	52° 10′ 3	S.
	“	Bowditch	52 10 10	S.
	“	Raper	52 19 12	S.

Deviation.— North, 0° 34′ E.; N. E., 6° 41′ W.; East, 11° 11′ W.
S. E. 8 26 W; South, 0 56 W.; S. W. 8 19 E.
West, 9 49 E.; N. W., 8 34 E.
Courses to steer, N. 65½° W.; N. 48° W.
Correct magnetic courses S. 0° 56′ E.; S. 53° 19′ W.
Correct magnetic bearings S. 44 26 E.; N. 89 26 W.

SET No. 5.

Logarithms.—	Product	Norie 289379	Bowditch 289373	
	Quotient	“ 312·9		
Day's Work.—	Course N. 65° W. Distance 101 miles. Latitude in 19° 33′ S. Longitude in 25° 1′ W.			
Mer. Altitude.—	Latitude	Norie	49° 11′ 41″	N.
	“	Bowditch	49 11 50	N.
	“	Raper	49 11 53	N.
Parallel Sailing.—	Difference of Longitude 115.8 miles.			
Mercator.—	Course N. 44° 5′ E. Distance 27.84 miles.			
Tides.—	Foynes Island	$11^h\ 38^m$ A M.		No P. M.
	Dalhousie Harbor	11 24	“	11 56 P. M.
Amplitude.—	Deviation 0° 0′.			
Chronometer.—	Longitude	Norie	5° 40′ 15″	W.
	“	Raper	5 40 30	W.
Azimuth.—	Deviation	Norie	2° 4′	E.
	“	Raper	2 5	E.
Ex-Meridian.—	Latitude	Norie	36° 50′ 0″	S.
	“	Bowditch	36 50 9	S.
	“	Raper	36 50 6	S.
Star.—	Latitude	Norie	46° 18′ 55″	S.
	“	Bowditch	46 19 1	S.
	“	Raper	46 18 57	S.

Deviation.— North, 4° 50′ W.; N. E., 18° 20′ E.; East, 20° 20′ E.
S. E., 13 0 E.; South, 0 20 E.; S. W., 12 10 W
West, 19 50 W.; N. W., 15 10 W.
Courses to steer. N. 73 W; N. 60½ E.
Correct magnetic courses, N. 60° 10′ W.; S. 69° 40′ E
Correct magnetic bearings, N. 25 10 E.; S. 19 50 E

SET No. 6.

Logarithms.—	Product	Norie 948676	Bowditch	948660
	Quotient	" 44383	"	44382

Day's Work.— Course N. 39° E. Distance 136 miles. Latitude in 28° 28′ S. Longitude in 0° 28′ E.

Mer. Altitude.—	Latitude	Norie	20° 1′ 8″N.
	"	Bowditch	20 1 15 N.
	"	Raper	20 1 13 N.

Parallel Sailing.—Difference of Longitude 14.71 miles.
Mercator.— Course S. 75° 56′ W. Distance 9113 miles.

Tides.—	Peterhead	No A. M.	0^h 9^m P. M.
	Hobarton	7 26 A. M.	7 50 "

Amplitude.— Deviation 17° 10′ W.

Chronometer.—	Longitude	Norie	57° 21′ 15″E.
	"	Bowditch	57 21 30 E.
	"	Raper	57 21 30 E.
Azimuth.—	Deviation	Norie	15° 24′ W.
	"	Raper	15 23 W.
Ex-Meridian.—	Latitude	Norie	49° 35′ 6″S.
	"	Bowditch	49 35 13 S.
	"	Raper	49 35 7 S.
Star.—	Latitude	Norie	0° 1′ 31″N.
	"	Bowditch	0 1 40 N.
	"	Raper	0 1 39 N.

Deviation.— North, 2° 25′ E.; N. E., 14° 5′ E.; East, 15° 45′ E.
S. E. 11 20 E.; South, 0 40 W.; S. W., 12 35 W
West, 17 35 W.; N. W. 12 45 W.
Courses to steer. N. 66° W.; N. 79½° E.
Correct magnetic courses N. 2° 25′ E.; S. 33° 40′ E.
Correct magnetic bearings S. 32 25 W.; N. 77 25 E.

CHART.

Ex. 1.—Lat. 49° 23′ N. Long. 63° 36′ W.
" 2.— " 43 58 N. " 68 1 W.

Ex 3.— " 46 39 N. Long. 53 3 W.
" 4.— " 45 20 N. " 60 55 W.
" 5.— " 45 50 N. " 62 30 W.

Ex. 6—$\underset{r}{43}$ Ex. 7—$\underset{st}{31}$ Ex. 8—$\underset{m}{51}$ Ex. 9—$\underset{sh}{31}$ Ex. 10—$\underset{m}{64}$

Ex. 11.—	Course	E. by S ½ S	Distance	278	miles.
12.—	"	W. N. W.	"	159	"
13.—	"	S. E. ¼ S.	"	114	"
14.—	"	W. by S.	"	196	"
15.—	"	S. E. ¼ S.	"	210	"
16.—	"	S. E by E.	"	100	"
17.—	"	W. ¼ N.	"	125	"
18.—	"	W. ¾ N.	"	363	"
19.—	"	N. W. by N. ¼ N.	"	155	"
20.—	"	N. W. by W. ½ W.	"	428	"

COMMERCIAL CODE OF SIGNALS.

Ex. 16.—Report me all well.
17.—I will send the mate.
18.—Can you supply me with salt beef.
19.—E. by N.
20.—I am waterlogged, take people off.
21.—Vessels that wish to be reported all well shew your distinguishing signals.
22.—When were your chronometers last rated.
23.—S. E. ½ S.
24.—"Seaman's Pride" of Halifax N. S. official number 37599. Tonnage 108.
25.—St. John N. B.
26.—Long. 26° 49'
27.—"Lady Bird" of Quebec—Official Number 51530. Tonnage 111.
28.—Pictou N. S.
29.—$8^h\ 14^m\ 16^s$.
30.—Seaton.

Ex. 31—N S	Ex. 37—G S	Ex. 43—T M K L
32—J T	38—F G H	44—D W
33—L D B	39—W M N	45—L J P
34—B Q S W	40—J F	46—G L T J
35—M H P	41—C V W	47—G S M, G W Q, W B T
36—V S T P	42—M G	48—G T M L

Ex. 49—F N T, G V S
50—C D J Q, W T P, W V L, C F M D, C D H P, W T H

INDEX.

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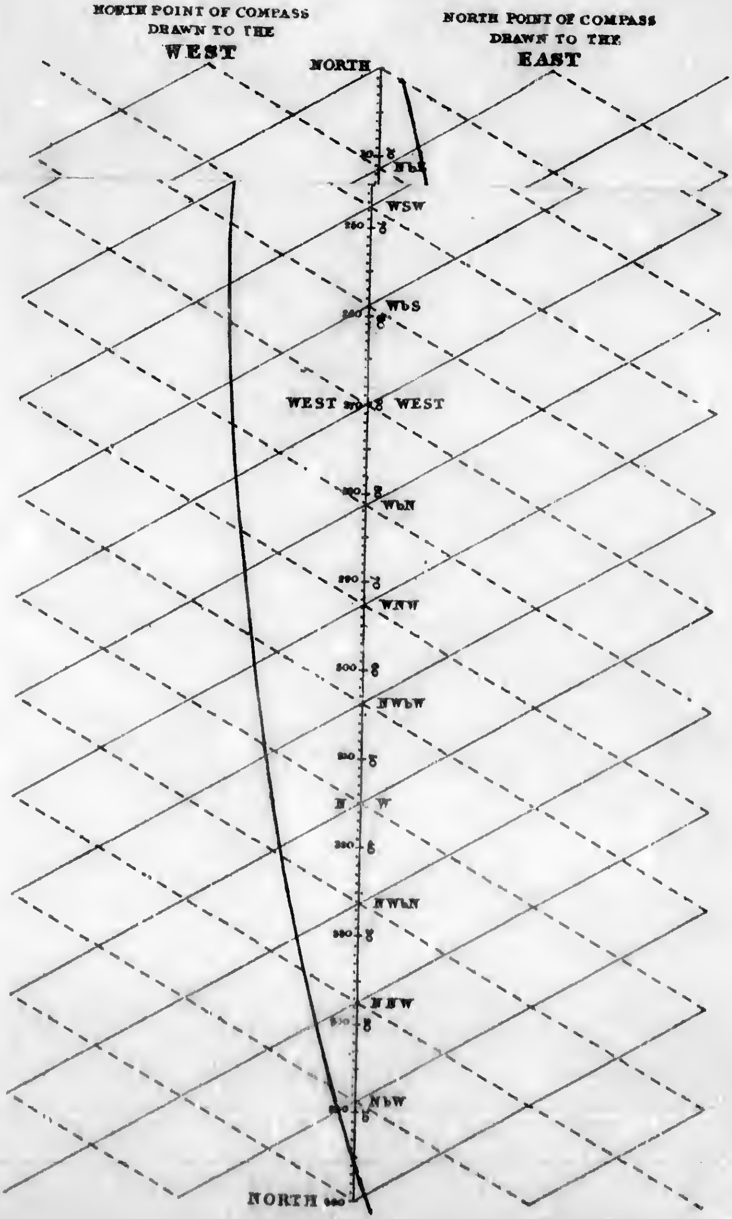
Superintendent.

DEVIATION OF THE COMPASS.

NAPIER'S DIAGRAM.

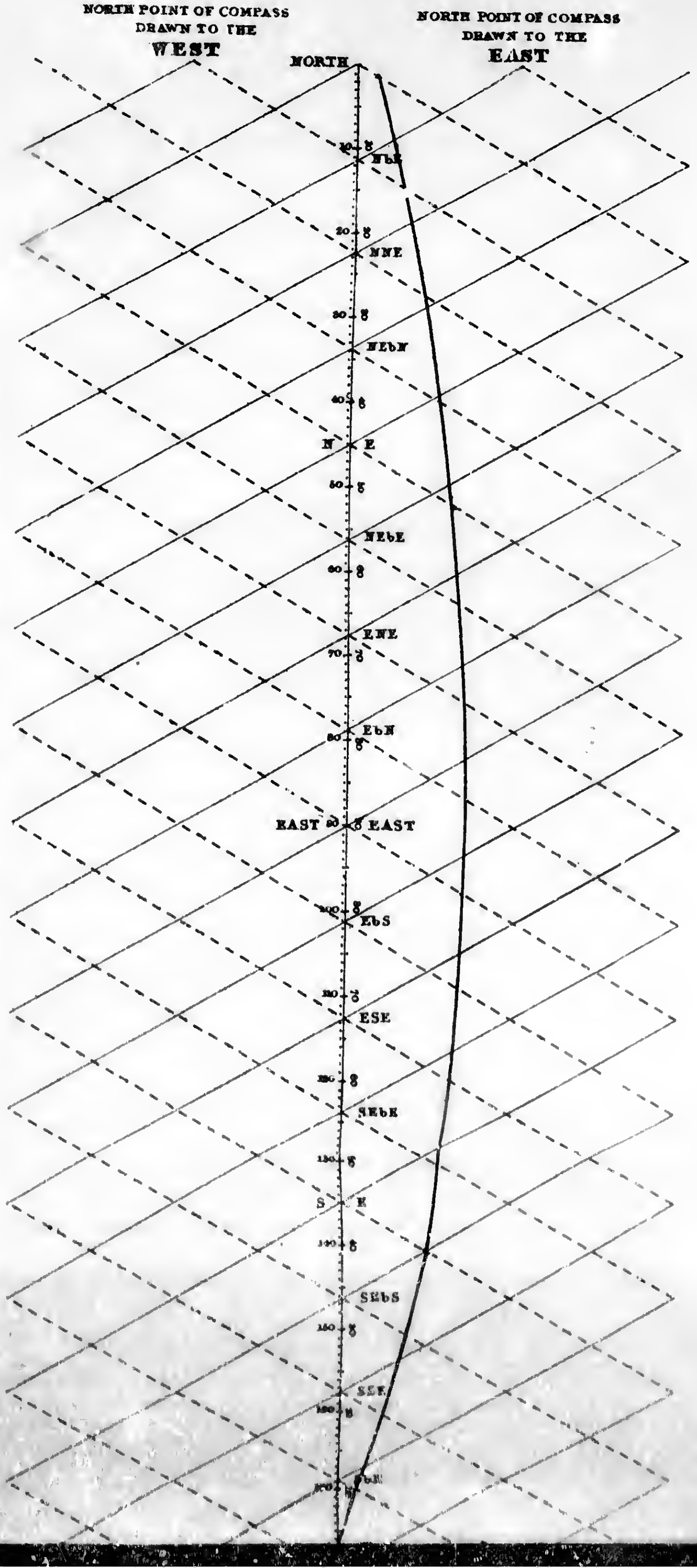
Plate VI.

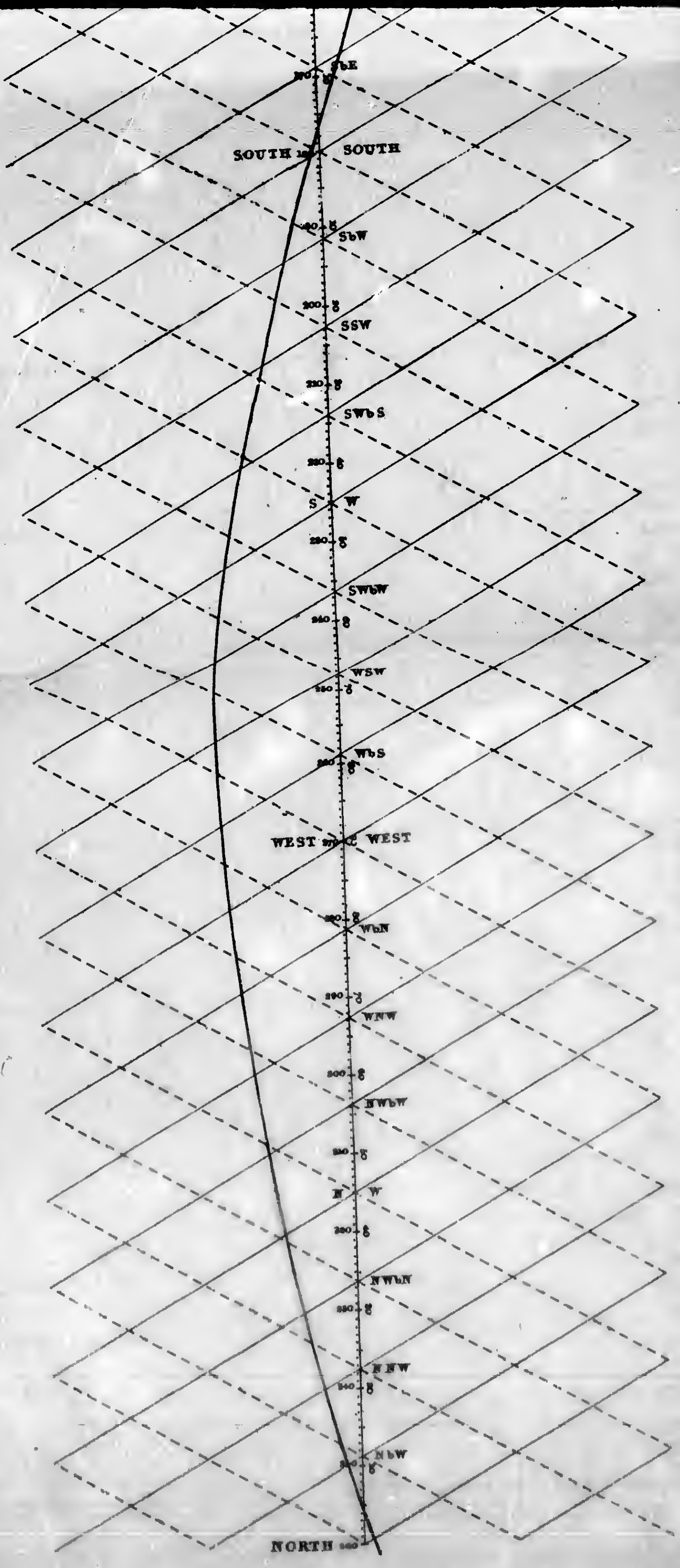


DEVIATION OF THE COMPASS.

NAPIER'S DIAGRAM.

Plate VI.




SbE
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NORTH

APPENDICE.

PROGRAMME DES CONNAISSANCES REQUISES POUR L'ADMISSION DES CANDIDATS.

AJUSTEMENTS DU SEXTANT.

Le candidat répondra par écrit, sur une feuille de papier que lui remettra l'examinateur, à toutes les questions suivantes, en apposant à chacune, le numéro correspondant à celui de la question.

1. Quel est le premier ajustement du sextant ?

Celui de placer la lunette d'index perpendiculairement sur la surface du sextant.

2. Comment faites-vous cet ajustement ?

Placez le vernier à peu près au milieu de l'arc ; tenez le sextant horizontalement entre le limbe et votre personne et regardant obliquement dans le verre indicateur, voyez si l'arc qui y est réflété, et le véritable arc, tel que vu au dehors, paraissent faire une ligne non interrompue ; si non, il faut la rectifier au moyen de vis, placés au dos du verre.

3. Quel est le deuxième ajustement ?

Celui de placer la lunette d'horizon perpendiculaire à la surface du sextant ?

4. Comment faites-vous cet ajustement ?

Placez le zéro du vernier au zéro de l'arc, tenez le sextant horizontalement, et voyez si les horizons réflétés et vrais paraissent dans la même ligne droite, si non, tournez le vis requis jusqu'à ce qu'ils le soient.

5. Quel est le troisième ajustement ?

Placez la lunette d'horizon parallèlement à la lunette d'index.

6. Comment faites vous ce troisième ajustement ?

Placez le zéro du vernier sur le zéro de l'arc, tenez le sextant perpendiculairement. et voyez si les horizons vrais et réflétés, paraissent dans la même ligne droite, si non, tournez le vis requis, jusqu'à ce qu'ils le soient.

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7 Si un vis venait à manquer, comment procéderiez-vous ?

Trouver l'erreur d'index.

8. Comment trouveriez-vous l'erreur d'index au moyen de l'horizon ?

Placez le zéro du vernier au zéro de l'arc, et faites disparaitre les horizons vrais et réflétés dans une seule ligne droite, alors ce que le sextant indiquera sera l'erreur d'index.

9. Comment doit-il être employé ?

Il sera additif, si le niveau n'est pas sur l'arc, et soustractif s'il y est.

10. Placez l'index à erreur de......... minutes, à être ajoutées, changez le et laissez-le.

Note.—L'examinateur verra à ce que cela soit fait avec exactitude.

11. L'examinateur placera alors le zéro du vernier sur l'arc à distance des divisions inscrites, et le candidat le lira.

Note.—Dans chaque cas le candidat nommera, ou désignera autrement les vis dont on se sert dans les divers ajustements (117 à 120).

12. Comment trouvez-vous l'erreur d'index au moyen du soleil ?

En mesurant le diamètre du soleil, sous et sur le niveau de l'arc, puis la moitié de la différence des deux chiffres sera l'erreur d'index (121).

13. Comment ceci s'applique-t-il ?

Additif si le numéro inférieur est le plus considérable, mais soustractif si il est le moindre.

14. Quelle preuve avez-vous que ces mesurages, ou angles ont été établis avec une exactitude passable ?

La somme des deux mesurages, divisée par 4, devrait être égale au demi-diamètre du soleil, tel que porté à l'almanac nautique, pour le jour où les observations ont été faites.

CARTE.

Le candidat devra répondre par écrit, sur une feuille de papier que lui donnera l'examinateur, à toutes les questions suivantes, se rapportant à la classe de certificat demandé, en apposant à chaque réponse le numéro correspondant à la question.

1. Une carte inconnue ayant été placée devant vous, qu'est-ce que vous auriez à déterminer avec le plus de soin, avant de répondre à une question y ayant trait, ou avant d'essayer à vous en servir ?

Voyez si c'est une carte britannique, en constatant si sa longitude est basée sur le méridien de Greenwich, aussi, si les boussoles qui y sont gravées sont vraies ou magnétiques.

2. Comment pouvez-vous constater cela dans nos cartes britanniques ?

Le point nord d'une boussole vraie est désignée par une étoile et est tiré parallèle au méridien. La ligne portant le point nord d'une boussole magnétique fait un angle Est ou Ouest d'un méridien égal à la variation.

3. Comment trouveriez-vous sur la carte la course entre deux endroits A et B ?

Couchez l'arête de la règle à parallèles sur A et B, faites mouvoir les règles jusqu'au centre de la boussole la plus voisine qui alors vous indiquera la course à prendre, magnétique ou vraie, selon la carte.

4. En supposant qu'il y ait......... points de......... variation à la première place nommée, quelle serait la course magnétique, la vraie étant d'environ.............. ?

Je dirigerais ma course par la droite pour la variation Ouest et par la gauche pour là variation Est.

5. Comment mesureriez-vous la distance entre ces deux endroits ou deux autres places sur la carte ?

Avec une paire de compas ; portez l'espace entre les deux endroits et appliquez-le sur le méridien gradué, qui, si la latitude du milieu est le centre de l'échelle employée, donnera la distance requise.

6. Pourquoi mesusuriez-vous ainsi ?

Parce que la distance entre les parallèles est augmentée vers les pôles, afin de balancer l'expansion de la différence du méridien.

Ce qui précède comprend toutes les questions sur la carte qui sont posées aux contre-maîtres.

A ce qui précède les patrons devront de plus, répondre aux questions suivantes :

7. Que signifient ces petits numéros qui se trouvent sur la carte ?

Des sondages, généralement par brasses.

8. A quelle époque de la marée ?

A marée basse, dans les grandes marées ordinaires.

9. Quels renseignements devez-vous avoir afin de pouvoir comparer les profondeurs mesurées par votre ligne de sonde, à bord, avec les profondeurs indiquées sur la carte ?

L'intervalle de temps jusqu'à la marée haute, et la moitié de la portée de la marée à l'endroit où se trouve le navire. Avec ces données, la table B dans les tables des marées de l'amirauté fournira une correction qui pourra être appliquée à la moitié de la portée moyenne de la grande marée à cet endroit, le résultat étant le montant de la marée au moment du sondage.

10. Que signifient les chiffres romains que l'on voit parfois près de la côte et dans les ports ?

Le temps de la haute marée lors de la pleine et de la nouvelle lune.

11. Comment trouveriez-vous le temps de la haute marée dans un endroit quelconque, quand il n'y a pas moyen de se procurer de tables de marées de l'amirauté, ni aucune autre table spéciale ?

En ajoutant 48 minutes pour chaque jour écoulé depuis la pleine et la nouvelle lune.

Toutes les questions qui précèdent doivent avoir une réponse, mais ceci n'empêche pas l'examinateur de poser toute autre question se rapportant à ce sujet, ou que les circonstances locales du port peuvent rendre utiles.

DEVIATION DE LA BOUSSOLE.

[Le candidat doit répondre correctement à au moins huit des questions suivantes désignées par une croix faite par l'examinateur. Celui ci ne devra pas en marquer moins de douze.]

1. Qu'entendez-vous par déviation de la boussole ?

C'est une erreur de la boussole causée sur l'aiguille par l'action magnétique du fer dans le navire ou sa cargaison.

2. Comment constatez-vous la déviation (a) en rade et (b) en mer ?

(a) Par des relèvements réciproques.

(b) Par des relèvements astronomiques.

3. Ayant constaté par le nez du vaisseau la déviation des divers points de la boussole, comment savez-vous quand elle est à l'est ou à l'ouest ?

Elle sera à l'est, si le relèvement magnétique posé sur la boussole est à la droite du relèvement pris du vaisseau, mais elle sera à l'ouest dans le cas contraire.

4. Pourquoi est-il nécessaire, pour bien vérifier ces déviations, de diriger le nez du navire dans plus d'une direction ?

Parce que chaque variation dans la course place le fer dans le navire dans une position relativement différente par rapport à l'aiguille de la boussole.

5. Pour arriver à un résultat exact, quel est le plus petit nombre de points vers lesquels le nez du navire devrait être dirigé ?

Huit.

6. Comment trouveriez-vous la déviation en naviguant le long d'une côte bien connue ?

Quand les relèvements réciproques de deux objets bien définis, tel que des phares, sont connus, mettez-les en regard, et la différence entre le relèvement observé et le relèvement connu sera la déviation pour la direction vers laquelle se trouvait le nez du navire au moment du relèvement.

Pour les questions 7, 8 et 9 voyez le paragraphe qui traite de la déviation, à la page

11. Nommez quelques objets propres à aider à la constatation de la déviation de la boussole en naviguant le long des côtes de la Manche ?

Les feux du cap Lézard, de Portland et de Foreland sud.

12. Croyez-vous que la déviation change ? dans le cas affirmatif, dites sous quelles circonstances :

Elle changera rapidement pendant quelques temps, après la mise à flot, de même que, par un changement considérable de latitude, par un changement dans la position de la boussole, la quantité de fer, ou encore, l'endroit où se trouve le fer à bord.

13. Combien de fois est-il bon de vérifier l'exactitude de votre table de déviation ?

A chaque occasion favorable.

14. Dites en peu de mots, ce dont vous avez à vous méfier, en choisissant une position pour la boussole ?

Qu'elle soit éloignée autant que possible des épontilles en fer, des baux, des cheminées, ou de toute autre influence semblable.

15. Les boussoles des navires en fer sont plus ou moins affectées parce qu'on appelle, erreur causée par la bande ; sur quelles courses disparait-elle, et sur quelles courses est-elle la plus considérable ?

Elle disparait aux points Est et Ouest, et elle est plus considérable aux points Nord ou Sud.

16. Dites à quel côté du navire, dans la plupart des cas, est attiré le point Nord de la boussole, dans l'hémisphère boréal, et quel est son effet relativement à la position supposée sur une course Nord ou Sud ?

La pointe Nord, de l'aiguille est attirée au vent et conséquemment en tirant au nord le navire fait une course plus vers le vent qne ne l'indique la boussole, tandis qu'en tirant au sud il se trouve sous le vent de sa course apparente.

17. L'effet étant tel que vous le dites, sur quelles courses arriveriez-vous, et sur quelles courses lofferiez-vous afin de gouverner selon une course bâsée sur la boussole ?

J'arriverais sur les courses au nord et je lofferais sur les courses au sud.

18. Est-ce que la même règle peut-être suivie dans les deux hémisphères, en ce qui a trait à l'erreur causée par la bande.

Non, à quelques exceptions près, le contraire de la règle suivie dans l'hémisphère boréal doit être suivi dans l'hémisphère austral.

19. Votre boussole errant considérablement, comment procéderiez-vous à la corriger, au moyen d'aimants équivalents et de fer poli, de manière à faire rentrer l'erreur dans des bornes controlables.

Faites une marque sur le pont, exactement sous le milieu de la boussole, tracez deux lignes en craie à ce point, l'une de l'avant à l'arrière, et l'autre en travers. Redressez le navire et mettez le nez au vrai N. ou S. magnétique ; puis placez une barre aimantée en travers, avec son centre sur la ligne de l'avant à l'arrière, et le N. ou bout marqué, pointant à tribord, si la pointe N. de l'aiguille est attirée à tribord, et *vice-versâ.* Gardant toujours le centre sur la ligne de l'avant à l'arrière, faites mouvoir la barre aimantée, de et à la boussole, jusqu'à ce que le nez du navire soit N. ou S. par la boussole. Mettez alors le nez à E. ou O. magnetique exact et placez la barre aimantée de l'avant à l'arrière, avec la pointe marquée à l'arrière, si l'aiguille est attirée vers l'arrière, et *vice-versâ* ; placez le centre de la barre le long de la ligne en travers, jusqu'à ce que le nez du navire soit dirigé vers l'E. ou O. par la boussole. Ensuite dirigez le devant sur un des 4 points de courses magnetiques exacte, et placez une boîte de fer poli de chaque côté de l'habitacle, de niveau avec l'aiguille. Mettez plus ou moins de fer dans ces boîtes jusqu'à ce que la boussole s'accorde avec la direction du devant du navire. Ce dernier ajustement est permanent, mais les deux autres exigeront de la surveillance, et par conséquent les aimants devraient être fixés de manière à pouvoir être déplacés à volonté, dans ce but, pendant le voyage. Les aimants devraient être de 10 à 18 pouces de long, leur largeur un dixième de la longueur et leur épaisseur un quart de la largeur. Ils ne devraient jamais être approchés de plus de deux fois leur longueur de l'aiguille de boussole.

DEFINITIONS DES TERMES DE NAVIGATION ET D'ASTRONOMIE NAUTIQUE.

Le candidat devra écrire une courte définition vis-à-vis de chacun des termes suivants, que l'examinateur désignera par une croix. Il n'en marquera pas moins de 10. L'écriture devra être lisible, et l'épellation soignée.

Un plan est une surface plate et unie sans profondeur, cette surface peut être supposée placée dans toute direction voulue, et alors tous les objets qu'elle comprend sont dits appartenir à ce plan.

Un grand cercle est un cercle dont le plan passe par le centre d'une sphère ; par conséquent il divise cette dernière en deux parties égales, et est le plus grand cercle qui puisse être tracé sur un globe.

Un petit cercle est un cercle dont le plan ne passe pas par le centre de la sphère, conséquemment il divise la sphère en deux parties inégales.

Déf. 1. **L'Equateur** est un grand cercle également éloigné des deux pôles.

Déf. 2. **Les Pôles** sont les extrémités de l'axe de la terre.

Déf. 3. **Un méridien** est un grand cercle qui passe à travers les pôles.

Déf. 4. **L'Ecliptique** est un grand cercle qui indique la route apparente du soleil dans le firmament.

Déf. 5. **Les Tropiques** sont deux petits cercles parrallèles à l'équateur, coupant chacun un zénith de l'écliptique.

Déf. 6. **La Latitude** est l'arc d'un méridien intercepté entre un endroit donné et l'équateur.

Déf. 7. **Les Parallèles de Latitude** sont des petits cercles parallèles à l'équateur.

Déf. 8. **La Longitude** est l'arc de l'équateur intercepté entre ce qui est appelé le premier méridien et le méridien passant par un endroit donné.

Déf. 9. **L'Horizon visible** est le cercle, dans la pleine mer, formé par les limites de la vue.

Déf. 10. **L'Horizon sensible** est le plan qui, passant par la vue de l'observateur, est parallèle à l'horizon visible.

Déf. 11. **L'Horizon rationnel** est le plan qui passe par le centre de la terre parallèle à l'horizon visible.

Déf. 12. **L'Horizon artificielle et son usage.** L'horizon artificielle est un petit auge à bas-fond contenant du vif argent. On s'en sert lorsqu'il n'y a pas d'horizon visible pour mesurer la hauteur d'un objet.

Déf. 13. **La course exacte d'un navire** est l'angle contenu entre le nez du navire et le vrai méridien.

Déf. 14. **La course magnétique** est l'angle contenu entre le nez du navire et le méridien magnétique exact.

Déf. 15. **La course à la Boussole** est l'angle contenu entre le nez du navire et le méridien à la boussole.

Déf. 16. **La Variation de la Boussole** est l'angle entre les véritables méridiens et les méridiens magnétiques.

Déf. 17. **La Déviation de la Boussole** est l'angle entre le méridien magnétique exact et le méridien indiqué par la boussole.

Déf. 18. **L'erreur de la Boussole** est le résultat produit par l'effet combiné de la variation et de la déviation de la boussole, à bord.

Déf. 19. **La Dérive** est l'angle formé par la quille du navire avec sa course actuelle dans l'eau

Déf. 20. **La hauteur méridienne d'un astre** est sa hauteur sur le méridien du point d'observation.

Déf. 21. **L'Azimut** est l'angle compris entre les pôles Nord et Sud et le cercle vertical qui passe par cet objet.

Déf. 22. **L'Amplitude** est l'angle compris entre les points Est et Ouest de l'horizon et un objet à son lever ou à son coucher.

Déf. 23. **La Déclinaison** est la distance angulaire d'un astre Nord ou Sud de l'équateur céleste.

Déf. 24. **La distance Polaire** est la distance angulaire d'un astre du pôle ou se trouve l'observateur.

Déf. 25. **L'ascension droite** est l'arc de l'équateur céleste compris entre le premier point du Bélier et le cercle de déclinaison passant par un astre donné.

Déf. 26 **L'abaissement** est l'angle compris entre l'horizon sensible et une ligne tirée depuis l'œil de l'observateur à un point de l'horizon visible.

Déf. 27. **La Refraction** est la somme dont la hauteur d'un astre est augmentée par l'effet de l'atmosphère de la terre.

Déf. 28. **La parallaxe** est la correction additive, à une hauteur, pour la rendre égale à ce qu'elle devrait être si l'observation eût été faite du centre de la terre.

Déf. 29. **Le demi-diamètre** est la moitié du diamètre apparent d'un astre.

Déf. 30. **L'augmentation du demi-diamètre de la Lune** est l'augmentation du demi-diamètre apparent de la lune, causée par le rapprochement de l'endroit où se trouve l'observateur de la lune, pendant qu'elle monte de l'horizon au zenith.

Déf. 31. **La hauteur observée** est la distance angulaire entre un astre et l'horizon d'après le sextant.

Déf. 32. **La hauteur apparente** est la distance angulaire entre un objet et l'horizon sensible.

Déf. 33. **La hauteur vraie** est la hauteur apparente d'un objet corrigée par la réfraction et la parallaxe.

Déf. 34. **La distance au Zenith** est la distance angulaire entre un objet et le point dans le firmament, immédiatement au dessus de l'observateur.

Déf. 35. **Les cercles verticaux** sont des grands cercles passant par le zénith.

Déf. 36. **Le premier vertical** est le cercle vertical qui est à angles droits avec le méridien céleste.

Déf. 37. **Le temps civil** est le moyen ordinairement usité pour calculer le temps à terre.

Déf. 38. **Le temps astronomique** est l'intervalle de temps écoulé depuis la lune précédente.

Déf. 39. **Le temps sidéral** est le temps écoulé depuis le passage du premier point du bélier.

Déf. 40. **Le temps moyen** est le temps ordinaire à l'horloge.

Déf. 41. **Le temps apparent** est le temps écoulé depuis le passage du vrai soleil.

Déf. 42. **L'Equation du temps** est l'intervalle de temps entre le temps moyen et le temps apparent.

Déf. 43. **L'angle Horaire d'un astre** est l'angle compris entre l'astre et le méridien céleste.

Déf. 44. **Le complément d'un arc ou d'un angle** est la différence entre un arc ou un angle et 90°.

Déf. 45. **Le supplément d'un arc ou d'un angle.**—La différence entre cet arc et un angle de 180°.

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