CHAPTER I

INTRODUCTION

When the ship is being navigated along or near the coast, the art of fixing the ship's position graphically, laying a safe course to destination and checking ship's position whilst on, the course to ensure the vessel's safe arrival is called "Chart Work".

This naturally involves the use of a suitable graphical representation of the earth's surface on the plane of the paper, which when constructed to suit the special needs of a navigator is called the "Navigational Chart".

Navigational charts are mostly drawn on Mercator's projection, which ensures that all meridians and parallels of latitude are straight lines, at right angles to each other and all angles on the earth's surface are equal to the corresponding angles drawn on the chart. A special feature of this projection is that rhumb lines are also represented as straight lines.

As the safety of the ship depends upon the accuracy of the navigational chart, utmost care is taken in its construction and upkeep. It is drawn precisely giving full details of all the information required by the navigator.

The chart must naturally cover more area of the sea, as compared to the land, and should highlight the information that a mariner requires to navigate his ship safely from one position to another, that is to say the chart must show clearly the depth of water, nature of the bottom, details of coastline and off lying dangers and the various navigational aids e.g. light houses, prominent land marks, light vessels and radio beacons.

FATHOM CHARTS AND METRIC CHARTS

The unit used for indicating the depths i.e. "Fathom" or "Feet" or "Metres" is boldly displayed just below the title of the chart.

British Admiralty charts, which have traditionally been using fathom and feet for depths and also feet as unit for height, are being changed to adopt metric units, thus conforming to charts of most of the other countries. The words "DEPTHS IN METRES" are printed in bold letters under the title of these charts.

The British Admiralty plans that all new charts will be metric, and that existing charts will also be converted to metric form as soon as possible. However, it will be many years before all the charts will be converted.

The metric charts differ in appearance from old fathom charts by their improved design and greater use of colour. Full details of symbols and abbreviations used on metric and fathom charts are given on British Admiralty chart and publication No. 5011.

CATEGORIES OF CHARTS

Navigational charts may be generally classified into three categories.

OCEAN CHARTS

These charts are prepared on a very small scale, covering large portions of the globe e.g. Indian Ocean, North Atlantic Ocean. On such charts only the outstanding coastal features and important ports etc. are shown. These charts are used for planning and executing long voyages across the oceans and are obviously unsuitable for coastal navigation.

COASTAL CHARTS OR COASTAL SHEETS

These charts are of medium scale and cover only a portion or a part of the coast. They show all the aids to navigation e.g. lights (their characteristics), Radio and D.F. beacons, important navigation marks including offlying rocks and other dangers. Such charts are used when the ship is being navigated along the coast. Coastal charts thus highlight the features on and along the coast and the adjoining portions of the seas.

PLANS

These charts are drawn on a very large scale and each plan covers only a small area e.g. Plan of Bombay Port. They contain all the information required when navigating a ship in harbours, and other congested and enclosed waters. Every possible information of use to a navigator is shown in great detail.

The scale of these plans enables the mariner to plot his position with great accuracy and thus avoid the dangers which are frequent in ports and in harbours.

SOME SPECIAL TYPES OF CHARTS

DECCA CHARTS

These are normal basic navigational charts with the appropriate Decca lattice superimposed on them, and can be used in place of corresponding basic navigational charts. The number of Decca chart is the same as that of the basic chart but is prefixed L (D) and suffixed with Decca chain number.

CONSOL CHARTS

These are mostly used in air-navigation but may be used as an aid to ocean navigation also. They show great circle bearings of the consol stations. Details of consol systems e.g. in USSR and USA are shown in Admiralty List of Radio Signals.

LORAN CHARTS

Loran chains used for ocean navigation cover most of the Northern Hemisphere, and parts of Central Pacific Ocean. British Admiralty Loran charts cover only the North Atlantic. The U.S. Oceangraphic office publishes Loran charts for the Pacific Ocean.

ROUTEING CHARTS

These charts give important information for planning of passages across the oceans. Separate charts recommending routes for different months of the year are published for each ocean and they give recommended tracks and distances between ports, average meteorological and ice conditions and ocean currents. The information regarding load lines is also provided in these charts.

CHAPTER II

SALIENT FEATURES OF THE CHARTS

HOW CHARTS ARE MADE

Navigational charts in U.K. are published by the Hydrographic Department of the British Admiralty; under the Hydrographer of the Royal Navy. The Hydrographer of the Navy is responsible for the preparation, correction and issue of the charts and other navigational publications. He is also the authority for surveying the British and other connected waters.

In India, the Hydrographic Department of the Indian Navy, with its Headquarters at Dehradun, prepares and issues the charts and other navigational publications. However, its activities and publications are restricted at present to the Indian and adjacent waters only.

The Hydrographic Department of the British Admiralty issues charts for almost all the parts of the world. This task has now become easier, because the Admiralty gets the necessary information from the Hydrographic Departments of the countries, which are responsible for the publication of the charts for the waters under their jurisdiction.

To start with, the surveying department carries out an extensive survey of the area required to be covered by the chart and all information from various sources is collected and carefully analysed.

A modern survey, with all the resources of such inventions as Radar, Echo sounders, Hi-Fix and DECCA systems is a very thorough and detailed operation. The depths are closely sounded and elaborate examination is made of reported or suspected dangers. The actual Latitude and Longitude of some key stations is also determined.

From the data thus obtained, the charts are produced, ready for the engravers, by the specialist staff of the Chart Branch. Projections are computed and all important points are plotted accurately before the actual drawing of the chart begins.

This drawing is very accurately engraved on a copper plate by coating it with wax by using special ink on the drawing. The engraving of this copper plate is transferred to a lithographic stone or a zinc plate by contact or by Photo lithography. The plate is then ready for printing on paper, which is done by lithography or multicoloured offset printing. The paper used is high grade non-distortion paper.

Every new chart, in its final proof is examined by the officers of the Department responsible for such details. No effort is spared to ensure the accuracy and completeness of the chart.

After the chart is published and distributed, it must be kept up-to-date by incorporating any changes or corrections, which may have occurred subsequently. Such corrections and changes in charts of various parts of the world are issued as "Notices to Mariners" by the Hydrographic Departments.

DESCRIPTION OF THE CHARTS

TITLE OF THE CHART

The title of each chart is printed in some convenient, conspicuous place on a chart, where it does not hinder the navigational use of it.

Under the title, the information about datum, bearings, lights, Natural scale, Projection etc. are shown. Below this "Cautions" are given in respect of the use of chart. Examples of titles are "Arabian Sea", "Karachi to Vengurla".

NATURAL SCALE

Natural scale is the relationship between the actual length of something on the Earth and the length by which that thing is shown on the chart e.g. $\frac{1}{12,500}$ natural scale. The numerator of the fraction is always unity, and both the lengths (that on the Earth and that on the chart) must be

in the same units e.g. Natural Scale of $\frac{1}{12,500}$ means a feature of 12,500 cms. length on the earth would be represented by a length of one cm. on the chart.

Natural scale of the chart is shown below the "Title of the chart".

SCALES OF LATITUDE AND LONGITUDE

Whenever a three dimensional Earth's surface is represented on two dimensional plane of paper, distortion must occur, as is evident from different types of "Projections".

Mercator's projection, which is mostly used in the charts, is one such method by which Earth (which is three dimensional) is represented on the paper. This projection has the following properties and principles :--

(a) Direction lines on the Earth's surface are represented by straight lines on the chart, called "Rhumb Lines".

(b) All angles on the chart are true and equal to the corresponding angles on the Earth's surface.

(c) On the chart the meridians are shown as equidistant parallel lines, perpendicular to the Equator, whilst on Earth's surface they converge at the poles.

Hence to retain the property of "correct angles" on the chart, the parallels of Latitude are shown as straight lines, parallel to Equator, but at increasingly larger distance apart (and not equidistant) as one moves away from Equator. Hence on the Mercator's chart, the Latitude scale is increased gradually as the Latitude becomes higher and higher, with Longitude scale being kept constant all over. To be more precise the length of 1' D' Lat. = Length of 1' D' Long X sec. Lat. Thus on a Mercator's chart all distances are measured along the Latitude scale (1' of Lat. scale representing one nautical mile). The Longitude scale is used for measuring Longitude and the difference in Longitude only.

All charts have two scales, Latitude and Longitude. The former is shown at both the sides and the latter at the top and bottom edges of the chart. These are properly and accurately graduated in minutes and degrees.

NUMBER OF THE CHART

Each chart has a serial number assigned to it. This is shown at the bottom right hand corner and the top left hand corner, outside the margin. The chart catalogue gives the list of charts with the title and number for the various parts of the world.

DATE OF PUBLICATION

The date of publication alongwith the name of the Hydrographer to the Admiralty or Government authority is printed at the bottom, in the middle just outside the margin. Recent publication would mean a more reliable chart, incorporating all corrections, large and small, upto that date.

DATE OF PRINTING

This is shown as the number of the day in the year, printed at the top right hand corner, outside the margin e.g. 335.88. This means that the chart was printed on the 335th day of 1988.

SMALL CORRECTIONS

As stated earlier, various Hydrographic Departments issue "Notices to Mariners". These include corrections to be made to the navigational charts already printed. Notice number under reference is called "small corrections" and is shown at the bottom left hand corner, outside the margin. These corrections are entered by hand e.g. 1988-1462, 1989-1225 mean Notice to Mariners No. 1462 of 1988 and Notice to Mariners No. 1225 of 1989 respectively and refer to the corrections made on the chart, vide those notices.

Prior to 1954, the corrections, which were of temporary nature or of minor importance, in general, were shown as 1943 [5.12] which means 12th May 1943 or 1945 [VII-25] which means 25th July 1945. Small corrections with date enclosed

in a rectangle have been discontinued.

Temporary (T) and Preliminary (P) notices are not shown in small corrections.

NEW EDITIONS AND LARGE CORRECTIONS

Large corrections are shown near the new edition dates, at the bottom, in the middle (outside the margin).

These are the corrections involving major changes in the chart, which a navigator normally cannot incorporate in the chart himself. So a new chart is published/printed, whenever large corrections occur on the same. So whenever a chart is revised throughout or modernised in style, a new Edition is published.

All notations of earlier large and small corrections are at the same time erased in the new editions and old copies of the charts are cancelled.

From 1972 onwards, large corrections are discontinued and only New Editions are shown.

CHART BLOCKS

Sometimes a "Notice to Mariner" includes a reproduction of a small area of a chart, in which the corrections have been carried out. This is called a chart block and it is cut and pasted in its appropriate position on the chart as a part of "Small Corrections"

SOUNDINGS AND THE CHART DATUM

Soundings mean the depths of water below the chart datum and are thus one of the most important features of the navigational chart. The units used for Soundings are clearly shown below the "Title" of the chart.

Soundings figures are scattered on the chart, and their distance apart from each other is a measure of the extent of survey and hence the "Reliability" of the chart. On all charts the position of sounding is the centre of space occupied by the Sounding figure.

Sometimes during survey the lead is lowered to only a certain predetermined depth and if no bottom is detected then such a sounding is shown as "No bottom sounding" e.g.

___ means "No bottom at 110 fathoms".
110

On Metric charts, generally soundings are shown in metres and decimetres in depth of 20 metres or less and in metres elsewhere.

On Fathom charts soundings are shown in fathoms and feet in depths of less than 11 fathoms and in fathoms elsewhere.

Soundings on the chart are the depths below the chart datum. CHART DATUM being an imaginary datum, beyond which the sea level rarely falls. In modern practice, the datum is established at or near the Lowest Astronomical Tide (L.A.T.)

The height of tide at any given time is thus an "error on the safer side."

Chart datum is also the level above which tidal levels and predictions are given in Admiralty Tide Tables. This datum is also used on the charts for giving "drying heights" of features which are periodically covered and uncovered by the tide.

NATURE OF BOTTOM

Under certain soundings, the nature of the sea bottom, is also indicated e.g. soM (soft mud), Co (Coral), Sh (Shells) Sn (Shingles).

This information is very useful when anchoring a ship. The nature of bottom also becomes helpful in estimating the ship's position, when worked alongwith the soundings.

DEPTH CONTOURS

The soundings in the chart are very useful to a navigator but if these soundings on the chart are shown very closely, the chart will become confusing and impracticable. Hence all areas, having certain selected equal soundings are

shown as below:--

. . . .	One fathom line.
. . . .	Two fathom line
- - - - - - - - -	Six fathom line
- . - . - . - . - . - . - .	Ten fathom line
- - - - - . - - - - -	One hundred fathom line
(10) SD	Sounding of doubtful depth
___ 120	No bottom found at 120 fathoms.

HEIGHTS

All heights, unless otherwise stated are given in metres or feet above Mean high water springs or in places where there is no tide, above Mean Sea level. Heights of small islets and of the tops of artificial features are enclosed in brackets. Brackets are used wherever the figure expressing height in necessarily set apart from the objects.

DRYING HEIGHTS

Underlined figures, on rocks and banks which uncover, express the heights (in metres and decimetres or in feet as appropriate) above the datum of chart.

BEARINGS

Bearings are always from seaward and are always true bearings.

SEA MILE

A Sea Mile is a length of one minute of Latitude at a place and it is the principal unit of distance.

PLATE DIMENSIONS

The figures in brackets shown outside the lower right hand border of the chart thus (425.0 x 860.0 mm) or (34.46 x 25.49) express the dimension (in millimetres or inches) of the plates from which charts are printed. The dimensions of the charts are measured from the inner rectangle of the chart and exclude the chart borders.

A check on these dimensions serves as a good guide to assess the distortion of the chart in use.

INFORMATION REGARDING LIGHTS

(1) All the heights of the lights are given above the Mean High Water Springs.

(2) Range of the light is given in nautical miles. The range of the light may be Geographical or Luminous. "Geographical Range" is based only on its height above sea level (assuming the observer to be at a 15 feet height). The "Luminous" (nominal) range, on the other hand is based on the intensity of the light. Until 1972, the charts showed the lesser of the geographical and luminous ranges but on the new charts now, only the luminous range is shown. The Lists of Lights also give the luminous range now.

LEADING LIGHTS

Quite often, at the entrance or approaches to the harbour, two lights of different characteristics are erected, some distance apart, in such a manner that a mariner entering the harbour correctly and properly, would see them in one line, thereby indicating to the navigator that the ship lies on a line joining the two lights.

ADVANTAGES OF THE LEADING LIGHTS

(1) The leading lights indicate the safe passage of the ship in a channel.

(2) The leading lights help in fixing the position of the ship.

(3) The leading lights also help the navigator in finding the compass error. The (actual) true transit bearing of the two leading lights is read off the chart and the compass bearing of the two lights, when in transit is taken, and the difference between the two bearings is the compass error.

COMPASS ROSE

Compass roses for laying off bearing and courses are engraved on charts, and they are referred to as compass roses to avoid confusion with ship's compass.

The compass roses are printed on the chart, at two or three places, wherever it is possible, so that it does not interfere with any useful information given on the chart.

The compass rose is printed as two concentric cards, the outer compass rose is on the true north and the inner card is on the magnetic meridian, at the place where the centre of the compass rose is shown on the chart. The number of degrees by which the magnetic north is to the east or west of the true north is the Variation, and is shown on the compass rose on the 90° & 270° line. The year for which the variation is given, is shown within brackets (next to variation) and the annual change (variation) at that place is indicated in italics, alongside the variation.

HINTS TO REMEMBER WHEN USING CHARTS

(1) Always use the largest scale charts available for the area.

(2) Note carefully the units in which soundings are given.

(3) Familiarise yourself thoroughly with graduations on the chart before reading the Latitude and Longitude.

(4) When measuring distance, along the Latitude scale, the dividers should be used along the mean latitude between the two points.

(5) When using the compass rose, the ruler must pass through the centre of compass rose and 180° on the opposite direction.

(6) If in doubt about a "Cocked hat" always assume the ship to be closer to danger.

(7) Always keep the chart dry. Keep bottles and pens away from the chart. Use soft black pencils and soft erasers. Never use copying pencils.

LARGEST SCALE CHART ALWAYS TO BE USED

The large scale charts show in greater detail all the useful information required by a mariner. These charts are always corrected first and it may happen that a large scale chart of a particular locality may have received corrections of coastline and water-work from a major new survey.

CAUTION IN USING SMALL SCALE CHARTS

Whenever approaching the land or dangerous banks, only large scale charts should be used. A small error in laying down a position on a large scale chart means a few metres difference; while on a small scale chart, a small error may mean difference of a few cables or a mile.

THE INTERNATIONAL HYDROGRAPHIC ORGANISATION

The first International Hydrographic conference was held at London in 1919 and it was attended by 24 nations only. At the end of this conference it was agreed that a permanent organisation should be established, firstly for the purpose of carrying through the decisions taken and secondly for maintaining close liaison among the various Hydrographic offices.

The International Hydrographic Bureau started at Monaco in 1921, with 19 member countries. The Hydrographic conferences were held nearly every 5th year. In 1967, a convention was adopted with the aim of establishing the Bureau as Intergovernmental Organisation. This convention came into force in 1970 and since then the new title "The International Hydrographic Organisation" came into effect.

The organisation's principal objective, as stated in the convention are:--

(1) The Co-ordination of the activities of national Hydrographic offices.

(2) The greatest possible uniformity in nautical charts and documents.

(3) The adoption of reliable and efficient methods of carrying out and exploiting hydrographic surveys.

(4) The development of the sciences in the field of Hydrography and techniques employed in descriptive Oceanography.

There are lots of useful hydrographic publications published by this organisation.

CHAPTER III

MISCELLANEOUS ADMIRALTY PUBLICATIONS

ADMIRALTY NOTICES TO MARINERS

Notices to Mariners, which contain important information for the mariners, are issued by the Hydrographic Department of the British Admiralty.

In India also, the Hydrographic Department of the Indian Navy, at Dehra Dun issues the Notices to Mariners.

The "Notices to Mariner" enable a navigator to keep his charts and other books corrected for the latest information. They are published in Weekly Editions. These Notices and Weekly editions are numbered consecutively, commencing at the beginning of each year. However, the Notices to Mariners issued by the Indian Hydrographic Department are issued once every fortnight.

Temporary & Preliminary Notices have their consecutive number prefixed by (T) & (P) respectively.

The Symbol * when it appears in the Notices to Mariners of the British Admiralty means that the notice is based on original information as opposed to one that republishes information from another country. Obviously, almost all notices pertaining to the English coast would bear * mark.

The Weekly Editions of the Notices to Mariner can be obtained gratis from the Admiralty chart agents and depots, Mercantile Marine Department, Customs House and Shipping offices.

WEEKLY EDITIONS

Each Weekly Edition of the Notices to Mariners contains the following six sections:-

(1) Index.

(2) Admiralty Notices to Mariners.

(3) Navigation Warnings.

(4) Amendments to CHINPACS (China Sea, Indian & Pacific Oceans) and the Notice in the Annual Summary of Notices to Mariners relating to these publications.

(5) Corrections to Admiralty List of Lights.

(6) Correction to Admiralty List of Radio Signals.

NO. 1 WEEKLY EDITION

No. 1 weekly edition published at the beginning of every year is different from the typical Weekly Edition described above.

It contains in a consolidated form, the information of important and permanent nature. The topics covered are as under:--

(1) Admiralty Tide Tables.

(2) Admiralty Agents for the sale of Charts, etc.

(3) Official Radio Messages to U.K. Registered Merchant Ships. "The GBMS Organisation".

(3A) Official Messages to U.K. Registered Merchant Ships. (Small Craft and Fishing Vessels).

(3B) Official Radio Message – The Merchant System.

(4) Distress and Rescue at Sea – Ships and Aircraft.

(4A) Distress and Rescue – Indian and S.W. Pacific Oceans – Ship's Position Reports.

(4B) The AMVER Organisation (Automated Mutual – Assistance Vessels Rescue System).

(5) Firing Practice and Exercise Areas.

(6) Areas Dangerous due to Mines, Swept Routes and Instructions regarding Explosive picked up at Sea.

(7) British Merchant Ships – Use of Radar in time of Emergency or War.

(8) Information concerning Submarines.

(9) British Isles – Warnings Broadcast by Coast Radio Stations.

(10) Minelaying and Mine Countermeasures Exercises – North Sea, English Channel and waters around the British Isles.

(11) North Atlantic and North Pacific Oceans – Ocean Weather ships.

(12) Territorial Waters and Fisheries Jurisdiction Claims.

(13) Radio Navigational Warnings.

(14) Availability of Notices to Mariners and Chinpacs Route – Book.

(15) Under-Keel Clearance – Reliance on Charts and Predicted Tides.

(16) Protection of Historic and Dangerous Wreck Sites.

(17) Traffic Separation Schemes.

ANNUAL EDITION OF THE INDIAN NOTICES TO MARINERS

The Indian Hydrographic Department also publishes similar Annual Edition of Notices to Mariners in the beginning of each year, the contents of which are as follows:--

(1) General Notice.

(2) Availability of Notices to Mariners.

(3) Under-Keel Clearance – Reliance on Chart & Predicted Tides.

(4) Caution when approaching Indian Ports.

(4A) Andaman and Nicobar Islands – Restrictions.

(5) Weather bulletins issued to ships by the India Meteorological Department.

(6) List of Storm Signal Stations.

(7) Distress and Rescue at Sea – Ships and Aircraft.

(8) Firing Practice and Exercise Areas.

(9) Caution with regard to Ships Approaching Squadrons.

(10) Information concerning Submarines.

(11) Radio Navigational Warnings.

(12) Long Range (H/F) Radiotelegraphy Service for Indian Merchant Ships in Area IN.

(13) Submarine Cables.

(14) Indian Merchant Ships – Use of Radar in time of War.

(15) Reports of Shoals obtained by Echo Sounding – Instructions.

(16) Decca Navigator System.

(17) The International Hydrographic Organisation.

(18) Information about Radar Responder Beacon.

(19) List of Charts published by Naval Hydrographic office.

(20) List of up-to-date Corrections to Charts.

List of Temporary and Preliminary Notices in force on 31st December.

ADMIRALTY PUBLICATIONS & BOOKS

SAILING DIRECTIONS

Sailing Directions or generally known as PILOT Books are also issued by the British Admiralty.

Indian Hydrographer also issues similar Sailing Directions for Indian waters.

The Sailing Directions amplify the information given on charts and also give other useful guidance to the mariners for approaching the ports and harbours.

The whole world is covered by approximately 75 volumes of the Sailing Directions, numbered consecutively. A new volume is republished at intervals of about 12 years and between the editions, it is kept upto date by means of successive supplements every 18 months. Whenever a new supplement is published, the previous one is cancelled. The supplement must be referred to, when consulting Sailing Directions.

A small number of Notices to Mariners are also published each year to correct Sailing Directions.

The limit of the area covered in each Sailing Directions is shown in the Chart Catalogue.

ADMIRALTY LIST OF LIGHTS

Admiralty List of Lights and Fog Signals, usually termed as "Admiralty List of Lights" give details of lights, light structure, and fog signals available throughout the world. There are 12 volumes, numbered alphabetically, covering the whole world and the limits of each is shown in the Chart Catalogue.

Details of light vessels, light floats and light buoys, exhibiting lights at elevations exceeding 6 metres are also included in the "Lists".

A new volume of "List of Lights" is published every 18 months approximately and during this time, it should be kept corrected from section V of the Weekly Editions of Notice to Mariners.

ADMIRALTY LIST OF RADIO SIGNALS (ALRS)

Admiralty List of Radio Signals are published in eight volumes as follows:-

VOLUME 1 – COAST RADIO STATIONS (NP281, PARTS 1 & 2)

A complete, detailed global listing of Coast Radio Stations accepting public correspondence, distress, urgent and safety traffic. Published annually.

VOLUME 2 – RADIO NAVIGATIONAL AIDS (NP282)

World-wide listing of all Marine Radio Navigational Aids including information on Global Satellite Position Fixing Systems. Published annually.

VOLUME 3 – RADIO WEATHER SERVICES AND NAVIGATIONAL WARNINGS (NP283, PARTS 1 & 2)

A complete listing of all stations broadcasting Radio Weather Services and Navigational Warnings world-wide. Published annually.

VOLUME 4 – METEOROLOGICAL OBSERVATION STATIONS (NP284)

A comprehensive list of over 9,000 Meteorological Observation Stations world-wide taken from the official data supplied by the World Meteorological Organisation (WMO) and the UK Meteorological Office. Published every 18 months.

VOLUME 5 – GLOBAL MARITIME DISTRESS AND SAFETY SYSTEM (NP285)

Recognised by the International Maritime Organisation as fully compliant with the SOLAS V/20 requirements, this easily the most comprehensive world wide guide currently available on ail aspects of the GMDSS. Published annually.

VOLUME 6 – PILOT SERVICES AND PORT OPERATIONS (NP286 PARTS 1 & 2)

All the radio procedures essential to assist vessels requiring pilots or entering any recognised port, harbour or marine world-wide. Published annually.

VOLUME 7 – VESSEL TRAFFIC SERVICES AND REPORTING SYSTEMS (NP287 PARTS 1 & 2)

Contains all the information on the many local, national and international Vessel Traffic Services (VTS), including those that have been adopted by the International Maritime Organisation. Comprehensive cross-referencing with ALRS Volume 6. Published annually.

VOLUME 8 - SATELLITE NAVIGATION SYSTEM (NP288)

Comprehensive information on all aspects of Satellite Navigation System including detailed explanation and advice on various position error sources. Published annually.

ADMIRALTY TIDE TABLES

Admiralty Tide Tables are issued annually in three Volumes-

VOLUME 1

United Kingdom and Ireland (including European Channel Ports)

VOLUME 2

Europe, Mediterranean Sea and Atlantic Ocean.

VOLUME 3

Indian Ocean and South China Sea

VOLUME 4

Pacific Ocean.

- Each Volume is divided into 2 parts. Part 1 gives daily predictions of times and heights of high water and low water for a selected number of ports, known as "Standard Ports".
- Part 2 gives data for predictions of the rest of the ports known as "Secondary Ports".
- The Indian Hydrographic Department at Dehra Dun also issues one volume of Tide Tables known as "The Indian Ocean Tide Tables".

OCEAN PASSAGES OF THE WORLD

The British Admiralty also issues "Ocean Passages of the World" which helps the mariner to plan his passage across the oceans. It gives recommended routes and distances between various ports of the world, with the details of wind, current data and ice hazards.

ADMIRALTY CHART CATALOGUE

Admiralty chart catalogue is issued annually by the Admiralty and gives the numbers etc. of the charts published, and the area the chart covers. It also gives area covered by each of the "Sailing Directions" and the "List of Lights".

The Indian Hydrographic Department at Dehra Dun also issues similar Chart Catalogue.

CHAPTER IV

TO FIND POSITION, COURSE AND DISTANCE

[English Channel (Eastern Portion) Chart B.A. No. 2675]

Position:

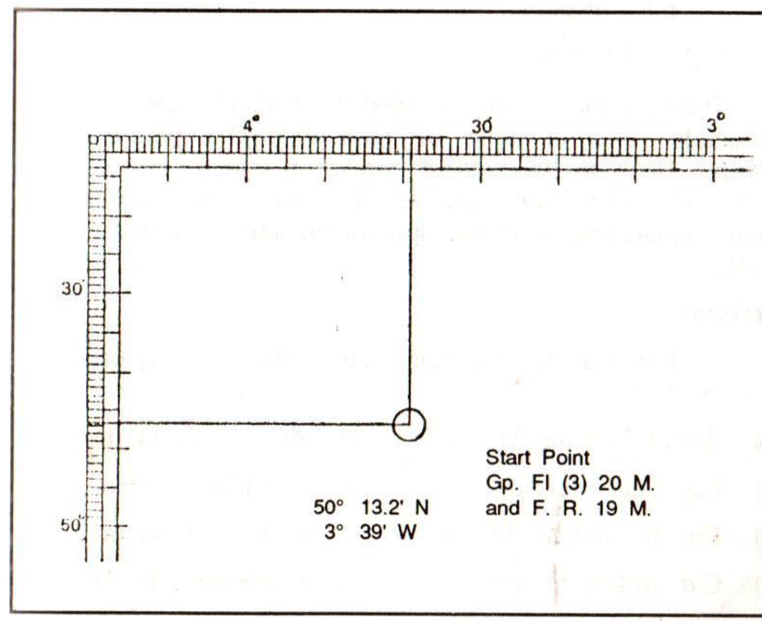
A position on a chart may be stated in one of the two ways:

(a) By the Latitude and Longitude.

(b) With reference to another position i.e. by giving the bearing and distance of, or from, that position.

Example 1.

To find the Latitude and Longitude of Start Point Light house.



(1) To find the Latitude.

Place the parallel ruler on the chart with one edge set along a parallel of Latitude. Carefully open/roll parallel ruler out until one edge passes through the required position. Where this edge (or the continuation of this edge) cuts the scale of Latitude, at the side of chart, read off the Latitude of the light house i.e. 50°13.2' North.

(2) To find the Longitude

Place the parallel ruler on the chart with one edge set along a meridian. Carefully open/roll parallel ruler out until one edge passes through the required position. Where this edge (or the continuation of this edge) cuts the scale of longitude at the top or bottom of the chart, read off the Longitude of the Lighthouse i.e. 3°39' West.

Hence Position of Start Point Lighthouse:--

Lat. 50°13.2' North Long. 03°39' West.

NOTE: A position is always given by the Latitude first then the Longitude.

SECOND METHOD

Dividers may also be used to find the Latitude and Longitude. This is done by measuring the perpendicular distance between the nearest parallel of latitude or longitude (meridian) and the required position and transferring these measurements to the appropriate latitude and longitude scale.

Exercise:

Find the Latitude and Longitude of the following positions on the chart.

(1) Bill of Portland Lt. Ho
(2) Anvil Point Lt. Ho.
(3) Les Sept. Iles Lt.
(4) Casquets Lt. Ho.
(5) Pte de Barfleur Lt. Ho.
(6) Beachy Head Lt. Ho.
(7) C.d' Antifer Lt. Ho
(8) Dungeness Lt. Ho.

Answers:

(1) Lat. 50°31' N Long. 02°27.5' W

(2) Lat. 50°35.8' N Long. 01°57.7' W

(3) Lat. 48°52.8' N Long. 03°29.4' W

(4) Lat. 49°43' N Long. 02°22.7' W

(5) Lat. 49°41.4' N Long. 01°16.0' W

(6) Lat. 50°44.4' N Long. 00°14.5' E

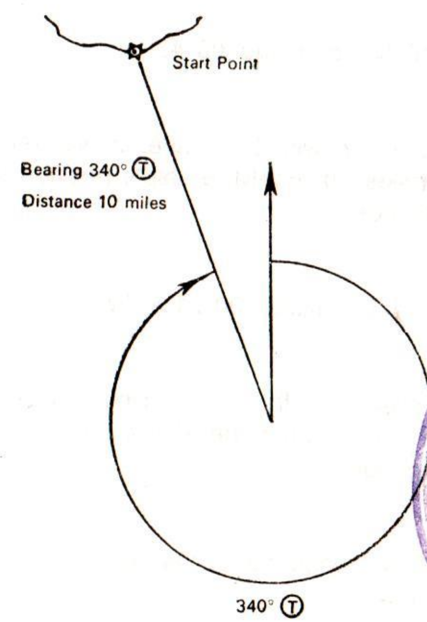
(7) Lat. 49°41.1' N Long. 00°10' E

(8) Lat. 50°55' N Long. 00°59' E

POSITIONS BY BEARING AND DISTANCE

A Position can also be indicated or found by a bearing from a lighthouse (or a navigational mark) and the distance from the light house:-

Example: A vessel is in position with Start Point Lt. Ho. bearing 340° (T) distance 10 miles off. Find the ship's position in terms of latitude and Longitude.



(1) To lay off true bearing:-

Place the parallel ruler on the nearest compass rose in such a manner that one edge passes through the exact centre of the compass rose and the required true bearing i.e. 340° in this case. Transfer the parallel ruler until one edge passes through the point of which bearing is given (Start Point in this case) and draw a line through this position. This is the required bearing.

(2) Set the divider apart to the given distance (i.e. 10 miles in this case) and cut off the same along this line of bearing from the point under reference (Start Point in this case). This will give the required position.

Answer:

Latitude 50°04' N Longitude 03°32.7' W

Exercise:

A vessel is in position with Pte. D'Ailly light bearing 128° (T) distance 12 miles off. Find the ship's position in terms of Latitude and Longitude.

Answer:

Latitude 50°02.8' N Longitude 00°43' E

Exercise:

A vessel is in position with Le Havre Lt. Vessel bearing 115° (T) distance 9 miles off. Find the ship's position in terms of Latitude and Longitude.

Answer:

Latitude 49°36' N Longitude 00°21.5' W

Exercise:

A vessel is in position with Roches Douvres Lt. bearing 076° (T) distance 10 miles. Find the ship's position in terms of Latitude and Longitude.

Answer:

Latitude 49°3.9' N Longitude 03°04' W

THE COURSE AND DISTANCE

Example:

Find the true course and distance from position (A)

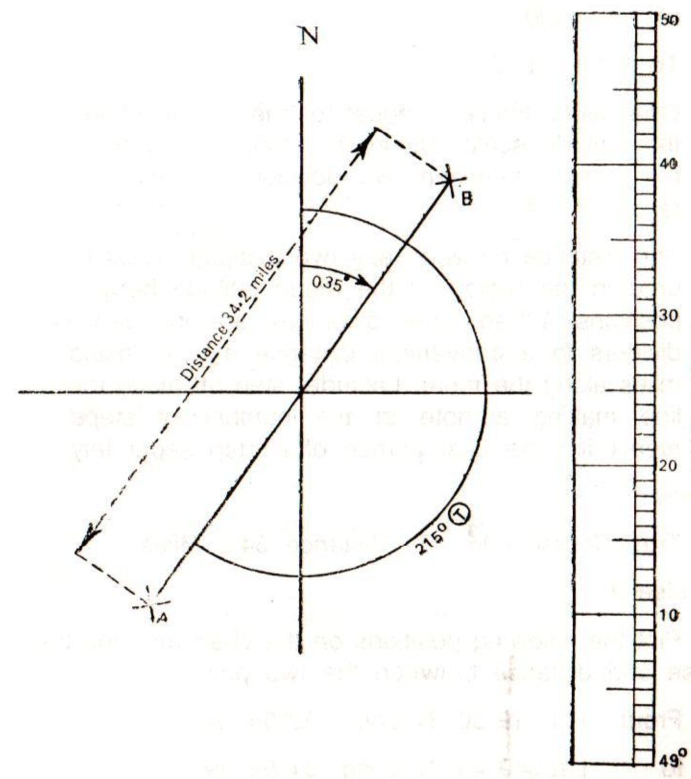
Lat. 49°05' N Long: 03°40' W to a position (B)

Lat. 49°33' N Long: 03°09' W.

SOLUTION

(1) Plot the two positions on the chart, using the reverse procedure to that given in the previous Example.

(2) Join the two positions by a straight line; the direction of this line represents the course and the length of the line is the distance between two positions.



(3) To find the true course:

(a) **First Method**

Set the edge of the parallel ruler along the course line and carefully transfer them to the nearest compass rose, placing one edge through the exact centre of the rose. Read off the true direction from the compass rose, taking care not to read off the reciprocal course (i.e.180° away) (True direction or the course being from starting position towards the destination).

(b) **Second Method:**

The angle that the course line makes with the meridian, measured in a clock wise direction from north and given in the three figure notation, is the true course i.e. 035° (T). If the true course was required from position (B) to (A), it would be 215° (T).

(4) **To Find the Distance:-**

One nautical mile is equal to one minute of the arc on the latitude scale. Using the dividers and the scale of the latitude between two positions, measures the distance i.e. 34.2 miles.

The distance between any two positions must be measured in the region of the mean latitude between these positions. When large distances are involved, set the dividers to a convenient distance e.g. 10 miles, or 20 miles along the mean Latitude; step off along the course line making a note of the number of steps taken, measuring the final portion of a step separately.

Answer:

True Course 035° (T) Distance 34.2 Miles.

Exercise 1.

Plot the following positions on the chart and find the true course and distance between the two points:-

(a) From Lat. 49°50' N Long. 02°04' W
to Lat. 49°46' N Long. 01°06' W

(b) From Lat. 49°43' N Long. 00°02' W
to Lat. 50°27' N Long, 00°56' E

(c) From Lat. 50°39' N Long. 00°35' E
to Lat. 50°32' N Long. 00°57' W

Answer:

(a) Course 096° (T) Distance 37.8 Miles.

(b) Course 040° (T) Distance 57.5 Miles.

(c) Course 263° (T) Distance 58 Miles.

Exercise II.

A vessel started from a position in Lat. 49° 42'N Long.00° 57'W and steered true course 066° (T) for a distance of 48 miles. Find the position reached.

Answer:

Latitude 50°02' N Longitude 00°11' E

Exercise III.

A vessel is in a position Lat. 50°04' N Long. 03°40' W and steers a true course of 072° (T) for a distance of 56 miles. Find the position reached.

Answer:

Latitude 50°21.2' N Longitude 02°16' W

Exercise IV.

A vessel is in a position. Latitude 49°44' N Longitude, 01°17' W and steers a true course of 117° (T) for a distance of 39 miles. Find the position reached.

Answer:

Latitude 49°26' N Longitude 00°23' W

CHAPTER V

FIXING SHIP'S POSITION

[English Channel (Eastern Portion) Chart B.A. No. 2675]

A ship's position during a voyage has to be ascertained, at short intervals, in order to maintain the ship on the course line laid on the chart. This can be done by observation of terrestrial objects.

A Position Line

A position line is a line drawn on a chart, on which the position of the ship is known to be. Hence bearing is also a position line.

A FIX

The intersection of the two or more position lines, which have been obtained at the same time will give the position of ship.

VARIOUS METHODS OF OBTAINING A POSITION LINE

(1) A visual bearing of a terrestrial object.

(2) A transit bearing. (Two Terrestrial objects in a line).

(3) A radio bearing of a radio D.F. beacon.

(4) A circle of position obtained from a vertical sextant angle.

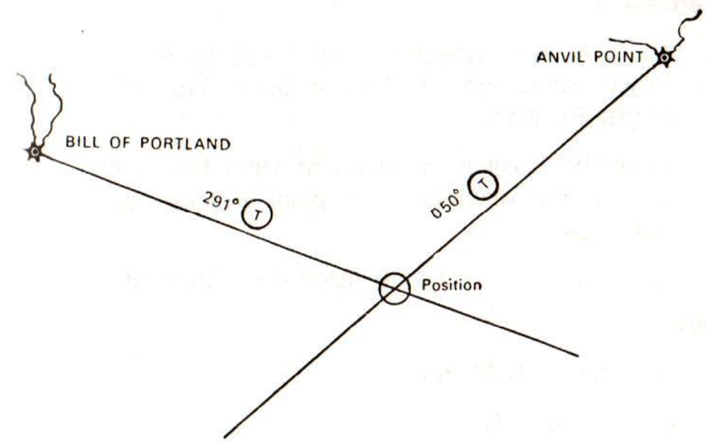
(5) A circle of position obtained from a horizontal (sextant) angle.

(6) An observation of a celestial body giving the position line.

POSITION BY CROSS BEARINGS

Example I.

A ship steering 085° (T) Anvil Point Lt. Ho. bore 050° (T) and Bill of Portland Lt. Ho. bore 291° (T). Find the ship's position.



SOLUTION

Lay 050° (T) bearing from Anvil Point Light (as explained earlier).

Similarly lay 291° (T) bearing line from Bill of Portland Light.

The point where the two lines intersect is the position of the ship.

Now read off the position in terms of Latitude and Longitude as explained earlier.

Position of the ship:--

Latitude 50°27' N Longitude 02°13.2' W

Exercise I

A ship steering 255° (C), at 2100 hrs. St. Catherine Point Lt. bore 285° (T) and Nab Tower bore 000° (T). Find the ship's position at 2100 hrs.

Answer:

Ship's position at 2100 hrs:--

Lat. 50°31.2' N Long. 00°57.3' W

Exercise II.

(a) At 1800 hrs. Beachy Head Light bore 335° (T) and Royal Sovereign Lt. Vessel bore 045° (T). Find the Ship's Position.

(b) From the Position obtained at 1800 hours, find the true course and distance to a point 9 miles due South of Nab Tower.

(c) Find also the Position 9 miles due South of Nab Tower.

Answer:

(a) Position at 1800 hours:-

Lat. 50°38.2' N Long. 00°19' E

(b) True course 262° (T) Distance 48.4 Miles.

(c) Position off Nab Tower:-

Lat. 50°31.2' N Long. 00°57.3' W

Exercise III.

(a) At 2000 hours, Le Havre Lt. Vessel bore 187° (T) and C. d'Antifer Lt. bore 101° (T). Find the ship's position.

(b) From the position at 2000 hrs. obtained in (a), find the true course and distance to a position with Pte. d'Ailly Lt. bearing 128° (T) 12 miles off.

(c) Find the position off Pte. d'Ailly light.

Answer:

(a) Position at 2000 hrs. Lat. 49° 43.5'N Long, 00° 07'W

(b) True course 059° (T) Distance 38 miles.

(c) Position off Pte. d'Ailly Lt.:-

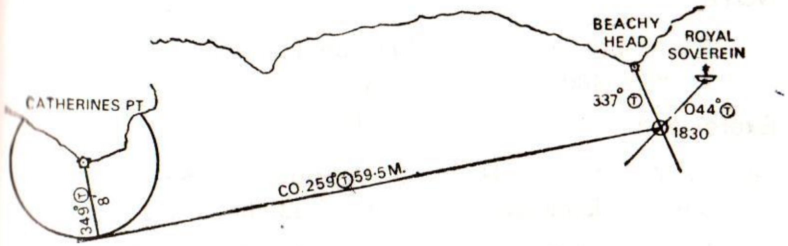
Lat. 50°03' N Long. 00°43' E

Example II.

(a) From vessel steering 270° (T), at 1830 hrs. Royal Sovereign Lt. Vessel bore 044° (T) and Beachy Head Light bore 337° (T). Find the ship's position.

(b) From the position obtained at 1830 hrs. find the true course to steer to pass St. Catherine Point Light 8 miles off when abeam to starboard.

(c) Find the time when St. Catherine Pt. Light will be abeam, if ship's speed was 12 knots?



SOLUTION

(a) To find ship's position at 1830 hrs.

Draw a line with Royal Sovereign Lt. Vessel bearing 044° (T) and Beachy Head light bearing 337° (T) and where the two bearings intersect is the position of the ship at 1830 hrs. Ship's position at 1830 hrs:--

Lat 50°38' N Long 00°19' E

(b) To find true course to pass 8 miles off St. Catherine Point Lt. when abeam.

With St. Catherine Pt. Lt. as centre and 8 miles as a radius, draw a circle.

From 1830 hrs. position draw a tangent to this circle then this tangent will be the true course to steer.

True course to steer 259° (T).

(c) Beam bearing off St. Catherine Pt. 259°+90° = 349° (T) Draw the beam bearing i.e. 349° from St. Catherine Pt. The point where the above bearing cuts the course steered is the position when St. Catherine Pt. Lt. will be abeam.

Measure the distance from 1830 hrs. to this position. Distance is 59.5 Miles.

Now calculate the time taken to cover 59.5 Miles at 12 knots.

The ship will arrive at this position at 2328 hours.

NOTE:

Beam bearing is ALWAYS on the course steered i.e. Course steered ± 90°

Exercise IV.

(a) At 0300 hrs. Le Havre Lt. Vessel bore 185° (T) and C. d'Antifer Light bore 078° (T). Find the ship's position.

(b) From the position at 0300 hrs. find the true course to steer to pass Pte. de Barfleur Lt. 10 Miles off to port.

(c) Find the time when Pte. de Barfleur light will be abeam, if ship's speed was 13 knots.

Answer:

(a) Position at 0300 hrs. Lat. 49°39' N Long. 00°09' W

(b) True Course to steer 288° (T)

(c) Beam bearing of Pte. de Barfleur Lt. 198° (T)

Distance is 42 miles.

The ship will arrive beam bearing position at 0613 hours.

CHAPTER VI

THE VARIATION, DEVIATION, MAGNETIC AND THE COMPASS COURSE

TRUE MERIDIAN

A true meridian is a great circle, passing through the geographical North and South Poles of the earth and cutting the Equator at right angles.

MAGNETIC MERIDIAN

Magnetic meridian is a great circle passing through the magnetic North and South Poles of the earth.

It is the direction in which a magnetic needle lies when freely suspended, and acting under the influence of the earth's magnetism only.

VARIATION

Variation is the angle between the true and the magnetic meridian that is to say, the angle which the freely suspended magnetic needle makes with the true meridian.

If the magnetic needle is drawn to the right of the true meridian, the Variation is said to be EASTERLY and if the magnetic needle is drawn to the left of the true meridian, the Variation is termed WESTERLY.

Variation differs from place to place but is constant for different ship's head i.e. it does not vary with the course of the ship.

DEVIATION

Due to the earth's magnetism, the vessel, which is built mainly of steel, also acquires a certain amount of magnetism and thus the compass needle of the ship does not lie in the magnetic meridian, but may be deflected to one side or the other from it. The angle which the compass needle makes with the magnetic meridian, is known as the "Deviation".

If the compass needle is drawn to the right of the magnetic meridian, the deviation is called Easterly and if the compass needle is drawn to the left of the magnetic meridian, the deviation is called Westerly.

The deviation varies in name and amount, as the ship's head turns in azimuth.

The value of the deviation, on the different courses or ship's head, usually 10° apart, are ascertained by the observations and a table called "Deviation Card" is drawn up. This Deviation Card is usually kept pasted at a conspicuous place in the Chart Room. A few typical Deviation Cards are shown at the end of this book and these cards will be used in the questions given in this book.

It may, however, be mentioned that the Deviations of the magnitude shown in these tables seldom exist on board a ship as these Deviation Cards have been prepared specifically so that the navigator is made fully conversant with the correct application of this error.

COMPASS ERROR

The resultant of the variation and the deviation is called the compass error. Compass error thus is the angle between the compass needle on board the ship and the true meridian and is computed by finding the algebraic sum of the Variation and Deviation.

If both Variation and the Deviation are of the same name then add the two and give the same name to the compass error; and if different in names, subtract the two and give the name of the higher quantity.

Example:

(a) If Variation is 8°W and Deviation for the ship's head is 4°W, then the compass error will be 12°W.

(b) If Variation was 6°E and Deviation for the ship's head was 3°W, then the compass error will be 3°E.

(c) If Variation is 7°W and Deviation is 12°E, then the compass error will be 5°E.

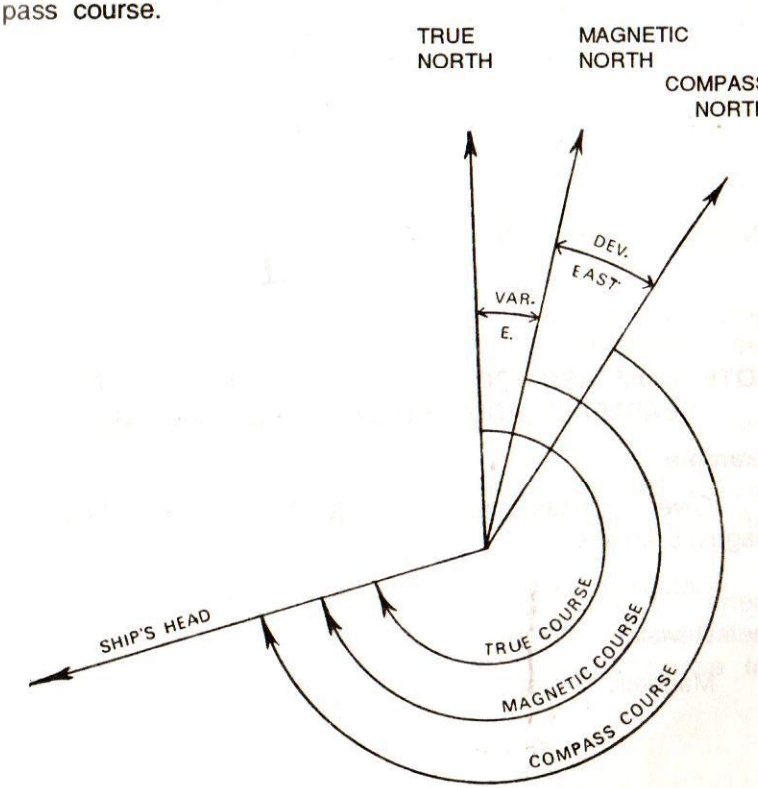
TO CONVERT COMPASS COURSES TO MAGNETIC COURSES AND VICE VERSA

To convert compass course into magnetic course, it is only necessary to apply the Deviation.

If the deviation is Easterly, it means that the compass needle has been drawn to the Eastward or to the right of the magnetic meridian and if the deviation is Westerly, the compass needle has been drawn to the Westwards or to the left of the magnetic meridian.

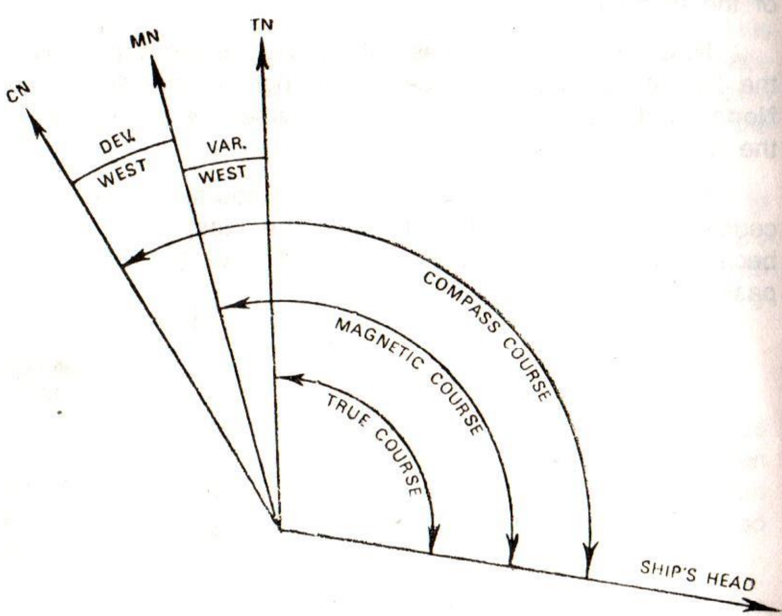
Now consider a compass affected by Easterly deviation, the "Compass North" will be to the right of the "Magnetic North" and therefore the compass course will be less than the magnetic course.

So in order to convert compass course to magnetic course, the navigator has to add the Easterly deviation, because the magnetic course will read more than the compass course.



Now consider a compass affected by the Westerly deviation, the "Compass North" will be to the left of the "Magnetic North", so the compass course will be more than the magnetic course or in other words the magnetic course will be less than the Compass course.

So in order to convert Compass course to Magnetic course the navigator has to subtract the Westerly deviation.



NOTE: COMPASS COURSE TO MAGNETIC COURSE EASTERLY ADD AND WESTERLY SUBTRACT.

Example I.

Given Compass course 035° (C) Deviation 6°E. Find the Magnetic course.

Compass course	035° (C)
Deviation	6° E
Magnetic course	041° (M)

Example 2.

Given Compass course 185° (C) Deviation 3°W. Find the Magnetic course.

Compass course	185° (C)
Deviation	3° W
Magnetic course	182° (M)

Example 3.

Given Magnetic course 300°(M) and Deviation 8°E, find the Compass course.

Magnetic course	300° (M)
Deviation	8° E
Compass course	292° (C)

Example 4.

Given Magnetic course 160° (M) and Deviation 5° W, find the Compass course.

Magnetic course	160° (M)
Deviation	5° W
Compass course	165° (C)

TO CONVERT MAGNETIC COURSE TO TRUE COURSE AND VICE VERSA

To convert Magnetic courses to True courses, it is only necessary to apply the variation, which is usually given in the question itself.

However, in the practical Chart Work, the variation can be obtained from the chart itself (it is shown in the Compass rose). When taking off the variation from the chart, always use the variation shown on the compass rose nearest to the position of the ship.

It may be noted that the magnetic course is converted to the true course in accordance with the same rule as stated earlier in the case of conversion of Compass course to Magnetic course.

MAGNETIC COURSE TO TRUE COURSE EASTERLY ADD and WESTERLY SUBTRACT

Example:

Given Magnetic course of 050° (M) and Variation 8° E, find the true course.

Magnetic course	050° (M)
Variation	8° E
True Course	058° (T)

Example:

Given a true course of 310° (T) Variation of 6° East, find the Magnetic course?

True course	310° (T)
Variation	6° E
Magnetic course	304° (M)

TO CONVERT COMPASS COURSE TO TRUE COURSE

In many cases, the direction of the ship's head by compass is given, and therefore it is necessary to apply the compass error (Deviation and Variation) before the course can be laid on the chart. It must always be remembered that only True courses and bearings are laid on the chart.

The deviation is easily obtained from the Deviation Card and if need be, the deviation for a particular ship's head is interpolated between the two ship's head nearest to the course in question. For example, if the Deviation for 035° (C) is required, then we find (from the Deviation Card 1) that when ship's head by compass is 030° (C) Deviation is 7° W and when ship's head by compass is 040° (C) Deviation is 9° W.

Hence for ship's head by compass 035° (C) Deviation is 8° W.

Apply this Deviation (8° W) to Compass Course [035° (C)] to obtain the Magnetic Course which will be 027° (M).

Now convert this Magnetic course 027° (M) to the true course by applying Variation (say 3° East), thus the true course in this case will be 030° (T).

It may be noted that the compass error, which is the resultant or the algebraic sum of Variation and Deviation, in this case is 5° West. This shall be the compass error which must be applied to all Compass bearings observed, before these bearings are laid on the chart, as long as the ship continues on 035° (C) course.

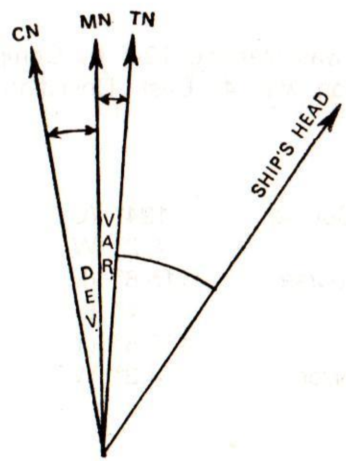
NOTE:

THE COMPASS ERROR IS ALWAYS FOR A PARTICULAR SHIP'S HEAD AND NOT FOR THE BEARING.

Example:

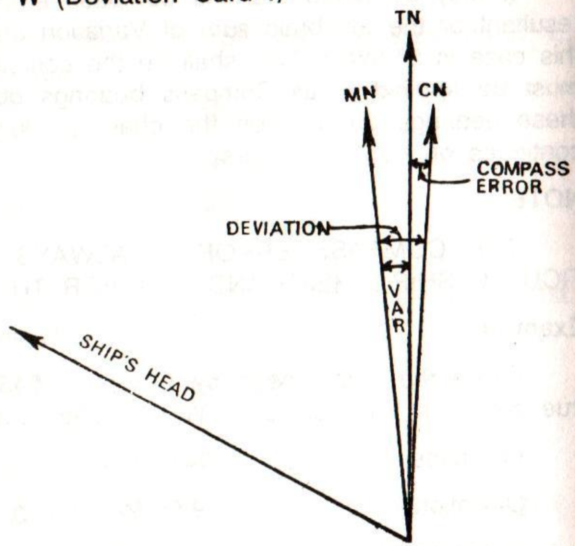
Given the ship's head by Compass 045° (C) find the true course if Variation is 5° W (Deviation Card 1).

Compass Course	045° (C)
Deviation	9.5° W
(From card)	(interpolate between 040° and 050°)
Magnetic course	035.5° (M)
Variation	5° W
True course	030.5° (T)
Compass Error	14.5° W



Example:

Given the ship's head 295° (C), find the true course if Variation is 6° W (Deviation Card I)



Compass course	295° (C)
Deviation	9° E (from Deviation Card I)
Magnetic course	304° (M)
Variation	6° W
True course	298° (T)
Compass error	3° E

Exercise I.

If the ship was steering 124° by Compass, find the true course if Variation was 4° East. Deviation as per Deviation Card I.

Answer:

Compass Course	124° (C)
Deviation	8.2° W
Magnetic course	115.8° (M)
Variation	4° E
True Course	119.8° (T)
Compass error	4.2° W

Exercise II.

If the ship's course by compass was 165° (C), find the true course? Variation 3° West. Deviation as per Deviation Card I. Also find the Compass error.

Answer:

Compass Course	165° (C)
Deviation	0.3° W
Magnetic course	164.7° (M)
Variation	3° West
True course	161.7° (T)
Compass Error	3.3° West.

Exercise III.

If the ship was steering 223° (C) find the true course if Variation was 5° West. Also find the compass error. (Deviation Card I)

Answer:

Compass course	223° (C)
Deviation	9.0° East
Magnetic course	232° (M)
Variation	5° West
True course	227° (T)
Compass error	4° East.

Exercise IV.

If the ship's head by compass was 055° (C), find the true course if Variation was 3° West (use Deviation Card II).

Answer:

Compass course	055° (C)
Deviation	4° E
Magnetic course	059° (M)
Variation	3° W
True course	056° (T)

Exercise V.

If the ship's head by compass is 133° (C) find the true course if Variation is 6° W (use Deviation Card II).

Answer:

Compass course	133° (C)
Deviation	9° W
Magnetic course	124° (M)
Variation	6° W
True course	118° (T)

Exercise VI.

If the ship's head by compass is 250° (C), find the true course if Variation is 6° East. (Use Deviation Card II.)

Answer:

Compass course	250° (C)
Deviation	1° W
Magnetic course	249° (M)
Variation	6° E
True course	255° (T)

TO CONVERT TRUE COURSE TO COMPASS COURSE

To convert true course to compass course, the true course must first be converted to Magnetic course (by applying variation), and then the Magnetic course is converted into compass course by applying the Deviation.

TO CONVERT TRUE COURSE TO THE MAGNETIC COURSE

In order to convert True course to Magnetic course, as already explained, only variation is to be applied to the true course. The variation is given usually in the question itself.

TO CONVERT MAGNETIC COURSE TO COMPASS COURSE

The Deviation is shown on the Deviation Card for various *compass courses.* Already, it has been explained

earlier in this chapter, as to how Compass course is converted to Magnetic course.

Magnetic course is converted into Compass course by applying the necessary deviation. However, it is to be appreciated that the Deviation for Magnetic course cannot be found from the Deviation Card by direct interpolation, as these Deviations on the Deviation Card are tabulated for the Compass courses only and not for magnetic courses.

The method followed for finding deviation on the Magnetic course using the Deviation Card is as follows:--

From the Deviation Card, select two compass courses, which when their respective Deviations are applied, (as already explained in the previous paragraphs) will give two magnetic courses, one on each side of the Magnetic course, for which the deviation is required. The given Magnetic course now lies in between these two Magnetic courses just computed and for which the Deviations are known. Now the deviation for the given Magnetic course can easily be obtained by interpolation.

Apply the deviation, so obtained by interpolation, to the given magnetic course, and you will get the Compass course.

Example:

Find the compass course to steer, if the true course is 030° (T) Variation 5.5° W, (Deviation as per Deviation Card I). Also find the compass error.

SOLUTION

Firstly convert the true course to Magnetic course by applying Variation.

True course	030° (T)
Variation	5.5° W
Magnetic course	035.5° (M)

Now to convert the above Magnetic course i.e. 035.5° (M) into Compass course, we have to find the Deviation for 035.5° (Magnetic) heading and for this proceed as follows:--

Referring to the Deviation Card No. I, we find that:--

For Ship's Head 040° (C), Deviation is 9° W and hence Magnetic course 031° (M).

Similarly for Ship's Head 050° (C), Deviation is 10° W and hence the Magnetic course 040° (M)

Thus, we have found two magnetic courses Viz. 031° (M) and 040° (M), With corresponding Deviations of 9° W and 10° W respectively, between which lies the Magnetic course of 035.5° (M) of our question.

By simple interpolation, the required Deviation for the Magnetic course of 035.5° (M), can easily be obtained.

Thus the required Deviation (for Magnetic course 035.5°),

$$= 9^\circ + \frac{1 \times 4.5^\circ}{9^\circ}$$

$$= 9^\circ + 0.5^\circ$$

$$= 9.5^\circ \text{ W}$$

Now Magnetic course	=	035.5° (M)
Deviation	=	9.5° W
∴ Compass course	=	045.0° (C)

Hence 045° (C) is the Compass course to steer in order to get 030° true course.

The compass error = Variation ± Deviation

Variation	= 5.5° W
Deviation	= 9.5° W
Compass error	= 15° West.

Exercise I.

Find the compass course to steer, if the true course is 135° (T) Variation 4° East. Deviation as per card I.

Answer:

True course	135° (T)
Variation	4° East
Magnetic course	131° (M)

Compass course	Deviation	Magnetic course
130° (C)	7.0° W	123° (M)
140° (C)	5.0° W	135° (M)

Hence by interpolation

if Magnetic course is 131° (M) then Deviation is 5.7° W

Now Magnetic course	131° (M)
Deviation	5.7° W
Compass course	136.7° (C)

Exercise II.

If true course is 210° (T) Variation 3° West (Deviation as per card I), find the compass course.

Answer:

Magnetic course	213° (M)
Deviation	6.3° East
Compass course	206.7° (C)

Exercise III.

If true course is 285° (T) Variation is 7° East, Deviation as per card I, find the Compass course.

Answer:

Magnetic course	278° (M)
Deviation	12.7° E
Compass course	265.3° (C)

Exercise IV.

If the true course is 315° (T) Variation 5° West, Deviafollows:--

Referring to the Deviation Card No. I, we find that:--

For Ship's Head 040° (C), Deviation is 9° W and hence Magnetic course 031° (M).

Similarly for Ship's Head 050° (C), Deviation is 10° W and hence the Magnetic course 040° (M)

Thus, we have found two magnetic courses Viz. 031° (M) and 040° (M), With corresponding Deviations of 9° W and 10° W respectively, between which lies the Magnetic course of 035.5° (M) of our question.

By simple interpolation, the required Deviation for the Magnetic course of 035.5° (M), can easily be obtained.

Thus the required Deviation (for Magnetic course 035.5°),

$$= 9° + \frac{1 \times 4.5°}{9°}$$

$$= 9° + 0.5°$$

$$= 9.5° \text{ W}$$

Now Magnetic course	=	035.5° (M)
Deviation	=	9.5° W
∴ Compass course	=	045.0° (C)

Hence 045° (C) is the Compass course to steer in order to get 030° true course.

The compass error = Variation ± Deviation

Variation	= 5.5° W
Deviation	= 9.5° W
Compass error	= 15° West.

Exercise I.

Find the compass course to steer, if the true course is 135° (T) Variation 4° East. Deviation as per card I.

Answer:

True course	135° (T)
Variation	4° East
Magnetic course	131° (M)

Compass course	Deviation	Magnetic course
130° (C)	7.0° W	123° (M)
140° (C)	5.0° W	135° (M)

Hence by interpolation

if Magnetic course is 131° (M) then Deviation is 5.7° W

Now Magnetic course	131° (M)
Deviation	5.7° W
Compass course	136.7° (C)

Exercise II.

If true course is 210° (T) Variation 3° West (Deviation as per card I), find the compass course.

Answer:

Magnetic course	213° (M)
Deviation	6.3° East
Compass course	206.7° (C)

Exercise III.

If true course is 285° (T) Variation is 7° East, Deviation as per card I, find the Compass course.

Answer:

Magnetic course	278° (M)
Deviation	12.7° E
Compass course	265.3° (C)

Exercise IV.

If the true course is 315° (T) Variation 5° West, Deviation as per card I, find the Compass course to steer.

Answer:

Magnetic course	320° (M)
Deviation	5.6° E
Compass course	314.4° (C)

Exercise V.

If the true course is 040° (T). Variation 4° West. (Deviation as per card II), find the Compass course.

Answer:

Magnetic course	044° (M)
Deviation	7.7° E
Compass course	036.3° (C)

Exercise VI.

Find the Compass course to steer, if the true course was 145° (T), Variation 3° E (Deviation as per card II).

Answer:

Magnetic course	142° (M)
Deviation	11.3° W
Compass course	153.3° (C)

Exercise VII.

Find the compass course to steer, if the true course was 245° (T) Variation 3° East (Deviation as per Card II).

Answer:

Magnetic course	242° (M)
Deviation	1.9° W
Compass course	243.9° (C)

Exercise VIII.

Find the Compass Course to steer, if the true course is

308° (T) Variation 4° West (Deviation as per Deviation Card II.)

Answer:

Magnetic course	312° (M)
Deviation	7.8° East
Compass course	304.2° (C)

GYRO ERROR

Now a days, most of the ships are equipped with gyro compass on board. When gyro compass reads higher than the true course, gyro error is termed "High" and if the gyro compass is less than the true course, gyro error is "Low". Hence when the gyro error is "High" subtract it from the gyro course in order to get the true course. Similarly, when the gyro error is "Low" add the gyro error to get the true course.

The above rule is reversed when converting true course to gyro course.

NOTE: It must be borne in mind that the gyro error is for particular ship's head, like the magnetic compass, and not for the bearings.

Example I. If the gyro course is 060° (G) and the gyro error is 1° (Low) find the true course.

Solution:-	Gyro Course	060° (G)
	Gyro Error	1° Low
	True Course	061° (T)

Example II. If the true course is 055° (T) and the gyro error is 1° (High) find the gyro course to steer.

Solution:-	True Course	055° (T)
	Gyro Error	1° High
	Gyro Course	056° (G)

Exercise I. Find the gyro course to steer, if true course is 252° (T) and the gyro error 2° (Low).

Answer: Gyro Course to steer 250° (G)

Exercise II. Find the gyro course to steer, if the true course is 115° (T), gyro error is 1° (High).

Answer: Gyro Course to steer 116° (G).

Exercise III. Find the true course, if the gyro course is 138° (G) and the gyro error is 2° (High).

Answer: True Course 136° (T)

Exercise IV. Find the true course if the gyro course is 260° (G) and the gyro error is 1° (Low).

Answer: True Course 261° (T).

Exercise V. Find the gyro course to steer if the true course is 308° (T) gyro error is 2° (Low).

Answer: Gyro Course 306° (G).

Exercise VI. Find the true course, if the gyro course is 265° (G) and the gyro error is 1° (High).

Answer: True Course 264° (T)

CHAPTER VII

RUNNING FIX

[English Channel (Eastern Portion) Chart B.A. No. 2675]

The position of a vessel can also be ascertained by taking a bearing of an object, and after an interval taking a second bearing of the same object or the bearing of another object, the course steered and the distance steamed between the two observations being known. This method of finding the ship's position, is said to be "Running Fix". This can best be explained with the help of an example:--

Example:

While steering a course of 070° (T) Start Point Lt. bore 009° (T) at 2200 hrs. and the same light bore 299° (T) at 2300 hrs. Find the ship's position at 2200 hrs. & 2300 hrs. (speed of the ship 12 knots).

SOLUTION:

(a) Lay LD, the true bearing of Start Point Light at 2200 hrs. i.e. 009° (T). Take any point A on LD and lay true course steered i.e. 070° (T). Now mark off AB = 12 miles i.e. the distance steamed between 2200 hrs. and 2300 hrs.

Now through B, transfer the first bearing i.e. draw BF parallel to LD. The ship lies at 2300 hrs. somewhere on this line B'F, which is called the transferred position line.

To obtain the "Fix", now draw LE, the bearing taken at 2300 hrs. i.e. 299° (T). The point where this bearing cuts the transferred position line (i.e. C) is the Position of the ship at 2300 hrs.

Position at 2300 Hrs:-

Latitude 50°08.3'N Longitude 03°23'W **ANS :**

(b) To find the position at 2200 hrs.:-

From C, draw the reverse course steered i.e. CG paral-

Answer: Gyro Course to steer 250° (G)

Exercise II. Find the gyro course to steer, if the true course is 115° (T), gyro error is 1° (High).

Answer: Gyro Course to steer 116° (G).

Exercise III. Find the true course, if the gyro course is 138° (G) and the gyro error is 2° (High).

Answer: True Course 136° (T)

Exercise IV. Find the true course if the gyro course is 260° (G) and the gyro error is 1° (Low).

Answer: True Course 261° (T).

Exercise V. Find the gyro course to steer if the true course is 308° (T) gyro error is 2° (Low).

Answer: Gyro Course 306° (G).

Exercise VI. Find the true course, if the gyro course is 265° (G) and the gyro error is 1° (High).

Answer: True Course 264° (T)

CHAPTER VII

RUNNING FIX

[English Channel (Eastern Portion) Chart B.A. No. 2675]

The position of a vessel can also be ascertained by taking a bearing of an object, and after an interval taking a second bearing of the same object or the bearing of another object, the course steered and the distance steamed between the two observations being known. This method of finding the ship's position, is said to be "Running Fix". This can best be explained with the help of an example:--

Example:

While steering a course of 070° (T) Start Point Lt. bore 009° (T) at 2200 hrs. and the same light bore 299° (T) at 2300 hrs. Find the ship's position at 2200 hrs. & 2300 hrs. (speed of the ship 12 knots).

SOLUTION:

(a) Lay LD, the true bearing of Start Point Light at 2200 hrs. i.e. 009° (T). Take any point A on LD and lay true course steered i.e. 070° (T). Now mark off AB = 12 miles i.e. the distance steamed between 2200 hrs. and 2300 hrs.

Now through B, transfer the first bearing i.e. draw BF parallel to LD. The ship lies at 2300 hrs. somewhere on this line B'F, which is called the transferred position line.

To obtain the "Fix", now draw LE, the bearing taken at 2300 hrs. i.e. 299° (T). The point where this bearing cuts the transferred position line (i.e. C) is the Position of the ship at 2300 hrs.

Position at 2300 Hrs:-

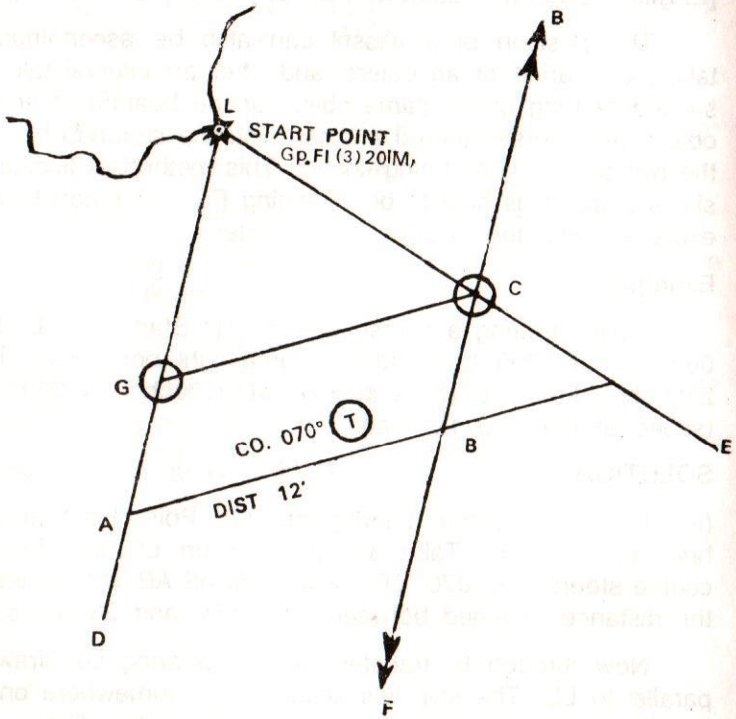
Latitude 50°08.3'N Longitude 03°23'W **ANS :**

(b) To find the position at 2200 hrs.:-

From C, draw the reverse course steered i.e. CG parallel to AB cutting the first bearing LD at G. Then G is the position of the ship at 2200 hrs.

Position at 2200 hrs:-

Latitude 50°04'N Longitude 03°41'W **ANS :**



NOTE:

The Point "A" on the first bearing may be taken at any convenient position, preferably near the Estimated Position of the ship. It may be pointed here that at whatever position the point "A" is taken on the first bearing, "the fix" (actual final position) will be the same.

Exercise I.

While steering a course of 184° (C) Les Hanois Light, bore 150° (C) at 2030 hours and at 2115 hours it bore

106° (C). Find the vessel's position at 2030 hours and at 2115 hours. (Variation 3° W Deviation 5° E, speed 16 knots)

Answer:

Compass course	184° (C)
Compass Error	2° E
True course	186° (T)
Compass bearing of Les Hanois Lt.	150° (C)
True bearing of Les Hanois Lt.	152° (T)
2nd Compass bearing of Les Hanois Lt.	106° (C)
2nd True bearing of Les Hanois Lt.	108° (T)

2030 hrs. Position Lat. 49°40.6' N Long. 02°55' W

2115 hrs. Position Lat. 49°28.9' N Long. 02°56' W

Exercise II.

While steering a course of 255° (C), Anvil Point Light bore 019° (C) at 0300 hrs. and after 1 hour, Bill of Portland Light bore 345° (C). Find the ship's position at 0300 hrs. and 0400 hrs. Ship's speed 15 knots. Variation 7.5° W. Deviation as per Card 1.

Answer:

Compass course	255° (C)
Deviation	12.5° E
Variation	7.5° W
Compass error	5° E
True course	260° (T)
Compass bearing of Anvil Point Lt.	019° (C)
Compass Error	5° E
True bearing of Anvil Point Lt.	024° (T)
Compass bearing of Bill of Portland Lt.	345° (C)
Compass Error	5° E
True bearing of Bill of Portland Lt.	350° (T)

Ship's Position at 0300 hrs. Lat. 50°28.5'N Long. 02°02.7'W

Ship's Position at 0400 hrs. Lat. 50°25.5'N Long. 02°26'W

Exercise III.

On a voyage from Le Havre to Antwerp, ship steering a course of 061° (C), C. de Antifer Lt. bore 201° (C) at 0440 hrs. and at 0600 hrs. Pte. d'Ailly Lt. bore 142° (C). Find the ship's position at 0600 hrs. Ship's speed 12 knots. Variation 6.5° East. Deviation Card I.

Answer:

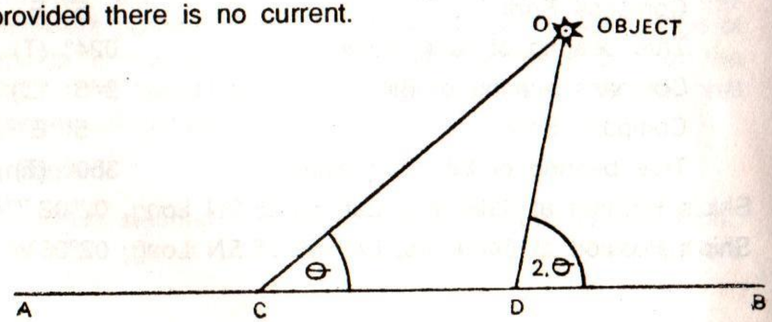
Compass course	061° (C)
Deviation	11.5° W
Variation	6.5° E
Compass Error	5° W
True course	056° (T)
Compass bearing of C. de Antifer Lt.	201° (C)
Compass Error	5° W
True bearing of C. de Antifer Lt.	196° (T)
Compass bearing of Pte. D'Ailly Lt.	142° (C)
Compass Error	5° W
True bearing of Pte. D'Ailly Lt.	137° (T)

Ship's Position at 0600 hours:

Lat. 50°08.2'N Long.00°38.7'E

DOUBLE ANGLE ON THE BOW

Note the time and the patent log reading when the object is a certain number of degrees on the bow, and again when that object's angle on the bow is double of first angle, then the distance run during the interval is the distance off the object, at the instant of taking the second observation, provided there is no current.



In the above figure, A B is the course of the ship and O is the object at the bow.,

When the bearing is C O, the angle at the bow is θ and at D, when bearing is D O, the angle at the bow is 2θ.

In ΔOCD, ΔCOD will also be θ, thereby making triangle OCD an isosceles triangle. Hence O D, which is the distance off at the time of second bearing will be equal to C D, the distance steamed between the two bearings.

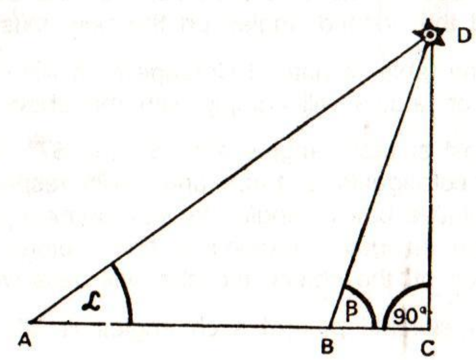
FOUR POINT BEARING

From the above, it will be seen that if light or a shore object bears 4 points on the bow and again after a certain lapse of time it is abeam, the distance run in the interval is the distance off the object, when abeam.

(NOTE: DISTANCE RUN IS THE DISTANCE SHIP WILL PASS OFF THE OBJECT WHEN ABEAM)

SELECTED BOW ANGLES

It is quite often desirable to know the distance off, a vessel will pass abeam of an object before it comes actually abeam, because that is the closest distance the ship will pass off that object. This can be accomplished by the use of certain selected pairs of "angles on the bow" whereby the distance traversed between the bearings, (i.e. selected bow angles) is actually the distance the ship will pass from the object, when abeam.



In the figure above, let D be the object, A D and B D the first and the second bearings respectively, A C is the ship's course and C D the beam bearing.

Let $\angle BAD = \alpha$ and $\angle CBD = \beta$

Given AB = CD = distance steamed = distance off abeam.

In Δ DCA, $\dfrac{AB + BC}{CD} = \cot \alpha$ .... (i)

In Δ DCB, $\dfrac{BC}{CD} = \cot \beta$ .... (ii)

Subtracting (ii) from (i) we get.

$$\therefore \quad \frac{AB + BC}{CD} - \frac{BC}{CD} = \cot \alpha - \cot \beta$$

$$\frac{AB}{CD} = \cot \alpha - \cot \beta$$

but AB = CD.

$$\therefore \quad 1 = \cot \alpha - \cot \beta$$

Hence, in order that distance run between the first and the second bearings will be equal to the distance off the object when abeam, the difference between the Cotangents of the first and the second angles on the bow must be UNITY

From the table of natural Cotangents it will be seen that many pairs of angles will comply with the above equation.

The most suitable angles are 35° and 67°, whose natural value of cotangents is 1.428 and 0.425 respectively. This is quite a suitable pair of angles for navigational purposes, as it will tell the navigator reasonable time before, as to how much distance off the object, the ship will pass when abeam.

Another suitable pair of such angles is 37° & 72°.

CHAPTER VIII

SOME WORKED EXAMPLES AND EXERCISES

[English Channel (Eastern Portion) Chart B.A. No. 2675]

Example I

(a) On a voyage from London to Liverpool, a ship heading 105° (C), Anvil Point Lt. Ho. bore 325° (C) and St. Catherine Point Lt. Ho. bore 048° (C). Find the ship's position.

(b) From this position, course was set to pass Start Point Lt. Ho. 12 miles off, when abeam on the starboard side. Find the Compass course to steer.

(c) While on this course, Bill of Portland Lt. Ho. bore 286° (C) and 30 minutes later, it bore 314° (C). Find the ship's position at the time of second bearing.

(Variation 13° E. Deviation as per Deviation Card I. Speed 16 knots).

SOLUTION

(a) (i) To find the Compass error for the ship's head.

Ship's head by compass	105° (C)
Deviation	11° W
Magnetic course	094° (M)
Variation	13° E
True course	107° (T)

Hence find the Compass error on 105° (C) :-

Deviation	11° W
Variation	13° E
Compass Error	2° E

NOTE: Compass error is also True course. ~ Compass course (in this case 107° ~ 105° = 2° East).

(ii) To convert Compass Bearings to True Bearings:-

Compass bearing Anvil Pt. Lt. Ho. 325° (C)
Compass error 2° E (Easterly Error ADD)
True bearing of Anvil Pt. Lt. Ho. 327° (T)
Compass bearing of St. Catherine Pt. Lt. Ho. 048° (C)
Compass error 2° E
True bearing of St. Catherine Pt. Lt. Ho 050° (T)

Now plot the true bearing of Anvil Point Lt. Ho. and St. Catherine Point Lt. Ho. on the chart and thus obtain the ship's position by cross bearings.

From the Chart:--

Ship's position Lat. 50°21'N Long. 1°42.8'W.

(b) (i) To find Course to Steer:-

Now with Start Point light as centre and 12 miles as a radius (Taken from the Latitude scale near to Start Point) draw a circle.

(ii) From the Position obtained in (a), draw a tangent to the circle just drawn. This will be your true course to steer (Making sure not to make 180 error in the direction).

True Course 255° (T)

(iii) To Convert True Course to Compass Course:-

True Course 255° (T)
Variation 13° E
Magnetic course 242° (M)

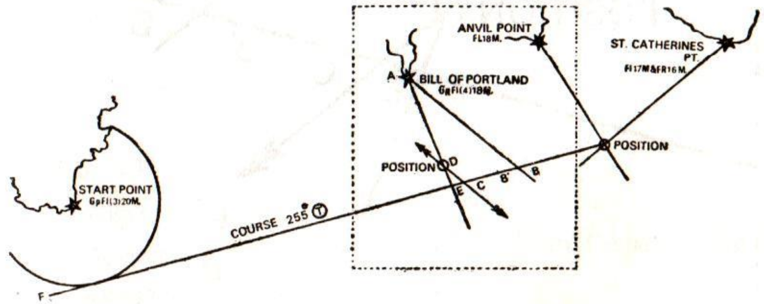
Using the Deviation Card I.

Ship's head by Compass	Deviation	Magnetic Course
230° (C)	10° E	240° (M)
240° (C)	11° E	251° (M)

So now for Magnetic Course 240° (M)
Deviations is 10.0° E
and for Magnetic Course 251° (M) Deviation is 11.0° E
and interpolating for Magnetic Course 242° (M)
We get Deviation of 10.2° E
Now given Magnetic Course 242° (M)
Deviation 10.2° E
∴ Compass course to steer 231.8° (C)

(iv) To find Compass error on this course

Variation 13° E
Deviation 10.2° E
Compass error 23.2°

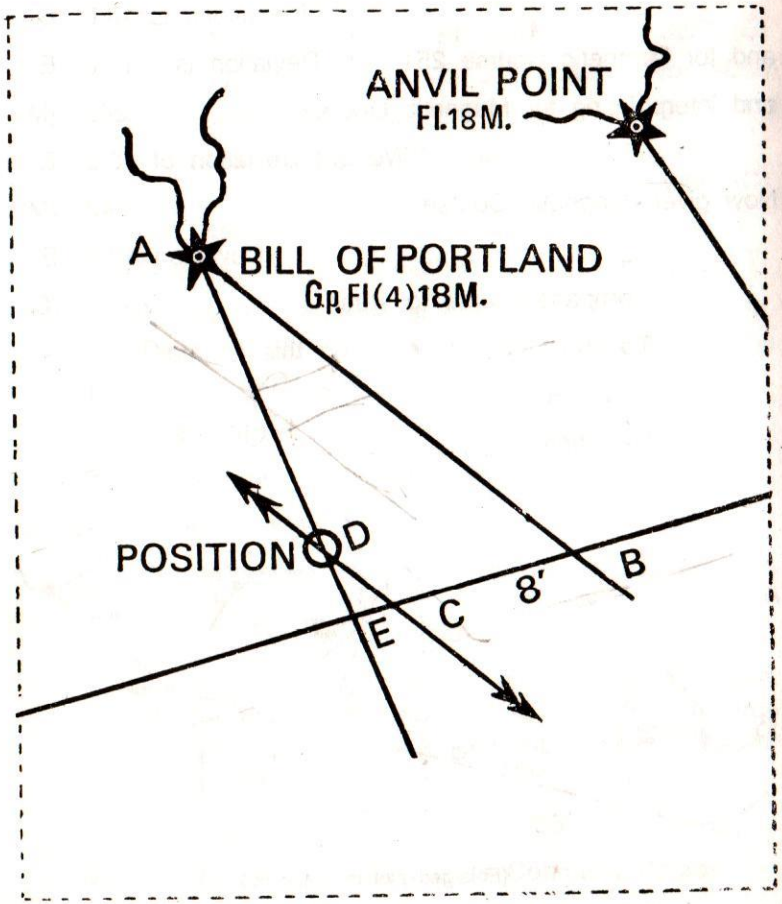


(Enlarged plot on page 60)

(c) (i) Find the True Bearings of Bill of Portland Lt.

First Compass bearing of Bill of Portland Lt. 286° (C)
Compass Error 23.2° E
True bearing of Bill of Portland Lt. 309.2° (T)

Second Compass bearing of Bill of Portland Lt. 314° (C)
Compass Error 23.2° (E)
Second true bearing of Bill of Portland Lt. 337.2° (T)



Distance run between 1st and 2nd bearing in 30 minutes @ 16 knots = 8 Miles.

From Bill of Portland Lt. draw the 1st bearing AB i.e. 309.2° (T) cutting the course steered at B.

From B, measure BC = 8 Miles i.e. distance steamed between the bearings.

Through C, transfer the first position line or the first bearing (in other words draw CD parallel to AB)

Plot the second bearing viz. 337.2° (T) as AE and where this cuts the transferred position line CD (i.e. at "D") is the position of the vessel at the time of second bearing.

Position of Ship. Lat. 50°18'N Long. 2°18.5'W.

Example II.

On a voyage from London to Avonmouth,

(a) A vessel steering 250° (C), at 1900 hrs. St. Catherine Point Lt. bore 302° (C) and Nab Tower bore 002° (C). Find the ship's position at 1900 hrs.

(b) From this position, set a course by compass to pass Bill of Portland Lt. 10 miles off when abeam on the starboard side.

(c) While on this course, at 2100 hrs. Anvil Point Lt. Ho. bore 4 points on the starboard bow and at 2145 hrs. Anvil Point Lt. was abeam on the starboard side. Find the ship's position at the time of beam bearing @ 2145 hrs?

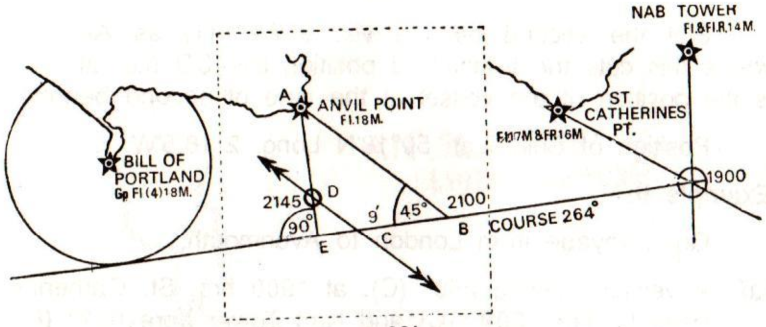
(Variation 14° W Ship's speed 12 Knots. Deviation Card I).

SOLUTION

(a)	Ship's head	250° (C)
	Deviation	12.0° E (From Deviation Card).
	Variation	14° W
	Compass error	2° W
	Compass bearing of St. Catherine Point Lt.	302° (C)
	Compass Error	2° W
	True bearing of St. Catherine Point Lt.	300° (T)
	Compass bearing of Nab Tower	002° (C)
	Compass Error	2° W
	True bearing of Nab Tower	000° (T)

Plotting the true bearings of St. Catherine Pt. and Nab Tower, the ship's position at 1900 hrs. is:-

Lat. 50°27'N Long. 00°57.4'W.



(Enlarged plot given on page 63)

(b) (i) With Bill of Portland Lt. as centre and 10 miles as a radius, draw a circle.

(ii) From the Position obtained in (a) draw a tangent to this circle. This tangent will be the true course to steer, viz 264° (T).

(iii) To Convert true course to compass course.

True course	264° (T)
Variation	14° W
Magnetic course	278° (M)

Using the Deviation Card:-

Ship's head by Compass	Deviation	Magnetic course
260° (C)	13.0° E	273.0° (M)
270° (C)	12.5° E	282.5° (M)

Now for 273.0° (M) Magnetic course, Deviation is 13.0°E and for 282.5° (M) Magnetic course, Deviation is 12.5°E.

Then by interpolation, for 278° (M) Magnetic course, Deviation is 12.7°E,

Now Magnetic course	= 278° (M)
Deviation	= 12.7° E
Compass course to steer	= 265.3° (C)

(c) True course steered = 264° (T)

2100 hrs. bearing. (4 Pts. on St. bd. bow)

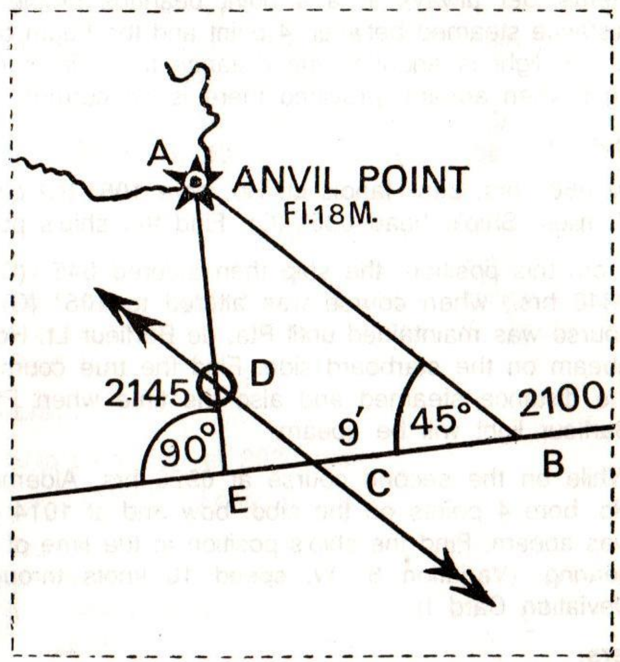
= 264° (T) + 45° = 309° (T)

2145 hrs. beam bearing = 264° (T) + 90° = 354° (T)

Distance steamed between bow and the beam bearing is 9 miles (45 minutes @ 12 knots.), which is also the distance off when abeam. Hence by plotting the beam bearing of 354° (T) and distance 9 miles off, we get a "Fix" at 2145 hours.

From the chart, the position at 2145 hours is:-

Lat. 50°26.5'N Long. 1°56'W. **ANS :**



NOTE:

This part of the question could also be done by "Running Fix" method as under:-

From Anvil Pt. Lt. draw the first true bearing AB i.e. 309° (T) and also the second bearing AE i.e. 354° (T).

With B as centre, measure BC = 9 miles i.e. the distance between the two bearings.

Now from C transfer the position line or 1st bearing, cutting AE, the second bearing at D.

Then "D" is the position of the ship when the Anvil Point light is abeam.

Ship's Position at 2145 hours:-

Lat. 50° 26.5'N Long. 01°56'W. **ANS :**

NOTE:

Remember always in a 4 point bearings problem, the distance steamed between 4 point and the beam bearing of the light is equal to the distance the ship is off the light when abeam, provided there is no current.

Exercise I.

(a) At 0600 hrs. Les Hanois Lt. Ho. bore 106° (C) distance 7 miles. Ship's head 035° (C). Find the ship's position.

(b) From this position, the ship then steered 045° (C) until 0848 hrs., when course was altered to 105° (C). This course was maintained until Pte. de Barfleur Lt. Ho. was abeam on the starboard side. Find the true course and the distance steamed and also the time when Pte. de Barfleur light will be abeam.

(c) While on the second course at 0926 hrs. Alderney Lt. Ho. bore 4 points on the stbd. bow and at 1014 hrs. it was abeam. Find the ship's position at the time of beam bearing. (Variation 8° W, speed 10 knots throughout. Deviation Card I).

Answers:

(a) Ship's position at 0600 hrs:-

Lat. 49°26'N Long. 02°53'W

(b)

1st Compass course	045° (C)
Compass Error	17.5° W
True course	027.5° (T)
Distance	28 Miles.
Course altered at 0848 hrs.	
Second Compass Course	105° (C)
Compass Error	19° W
True course	086° (T)
Distance	49 Miles.

Pte. de Barfleur will be at beam at 1342 hrs.

(c) Ship's position at beam bearing:-

Lat. 49°51.7'N Long. 02°11'W.

Exercise II.

(a) A vessel steering 240° (C) at 2030 hrs. Needles Point Lt. bore 007° (C) and Anvil Point Lt. bore 308° (C). Find the ship's position at 2030 hrs.

(b) From this position set a course by Compass to pass Start Point Lt. 10 miles off when abeam on the starboard side.

(c) While on this course at 2200 hrs. Bill of Portland Light was 4 points on the bow and at 2300 hrs, the same light was abeam. Find the ship's position at 2300 hrs. (Variation 8° W. Ship's speed 10 knots Deviation Card I).

Answers:

(a) Ship's position at 2030 hrs:-

Lat. 50°25.8'N Long. 01°39'W.

(b)

True course	253° (T)
Variation	8° (W)
Magnetic course	261° (M)
Deviation	11.9° E
Compass course to steer	249.1° (C)

(c) Position at 2300 hrs:-

Lat. 50°21.2'N Long. 02°22'W

CHAPTER IX

HORIZONTAL ANGLES

[English Channel (Eastern Portion) Chart B.A. No. 2675]

Another accurate method of fixing a vessel's position is by means of observing horizontal angles subtended by shore objects at the observer.

When the horizontal angle subtended between two terrestrial objects is known, a circle of position can be obtained, which is drawn on the chart. The intersection of this circle of position with another similar position circle or a position line, will fix the position of the ship.

Normally three suitable objects are chosen from the chart, and the angles at the observer contained between the two pairs viz. the left hand and middle object and the right hand and the middle object are measured with a sextant.

The two horizontal angles between the three objects give two circles of position and where these two circles intersect is the position of the ship.

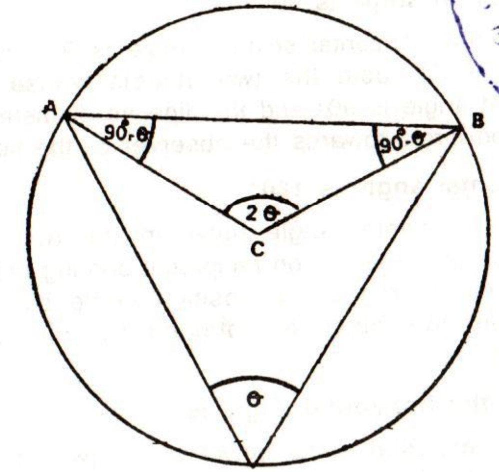
(a) Horizontal angle less than 90°

i) When the horizontal angle is less than 90°, then subtract the horizontal angle from 90° or determine the complement angle.

ii) Now draw the complement angles on the same side as the observer and where the complement angles meet is the centre of the position circle.

iii) With the centre of position circle as a centre and radius equal to either of the observed objects, draw a circle which will be the position circle. This can best be explained with the help of a sketch.

If θ° (less than 90°) is the horizontal sextant angle measured between the two light houses A and B, then AOB is the circle of position.



(i) Join A and B by a straight line.

(ii) At A and B lay off, on the same side as the observer, the complement of the horizontal angle (i.e. 90° — θ).

(iii) The point of intersection of these two arms of the angles is at C. Now with C as centre and CA or CB as a radius, draw the circle of position i.e. AOB.

The ship will be anywhere on this circle of position.

NOTE:

This method is based on the Geometric Theorem that the angle at the centre is twice the angle at the circumference.

b) Horizontal angle more than 90°

When the horizontal sextant angle is greater than 90°, the centre of the position circle lies on the opposite side (of the line joining the two objects), to that of the observer. For plotting, subtract 90° from the observed horizontal angle and proceed in the same manner as before. However lay the required angles on the opposite side of observer in this case.

c) **Horizontal angle is 90°**

When the horizontal sextant angle is 90°, complement angle is 0°. Join the two objects whose horizontal sextant angle is 90° and this line as diameter draw the position circle towards the observer or the sea.

d) **Horizontal angle is 180°**

If the horizontal angle between the two objects is 180°(or one object is on reciprocal bearing of the other), then we do not get a position circle but we get a position line which is obtained by joining the two objects.

e) **When the horizontal angle is 0°**

If the horizontal angle between the two objects is 0° then the objects are in transit. Thus the tranist bearings are the position line.

NOTE:

The compass error can easily be determined if the two objects are in transit. The transit objects are joined and the true bearing of these object is obtained from the chart.The difference between the observed compass bearing and the true transit bearing obtained from the chart is the compass error.

Example I.

From a ship, the following horizontal sextant angles were obtained :-

Needles Pt. Lt. Ho. 33° St. Catherine Pt. Lt. Ho and St. Catherine Pt. Lt. Ho. 49° Nab Tower.

Find the ship's position

SOLUTION:

Complement of Needles & St. Catherine Pt. Lt.

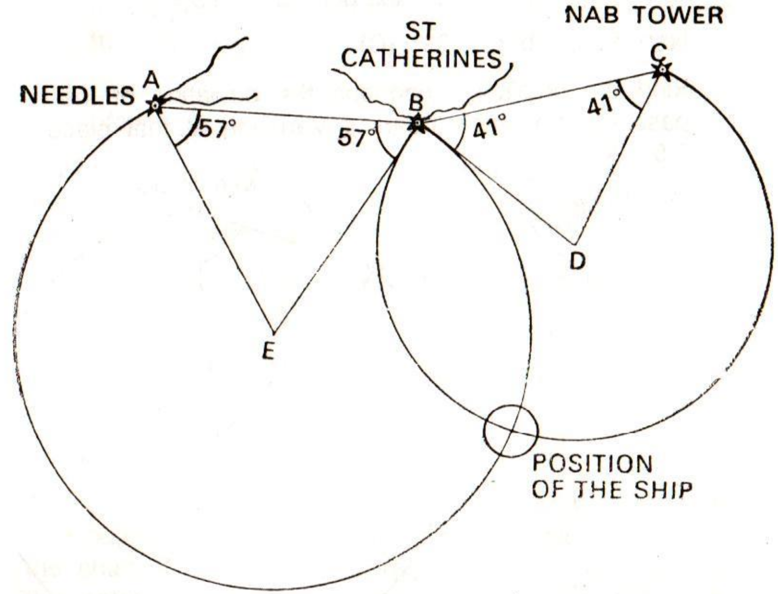
= 90° − 33° = 57°

Complement of St. Catherine Pt. Lt. Ho. & Nab Tower

= 90° − 49° = 41°

(1) Join Needles Point Lt. Ho. & St. Catherine Pt. Lt. Ho. and then draw ∠ EAB = 57° & ∠ ABE = 57°

These two arms of the angles intersect at E. With E as a centre and EA or EB as a radius, draw a circle. The ship is somewhere on this position circle.



(2) Join St. Catherine Pt. Lt. Ho. & Nab Tower and make ∠ CBD = ∠ BCD = 41°. These two arms of the angles intersect at D. With D as a centre and DB or DC as radius draw the second position circle.

Where the two position circles cut each other, is the position of the ship.

Position of the Ship.

Lat. 50°25.5'N Long. 01°15'W.

NOTE:

The two position circles will obviously, cut at two points, one at the middle object which can not be the position of the ship and the other point, is the Position of the Ship:-

Example II.

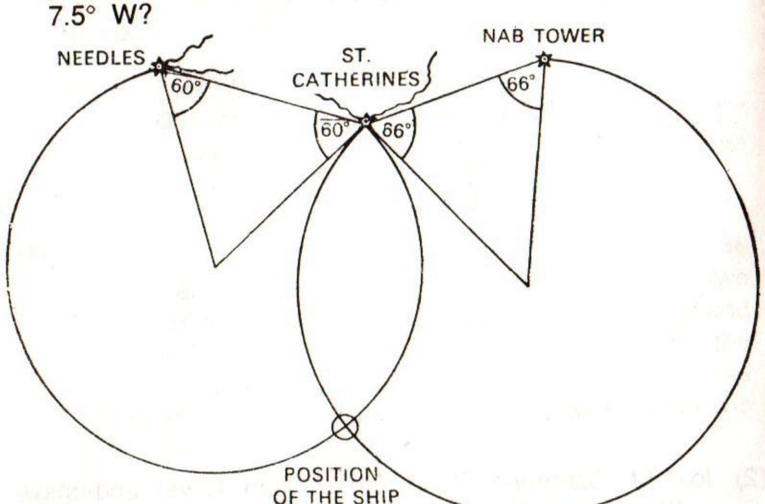
From a vessel at anchor, the following compass bearings were observed:-

Needles Pt. Lt. Ho. bore 345° (C)

St. Catherine Pt. Lt. Ho. bore 015° (C)

Nab Tower bore 039° (C)

Find the ship's position and the deviation of the compass for the ship's head, if Variation at that place was 7.5° W?



NOTE:

In a question of this nature, since deviations are not known, it is to be solved by "Horizontal angles" method.

METHOD

(a) To draw the position circle through Needles Pt. Lt. Ho. and St. Catherine Pt. Lt. Ho.

(i) Join Needles Pt. Lt. Ho. and St. Catherine Pt. Lt. Ho.

(ii) Since compass bearing of Needles Pt. Lt. Ho. is 345° (C) and St. Catherine Pt. Lt. Ho. is 015° (C), the horizontal sextant angle is 345° ~ 015° = 30°.

(iii) At each lighthouse, lay off, on the same side as the observer, the complement of the horizontal angle i.e. 90° − 30° = 60°.

(iv) The point of intersection of these two arms of the angles is the centre of the required position circle, which passes through the two objects observed and the observer.

(v) Draw in the required circle of position as explained previously.

(b) Similarly, draw the circle of position through St. Catherine Pt. Lt. Ho. and Nab Tower and the observer. (The horizontal angle in this case is 039° − 015° = 24°)

(c) The intersection of the two circles of position will give the position of the ship.

Position of the ship:-

Lat. 50°16.5'N Long. 1°23'W **ANS.**

(d) To find the Deviation:-

The position of the ship having been ascertained, the true bearings of the lighthouses can be picked up from the chart. The difference between the true bearing and the compass bearing in each case will give the Compass Error.

True bearing of Needles Pt. Lt. Ho. (from the chart)	341° (T)
Given Compass bearing of Needles Pt. Lt. Ho.	345° (C)
∴ Compass Error	4° W
Variation	7.5° W
Deviation	3.5° E **ANS.**

NOTE

The result can be checked and confirmed with the bearings of St. Catherine Pt. Lt. Ho. and Nab Tower.

Exercise I.

On board a ship at 1100 hrs. the following horizontal sextant angles were obtained:-

Needles Point Lt. Ho. 40° St. Catherine Pt. Lt. Ho. and St. Catherine Pt. Lt. Ho. 51° Nab Tower. Find the ship's position at 1100 hrs.

Answer:

Complement of Needles Pt. Lt. and St. Catherine Pt. = 90° – 40° = 50

Complement of St. Catherine Pt. and Nab Tower = 90° – 51° = 39

Ship's position at 1100 hrs:-
Lat. 50°28'N Long. 01°16.5'W

Exercise II.

At 1400 hrs. the following Compass bearings were observed:-

Casquet's Light house	061° (C)
Les Hanois Light house	112° (C)
Roches Douvres Light house	173° (C)

Find the ship's position and the deviation of the compass for the ship's head, if variation was 2° East.

Answer:

Horizontal angle between Casquets Lt. Ho. and Les Hanois Lt. Ho. = 51°

∴ Complement angle of Casquets Lt. Ho. and Les Hanois Lt. Ho. = 39°

Horizontal angle between Les Hanois Lt. Ho. and Roches Douvres Lt. Ho. = 61°

Complement angle of Les Hanois Lt. Ho. and Roches Douvres Lt. Ho. = 29°

Ship's position at 1400 hrs.:-
Lat. 49°28.8'N Long. 02°56'W

True bearing of Casquets Lt. Ho.	057° (T)
Compass bearing of Casquets Lt. Ho.	061° (C)
Compass Error	4° West
Variation	2° East
Deviation	6° West

EXERCISE III.

At 1000 hrs. the following compass bearings were observed:-

Cap Levy Lt. Ho.	120° (C)
Cap de la Hague Lt. Ho.	210° (C)
Alderney Lt. Ho.	250° (C)

Find the ships position at 1000hrs and also the deviation of the compass if variation was 2° East.

Solution :

Horizontal angle between Cap Levy Lt. Ho. and of Cap de la Hague Lt. Ho = 90°

∴ Base angle = 90°– 90° = 0°

Horizontal angle between Cap de la Hague Lt. Ho. and Alderney Lt. Ho. = 40°

Base angle = 90°– 40° = 50°

Position at 1000 hrs. = 49°50'N 01°53'W

Compass bearing of Cap Levy Lt. Ho.	120° (C)
True bearing of Cap Levy Lt. Ho.	116° (C)
Compass error	4° W
Variation	2° E
Deviation	6° W

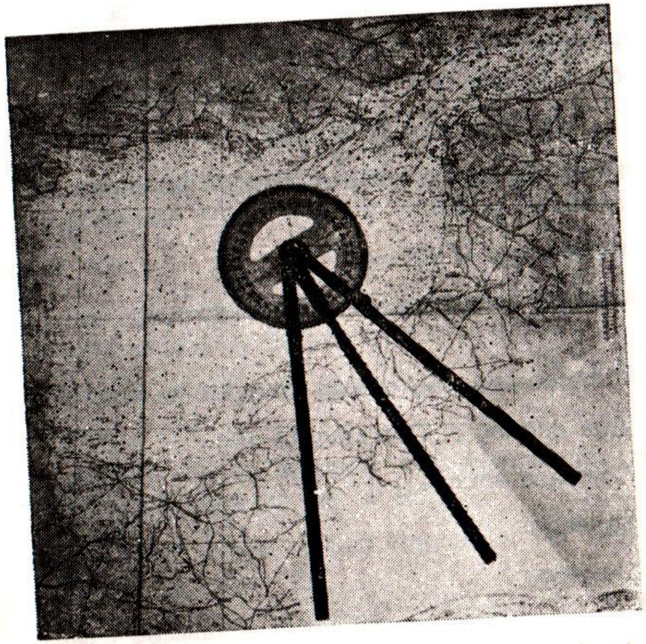
NOTE:

As the horizontal angle between Cap Levy Lt. Ho. and

Cap de la Hague is 90°, therefore the base angle is 0°. Thus draw a circle with a line joining these two light houses, which will be the diameter of the position circle.

STATION POINTER

A station pointer is an instrument which facilitates a quick plot of horizontal angles. It consists of a circular disc graduated in degrees from zero to 180° on either side of zero, with three legs, having bevelled edges radiating from the centre of the disc. One leg is fixed with its bevelled edge at zero of the graduations and is known as middle leg. The other two legs are called the right and left leg and they are free to revolve about the centre of the disc, one on either side of the fixed leg. These movable legs can be clamped by means of a small screw at any particular degree of graduations, which will show the inclination of the bevelled edge of the movable leg to the bevelled edge of fixed leg.



To Use The Station Pointer

The fixed leg represents the middle object. Clamp the right leg at the observed angle between the middle and the right hand object and then clamp the left leg at the observed angle between the middle and left hand object. Place the "Station Pointer"on the chart, with the bevelled edges of two legs passing through the centres of their respective objects.Then carefully move it until the bevelled edge of the third leg passes through the centre of the third object. The centre of the disc will be the position of the observer, which should be marked with pencil.

CHAPTER X

CURRENT AND LEEWAY

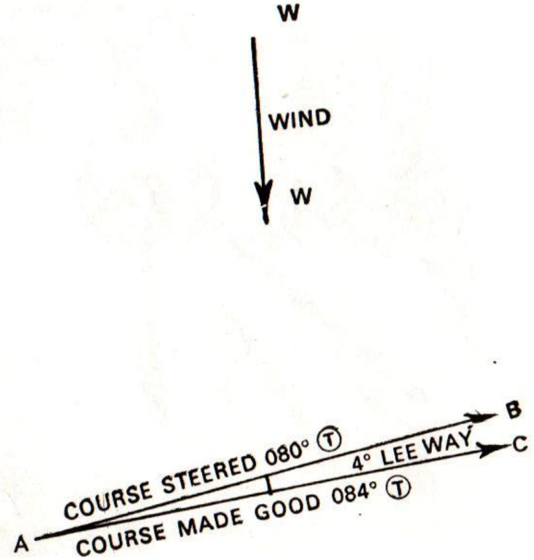
[English Channel (Eastern Portion) Chart B.A. No. 2675]

LEEWAY

The effect of wind on the course steered is called the "Leeway".

Leeway is the angle between the ship's fore and aft line and the line of the wake left behind her. In other words, it is the angle between the course steered and the course made good. It is estimated approximately in number of degrees to the leeward side, according to the direction and the force of the prevailing wind.

In practice the leeway is estimated by the navigator as so many degrees to port or starboard and necessary allowance made for it in computing the course to steer.



EXPLANATION:-

If the ship steers a course of 080° (T) and the wind is from North (force 5) and she experiences a leeway of say 4°, then the course made good (after allowing for leeway) is ascertained as follows:-

In the Figure (on page 74) A B is the course steered viz. 080° (T). WW′ is the direction of the wind from North, then ∠ BAC will be the leeway i.e. 4° (or 4° to stbd.) and the course made good will be 084° (T).

Note

In all questions dealing with leeway, it is advisable to draw a rough sketch.

Example:

A vessel wishes to make good a true course of 010° (T), find the true course to steer if the wind is from East-force 6. Leeway 5°.

True course to be made good	010° (T)
Leeway (Wind East)	+ 5°
True course to steer counteracting leeway	015°

DEAD RECKONING (D.R.) POSITION

This is a position of the ship found by allowing for the courses steered and distance steamed through the water from a Fixed Position or any starting position. It is only an approximate position.

When a ship steers a certain course or courses, she does not necessarily arrive at her D.R. Position, obtained by allowing only for the courses steered and distances steamed. This is due to the effect of wind and current etc. on her hull and superstructure.

ESTIMATED POSITION (E.P.)

The calculated position, which a ship is expected to reach after allowing for her course and speed and estimated leeway and the current (set and drift) is called the Estimated Position.

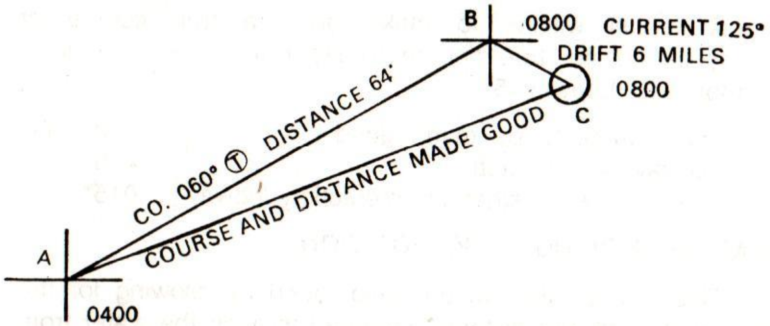
OBSERVED POSITION (OR FIX)

Observed Position on the other hand, is the actual true position of the ship, which may be ascertained by any means such as terrestrial bearings, astronomical observations, or the radio aids to navigation.

The Observed Position is the most accurate one, because it is based on the actual observations, whereas the accuracy of the Estimated Position will depend entirely on the estimates of the wind and current made by the navigator.

SET AND DRIFT OF THE CURRENT

The course and the distance between the D.R. Position and the observed position is the set and the drift of the current during the period under reference. (assuming there is no leeway).



Explanation:-

Suppose the ship starts from position A at 0400 hrs. and steers a Course of 060° (T) for 64 miles and reaches D.R. Position B at 0800 hrs.

At 0800 hrs. observed position of the ship is obtained by terrestrial bearings i.e. at "C".

Then direction of BC i.e. 125° (T) is the set of current and the distance BC i.e. 6 miles, is the drift of the current from 0400 hrs. to 0800 hrs. Hence the rate of the current experienced is 1.5 knots.

AC represents the course and the distance made good.

NOTE

It must always be remembered that the set and drift of the current is always from D. R. Position to the Observed Position.

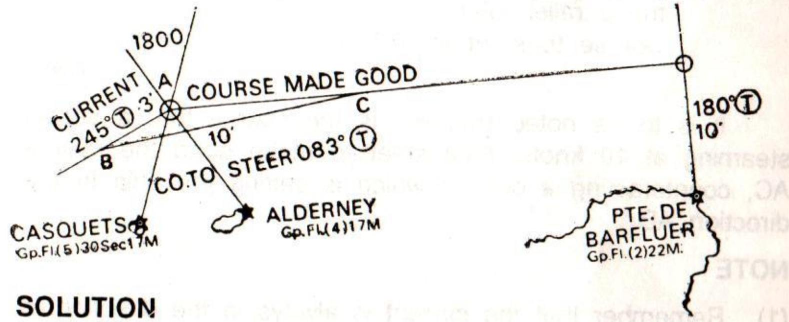
TO FIND THE COURSE TO STEER TO COUNTERACT THE CURRENT.

Example I.

(a) At 1800 hours ship steering 050° (C), Casquets Lt. Ho. bore 200° (T) and Alderney Lt. Ho. bore 149° (T). Find the ship's position.

(b) From the position at 1800 hours, find the true course, to a position with Pte. de Barfleur Lt. Ho. bearing 180° (T), distance 10 miles off.

(c) From 1800 hrs. position, find the true course to steer so as to make good the course as found in section (b), counteracting the current which was known to be setting 245° (T) at 3 knots, ship's engine speed being 10 knots.



SOLUTION

(a) Find the ship's position by laying the cross bearings of Casquets Lt. Ho. 200° (T) and Alderney Lt. Ho. bearing 149° (T). Ship's Position at 1800 hrs:-
Lat. 49°52′ N Long. 02°17.5′ W.

ANS.

(b) Now lay off the position with Pte. de Barfleur Lt. Ho. bearing 180° (T) distance 10 miles off. Join 1800 hrs. position with the position just obtained. This will be the required true course to make good so as to pass Pte. de Barfleur Lt. Ho. bearing 180° (T) distance 10 miles.

True course is 091° (T)

ANS.

(c) To find the true course to steer counteracting the current.

(i) Call 1800 hrs. Position as A.

(ii) Now from A lay off the current A B, known to be setting 245° (T)

(iii) Mark off point B making A B = 3 miles i.e. current expected to set in one hour (Rate of the current).

(iv) With B as a centre, and radius equal to 10 miles or the distance steamed in 1 hour, (speed of the ship) draw an arc cutting the course to be made good [i.e. 091° (T)] at C.

(v) Then BC is the course to steer. Measure it with the parallel ruler.
Course to steer is 083° (T).

ANS.

It is to be noted that BC is the course that a vessel steaming at 10 knots must steer to make good the course AC, counteracting a current which is setting the ship in the direction AB.

NOTE

(1) Remember that the current is always in the direction in which it sets the ship.

(2) If you take the current for 1 hour then take the engine speed also for 1 hour and if you take the current for 2 hours then take the distance steamed also for 2 hours in the plot.

(3) When the tide is from right ahead or right astern, the course made good is the same as the course steered. The speed made good will be equal to the ship's speed plus or minus the rate of current.

TO FIND THE COURSE AND DISTANCE (SPEED) MADE GOOD AND THE SET AND DRIFT OF CURRENT.

Example II.

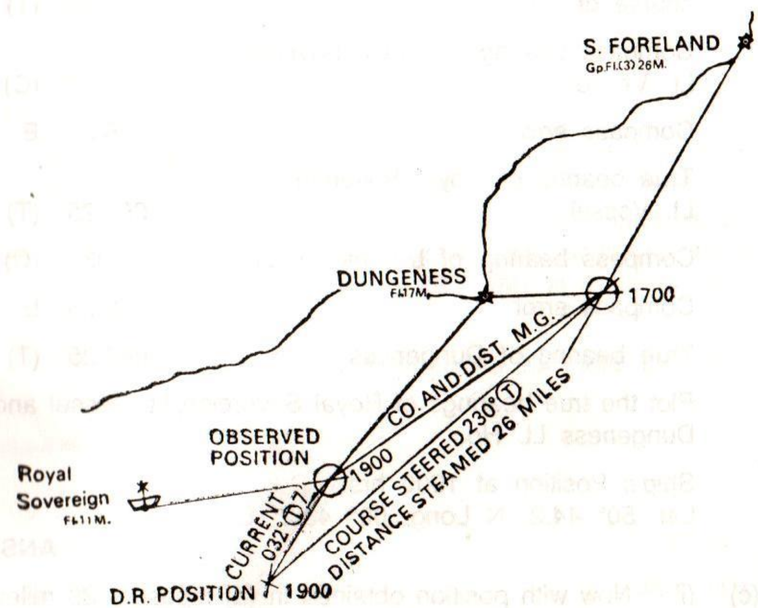
(a) At 1700 hrs. Dungeness Lt. Ho. bore 270° (T) and S. Foreland Lt. Ho. bore 031° (T). Find the ship's position.

(b) The vessel then steered 225° (C). At 1900 hrs. Royal Sovereign Lt. Vessel bore 257° (C) and Dungeness Lt. bore 037° (C). Find the ship's position.

(c) Find the set and drift of the current, if the ship's speed was 13 knots.

(d) Also find the course and speed made good.

(Variation 4 W. Deviation Card I).



SOLUTION

(a) Lay off Dungeness Lt. Ho. bearing 270° (T) and S. Foreland Lt. Ho. bearing 031° (T) and where the two bearings intersect is the ship's position.

Ship's position at 1700 hrs:-
Lat. 50° 55´ N Long. 01° 09.5´ E

(b)	Ship's head	225° (C)
	Deviation	9.25° E
	Magnetic course	234.25° (M)
	Variation	4° W
	True course	230.25° (T)
	Deviation	9.25° E
	Variation	4° W
	Compass Error	5.25° E
	From the position obtained in (a) lay true course of	230.25° (T)
	Compass bearing of Royal Sovereign Lt. Vessel	257° (C)
	Compass error	5.25° E
	True bearing of Royal Sovereign Lt. Vessel	262.25° (T)
	Compass bearing of Dungeness Lt.	037° (C)
	Compass error	5.25° E
	True bearing of Dungeness Lt.	042.25° (T)

Plot the true bearings of Royal Sovereign Lt. Vessel and Dungeness Lt. Ho.

Ship's Position at 1900 hrs.:-
Lat. 50° 44.2´ N Long. 00° 43.2´ E

ANS.

(c) (i) Now with position obtained in (a) measure 26 miles along the course line (230.25°) and mark off the D.R. Position at 1900 hrs.

(ii) Join the D.R. Position obtained just above in (c) (i) with the observed position at 1900 hrs. in section (b).

Measure the course and distance from the D. R. Position at 1900 hrs. to the observed position at 1900 hours. The course will be the set of the current and distance will be the drift of the current in 2 hours.

Set 032° (T) Drift 7 Miles and the rate of the current is 3.5 knots.

ANS.

NOTE

Current is always from D. R. Position to the Observed Position.

(d) Join 1700 hrs. and 1900 hrs. observed positions. This is the course and distance made good in 2 hours.

From the Chart, Course made good 236.5° (T)

Speed made good 9.6 knots.

Exercise I.

The ship's position at 1000 hrs. was found with Start Point Lt. Ho. bearing 298° (T) distance 8 miles. Find the compass course to steer so as to pass Shambles Lt. Vessel 4 miles off when abeam to port, counteracting a current known to be setting 285° (M) at 2 knots. Also find the speed made good.

(Variation 9° W, ship's engine speed 10 knots. Deviation Card I).

Answer:

True course to steer	074° (T)
Variation	9° W
Magnetic course to steer	083° (M)
Deviation	12° W
Compass course to steer	095° (C)
Speed made good	8.25 knots.

Exercise II.

At 0830 hours position was found with Pte. d'Ailly Lt. Ho. bearing 184° (T) 8.5 miles off. From this position, find the compass course to steer so as to pass C.d'Antifer Lt. Ho. 10 miles off. Whilst on this course, at 1130 hours C.d'Antifer Lt. Ho. was in transit with C. De. La Heve Lt. Ho. and the distance from C.d'Antifer Lt. Ho was 9 miles. Find the set and drift of the current experienced. (Variation 7.5° W, ship's engine speed 12 knots. Deviation Card I).

Answer:

True course to steer	249° (T)
Variation	7.5° W
Magnetic course to steer	256.5° (M)
Deviation	11.5° E
Compass course to steer	245° (C)

Current set 103° (T). Drift 5.4 miles at 1.8 knots.

Exercise III.

(a) On the 4th November, at 1600 hrs. Start Point Lt. Ho. bore 256° (C) and Berry Head Lt. Ho. bore 328° (C). Variation 8° W, Deviation 5° E, find the ship's position.

(b) From the above position, find the compass course to steer to pass Pte. de Barfleur Lt. 10 miles off to starboard counteracting a current setting 220° (T) at 3 knots. (Variation 8° W and Deviation as per Card I. Speed 14 knots).

(c) Find the time Pte. de Barfleur Lt. will be abeam.

Answer:

(a)	Compass Error	3° West
	True bearing of Start Point Lt. Ho.	253° (T)
	True bearing of Berry Head Lt. Ho.	325° (T)

Ship's Position at 1600 hrs:-
Lat. 50° 16.3′ N Long. 03° 21′ W

(b)	True course to steer counteracting current	096° (T)
	Variation	8° W
	Magnetic course	104° (M)
	Deviation	10° W
	Compass course to steer to counteract the current	114° (C)
	Course made good	107° (T)
	Speed made good	12.5 knots.
(c)	True course steered	096° (T)
	For beam bearing	+ 90°
	Beam bearing of Pte. de Barfleur Lt.	186° (T)
	Distance from 1600 hrs. Position to beam bearing Position	85.3 Miles

Time required $= \dfrac{85.3}{12.5} = 6H\ 50M.$

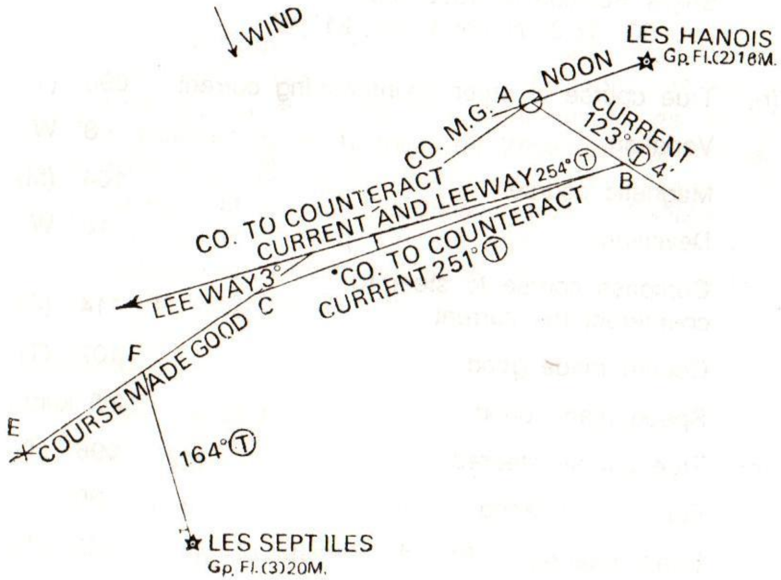
Pte. de Barfleur Lt. will be abeam at 2250 hrs.

ANS.

Example III.

(a) On 29th June, noon position was found with Les Hanois Lt. Ho. bearing 070° (T) Distance 8 Miles. From noon position, set course by compass to make good a course of 235° (T) counteracting a current setting 123° (T) at 4 knots and Leeway of 3° (Wind NNW force 5).

(b) Also calculate the time and the distance off Les Sept. Iles Lt. when abeam. (Speed 13.5 knots Variation NIL. Dev. as per Card I.)



SOLUTION

(a) (i) Find ship's position "A" with Les Hanois Lt. 070° (T) 8 miles off.

(ii) Draw the required course to be made good i.e. 235° (T)

(iii) Draw AB the current 123° (T) distance 4 miles.

(iv) With B as centre and BC as radius i.e. speed in 1 hour viz. 13.5 kts. draw an arc cutting AE (Course to be made good) at C.

(v) Then BC is the course to steer counteracting the current viz. 251° (T).
To find the course to steer to counteract leeway.

(vi) The wind is from NNW, leeway 3°, so the ship's head will have to be put to the windward by 3° i.e. + 3°.

Course to counteract current	251° (T)
Leeway	+ 3°

∴ Course to counteract current and leeway	254° (T)
Variation	NIL
Magnetic course	254° (M)
Deviation	11.3° E
Compass course to steer counteracting the current and leeway	242.7° (C)
Speed made good i.e. distance AC	11.2 knots.

(b) (i) To find the beam bearing of Les Sept. Iles:-

True course steered	254° (T)
For beam bearing	– 90°
∴ Beam Bearing	164° (T)

(ii) To find the distance off when abeam of Les Sept. Iles. Draw the beam bearing 164° (T) from Les Sept. Iles so that it cuts the course made good line i.e. AE at F. Distance from point F to the light house is the required beam distance of Les Sept. Iles Lt. i.e. 12.1 Miles. And AF is the distance to make good to have Les Sept. Iles Lt. abeam i.e. 32.5 Miles.

Distance to beam bearing	32.5 miles
Time taken to beam bearing	2 hrs. 55 minutes at 11.2 knots (speed made good)
Time When abeam	14 hrs. 55 minutes.

ANS.

NOTE

(1) Always remember that beam bearing is on the course steered and never on the course made good.

(2) Distance off when abeam is always on the course made good.

Example IV.

(a) From a vessel steering 030° (C) at 10 knots, position at 2100 hrs. was found with Les Hanois Lt. bearing 104° (C) distance 9 miles off. Whilst steering 030° (C), the ship experienced a current known to be setting 100° (T) at 3 knots and wind NW. Leeway 5°. Find the course and speed made good.

(b) Calculate the time when Casquets Lt. will be abeam and also find the beam distance off Casquets Lt.

(Variation 3° W Deviation Card I)

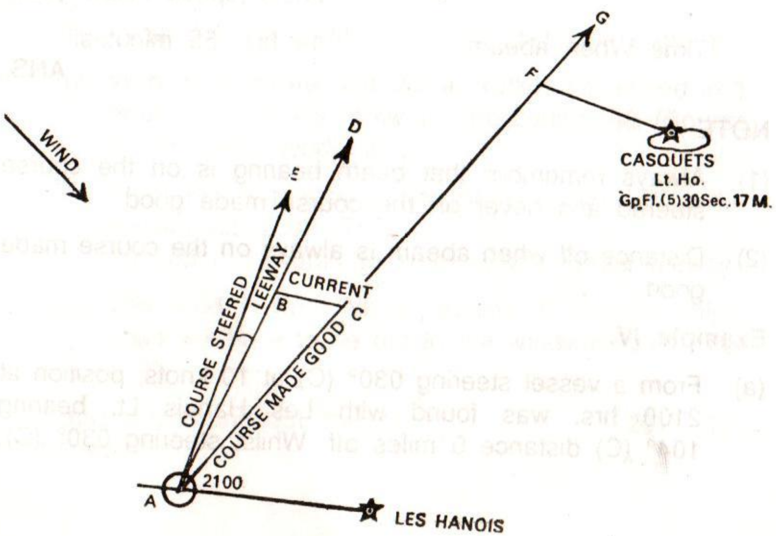
SOLUTION

(a) (1)

Compass course	030° (C)
Deviation	7° W
Variation	3° W
Compass Error	10° W
True course	020° (T)
Compass bearing of Les Hanois Lt.	104° (C)
Compass Error	10° W
∴ True bearing of Les Hanois Lt.	094° (T)

(2) Plot the position "A" with Les Hanois Lt. bearing 094° (T) 9 miles off.

(3) From "A" lay the true course 020° (T) as AE.



(4) To find the course made good:-

Course steered	020° (T)
Leeway Wind NW, (to the leeward)	+ 5°
Hence course made good after allowing for leeway	025° (T)

So draw Course AB, 025° (T) (course made good after allowing for leeway)

(5) Mark AB = 10 miles i.e. speed of the ship in 1 hour.

(6) Lay off BC as current i.e. 100° (T) distance 3 miles (Drift for 1 hour only).

(7) Join AC and extend it to F. Then AC is the course and speed made good after allowing for the leeway and current.

Course made good	040° (T)
Speed made good	11 knots.

ANS.

NOTE

Though the vessel is steering 020° (T), she will be actually moving along the line AC (i.e. 040°) over the ground.

(b) To find beam bearing of Casquets Lt. Ho:-

True course steered	020° (T)
For Beam bearing	+ 90°
True beam bearing	110° (T)

Draw 110° (T) beam bearing of Casquets Light till it cuts the course made good AG at F.

Distance off when Casquets Light is abeam = 5.8 miles.

ANS.

Then AF is the distance to make good till Casquets Lt.

Ho. is abeam. i.e. 24.5 miles.

Distance made good = 24.5 miles.

Speed made good = 11 knots.

∴ Time required to beam bearing =2 hrs. 13 minutes (Calculated at 11 Knots)

Expected time when Casquets Lt. will be abeam = 2313 hours.

NOTE

The distance off the light in such problems is where the beam bearing (i.e. ± 90° to the course steered) cuts the course made good line.

Exercise IV.

(a) From a vessel steering 105° (C) at 12 knots, position @ 1930 hrs. was found by Alderney Lt. Ho. bearing 220° (C) and C. de La Hague bearing 165° (C). Whilst continuing on this course, the ship experienced a current known to be setting 064° (M) at 3 knots. Wind North. Leeway 5°.

Find the course and speed made good.

(b) Also calculate the time when Pte. de Barfleur Lt. will be abeam and the distance off when abeam.

(Variation 4° W throughout. Deviation as per Card I).

Answer

(a)	Compass course	105° (C)
	Deviation	11° W
	Variation	4° W
	Compass Error	15° W
	True course	090° (T)
	Leeway (Wind North)	+ 5°
	Course after Leeway	095° (T)
	Current	064° (M)
	Variation	4° W
	True current	060° (T) at 3 knots.

Course made good after allowing for leeway and current = 088.5° (T).

Speed made good 14.5 knots.

(b) Beam bearing of Pte. de Barfleur Lt. 180° (T)

Distance to be made good when Pte. de Barfleur Lt. will be abeam 31 Miles.

Time taken = 2 hours 10 minutes.

E.T.A. off Pte. de Barfleur Lt. = 2140 hours.

Distance off when abeam = 10.2 Miles.

COURSE TO STEER SO AS TO PICK UP A LIGHT RIGHT AHEAD WITH CURRENT

EXAMPLE:-

(a) At 1900 hrs. a vessel steering 057° (C) Ile de Batz Lt. bore 195° (C) and Les Sept. Iles Lt. bore 110° (C). Find. the vessel's position.

(b) From the position obtained in (a) set a course so as to sight Les Roches Douvres Lt. right ahead in meteorological visibility of 5 miles and current setting 332° (M) at 3 knots. (Variation 6° W, Deviation Card No. 2, Vessel's speed 12 knots)

Solution:

(a)	Compass course	057° (C)
	Deviation	3.6° E
	Variation	6° W
	Compass Error	2.4° W
	True brg. of Ile de Batz Lt.	192.6° (T)
	True brg. of Les Sept. Iles	107.6° (T)
	Vessel's Posn. @1900 hrs.	48° 58.5'N 003° 57.5' W

(b) Nominal Range of Les Roches Douvres Lt. = 28 miles

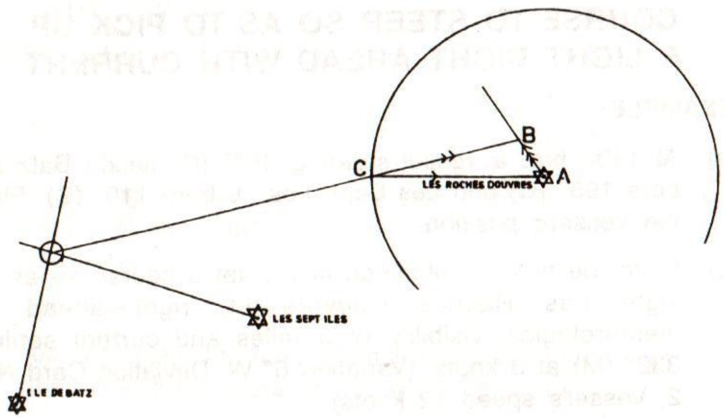
Luminous Range@5 miles meteorological visibility

= 15.9 miles

True Current = 326° (T) @3 knots

So now we have to set a course from 1900 hrs. position [as found in (a)] so as to sight Les Roches Douvres Lt. right ahead at a distance of 15.9 miles at 12 knots with current setting 326° (T) at 3 knots.

Time taken to steam 15.9 miles @ 12 knots = 1H19M. Drift in 1H19M @ 3 knots = 3.98 miles.



(1) With Les Roches Douvres Lt. as centre and sighting distance of the light right ahead as a radius viz. 15.9 miles draw a circle.

(2) Draw the current AB from Les Roches Douvres Lt. for 1H19M (the time taken by the vessel to steam when the light is to be sighted right ahead) viz. draw AB as current 326° (T) drift 3.98 miles.

(3) Join the starting position i.e. position at 1900 hrs. to a position obtained after applying current from the light i.e. Join DB cutting the sighting range of the light or the circle drawn earlier as stated in (1) at 'C'.

(4) Join CA which will be the course to steer so as to sight the light right ahead i.e. 089° (T)

Thus course to steer so as to sight Les Roches Douvres Lt. right ahead is 089° (T).

(5) Course made good by the vessel i.e. CB will be 076° (T). (not asked in the question)

(6) The vector ABC will be such in which CA will be the course to steer to sight the light right ahead and CB will be the course made good and AB will be the current.

It must be remembered that the set and drift of the current, the course and distance made good and course to steer and distance to steam by engines are all for the period it will take the vessel to steam when the light will be sighted right ahead i.e. 1 hour and 19 minutes.

NOTE :

It must be appreciated that from starting position viz. 'D' the course made good will be DCB i.e. 076° (T) whilst the vessel will be steering a course of 089° (T) right from the starting position.

Excercise I.

(a) A vessel steering 278° (C), Start Point Lt. bore 018° (C), and Eddystone Rocks Lt. bore 309° (C), find the vessel's position.

(b) From the position obtained in (a), set a course by compass so as to sight Lizard Point Lt. right ahead in meteorological visibility of 5 miles and current setting 180° (T) at 3 knots. (Variation 6° W, Deviation Card No. 2, Vessel's speed 12 knots)

Solution:

(a)	Compass Course	278° (C)
	Deviation	3° E
	Variation	6° W

	Compass Error	3° W
	True brg of Start Point Lt.	015° (T)
	True brg of Eddystone Rocks	306° (T)
	Ship's Position	49°57.8'N 03°45' W
(b)	Nominal Range of Lizard Piont Lt.	29 M
	Luminous Range @ 5 miles visibility	16 M
	Time taken to steam 16'@ 12 knots	1H20 M
	Drift in 1H20M	4 Miles
	Current	180° (T)
	True Course to steer	280° (T)
	Variation	6° W
	Magnetic Course	286° (M)
	Deviation .	4.0° E
	Compass Course to Steer	282° (C)
	Course made good	265½° (T)

CHAPTER XI

DIPPING AND RISING BEARINGS OF THE LIGHTS

[English Channel (Eastern Portion) Chart B.A. No. 2675]

GEOGRAPHICAL RANGE

A light is said to be "raised" when the light is first sighted on the Bridge of the ship. Similarly a light is "dipped" when the light is seen for the last time before it dips below the horizon. Hence "dipping or rising" distance will be the maximum range of that particular light.

The range of the light depends upon the height of the lighthouse above the sea level and also upon the height of the observer. The distance of visible horizon due to the height of light is fixed, while the observer's distance of visible horizon changes because the height of eye is not constant (It depends upon the draft of the ship).

The distance of the visible horizon will depend on the height of the observer's eye and also the height of the object. It may be calculated as follows:-

(a) If the height of eye is given in feet then

Distance (d) of horizon = $1.15 \sqrt{h}$

where (d) = distance in miles.

and h = height of eye in feet.

(b) If the height of eye is given in metres then

Distance (d) of horizon = $2.08 \sqrt{h}$

where (d) = distance in miles.

and h = height of eye in metres.

The two ranges of visible horizons, i.e. for the height of the object and that of the observer are calculated separately and when added together, will give the geographical range of the light.

NOTE

It must be emphasized here that "Rising" and "Dipping" ranges calculated in the manner shown above are called the Geographical ranges and these are *theoretical* ranges only. A light will be seen at the "Rising" and "Dipping" range only if the luminosity of the light is sufficient for the range calculated.

The 'List of lights' now show the lower of the two ranges i.e. the lower of the geographical range (computed for the observer to be at height of 15 feet) and the "Nominal" luminous range depending upon the intensity of the light.

Example:

A shore light, height 144 feet, is observed to dip, height of eye 36 feet. Calculate the distance of the light from the observer.

Distance of visible horizon of light $= 1.15 \sqrt{144}$
$= 1.15 \times 12 = 13.8$ Miles.

Distance of visible horizon of the observer $= 1.15 \times \sqrt{36}$
$= 1.15 \times 6 = 6.9$ Miles

Geographical range of the light $= 13.8 + 6.9 = 20.7$ Miles.

The distance of the visible sea horizon for various heights is given in Burton's or Norie's Nautical Tables.

NOTE

The geographical range of visibility of lights shown on the charts is calculated for a height of the observer's eye of 4.57 metres (15 feet). The light will be visible at the range of the light shown on the chart, provided it is a dark night with clear atmosphere, under normal conditions of refraction. For example, if range of light shown on the chart is 20 miles, then the light will be raised or dipped at 20 miles, provided the observer's height of eye is 4.57 metres (15 feet).

Example I.

The range of Casquets Lt. given on the chart is 17 Miles, and height 36.58 Metres (120 feet). Find the raising distance of this light, if the observer's height of eye is 11 Metres (36 feet).

SOLUTION

First Method

Range of the light (from the chart)	=	17 Miles.
Sea horizon for 4.57 Metres (15 feet)	=	4.5 Miles.
Range of the light at sea level	=	12.5 Miles.
Sea horizon for 11 Metres (36 feet)	=	7.0 Miles.
Raising distance of the light	=	19.5 MIles.

(Subject to the light having sufficient luminosity).

Second Method

Range for height of light 36.58 Metres (120 feet) (From Nautical Tables)	=	12.5 Miles
Sea horizon for 11 Metres	=	7.0 Miles.
Raising distance of light	=	19.5 Miles.

(Subject to light having sufficient luminosity).

NOTE

(1) Since the height of light house is given on the chart, the sea horizon for the same is obtained straight-away from the tables and then visible sea horizon for the height of eye is allowed.

(2) When calculating the raising or dipping distance of the light, whose visibility is taken from the chart, the given range should first be reduced to sea level by subtracting the range of visible horizon for height of eye 4.57 Metres (15 feet) i.e. 4.5 Miles and then add the distance of visible horizon for the height of eye of the observer.

Exercise I.

Find the dipping distance of Alderney Lt. (GP. Fl (4) 17 Miles) if the height of eye is 12 Metres (39.5 feet).

Answer:

Dipping distance = 19.9 Miles.

Exercise II.

Find the raising distance of C. de Antifer Lt. (F1.27 M) if the height of eye is 10 Metres (33 feet.)

Answer:

Raising distance = 29.2 Miles.

LUMINOUS RANGE

Geographical range of a light is the maximum distance at which a light can be seen at a given time, determined by the elevation of the light and the height of eye of the observer, as affected by the curvature of the earth. But the luminosity of the light and meteorological visibility prevailing at that time are other important factors which also affect the range at which the light will be sighted. However these factors are ignored when calculating geographical range of the light. Thus the geographical range of the light is not accurate.

Luminous Range of a light is the range of the light as determined by the elevation of the light, the height of eye and also by the luminosity of the light and the meteorological visibility prevailing at that time.

Nominal Range of the light is the luminous range when the meteorological visibility is 10 miles.

Nominal Range of the light is given in Admiralty List of

Lights now a days but the charts printed before 1972 have the Geographical Range printed.

LUMINOUS RANGE DIAGRAM

This diagram enables the mariner to determine the range at which a light may be "First Sighted" or "Last Sighted" at night, in the meteorological visibility prevailing at the time of observation.

The diagram is entered from the top border, using nominal range given on the chart or in Admiralty List of Lights. The figures along the curves represent the estimated meteorological visibility at the time of observation and those along the left hand border give the luminous range under those conditions.

The Luminous Range Diagram is given at the end of this book.

NOTE:

1. The light is said to be "raised" or "dipped" when Geographical Range of light is used and the words "first sighted" or "last sighted" is used when Luminous Range is used.

2. In the day time, the light will be "first sighted"or "last sighted" at the meteorological visibility prevailing at that time. Thus Luminous Range Diagram must not be used in the day time.

Caution when using Luminous/Geographical Range of Lights for Fixing Ship's Position.

1. The ranges obtained are approximate.

2. The transparency of atmosphere is not necessarily consistent between the observer and the light.

3. Glare from the background lights will considerably reduce the range at which the lights will be sighted.

4. The distance of an observer from a light cannot be estimated from its apparent brightness.

5. The distance at which lights are sighted varies greatly with atmospheric conditions and this distance may be increased by abnormal atmospheric refraction.

6. When ice conditions are prevalent, the windows of the lights may be covered with frost or ice, which will greatly reduce the sighting range.

7. Lights placed at a great elevation are frequently obscured by cloud than those near the sea level.

VERTICAL SEXTANT ANGLES

Another method of finding the ship's position, is by means of taking a bearing of a light house or any terrestrial object and obtaining the distance off that object by means of a vertical sextant angle.

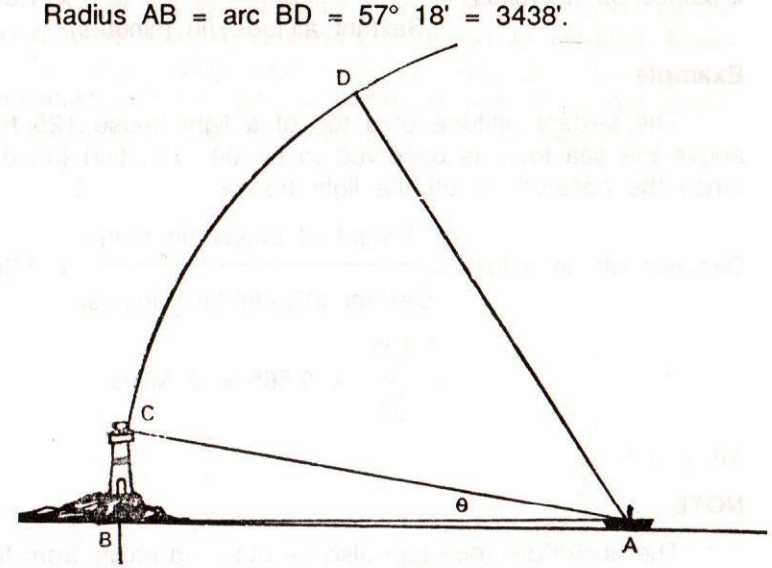
Ship's position can also be found by taking vertical sextant angles of two or more suitable objects; which in turn will give you the distance the vessel is off those objects. In other words, each observation will give a position circle and where the two position circles cut each other, will be the position of the ship.

The vertical sextant angle also proves very useful to a navigator, when a ship has to pass a certain safe distance off (say 2 milesoff) a light house or an off lying danger.

In the figure below if BC is the height of the light house, A is the ship and AB is the distance of the ship from the light house then θ is the vertical sextant angle.

Let the arc BD be equal to the radius AB, then BAD is a radian. The value of a radian in sexagesimal measure is 57° 18'45"

Radius AB = arc BD = 57° 18' = 3438'.



$$\frac{\text{arc BD}}{\text{arc BC}} = \frac{\text{radius AB}}{\text{chord BC}} = \frac{\angle \text{BAD}}{\angle \text{BAC}} \quad \text{where } \theta \text{ is small}$$

$$\frac{\text{AB}}{\text{BC}} = \frac{57^\circ\ 18'}{\theta}$$

$$\text{AB in feet} = \frac{\text{BC in feet} \times 3438'}{\theta}$$

$$\text{AB in Miles} = \frac{\text{BC in feet} \times 3438'}{\theta \text{ in Minutes} \times 6080'}$$

$$\text{Distance off (in miles)} = \frac{\text{Height of object (in feet)}}{\text{Sextant altitude (in minutes)}} \times 0.565$$

or

If the height of object is given in metres then use the following formula:-

$$\text{Distance off (in miles)} = \frac{\text{Height of object (in metres)}}{\text{Sextant altitude (in minutes)}} \times 1.854$$

Example

The sextant altitude of a top of a light house 125 feet above the sea level is observed to be 00° 35´, find the distance the observer is off the light house.

$$\text{Distance off (in miles)} = \frac{\text{Height of object (in feet)}}{\text{Sextant altitude (in minutes)}} \times 0.565$$

$$= \frac{125}{35} \times 0.565 = 2 \text{ Miles}$$

AB = 2 Miles.

NOTE

The above distance can also be obtained easily from the Burton's Nautical Tables or Norie's Nautical Tables.

DISTANCE SAILED ROUND AN ARC

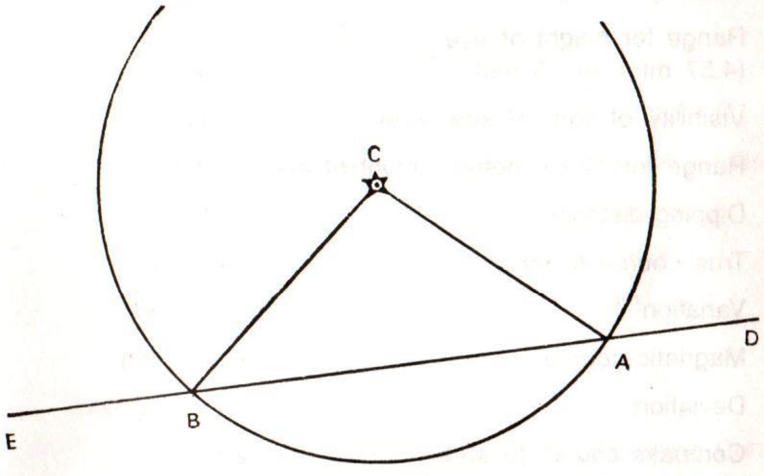
Sometimes, a ship may be required to sail round an arc, so as not to get closer than a certain distance to a danger or a rock, or a light house, whilst at the same time not deviating too much from the original course.

This is done by finding out the vertical sextant angle of the light house or a hill generally called a "Vertical Danger Angle" and then the sextant is set on that angle and this angle is maintained by altering the ship's course often, so that the ship can be made to sail round this arc, and at the same time not getting too far off the course line laid on the chart. This distance sailed round the arc is easily found and is explained as below:-

Supposing a ship continuing on her course DE does not want to get closer than 5 Miles off C (a light house) (Figure

below) and then with C as a centre and 5 Miles as radius, draw an arc cutting the original course DE at points A and B and the ship sails round the arc AB.

In order not to get closer than 5 Miles, as soon as the ship reaches point A, courses are altered as required, keeping the ship sailing round this arc AB, and distance off maintained with the help of a danger vertical sextant angle, until the ship reaches B, when the ship can resume back her old course.



The distance sailed round this arc is easily calculated by the formula:--

$$\text{Distance sailed round the arc} = \frac{\text{Angle subtended at the centre} \times \text{distance off}}{57.3}$$

Example II.

At 0430 hrs. Nab Tower Light dipped bearing 344°(T). From this position, course was set by compass to pass Les Hanois Light house 14.0 Miles off when abeam to port. Find the compass course to steer. While on the above course it was decided not to get closer than 8 miles off Casquets Lt. Ho. (Height 120 feet), calculate the vertical danger angle to set on the sextant and also the E.T.A. (Expected time of arrival) when Les Hanois Light house will be abeam. No current, height of eye 12.19 Metres (40 feet). Index error 3′ on the arc. (Variation 7.5°W. Speed 13 knots. Deviation Card I).

Answer :

Visibility of Light	19'	
Range for height of eye (4.57 mtrs. or 15 feet)	– 4.5	
Visibility of light at sea level	14.5'	
Range for 12.19 metres height of eye	+ 7.4	
Dipping distance	21.9'	
True course to steer	243°	(T)
Variation	7.5°	W
Magnetic course	250.5°	(M)
Deviation	11°	E
Compass course to steer	239.5°	(C)

Height of Casquets Lt. Ho. 120 feet.

Distance off = 8 Miles.

$$\text{Distance off} = \frac{\text{Height of object (in feet)}}{\text{Sextant altitude (in minutes.)}} \times 0.565$$

$$\text{Sextant altitude in minutes} = \frac{\text{Height of object (in feet)}}{\text{Distance off (in miles.)}} \times 0.565$$

$$= \frac{120 \times 0.565}{8} = 8.5'$$

Sextant altitude	8.5'
Index Error	3' on the arc
Sextant Altitude	11.5'
Angle subtended at the centre	113°
Distance off or radius	8 Miles

Distance sailed round the arc

$$= \frac{\text{Angle subtended at centre x distance off}}{57.3}$$

$$= \frac{113° \times 8}{57.3} = 15.8' \text{ Miles}$$

Beam bearing of Les Hanois Lt. Ho.	153° (T)
Total distance = 66.2' + 15.8' + 13.8' =	95.8 Miles
Speed	13 knots.
Time Taken	7 hours 20 minutes.
E.T.A. at the beam bearing	1150 hrs.

Ans.

Exercise I.

From a vessel steering 310°(C) the following Compass bearings were observed at 1930 hrs.

C. d'Antifer Lt. bearing	108° (C)
C. de La Heve Lt. bearing	165° (C)
Le Harve Lt. Vessel bearing	205° (C)

Find the ship's position. The vessel continued on her course and at 2054 hrs. Pte. de Barfleur Lt. was raised bearing 256° (C), find the ship's position and the set and drift of the current experienced. Find also the course and speed made good. (Use Variation 12.5°W. Deviation as per Card I. Speed 15 knots. Height of eye 10 Metres (33 feet).

Answer :

Ship's head	310° (C)

Deviation	6.5° E
Variation	12.5° W
Compass Error	6° W
True course	304° (T)
True bearing of C. d'Antifer Lt.	102° (T)
True bearing of C. de La Heve Lt.	159° (T)
True bearing of Le Havre Lt. Vessel	199° (T)

Ship's position at 1930 hrs:-
Lat. 49°42.7'N Long. 00°03.3'W

Range for Pte. de Barfleur Lt.	= 22 Miles.
Range for height of eye 15 feet	= – 4.5 Miles.
Visibility of Pte. de Barfleur Lt. at sea level.	= 17.5 Miles.
Range for height of eye 10 metres. (33 feet)	= + 6.7 Miles.
Visibility at Height of Eye 10 Metres.	24.2 Miles.
Compass bearing of Pte. de Barfleur Lt.	256° (C)
Compass Error	6° W
True bearing of Pte. de Barfleur Lt.	250° (T)

Obs. position at 2054 hrs:-
Lat 49°50.2'N Long 00°40.2'W

Distance steamed for 1H. 24M.	= 21 Miles.
Current = 239° (T)	
Drift = 7.7 Miles in 1 hour 24 minutes.	
Rate of current	5.5 knots.
Course made good	288° (T)
Distance made good	24.6 Miles
Speed made good	17.5 Knots.

Exercise II.

On a voyage from London to Portsmouth, a vessel steering 275° (C), speed 14 knots. At 1910 hrs. Beachy Head Light dipped bearing 025°(C) and at 2104 hours Nab Tower Lt. was raised bearing 318°(C). Variation 9 W. Height of eye 11 metres (36 feet).

Find the ship's position at 1910 hours and at 2104 hours, the set and drift of the current experienced and the course and speed made good.

(Deviation Card I)

Answer:

Course steered	275° (C)
Deviation	12° E
Variation	9° W.
Compass error	3° E
True course Steered	278° (T)

	Beachy Head Lt.	Nab Tower
Compass bearing	025° (C)	318° (C)
Compass error	3° E	3° E
True bearing	028° (T)	321° (T)
Range of light	16.0'	14.0'
Range for 4.57 metres (15 feet)	– 4.5'	– 4.5'
Visibility @ Sea level	11.5'	9.5'
Range for 11 metres (36 feet)	+ 7.0'	+ 7.0'
Dipping or raising distance	18.5'	16.5'

Position @ 1910 hrs. Lat. 50°27'N Long. 00°01.0'E
Position @ 2104 hrs. Lat. 50°28'N Long. 00°41.0'W

Set 181°(T) Drift 4 Miles @ 2.2 knots.
Course made good 270°(T)
Distance made good 26 Miles.
Speed made good 13.7 knots.

Exercise III.

On a voyage from Bristol to Antwerp, a vessel steering 145° (C) at 15 knots, position at 1500 hrs. was found with Bill of Portland Lt. Ho. bearing 318°(C) and Anvil Point Lt. Ho bearing 034°(C). Find the ship's position. The vessel continued on her course through an estimated current setting 281°(M) at 1.5 knots. Find how close did the ship pass Pte. de Barfleur Lt. Ho. and also the estimated time when the light house was abeam.

(Variation 11°W Deviation Card I.)

Answer:

Ship's head	145° (C)
Deviation	4° W
Variation	11° W
Compass Error	15° W

True course	130° (T)	
Current	281° (M)	
Variation	11° W	
Current	270° (T)	
	Bill of Portland Lt.	Anvil Point Lt.
Compass bearing	318° (C)	034° (C)
Compass Error	15° W	15° W
True bearing	303° (T)	019° (T)

Position at 1500 hrs. Lat. 50°21.5'N Long. 2°05'W

Nearest distance off Pte. de Barfleur Lt. Ho.	7.6 Miles
Distance to make to beam bearing	50.0 Miles
Speed made good	13.75 knots
Time taken	3 Hours 38 Minutes
E.T.A. for beam bearing	1838 hours.

Exercise IV.

(a) At 1700 hrs. vertical sextant angle of Hardy monument (772 feet) was 1°03' and that of Bill of Portland Lt. Ho. (145 feet) was 00°10'. Find the ship's position.

(b) From this position, course was set for Les Hanois Light counteracting a current setting 289°(M) at 2.5 knots. Wind East, force 6. Leeway 3°. Find the compass course to steer, and the speed made good.

(c) Calculate the time Casquets Light was raised.

(d) Find the time and the distance off when Casquets Light will be abeam. (H.E. 9.5 metres (31 feet) Variation 11°W. Ship's speed 12.5 knots. Deviation Card I).

Answer:

(a) Hardy Monument = 772 feet.
Vertical Sextant angle = 1° 03' = 63'

$$\text{Distance off (in miles)} = \frac{\text{Height of object (in feet)}}{\text{Sextant altitude (in minutes)}} \times .565$$

$$= \frac{772}{63} \times .565 = 7.0 \text{ miles.}$$

Bill of Portland Lt. Ho. height = 145 feet.
Vertical Sextant angle = 10'

$$\text{Distance off (in miles)} = \frac{\text{Height of object (in feet)}}{\text{Sextant altitude (in minutes)}} \times .565$$

$$= \frac{145 \times .565}{10} = 8.0 \text{ miles off.}$$

Ship's position at 1700 hrs.:-
Lat. 50° 35'N Long. 02° 38'W

(b)

Current	289° (M)
Variation	11° W
True Current	278° (T) at 2.5 knots.
True course to steer to counteract the current	171° (T)
Leeway (Wind East)	– 3°
True course to counteract the current and leeway	168° (T)
Variation	11° W
Magnetic course	179° (M)
Deviation	1.7° E
Compass course to steer Counteracting current and leeway	177.3° (C)
Speed made good	12 knots

(c)

Range of Casquets Light	17.0 Miles
Distance for H.E 4.57 metres (15 feet)	– 4.5'
Range at Sea level	12.5'
Distance for H.E. 9.5 metres (31 feet)	+ 6.5'
Raising distance of Casquets Lt.	19.0'
Distance to raising light position	37 Miles
Speed made good	12 knots.
Time taken to raise the light	3 H. 05 M
E.T.A. when light is raised.	2005 hrs.

(d)

True course steered	168° (T)
For beam bearing	– 90°
Beam bearing of Casquets Lt.	078° (T)

Distance from 1700 hrs. Position to beam bearing	54 miles
Speed made good	12 knots.
Time taken	4 Hrs. 30 Min.
Hence Casquets Light will be abeam at	2130 hours.
Distance off when Casquets Light is abeam	12 miles.

Exercise V.

(a) At 0800 hrs. horizontal sextant angle between St. Catherine Pt. Lt. Ho. and Nab Tower was 63° and the vertical sextant angle of Nab Tower was 00°11' (Height 41.15 metres or 135 feet). Find the ship's position.

(b) From this position find compass course to steer to pass 8 miles due south of Start Point Lt. Ho. counteracting a current setting 116°(M) at 4 knots. Wind North. Leeway 3°. Find the speed made good and the E.T.A. off Start Point Lt.

(c) Find the time when Anvil Point Lt. Ho. will be abeam. (Ship's speed 15 knots. Variation 9°W. Deviation Card I. Index Error NIL)

Answer:

(a) Complement of horizontal angle 27°

Vertical sextant angle of Nab Tower 00°11'

Distance off Nab Tower 7.0 Miles

Position at 0800 hrs. Lat. 50°34'N Long. 00°53'W

(b)	True course to steer counteracting current	263° (T)
	Leeway (Wind North)	+ 3°
	True course counteracting Current and Leeway	266° (T)
	Variation	9° W
	Magnetic course	275° (M)
	Deviation	12.9° E
	Compass course to steer to counteract Current and Leeway	262.1° (C)

	Speed made good	11.5 knots.
	Distance to the position 8 Miles due South of Start Point	109 Miles
	Time taken @ 11.5 knots.	9 Hrs. 29 Mins.
	E.T.A. off Start Point Lt.	1729 hrs.
(c)	True course steered	266° (T)
	Beam bearing	356° (T)
	Distance off Anvil Pt. Lt. abeam	41.8 Miles
	Time taken @ 11.5 knots.	3 H 38 M.
	E.T.A. when Anvil Pt. Lt. abeam	1138 hours.

Exercise VI.

(a) On 20th Jan. Position at 2200 hrs. was found with Berry Head Lt. bearing 332°(T) and Start Point Lt. bearing 245°(T), when course was set to pass St. Catherine Point Lt. 8 miles off to port. Find the Compass course to steer.

At 2330 hrs. Bill of Portland Lt. (Gp.Fl. (4) 18 M) was raised bearing 076°(C). Find also the set and drift of the current experienced.

(b) At 2330 hrs. on 20th January, course was reset to pass St. Catherine Lt. 10 miles off to port, counteracting the current experienced from 2200 hrs. to 2330 hrs. Find the compass course to steer. Also find the time and the distance off when Anvil Point Lt. will be abeam.

(Variation 6.5°E. Ship's speed 14 knots. Height of eye 12 metres (39.4 feet) Deviation Card I).

Answer:

(a)	True course to steer	083.5° (T)
	Variation	6.5° E
	Magnetic course	077° (M)
	Deviation	12.5° W
	Compass course to steer	089.5° (C)
	Compass error	6° W
	Range of Bill of Portland Light	18 Miles
	Reduction for 4.57 metres (15 feet)	– 4.5 Miles
	Range at sea level	13.5 Miles

Visible horizon for 12 metres	+7.4 Miles
Visibility of the light (H.E. 12 Mts.)	20.9 Miles
Compass bearing of Bill of Portland Lt.	076° (C)
Compass error	6° W
True bearing of Bill of Portland Lt.	070° (T)
Distance steamed in 1½ hrs.	21 Miles

Current Set 305°(T) drift 6.5 Miles at 4.3 knots.

(b)	True course to steer counteracting the current experienced	098° (T)
	Variation	6.5° E
	Magnetic course	091.5° (M)
	Deviation	11.3° W
	Compass course to steer	102.8° (C)
	Course made good	089° (T)
	Speed made good	10.75 knots.
	Beam bearing of Anvil Point Lt.	008° (T)
	Distance off when abeam	11.8 Miles
	Distance from 2330 hrs. position to beam bearing	36.5 Miles
	Speed made good	10.7 knots
	Time taken	3 H. 23 M.

E.T.A. when Anvil Point Lt. will be abeam 0253 hrs. on 21st January.

Exercise VII.

(a) From a vessel steering 252°(C) at 0800 hrs. Nab Tower bore 020°(C) and St. Catherine Pt. Lt. Ho. bore 308° (C). Find the ship's position.

(b) From this position, set a course by compass to counter-act current setting 158° (M) at 4 knots, Wind North. Leeway 2° so as to reach 8' due south of Start Pt. Lt. Ho.

(c) Find the time when the vessel will be abeam off the Shambles Lt. Vessel (Variation 8°W Deviation as per Card I. Ship's speed 12 knots.).

Answer:

(a)	Compass Course	252° (C)
	Deviation	12.2° E
	Variation	8° W
	Compass Error	4.2° E
	True course	256.2° (T)
	True bearing of Nab Tower	024.2° (T)
	True bearing of St. Catherine Pt.Lt.Ho.	312.2° (T)

Ship's position at 0800 hrs:-
Lat. 50°28'N Long. 01°06'W

(b)	Current 150°(T) @ 4 knots.	
	True course to steer to counteract the current	275° (T)
	Leeway (Wind N'ly)	+ 2°
	True course to steer counteracting Current and Leeway	277° (T)
	Variation	8° W
	Magnetic course	285° (M)
	Deviation	12.2° E
	Compass course to steer	272.8° (C)
(c)	Beam bearing of Shambles Lt. Vessel	007° (T)
	Distance from 0800 hrs. Position to Shambles Lt. Vessel abeam	50.4 Miles
	Speed made good	10.2 Knots

E.T.A. when Shambles Lt. Vessel is abeam 1254 hrs.

CHAPTER XII

POSITION LINES BY ASTRONOMICAL OBSERVATIONS

[English Channel (Eastern Portion) Chart B.A. No. 2675]

We have so far in the previous chapters found the ship's position by position lines obtained from various terrestrial observations. However, it may be appreciated that a position line can also be obtained and calculated from astronomical observations.

An astronomical position line is really a small arc of a circle of position, whose centre is the object observed and the radius is the angular distance of the observer's zenith from the object (Zenith distance).

The practical method of laying down a position line is to plot a small part of the circle of position, as a straight line. The position line from a celestial observation is thus found by adding and subtracting 90° to the Azimuth of a heavenly body.

It is not proposed to discuss in this chapter the theory of how a position of the ship is obtained by celestial observations but a brief description of the two methods, which give a position from where to draw a position line are enumerated below very briefly:-

(a) LONGITUDE BY CHRONOMETER METHOD

With D.R. Latitude and Declination and true altitude of the heavenly body known, calculate the local hour angle (L.H.A.) and thence the observed Longitude. With the help of ABC tables, calculate the Azimuth of that heavenly body and thus obtain the position line (P.L), which is always at right angles to the Azimuth of the body.

Plot the D.R. Latitude and the observed Longitude and through this position draw the position line. The ship at the time of observation lies somewhere on this position line.

(b) MARCQ ST. HILAIRE METHOD

In this method, the true Zenith distance of a celestial object is obtained by observing its altitude. Using the D.R. Lat. and D.R. Long., the Zenith distance of the body is calculated with reference to this D.R. Position. The difference between the true and calculated Zenith distance is called the Intercept. The Azimuth of the heavenly body is calculated by ABC Tables and thus the P.L., which is at right angles to the Azimuth.

The D.R. Position is plotted on the chart and the intercept laid off along the true bearing of the object (either Towards or Away) at the time of observation. This is called Inter Terminal Position. A line drawn at right angles to the Azimuth through this position is the required position line, and the ship lies somewhere on this position line.

In both the above stated methods, the position of the ship is not found, but it is only a means of finding the position through which to draw the position line. However, the position line so obtained can be used in finding the ship's position by intersecting it with another position line, found by the same or any other method.

For instance, if simultaneously with the observation of the heavenly body, a bearing of a terrestrial object is taken, or a D.F. bearing of a D.F. station is obtained, the intersection of the bearing (D.F. or terrestrial) and the position line obtained from the observation of a heavenly body, will give the position of the ship.

If a Position Line is obtained by a celestial observation and after a known lapse of time, a terrestrial bearing is observed, then the position of the vessel can also be obtained by the "Running Fix" method. In this case, the position through which the position line passes is laid on the chart and then the course steered and the distance steamed in the interval is laid off. From the position so arrived draw the transferred position line and where it cuts the terrestrial bearing is the position of the ship.

If, however, a current is experienced during the interval, then from the position through which to draw the position line, lay off the course and distance steamed and then apply the set and drift of the current during that interval and from this position, draw the transferred position line and where it cuts the terrestrial bearing, is the actual position of the ship at the time of taking the terrestrial bearing.

It may be noted that the second position line may be obtained by any suitable method including a second observation of a celestial body. The second celestial observation must, of course, make a "good cut" with the first (or the transferred) position line to give an accurate "FIX".

In practice a ship's position is found at sea by taking an observation of a celestial body (say sun in the morning) and thus finding a position through which the position line passes (either by Longitude by Chronometer method or Intercept method) and then applying the course and distance steamed i.e. the run, till the heavenly body (Sun) is at or near the meridian. A second observation of the heavenly body (Sun) is then taken when at or near the meridian and the second position line obtained. Position of the ship is now obtained by crossing the transferred position line with the position line computed from the second observation.

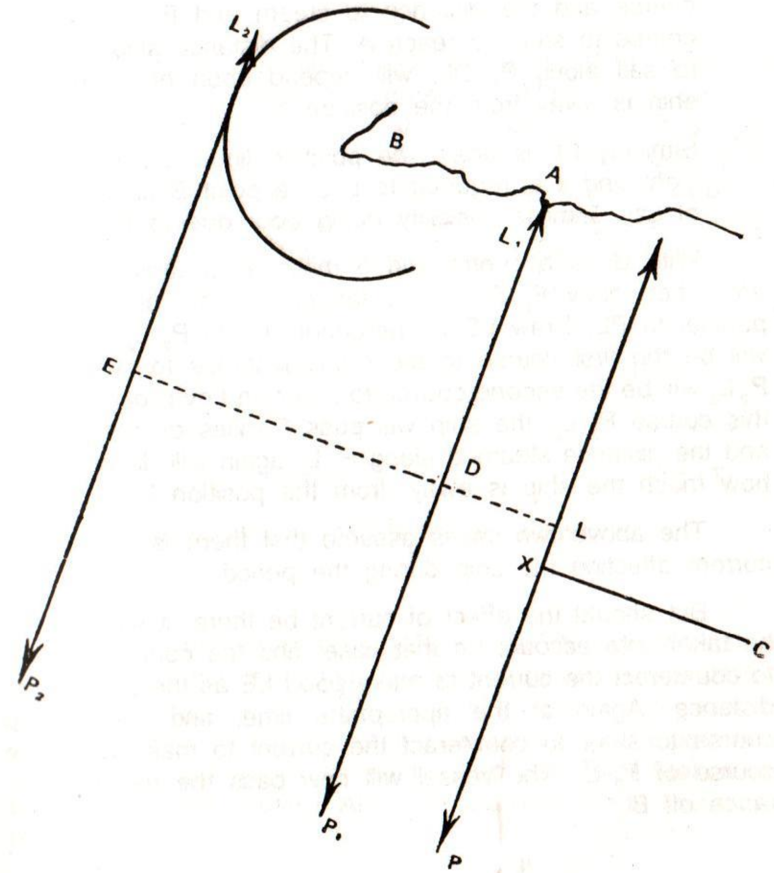
It may be appreciated that whatever be the D.R. position of the ship, at the time of first observation, the Fix i.e. resultant observed position at the time of second observation, will always be the same.

NOTE: It must be remembered in this type of Chart Work problems, that at NOON (when sun is on the observer's meridian) the sun bears North or South, the position line runs EAST & WEST i.e. a parallel of Latitude. Similarly again if an observation of a heavenly body is taken when it is on the prime vertical, it bears EAST or WEST and consequently the position line will run due North and South i.e. the meridian. Thus the meridian altitude observation gives the navigator the true Latitude and the prime vertical observation gives the true Longitude.

THE USE OF A SINGLE POSITION LINE

A single position line, as obtained from the observation of a heavenly body, does not give a fix, but it merely shows that the vessel is somewhere on that position line. The other main advantage of this position line is, that it may ensure steering a safe course to pass a certain distance off a light house or to arrive at a certain point or position. This can best be explained by an example.

Let C represent the D.R. Position (See Figure below) and X represent a position through which the position line PL passes. It must be remembered that PL gives only



the position line and the ship may not be at this "X" position, but will be somewhere on the position line PL.

In the vicinity of land, when the position line obtained may be succeeded by low visibility, then safe course to reach a certain position or to pass a head land at a safe distance or to clear a danger will be to take this position line as a COURSE, which will be safest, as explained below:-

(1) Suppose PL is the position line, obtained from a reliable sight and immediately thereafter visibility deteriorates and it is desired to reach the position A. Through A draw $P_1 L_1$ parallel to PL. Choose any point 'L' on PL and draw LD perpendicular to $P_1 L_1$. Then LD will be the first course and the distance to steam and $P_1 L_1$, the final course to steer to reach A. The distance ship will have to sail along $P_1 DL_1$ will depend upon how much the ship is away from the position X.

(2) Similarly PL is again the position line obtained from a sight and it is required to pass a point B at a distance of say 5 miles, visibility being poor due to fog.

With B as a centre and 5 miles as a radius draw an arc. Then draw $P_2 EL_2$ as a tangent to this arc and also parallel to PL. Draw LE as perpendicular to $P_2 L_2$. Then LE will be the first course to steer and distance to steam, and $P_2 L_2$ will be the second course to steer and by proceeding on this course $P_2 L_2$, the ship will pass 5 miles off the point B and the distance steamed along $P_2 L_2$ again will depend upon how much the ship is away, from the position X.

The above two cases assume that there is no wind or current affecting the ship during the period.

But should the effect of current be there, it will have to be taken into account. In that case, find the course to steer to counteract the current to make good LE as the course and distance. Again at the appropriate time, find the second course to steer to counteract the current to make good the course of $P_2 L_2$. The vessel will now pass the required distance off B.

Here it is advised that the navigator when using position line to clear a head land at a safe distance or to make a certain point, should make frequent and intelligent use of soundings and especially of crossing different "fathom lines" or depth contours.

The line of sounding, when used in conjunction with the position line or transferred position line may also be helpful to the navigator.

Similarly the navigator should also make use of all other navigational aids at his disposal, when using position line as a course to clear a head land at a safe distance.

Example I.

At 0615 hrs. a vessel in D.R. 50°37' N 06°41' W took a star sight which gave an intercept of 6' away and an Azimuth of 268°(T). Just after that fog set in and radar was not functioning properly. Set your own safe true courses so as to pass Seven Stones Lt. Vsl. 3 miles on the starboard side. Also find the distance to steam on the first course. What is the principle involved in setting your courses?

Solution:

First course to steer	088° (T)
Distance on 1st course	19 miles
2nd Course to steer	178° (T)

Distance to steam on 2nd course Unknown.

Excercise 1

At 1920 hrs. a vessel in D.R. 49° 38' N 04° 12' W took a star sight which gave the observed Longitude to be 04°04' W and Azimuth of 282° (T). Just after that the fog set in and the radar was not functioning properly. Find the safe true courses to steer so as to reach Deep Sea Pilot Station off Berry Head Pilot Station. Also find the distance to steam on the first Course.

Answer:

First course to steer	102° (T)
Distance on 1st Course	15 miles
2nd Course to steer	012° (T)

Distance to steam on 2nd Course is unknown, as it will depend upon her actual position at 1920 hrs.

Example II.

From a vessel steering 071° (C) an observation of the sun at 1600 hours, gave the following results:-

D.R. Position Latitude 49°09' N Longitude 03°44' W True Azimuth 238° (T). Intercept 8' Away.

The vessel continued on her course and at 1930 hrs. Casquets Lt. was observed bearing 103° (C). The ship's speed was 12 knots and Variation 8° W, find the vessel's position at 1930 hours. (Deviation Card I).

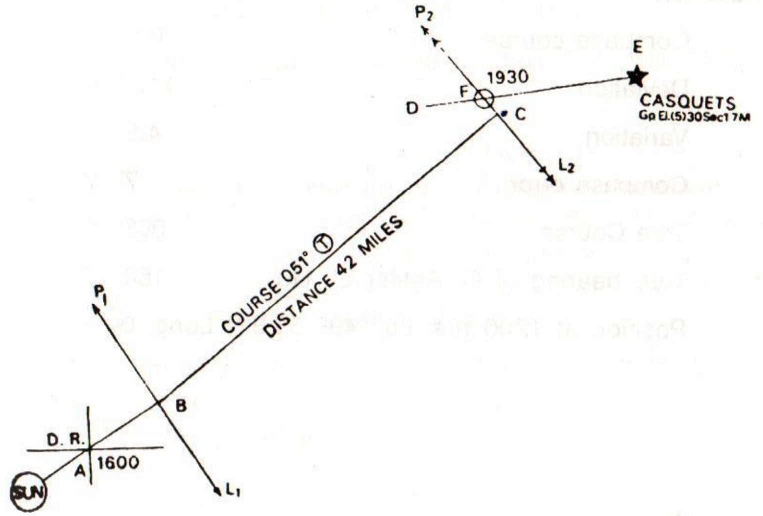
Solution :

Compass course	071° (C)
Deviation	12° W
Variation	8° W
Compass Error	20° W
True course	051° (T)
True bearing of Casquets Lt.	083° (T)

(1) Plot the D.R. Position i.e. 40°09' N 03°44' W on the chart and from it draw the Azimuth i.e. 238° (T)

(2) Since the intercept is 8' AWAY, mark off position B in the direction 180° away from the Azimuth (i.e. in 058° direction) and distance 8 miles. This is I.T.P.

(3) From B draw P_1L_1 (the position line) at right angles to the Azimuth. The ship is somewhere on this position line at the time of observation.



(4) Now lay true course BC i.e. 051° (T) making BC= 3½ hrs. steaming = 42 miles.

(5) Trough C draw the transferred position line P_2L_2.

(6) Draw the true bearing of Casquets Lt. Ho. at 1930 hrs. i.e. 083° (T).

(7) Where this true bearing 083° (T) cuts the transferred posititon line or P_2L_2 , is the position of the ship at 1930 hrs.

1930 hrs.Position. Lat. 49° 41.8' N Long. 02° 44.7' W.

Excercise 2

At 0900 hrs. a vessel in D.R. Lat. 50° 04' N Long. 01°15' W, a sun's sight gave observed Longitude 01° 08' W and the Azimuth 035° (T). The vessel then steered 100° (C) at 12 knots until 1200 hrs. when C. d'Antifer Lt. Ho. bore 167° (C). Find the ship's position at 1200 hrs.

(Variation 4.5° E, Deviation Card I).

Answer:

Compass course	100° (C)
Deviation	11.5° W
Variation	4.5° E
Compass error	7° W
True Course	093° (T)
True bearing of C. Antifer Lt. Ho.	160° (T)

Position at 1200 hrs. Lat. 49° 55.8'N Long. 00° 02'E

CHAPTER XIII

RUNNING FIX WITH CURRENT

[English Channel (Eastern Portion) Chart B.A. No. 2675]

In Chapter VII the procedure for finding the position of the ship by running fix method was explained. However, it was assumed that no current was affecting the ship during the period. This is hardly the case in practice, as some current is always present, which naturally effects the course and speed and thus the position of the ship.

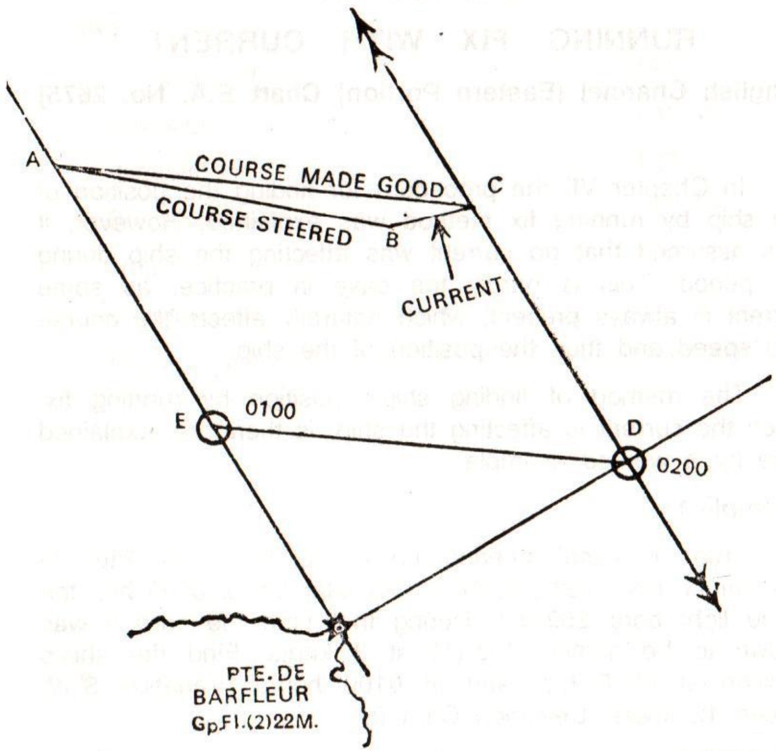
The method of finding ship's position by running fix, when the current is affecting the ship, is therefore, explained here by a worked example:-

Example 1

From a vessel steering 119°(C) at 0100 hrs. Pte. de Barfleur Lt. bore 168°(C). One hour later i.e. at 0200 hrs. the same light bore 259°(C). During that time the current was known to be setting 080°(T) at 3 knots. Find the ship's position at 0200 hrs. and at 0100 hours (Variation 8°W. Speed 12 knots. Deviation Card I).

SOLUTION

Compass course	119° (C)
Deviation	9.1° W
Variation	8° W
Compass error	17.1° W
True course	101.9° (T)
1st Compass bearing of Pte. de Barfleur Lt.	168° (C)
Compass Error	17.1° W
1st True bearing of Pte. de Barfleur Lt.	150.9° (T)
2nd Compass bearing of pte. de Barfleur Lt.	259° (C)
Compass Error	17.1° W
2nd True bearing of Pte. de Barfleur Lt.	241.9° (T)



Lay 150.9°(T) the first bearing of Pte. de Barfleur Lt. on the chart. Now choose any suitable point on this bearing, say at A. Then lay true course 101.9°(T) as AB, making AB = 12 miles i.e. distance steamed in 1 hour (one hour being the interval between the two bearings). Lay BC as current 080° (T) and make BC equal to 3 miles i.e. drift in 1 hour. Join AC. Then AC is the course and distance made good in 1 hour.

Course made good 098°(T) and the speed good is 14.8 knots.

Now from C transfer the position line i.e. draw a line parallel to the first bearing. Then plot the second bearing of Pte. de Barfleur Lt. i.e. 241.9°(T) and where the transferred position line and the second bearing intersect (i.e. at D) is the position of the ship at the time of second bearing.

Ship's position at 0200 hrs. Lat. 49°48'N Long.01° 00'W

ANS.

To find the position at the time of taking the first bearing:-

From D lay a course parallel to AC, cutting the first bearing at E. Then E is the required position of the ship at the time of 1st bearing.

Ship's Position at 0100 hrs:-

Lat. 49° 49.2'N Long. 01° 22.7'W

ANS.

NOTE

The point "A" on the first bearing may be taken at any convenient position, preferably near the Estimated Position of the ship. It may be pointed here that at whatever position the point "A" is taken on the first bearing, the "FIX" (actual final position) will be the same.

Exercise I.

At 1800 hrs. a vessel steering 030°(C), observed Casquets Lt. bearing 083°(C), and again at 1900 hours it bore 131° (C), The current was known to be setting 342°(M) at 2 knots throughout. Required the ship's position at 1900 hours and also estimate the ship's position at 2100 hours, (Ship's speed 12 knots. Variation 4°E Deviation Card I).

Compass Course	030° (C)
Deviation	7° W
Variation	4° E
Compass Error	3° W
True course	027° (T)
1800 hrs. Casquets Lt. true bearing	080° (T)
1900 hrs. Casquets Lt. true bearing	128° (T)

True current 346°(T) at 2 knots

Ship's position at 1900 hrs.:-
Lat. 49° 53'N Long. 02° 41.2'W

Speed made good = 13.6 knots.

Estimated ship's position at 2100 hrs:-
Lat. 50° 18.2'N Long. 02° 25.8'W.

Exercise II.

A ship steering 115°(C) at 12 knots, at 1930 hrs. Pte. de Barfleur Lt. bore 174°(C) and at 2030 hrs. Pte de Barfleur Lt. bore 238°(C). During this time the current was setting 208°(T) at 2.5 knots. Wind North. Leeway 3°. Find the ship's position at 2030 hrs. (Variation 8°W. Deviation Card I).

Answer:

Compass course	115° (C)
Deviation	9.7° W
Variation	8° W
Compass error	17.7° W
True course	097.3° (T)
Leeway	+ 3°
True course made good after Leeway	100.3° (T)
1930 hrs. True bearing of Pte. de Barfleur Lt.	156.3° (T)
2030 hrs. True bearing of Pte. de Barfleur Lt.	220.3° (T)

2030 hrs. Position Lat. 49°48.2'N Long. 01°07.2'W

Exercise III.

On a voyage from Southampton to Avonmouth, a vessel steering 260°(C), at 2000 hrs. St. Catherine Pt. Lt. bore 295° (C) and at 2100 hrs. it bore 027°(C). During this time the current was setting 209°(T) at 3 knots. Wind. South Force 6 Leeway 3°. Find the ship's position at 2100 hrs. and also at 2000 hrs. and the course and the speed made good (Variation 10°W. Engine speed 14 knots. Deviation Card I).

Answer:

Compass course	260° (C)
Deviation	13° E
Variation	10° W
Compass error	3° E
True course	263° (T)
Leeway (Wind South)	+3°
True course made good after allowing for leeway	266° (T)

Position at 2100 hrs. Lat. 50°25'N Long. 01°26'W
Position at 2000 hrs. Lat. 50°29'N Long. 01°01.5'W

Course made good	257° (T)
Speed made good	16.3 knots.

Exercise IV.

On a voyage from Cherbourg to Boulogne, at 0835 hrs. a sun's sight worked with D.R. Lat. 49°55'N Long. 00°50'W gave observed Long. 00° 44'W and Azimuth 111° (T). The vessel then steered 081°(C) at 12 knots until Noon when Pte. d'Ailly Lt. Ho. bore 134°(C). If the current during this time was estimated to be setting 120°(M) at 3 knots, find NOON position. (Variation 6.5°W. Deviation Card I).

Answer:

Ship's Head	081° (C)
Deviation	12.5° W
Variation	6.5° W
Compass Error	19° W
True course	062°(T) speed @ 12 knots.
True current	113.5°(T) @ 3 knots.
Time taken	= 3H. 25M.

Distance steamed in 3H. 25M. @ 12 knots. = 41 miles.
Drift in 3H. 25M.@ 3 knots = 10.25 miles.

Compass bearing of Pte d'Ailly Lt.	134° (C)
Compass error	19° W
True bearing of Pte. d'Ailly Lt.	115° (T)

NOON position Lat. 50° 05'N Long. 00° 24.3'E.

CHAPTER XIV

WIRELESS BEARINGS

[English Channel (Eastern Portion) Chart B.A. No. 2675]

Direction Finder sets are required to be carried by all ships of 1600 ton gross or more. In fact almost all sea going ships now are equipped with this useful aid to navigation. In this chapter, it is not proposed to deal with the principle or operation of the D.F. Set, but merely with the information which a navigator acquires from it and its use in finding ship's position.

At various places throughout the world are established Wireless Direction Finding Stations (W/T.D.F. Station). These stations transmit radio signals at certain frequencies, at specified times, the particulars and details of which are enumerated in the Admiralty List of Radio Signals Vol.II. The bearing of these Radio Signals and thus the bearing of the D.F. Station, is obtained on board the ship by the use of the ship borne D.F. receiver set. As these bearings are "Relative bearings", the true course of the ship should be applied to it (Relative bearing) to obtain the true bearings. Now a days, many D.F. Sets are Gyro stabilised and thus the navigator can obtain directly the Gyro bearing. In fact, the latest D.F. receivers are automatic in operation, thus removing the source of personal error.

It is important to remember that there can be an ambiguity of 180° in the D.F. bearing so obtained, but this 180° ambiguity can easily be removed by the use of "SENSE" check. In practice however, navigator is seldom in doubt of this 180° ambiguity, because he can easily remove it by consulting the chart.

In all cases, the observed D.F. bearings are however, to be corrected for calibration error from the "Calibration Curve" available on the ship and for convergency before plotting them on the charts.

CONVERGENCY

Radio wave travels by the shortest distance and since the shortest distance between two points on the earth's surface is the arc of a great circle, it necessarily follows that the D.F. bearings are great circle bearings.

On the surface of the earth the meridians converge and meet at the poles, while on a Mercator's Chart, meridian is represented by a straight line, parallel to each other and at right angles to the Equator. A great circle will, therefore, make a varying angle as it crosses each meridian and the difference in angle which it makes with any two meridians is known as CONVERGENCY.

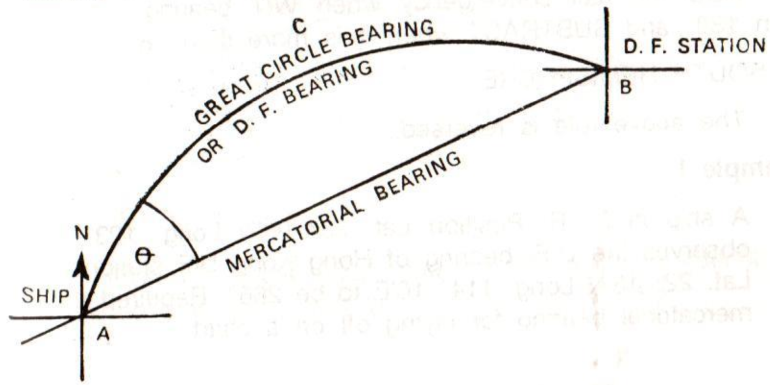
The angle of convergency varies with Latitude and the difference of Longitude between the points of intersection of the great circle, and it is calculated by the following formula:-

Convergency = D'Long. X Sine of Middle Latitude.

MEAN MERCATORIAL BEARING

Normally Mercator's charts are used in navigating the ships and thus the bearings of W/T.D.F. Stations which can be plotted on the chart should be mercatorial bearings only. But as W/T.D.F. bearings are great circle bearings, Half Convergency has to be applied to them, in order to obtain mean mercatorial bearings, for plotting on Mercator's chart.

Thus Mean Mercatorial bearing = True great circle bearing ± ½ convergency.



Suppose the ship A is in northern hemisphere and the relative position of the D.F. station B is marked. Then ACB is the great circle bearing of the D.F. station from the ship A and AB is the Mercatorial bearing of the station. θ is the half convergency which should be applied in order to get Mercator's bearing from D.F. bearing.

Assuming, for illustration that the D.F. bearing of the station from the ship is 040° and the half convergency is 1°, then the mercatorial bearing will be 041°(T).

The difference between the bearing i.e. half convergency, increases with the Latitude and the ship's distance from the W/T station. It is greatest when their relative position is East and West of each other and it is nil when the ship and the station are on the same meridian.

NOTE

Always remember that the mercatorial bearing always lies on the Equatorial side of the Great Circle bearing.

RULES FOR CONVERTING W/T BEARING INTO A MERCATORIAL BEARING

A rough sketch should be drawn as shown in the figure earlier, so that the relative positions of the ship and the shore station with a great circle joining them, is easily visualised.

RULE

IN NORTH HEMISPHERE

ADD the half convergency when W/T bearing is less than 180° and SUBTRACT when it is more than 180°.

IN SOUTH HEMISPHERE

The above rule is reversed.

Example I

A ship in D. R. Position Lat. 23° 00'N Long. 123° E observes the D.F. bearing of Hong Kong D/F station in Lat. 22° 13'N Long. 114° 16'E to be 266°. Required the mercatorial bearing for laying off on a chart.

Lat. of Wireless Station	22° 13'N
Lat. of the ship	23° 00'N
Mean Lat	22° 36.5' North
Long. of Wireless Station	114° 16'E
Long. of the ship	123° 00'E
Difference of the Long	= 8° 44'W
	= 524'

$$\text{Half convergency} = \frac{\text{D' Long x Sine Mean Lat.}}{2}$$

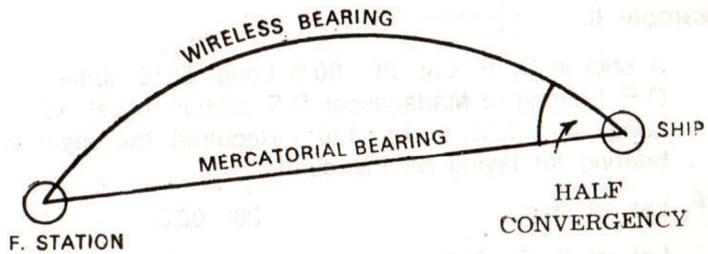
$$= \frac{524 \times \text{Sine } 22^\circ\ 36.5'}{2}$$

524	2.71933
Sine 22° 36.5'	1.58482
201.44	2.30415

$$\text{Half convergency} = \frac{201.44}{2}$$

$$= 100.72$$

$$= 1^\circ\ 40.7'$$



From the above figure and the rule quoted earlier it will be seen that Half convergency is SUBTRACTIVE.

Wireless Bearing	266°
½ Convergency	1° 40.7'
Mercatorial Bearing	264° 19.3'

Hence 264° 19." will be the mercatorial bearing which can be laid off on the chart.

(Because of Northern hemisphere and the W/T bearing being more than 180°, the correction is subtracted).

NOTE

(1) Half convergency correction Tables are given in BURTON'S OR NORIE'S NAUTICAL TABLES.

(2) The convergency can also be found by inspection from the Traverse Tables. Enter the tables with Mean Latitude as COURSE, the difference in Longitude (in minutes) as DISTANCE and the convergency is found in the DEPARTURE column.

By Inspection Method:- (Using Traverse Tables)

Mean Latitude 22° 36' in the Course column and D'Long 524' in the Distance Column gives convergency 200.5' in the Departure column.

$$\text{Hence ½ convergency} = \frac{200.5}{2} = 100.25'$$

$$= 1°\ 40.25'$$

Example II.

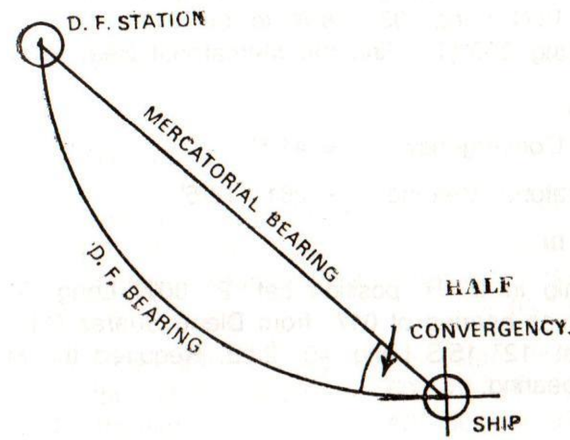
A ship in D. R. Lat. 20° 00'S Long. 50°E observes the D.F. bearing of Madagascar D.F. station in Lat. 15° 43'S Long. 46° 20'E to be 320°. Required the mercatorial bearing for laying on the chart.

Lat. of ship	20° 00'S
Lat. of D. F. Station	15° 43'S
Mean Lat	17° 51.5'S
Long. of ship	50° 00'E

Long. of D.F. station		46° 20'E
D'Long		3° 40'
D'Long	=	220'
Convergency	=	D'Long x Sine Mean Lat.
	=	220 x Sine 17° 51.5'
220		2.34242
Sine 17° 51.5'		1.48666
67.465		1.82908

$$\text{Half convergency} = \frac{67.46'}{2}$$

$$= 33.73'$$



D.F. Bearing = 320°
Half Convergency + 33.7'
Mercatorial Bearing = 320° 33.7'

ANS.

NOTE

The ship and station are in Southern hemisphere and since D.F. bearing is more than 180°, the half convergency correction is added.

Exercise I.

A ship in D. R. Position Lat. 41° 03'N Long. 50° 19'W takes D.F. bearing of Halifax D.F. station in Lat. 44° 40'N Long. 63° 35'W and observes it to be 286°. Required the true bearing so that it can be laid off on a Mercator's chart.

Answer:

Half Convergency = 270.7' = 4° 30.7'

Mercatorial Bearing = 281° 29.3'

Exercise II.

A ship in D. R. Lat. 50° 25'N Long. 01° 50'W observed the relative bearing of Start Point D.F. station in Lat. 50° 13'N Long. 03° 38'W to be 012°. The ship was steering 250°(T). Find the Mercatorial Bearing.

Answer:

Half Convergency = 41.5'

Mercatorial Bearing = 261° 18.5'

Exercise III.

A ship in D. R. position Lat. 2° 00'N Long. 53° 46'E receives bearing of 017° from Diege Suarez D.F. station in Lat. 12° 15'S Long. 49° 23'E. Required the Mercatorial bearing.

Answer:

Half Convergency = 16.3'

True Mercatorial Bearing = 016° 43.7'

Exercise IV.

A ship in D. R. Position Lat. 49° 29'N Long. 03° 52'W found that La Corbiere D.F. station in Lat. 49° 11'N Long. 02° 16'W was bearing 108° on the D.F. set. Find the mercatorial bearing to lay on the chart.

Answer:

Half Convergency = 0° 36.4'
True Mercatorial Bearing = 108° 36.4'

Exercise V.

At 0930 hrs. in D. R. position 49° 50'N 00° 39'W, the ship's speed was reduced due to thick fog and ship's head was kept steady at 255° (C). The following D/F bearings were taken with D.F. set:-

Start Point D.F. beacon bore 021° (Relative).

Bassurelle Lt. Vessel D.F. beacon bore 167° (Relative).

Find the ship's position at 0930 hrs.

(Deviation Card I. Variation 7° W).

Answer:

Ship's Head	255° (C)
Deviation	12.5° E
Variation	7° W
Compass Error	5.5° E
True ship's head	260.5° (T)
D.F. Bearing of Start Point	021° (Relative)
True D.F. Bearing	281.5° (T)
D.F. bearing of Bassurelle Lt. Vessel	= 167° (Relative)
True D.F. Bearing	= 067.5° (T)

To find the Half Convergency on Start Point Bearing:-

Start Point D.F. Station	50° 13.3'N	03° 38'W
D. R. Position	49° 50'N	00° 39'W
Mean Lat.	50° 01.7'N	
D'Long	02° 59'	

Half Convergency = 1/2 Sine Lat. x D'Long
68.6 = 1/2 (179 x Sine 50° 1.7')
Half Convergency = 1° 08.6'

Bassurelle Lt. Vessel D.F. station	50° 33.8'N	00° 58'E
D. R. Ship	49° 50'N	00° 39'W
Mean Lat	50° 11.9'N	
D'Long.	1° 37' or 97'	

Half Convergency	= ½ (Sine M Lat. x D'Long.)	
	36.49'	
	0.6°	
	Start Point	Bassurelle Lt. Vsl.
D.F. Bearing.	281.5°(T)	067.5°(T)
Half Convergency	– 1.1°	+ 0.6°
Mercator's Bearing	280.4°(T)	068.1°(T)

0930 hrs. Ship's Position 49° 57.8'N 01° 21.8'W

Exercise VI.

A vessel in D. R. Position 50° 10'N 00° 15'E, a Sun's sight gave Azimuth of 225° (T) Intercept 5' AWAY and at the same time D.F. bearing of Bassurelle Lt. Vessel was 036°(T). Find the ship's position.

Answer:

I.T.P. Position Lat. 50° 13'N Long. 00° 20'E

Position of Bassurelle Lt. Vsl. Lat. 50° 33.5'N
Long. 00° 57.5'E

Mean Latitude = 50° 23'North

D'Long. = 37.5'E

Half Convergency = + 14.4' = 0.2°

D.F. Bearing of Bassurelle Lt. Vessel = 036°(T)

Half Convergency = + 0.2°

Mercator's bearing of Bassurelle Lt. Vessel = 036.2° (T).

Ship's Position Lat. 50° 08.4'N long. 00° 28.7'E

CHAPTER XV

THREE POINT BEARINGS

[English Channel (Eastern Portion) Chart B.A. No. 2675]

If three bearings of a suitable shore object are taken at intervals of time, whilst the ship continues on her course, then the course made good and the ship's position can be found by what is commonly known as "Three Point Bearing Method".

"Three bearing problem" thus represents a convenient and accurate method of obtaining the course a vessel is making good over the ground provided the vessel steers the same course at a uniform speed, and the other factors like the Wind and Current which affect the course made good, remain constant.

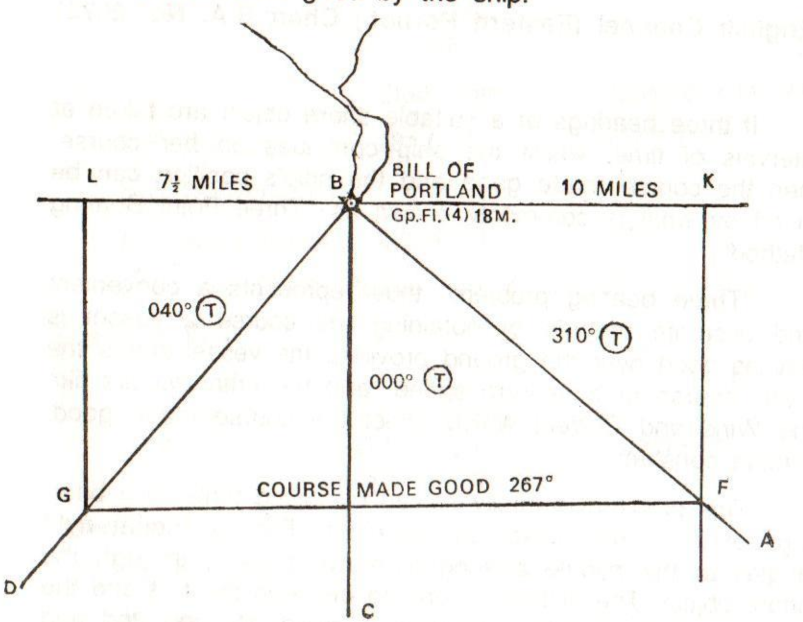
This problem is easily solved by laying three true bearings of the same object on the chart. Then a line at right angles to the middle bearing is drawn passing through the shore object. The distance steamed between the first and the centre bearing and the distance steamed between 2nd and 3rd bearing is marked on this perpendicular line drawn. Now draw lines parallel to the middle bearing through the points just obtained on the perpendicular line to cut the first and third bearing. By joining the points where they cut first and third bearings, the course made good is obtained.

NOTE

It is not necessary that the actual distance steamed between the 1st and 2nd, and 2nd and 3rd bearing should be taken. Any radii may be taken to describe the arcs provided the ratio existing between intervals of time elapsing between the bearings is maintained.

Example I.

At 1000 hrs. Bill of Portland Lt. Ho. bore 310°(T) and at 1040 hrs. it bore 000°(T) and at 1110 hrs. the same light house bore 040°(T). The vessel during the time steamed at a uniform speed of 15 knots. Find the course made good by the ship.



SOLUTION

(1) Draw the three bearings BA, BC & BD equal to 310°(T), 000° (T) and 040° (T) taken at 1000 hrs. 1040 hrs. and 1110 hrs. respectively.

(2) Draw a line KL perpendicular to BC.

(3) Mark of BK = 10 miles (distance steamed in 40 minutes) and

Mark of BL = 7½ miles (distance steamed in 30 minutes).

(4) Draw KF and LG parallel to BC cutting BA and BD at F and G respectively.

(5) Join FG. Then GF is the course made good by the ship which is 267°(T).

Hence course made good 267°(T).

ANS.

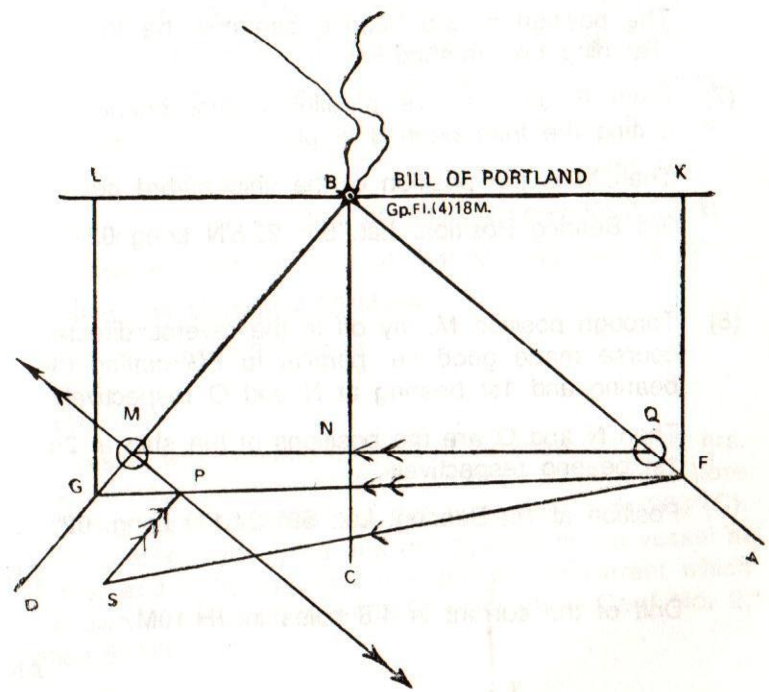
NOTE

It is of particular importance to note that the above plot would not give the distance made good or the position of the vessel at all, but gives only the course made good over the ground.

However, by the aid of additional data e.g. the direction of current, the distance made good, the position can also be found, as will be shown by the following example.

Example II.

On a voyage from Southampton to Avonmouth, a vessel was steering 260°(T) at 15 knots. At 1000 hrs. Bill of Portland Lt. Ho. bore 310°(T) and at 1040 hrs. it bore 000°(T) and at 1110 hrs. Bill of Portland Lt. Ho. bore 040°(T). Find the course made good and the position of the vessel at 1000 hrs. and 1110 hrs., and the drift of the current which was known to be setting 055°(T).



SOLUTION

(1) Draw BA, BC and BD the true bearings of the Bill of Portland Lt. House i.e. 310° (T) 000° (T), and 040° (T).

(2) Draw KL perpendicular to BC and mark off BK = 10 miles and BL = 7½ miles.

(3) Draw KF and LG parallel to BC.

(4) Then FG is the course made good which is 267° (T)

ANS.

(5) From F draw FS, the course steered i.e. 260° (T) making FS = 17½ miles i.e. distance steamed in 1H. 10M.

(6) Then lay off the current SP i.e. 055° (T) till it meets the course made good line GF at P. Then SP must be drift of the current in 1H. 10M. in order that FP may be the actual course and distance made good.

The position at 3rd bearing can now be found as by "Running Fix" method.

(7) From P draw a line parallel to first bearing i.e. AB cutting the third bearing at M.

Then M is the position of the ship at 3rd bearing.

3rd Bearing Position. Lat. 50° 23.8'N Long 02° 37'W

ANS.

(8) Through position M, lay off in the reverse direction, the course made good i.e. parallel to FG cutting the 2nd bearing and 1st bearing at N and O respectively.

Then N and O are the positions of the ship at 2nd and 1st bearing respectively.

Position at 1st Bearing. Lat. 50° 24.1'N Long. 02° 15'W

ANS.

Drift of the current is 4.6 miles in 1H.10M.

ANS.

Excercise I.

A ship steering 035°(C) at 12 knots, at 2000 hrs. observed C. d' Antifer light bearing 114°(C). After 30 minutes steaming the same light bore 147°(C) and after another 45 minutes at 2115 hrs. it bore 187°(C). Find the course made good and the ship's position at 2115 hrs. and 2000 hrs. and the drift of the current, which was known to be setting 151°(T). (Deviation Card I. Variation 3°E)

Answer:

Compas Course	035° (C)
Deviation	8° W
Variation	3° E
Compass Error	5° W
True Course	030° (T)
1st true bearing of C. d' Antifer Lt.	109° (T)
2nd true bearing of C. d' Antifer Lt.	142° (T)
3rd true bearing of C. d' Antifer Lt.	182° (T)
Distance steamed between 1st and 2nd bearing	6 Miles
Distance steamed between 2nd and 3rd bearing	9 Miles
Course made good	045° (T)

Position at 2115 hrs. Lat. 49°53.5' N Long.00° 10.7' E

Position at 2000 hrs. Lat. 49° 44' N Long. 00° 04' W

Drift of the Current 4.25 Miles

Rate of Current 3.4 knots.

Excercise II.

A vessel was steering 090°(C) at 12 knots. At 2000 hrs. Pte de Barfleur. Lt. bore 133°(C) and at 2030 hrs.it bore 170°(C) and again at 2130 hrs. the same light bore 260°(C). Find the course made good and the position of the vessel at 2000 hrs. and 2130 hrs. and the drift of the current which was known to be setting 148°(T). (Deviation Card No. 2, Variation 6° W)

Solution:

Compass Course	090° (C)
Deviation	2° W
Variation	6° W
Compass Error	8° W
True Course Steered	082° (T)

	1st brg.	2nd brg.	3rd brg.
Compass brg.	133° (C)	170° (C)	260° (C)
Compass Error	8° W	8° W	8° W
True brg.	125° (T)	162° (T)	252° (T)

Time Ratio 30 : 60 or 1 : 2

Distance steamed in 1H 30M = 18 miles.

2130 hrs Posn: 49°46' N 00°58' W

2000 hrs Posn: 49°47.8' N 01°29' W

Course made good 095° (T)

Drift of the current 5.3 miles in 1H30M @ 3.5 knots

Speed made good = 21 miles in 1H30M = 14 knots

COURSE TO STEER, CURRENT RATE AND DIRECTION KNOWN, ENGINE SPEED AND POSITION TO BE FOUND

Example 3

A vessel steering 104° (C) at 0900 hrs. Lizard Point Lt. bore 059° (C) and at 0930 hrs. it bore 004° (C) and again at 1010 hrs. it bore 328° (C). During this period the current was setting 182° (M) at 4 knots. Find the vessel's position at 1010 hrs., 0900 hrs. and the engine speed of the vessel and the course made good. (Variation 6° W, Deviation Card No. 2)

Solution:

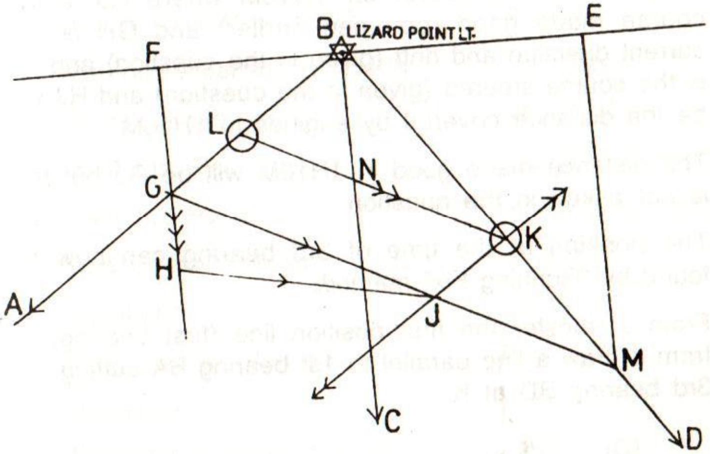
Course Course	104° (C)
Deviation	4.1° W
Variation	6° W
Compass Error	10.1° W
True Course	093.9° (T)

	1st brg.	2nd brg.	3rd brg.
Compass brg.	059° (C)	004° (C)	328° (C)
Compass Error	10.1° W	10.1° W	10.1° W
True brg.	048.9° (T)	353.9° (T)	317.9° (T)

Current	182° (M)
Variation	6° W
True Current	176° (T)

Drift in 1H10M @ 4 knots = 4.67 miles.

Time ratio 30 mins : 40 mins or 3 : 4



(1) Draw BA, BC and BD the three true bearings of Lizard Point Lt. at 0900, 0930 and 1010 hrs. respectively viz 048.9° (T), 353.9° (T) and 317.9° (T)

(2) Draw FBE perpendicular to the second bearing i.e. BC = 263.9° and 083.9° (T)

(3) Mark off BF and BE in the ratio 3 : 4 (time ratio) say 12' and 16'.

(4) From F & E draw FG and EM parallel to the 2nd bearing i.e. BC meeting the 1st and 3rd bearing at G and M respectively.

(5) Join GM. Then GM is the course made good i.e. 109°(T)

(6) From G draw the current GH for 1H 10M viz 176° (T) 4.67 miles@ 4 knots.

(7) From H draw the course steered i.e. 093.9° (T) till it meets the course made good at J.

Then HJ is the distance covered by engines in 1H 10M = 17.1 miles.

Thus engine speed = 14.66 knots

NOTE:

Now GHJ is the vector for 1H10M where GJ is the course made good (obtained earlier) and GH is the current direction and drift (given in the question) and HJ is the course steered (given in the question) and HJ will be the distance covered by engines in 1H10M.

The distance made good in 1H10M will be GJ but this is not asked in the question.

The position at the time of 3rd bearing can now be found by "Running Fix" method.

(8) From J transfer the first position line (first bearing) or from J draw a line parallel to 1st bearing BA cutting the 3rd bearing BD at K.

Then K is the position of the ship at the time of 3rd bearing

Position at 1010 hrs. Lat. 49°45.2' N Long. 04°55.6' W.

(9) From position K, lay off in the reverse direction the course made good i.e. parallel to GM cutting the 2nd and 1st bearings at N and L respectively.

Then N and L will be the position at the time of 2nd bearing (0930 hrs.) and 1st bearing (0900 hrs.)

Position at 0900 hrs. Lat 49°51.9' N Long 05°22'W

Excercise III.

At 0900 hrs. Start Point Lt. bore 297° (T) and at 0940 hrs. it bore 342° (T) and at 1040 hrs. it bore 038° (T). If the current was setting 205° (T) at 3 knots and her engine speed was 12 knots. Find the course made good and the compass course steered and the vessel's position at 0900 hrs. and 1040 hrs.

(Variation 6° W, Deviation Card No. 2)

Solution:

Time ratio	40: 60 or 2:3
Drift in 1H40M = 3X5/3	5 miles
Distance steamed in 1H40M	20 miles
Course made good	252.5° (T)
1040 hrs. Posn.	50°00.5' N 03°55' W
0900 hrs Posn.	50°07.3' N 03°21' W
True Course steered	263° (T)
Variation	6° W
Mag. Course Steered	269° (M)
Deviation	1.6° E
Compass Course Steered	267.4° (C)

Excercise IV.

A vessel was steering 084° (C) at 12 knots. At 0700 hrs. Les Sept Iles Lt. bore 130° (C) and at 0800 hrs. it bore 185° (C) and at 0840 hrs. the same Lt. bore 229° (C). Find the course made good and the position of the vessel at 0700 hrs. and 0840 hrs. and also the direction of the current which was known to be setting @ 3 knots in South East Quadrant (Variation 6° W, Deviation Card No. 2)

Solution:

Compass Course	084° (C)
Deviation	1.1° W
Variation	6° W
Compass Error	7.1° W
True Course steered	076.9° (T)

	1st brg.	2nd brg.	3rd brg.
Compass brg.	130° (C)	185° (C)	229° (C)
Compass Error	7.1° W	7.1° W	7.1° W
True brg.	122.9° (T)	177.9° (T)	221.9° (T)

Time ratio 60 : 40 or 3 : 2

Distance covered in 1H40M@12 knots = 20 miles

Drift current in 1H 40 M @ 3 knots = 5 miles

Course made good	088° (T)	
Direction of current	142° (T)	
0700 Hrs. Posn.	49°02.2' N	03°50.5' W
0840 Hrs. Posn.	49°03' N	03° 16.7' W

CHAPTER XVI

TRANSFERRED POSITION CIRCLE

We have explained in the running fix method (Chapter VII), a vessel's position can be obtained if we take the bearing of an object and after an interval take a second bearing of the same object or the bearing of another object, the course steered and the distance steamed between the two observations, presuming that there is no current and leeway experienced.

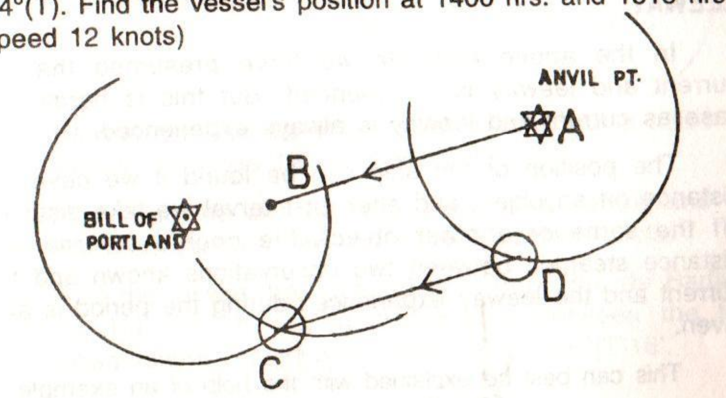
Similarly a vessel's position can be found if we take the distance off an object and after an interval take another distance off the same object or another object, the course steered and distance steamed between the two observations being known, presuming that there is no current and leeway. This can best be explained with the help of an example.

NOTE-

Distance off an object can be obtained by radar or by vertical or horizontal sextant angles. The distance off the lights can be obtained by calculating the geographical or luminous ranges of the lights.

Example I.

At 1400 hrs. Anvil Point Lt. Ho. was 7 miles off by radar and at 1515 hrs. Bill of Portland Lt. Ho. was 8 miles by radar. During this period the vessel steered a course of 254°(T). Find the vessel's position at 1400 hrs. and 1515 hrs. (Speed 12 knots)



Solution:

1) With Anvil Point Lt. Ho. as centre and 7 miles as a radius draw a position circle.

   The vessel is somewhere on this position circle at 1400 hrs.

2) With Bill of Portland Lt. Ho. as centre and 8 miles as a radius draw another position circle.

   The vessel is somewhere on this position circle at 1515 hrs.

3) From A draw AB the course 254°(T) 15 miles (distance covered between the two observations i.e. 1H15M).

4) With B as a centre and 7 miles as a radius (the distance of 1st position circle) draw an arc cutting the 2nd position circle at C.

   Then C is the position of the vessel at the time of 2nd observation.
   Position at 1515 hrs. 50°24'N 02°20'W.

5) From C draw the reverse course i.e. parallel to AB cutting the 1st position circle at D. Then D is the position of vessel at 1400 hrs.

   1400 hrs. Posn. 50°28'N 01°59'W.

TRANSFERED POSITION CIRCLE WITH CURRENT AND LEEWAY

In the above example we have presumed that no current and leeway is experienced. But this is hardly the case as current and leeway is always experienced.

The position of the ship can be found if we have the distance off an object and after an interval we take distance off the same or another object, the course steered and distance steamed between two observations known and the current and the leeway experienced during the period is also given.

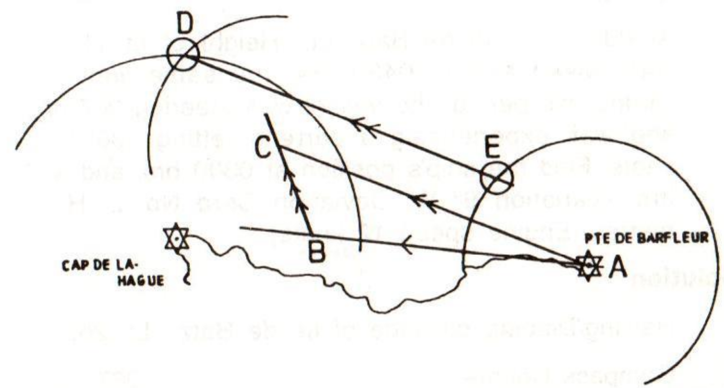
This can best be explained with the help of an example.

Example II.

At 0800 hrs. Pte de Barfleur Lt. Ho. was 8 miles off on the radar and at 0930 hrs. Cap. de La Hague Lt. Ho. was 12 miles off on the radar. During this period the vessel was steering 272°(T) at 12 knots and she was experiencing a current setting 340°(T) at 4 knots and southerly wind caused a leeway of 4°. Find the vessel's position at 0800 hrs. and 0930 hrs.

Solution:

True Course Steered	272° (T)
Wind S'ly Leeway	+ 4°
Leeway Track	276° (T)
Current	340° (T)
Drift for 1H 30M	6 miles
Engine distance for 1H 30M	18 miles



1) With A (Pte. de Barfleur Lt.) as centre and 8 miles as radius, draw the 1st position circle.

2) With Cap. de La Hague Lt. Ho. as a centre and 12 miles as radius, draw the second position circle.

3) Plot the leeway track i.e. 276°(T) from Pte. de Barfleur Lt. Ho. for 18' i.e. steaming time between the two observations viz. 1H30M. Thus AB is 276°(T)18'.

4) From B draw the current BC for 1H30M i.e. BC is 340°(T) 6 miles.

5) Join AC. Then AC is the course made good and distance made good in 1H30M.
Course made good is 291°(T).

6) With C as centre and radius equal to 8 miles (distance of the 1st position circle) draw an arc cutting the second position circle at D.

Then D is the position of the Vessel at the time of 2nd observation i.e. 0930 hrs.

0930 hrs. Position 49°55.5'N 01°55.8'W.

7) From D draw the reverse course made good i.e. draw DE parallel to CA cutting the 1st position circle at E. Then E is the position of the vessel at 0800 hrs.

0800 hrs. Position 49°48'N 01°24'W.

Example III.

At 0300 hrs. Ile de Batz. Lt. (Height of Lt. Ho. 77 m) was raised and at 0430 hrs. the same light dipped. During this period, the vessel was steering 067°(C) and she was experiencing a current setting 336°(M) at 4 knots. Find the ship's position at 0300 hrs. and at 0430 hrs. (Variation 6° W, Deviation Card No. 2, H. E. 15 metres, Engine speed 12 knots)

Solution:

Raising/Dipping distance of Ile de Batz.. Lt.	26.3 miles
Compass Course	067° (C)
Deviation	1.6° E
Variation	6° W
Compass Error	4.4° W
True Course	062.6° (T)
Distance steamed in 1H30M	18 miles

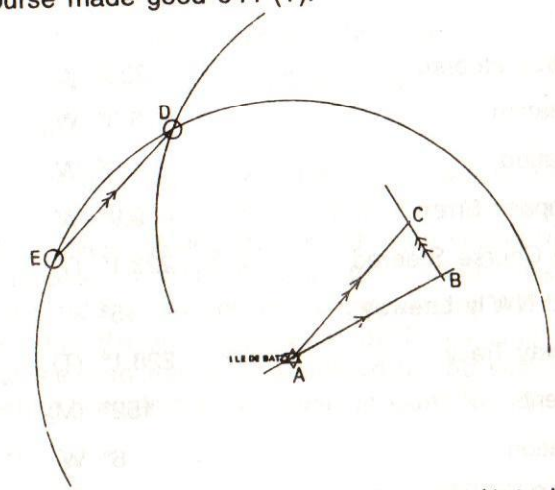
Current	336° (M)
Variation	6° W
True Current	330° (T)
Drift in 1H30M	6 miles

1) With A (Ile de Batz Lt.) as centre and dipping distance (2nd observation) i.e. 26.3 miles as radius draw a position circle.

2) From A plot the course steered AB 062.6°(T) and distance steamed in 1H30M i.e. 18 miles.

3) Draw BC as current 330°(T) for 1½ hrs. i.e. 6 miles.

4) Join AC. Then AC is the course made good i.e. 044°(T) and the distance made good i.e. 18.8 miles in 1H30M. Course made good 044°(T).



5) With C as centre and raising distance (1st observation) as radius, draw the transferred position circle cutting the first position circle (i.e. circle drawn with dipping distance or second observation) at D. Then D is the position of the ship at dipping distance i.e. 2nd observation.

0430 hrs. Position 49°08'N 04°19.0'W.

6) From D draw reverse course made good i.e. draw DE parallel to CA cutting the 1st position circle (i.e. raising distance) at E. Then E is the position of the ship at the time of raising the light.

At 0300 hrs. Position 48°53.0'N 04°38'W.

Exercise I.

At 0200 hrs. S. Foreland R.C. was 7 miles off on the radar and at 0245 hrs. Dungeness Lt. was 8 miles off on the radar. During this period the vessel was steering 233°(C) at 12 knots and she was experiencing a current setting 152°(M) at 4 knots and SE'ly wind caused a leeway of 5°. Find the vessel's position at 0200 hrs. and 0245 hrs.

(Deviation Card No. 2, Variation 6° W).

Solution:

Course steered	233° (C)
Deviation	3.9° W
Variation	6° W
Compass Error	9.9° W
True Course Steered	223.1° (T)
Wind NW'ly Leeway	+5°
Leeway Track	228.1° (T)
Current	152° (M)
Variation	6° W
True Current	146° (T) @4 Knots
Distance Steamed in 45 min.	9 miles
Current in 45 min.	3 miles
Course made good	211° (T)

0200 hrs. Position 51°01.8'N 001°20'E

0245 hrs. Position 50°53.1' N 001°11.3' E

Exercise II.

At 0600 hrs. Start Point Lt. Ho. was 5 miles off on the radar and at 0700 hrs. Berry Head was 5 miles off on the radar. During this period if the vessel made good a course of 025° (T) and the current was setting 336° (T)@3 knots. Find the true course steered and the vessel's position at 0600 hrs. and 0700 hrs.

(Engine speed 12 knots)

Solution:

Course made good	025° (T)
Current 336°(T)Drift in 1 hour	3 miles
Engine distance in 1 hour	12 miles
True Course steered	036° (T)

0700 hrs. Position 50°26'N 03°21.8'W.

0600 hrs. Position 50°13.5'N 03°30.4'W.

Exercise III.

At 0230 hrs. Cap de Alprech Lt. Ho. was 7 miles off on the radar and at 0330 hrs. Cap Gris Nez was 6 miles off the radar. During this period if the vessel made good a course of 012°(T) and the current was setting 106°(T)@3 knots and her engine speed was 12 knots. Find the Vessel's position at 0230 hrs. and 0330 hrs. and the compass course steered by the ship during this period. (Variation 6°W, Deviation Card No. 2)

Solution:

True course steered	359° (T)
Variation	6° W
Mag Course	005° (M)
Deviation	12.5° E
Compass course steered	352.5° (C)

0330 hrs. Posn. 50°56'N 01°27.8'E

0230 hrs. Posn. 50°44.2'N 01°23.8'E

Exercise IV.

At 1900 hrs. Pte. de Barfleur Lt. Ho. was 7 miles off on the radar and at 2015 hrs. Cap de La Hague Lt. Ho. was 13 miles off on the radar. During this period the vessel was steering 283°(T) at 12 knots and she was experiencing a current setting 305°(T) at 4 knots and southerly wind caused a leeway of 4°. Find the vessel's position at 1900 hrs. and 2015 hrs.

Solution:

Course steered	283° (T)
Wind S'ly Leeway	+4°
Leeway Track	287° (T)
Current	305° (T)
Drift for 1H15M	5 miles
Engine distance	15 miles
Course made good	291° (T)

1900 hrs. Posn. 49°48.5'N 01°20'W

2015 hrs. Posn. 49°55.7'N 01°49.5'W

Exercise V.

At 0500 hrs. Eddystone Rocks Lt. (Height of Lt. Ho. 85 meters) was raised and at 0645 hrs. the same light was dipped. During this period the vessel was steering 256°(C) at 12 knots and the ship was experiencing a current setting 120°(T) at 4 knots. Find the ship's position at 0500 hrs. and 0645 hrs.

(Variation 6°W, Deviation Card No. 2, H.E. 18 metres)

Solution:

Dipping/Raising Distance	27.9 miles
Compass Course	256° (C)
Deviation	0.1° W

Variation	6° W
Compass Error	6.1° W
True Course	249.9° (T)
Distance Steamed in 1H45M@12 knots	21 miles
Drift in 1H45M@4 knots	7 miles
Course made good	231° (T)

0500 hrs. Posn. 49°55'N 03°41'W

0645 hrs. Posn. 49°45.2'N 04°00'W.

CHAPTER XVII

PICKING UP A LINE OF SOUNDING

[English Channel (Eastern Portion) Chart B.A. No. 2675]

During thick weather, when the visibility is poor and the ship's position is uncertain, the navigator may be unable to find the vessel's position by normal visual observations. Under such conditions, the position of the vessel may be ascertained with reasonable accuracy by running "A line of soundings" (provided the vessel is in soundings).

A series of soundings are taken at fixed time intervals, and the soundings are corrected for the height of tide thereby reducing the soundings to the chart datum (and the ship is kept steaming on a steady course and at a uniform speed). These soundings are then compared with the soundings printed on the chart (near the D.R. Position) and the position of the ship is estimated by comparison of soundings. The nature of the bottom, whenever possible should also be ascertained, as this knowledge is of considerable help while comparing them with the chart soundings. However, it may be pointed out that position so found may not always be reliable and thus such position should be used with utmost caution.

The actual method of running a "line of sounding" is to take a slip of paper, mark off the distance steamed or made good on this paper for the time intervals, between the soundings and alongwith it write the corrected soundings at the time given intervals (and the nature of bottom, wherever available). Then keeping the parallel ruler in the direction of the course made good alongwith the paper marked with soundings near the D.R. Position, move it until the soundings marked on this paper coincide with the soundings on the chart. This will give the position of the ship.

The finding of the position is comparatively easier, if there is no current during the time of "line of soundings". But it is not always the case and therefore the effect of current must also be taken into account. This is done by moving the

paper marked with the sounding over the direction of the course made good and not the course steered.

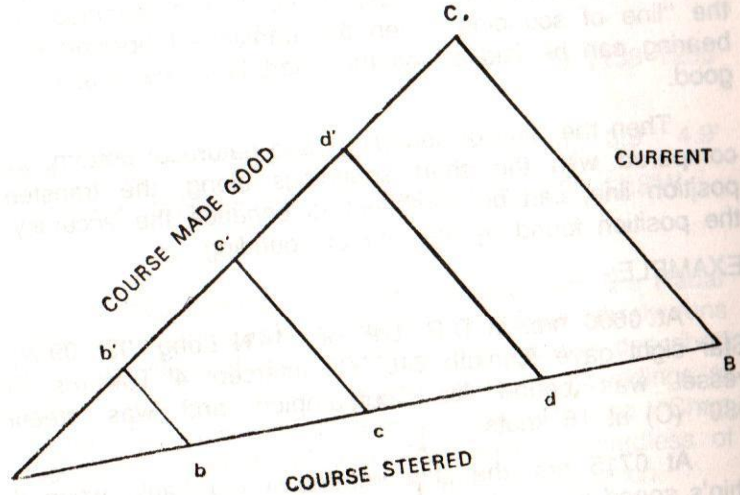
Similarly, the distance made good and not the distance steamed during the intervals of soundings should only be marked on this extra paper. This can easily be done by finding out the course and the speed made good. The set and the drift of the current, if being experienced, should be either known or estimated.

The method used can easily be explained with the help of an example:-

Suppose a vessel is steering 060°(T) at 5 knots, through a current known to be setting 330°(T) at 3 knots, the following soundings reduced to chart datum were observed:-

Time	1100 hrs.	1124 hrs.	1148 hrs.	1212 hrs.	1236 hrs.
Soundings	30 fms.	26 fms.	24 fms.	24 fms.	28 fms.

From the above it will be seen that from the first to the last soundings, time elapsed is 1H. 36M. and the ship steamed 8 miles and the drift of the current during this interval is 4.8 miles.



To find the course and distance made good:-

Lay off AB course steered anywhere on the chart i.e. 060°(T) and distance steamed for 1H.36M. i.e. 8 miles.

Then from B lay off BC as set and drift of current i.e. 330° for 4.8 miles.

AC is then the course and distance made good. Now mark off Ab. bc, cd and dB as distances steamed during the intervals at 1124, 1148, 1212 and 1236 hrs.

Draw dd', cc', bb', parallel to BC.

Then Ab', b'c', c'd' and d'C are the distances made good during the given intervals.

The parallel ruler is kept along AC and the points A, b', c', d' and C are transferred to the paper laid along the edge, and the parallel ruler is moved until the soundings marked, agree with those printed on the chart.

A reasonably good D.R. Position and the knowledge of the nature of the bottom at the time of soundings will be of great assistance in determining the position of the vessel.

Furthermore if, however, a sight had been taken previously or a bearing of terrestrial object was obtained before the "line of sounding", then the transferred position line or bearing can be laid off on the chart from the course made good.

Then the "line of sounding" and nature of bottom, when compared with the chart soundings along, the transferred position line, can be combined to enhance the accuracy of the position found by the line of sounding.

EXAMPLE:-

At 0600 hrs. in D.R. Lat. 50° 14'N Long, 02° 09'W, a Star sight gave Azimuth 246° (T) Intercept 4' Towards. The vessel was bound for Southampton and was steering 080° (C) at 16 knots.

At 0715 hrs. the ship entered a fog bank, when the ship's speed was reduced to 8 knots and the sounding of 23

fathoms, reduced to chart datum was obtained. Thereafter, casts with hand lead, all reduced to chart datum, were as follows:-

Time	0805	0832	0911	0942
Soundings	20 fms.	20 fms.	20 fms.	18 fms.
Nature of Bottom	(Shells Shingle)			Chalk
Time	1023	1129	1158	1235
Sounding	18 fms.	15 fms.	14 fms.	12 fms.
Nature of Bottom	Gravel			Sand

Find the ship's position at 1235 hours

(Deviation Card I Variation 7.5°E)

Answer:

Ship's Course	080° (C)
Deviation	12.5° W
Variation	7.5° E
Compass Error	5° W
True Course	075° (T)

I.T.P. Lat. 50° 12.1'N Long 02° 14.9'W

Position Line 156° (T) and 336° (T)

Time	0715	0805	0832	0911	0942	1023	1129	1158	1235
Distance Steamed	2.0'	6.7'	3.6'	5.2'	4.1'	5.5'	8.8'	3.9'	4.9'

1235 hrs. Position Lat. 50° 32.1'N Long 00° 43.8'W

NOTE

Now a days, since the radio navigational aids like Radar and Decca are easily available, the mariner rarely runs a formal "line of soundings" in the manner described above. However, the importance of taking soundings at regular intervals and checking them with the "Chart Soundings" cannot be over emphasized, regardless of the deployment of the modern aids to navigation.

CHAPTER XVIII

PASSAGE PLANNING

Merchant Shipping Notice No. 854

NAVIGATION SAFETY

Notice to ship owners, Master and Deck Officers in the Merchant Navy and Skippers and Second Hands of Fishing Vessels.

1. Research into recent accidents occurring to ships has shown that by far most important contributory cause of navigational accidents is human error, and in many cases information which could have prevented the accident was available to those responsible for the navigation of the ships concerned.

2. There is no evidence to show serious deficiency on the part of deck officers with respect either to basic training in navigation skills or ability to use navigational instruments and equipment; but accidents happen because one person makes the sort of mistake to which all human beings are prone in a situation where there is no navigational regime constantly in use which might enable the mistake to be detected before an accident occurs.

3. To assist masters and deck officers to appreciate the risks to which they are exposed and to provide help in reducing those risks it is recommended that steps are taken to:

   (a) ensure that all the ship's navigation is planned in adequate detail with contingency plans where appropriate;

   (b) ensure that there is a systematic bridge organization that provides for

      (i) comprehensive briefing of all concerned with the navigation of the ship;

      (ii) close and continuous monitoring of the ship's position ensuring as far as possible that different means of determining position are used to check against error in any one system;

      (iii) cross-checking of individual human decisions so that errors can be detected and corrected as early as possible;

      (iv) information available from plots of other traffic to be used carefully to ensure against overconfidence, bearing in mind that other ships may alter course and speed.

   (c) ensure that optimum and systematic use is made of all information that becomes available to the navigational staff;

   (d) ensure that the intentions of a pilot are fully understood and acceptable to the ship's navigational staff.

4. The Annex to this Notice provides information on the planning and conduct of passages which may prove useful to mariners.

Department of Trade,
Marine Division
London WCIV 6LP
August 1978.

ANNEX

GUIDE TO THE PLANNING AND CONDUCT OF PASSAGES

PILOTAGE

1. The contribution which pilots make to the safety of navigation in confined waters and port approaches, of which they have up-to-date knowledge, requires no emphasis; but it should be stressed that the responsibilities of the ship's navigational team do not transfer to the pilot and the duties of the officer of the watch remain with that officer.

2. After his arrival on board, in addition to being advised by the master of the manoeuvring characteristics and basic details of the vessel for its present condition of loading, the pilot should be clearly consulted on the passage plan to be followed. The general aim of the master

should be to ensure that the expertise of the pilot is fully supported by the ship's bridge team. (See also paragraph 16)

3. Attention is drawn to the following extract from IMCO Resolution A 285 (VII),

"Despite the duties and obligations of a pilot, his presence on board does not relieve the officer of the watch from his duties and obligations for the safety of the ship. He should co-operate closely with the pilot and maintain an accurate check on the vessel's position and movements. If he is in any doubt as to the pilot's actions or intentions, he should seek clarification from the pilot and if doubt still exists he should notify the master immediately and take whatever actions necessary before the master arrives".

Responsibility for Passage Planning

4. In most deep-sea ships it is customary for the master to delegate the initial responsibility for preparing the plan for a passage to the officer responsible for navigational equipment and publications, usually the second officer. For the purposes of this guide the officer concerned will be referred to as the navigating Officer.

5. It will be evident that in small ships. including fishing vessels, the master or skipper may himself need to exercise the responsibility of the navigating officer for passage planning purposes.

6. The navigating officer has the task of preparing the detailed passage plan to the master's requirements prior to departure. In those cases when the port of destination is not known or is subsequently altered, it will be necessary for the navigating officer to extend or amend the original plan as appropriate.

Principles of Passage Planning

7. There are four distinct stages in the planning and achievement of a safe passage:

(1) Appraisal
(2) Planning
(3) Execution
(4) Monitoring

8. These stages must of necessity follow each other in the order set out above. An appraisal of information available must be made before detailed plans can be drawn up and a plan must be in existence before tactics for its execution can be decided upon. Once the plan and the manner in which it is to be executed have been decided, monitoring must be carried out to ensure that the plan is followed.

Appraisal

9. This is the process of gathering together all information relevant to the contemplated passage. It will of course be concerned with navigational information shown on charts and in publications such as Sailing Directions, List of Lights, Current Atlas, Tidal Atlas, Tide Tables, Notices of Mariners, publications detailing Traffic Separation and other Routeing, Schemes, and radio aids to navigation. Reference should also be made to climatic data and other appropriate meteorological information which may have a bearing upon the availability for use of navigational aids in the area under consideration such as, for example, those areas subject to periods of reduced visibility.

10. A check list should be available for the use of the navigating officer to assist him to gather all the information necessary for a full passage appraisal and the circumstances under up-to-date information, for example, radio navigational warnings, meteorological forecasts, may be received after the initial appraisal.

11. In addition to the obvious requirement for charts to cover the area or areas through which the ship will proceed; which should be checked to see that they are corrected upto date in respect of both permanent and temporary Notices to Mariners and existing radio navigational warn-

ings, the information necessary to make an appraisal of the intended passage will include details of:

(a) Currents (direction and rate of set)

(b) Tides (times, heights and direction of rate of set)

(c) Draught of ship during the various stages of the intended passage

(d) Advice and recommendations given in Sailing Directions

(e) Navigational lights (characteristics, range arc of visibility and anticipated raising range)

(f) Navigational marks (anticipating range or which objects will show on radar and/or will be visible to the eye)

(g) Traffic Separation and Routing Schemes

(h) Radio aids to navigation (availability and coverage of Decca, Omega, Loran and D/F and degree of accuracy of each in that locality)

(i) Navigational Warnings affecting the area

(j) Climatological data affecting the area

(k) Ship's manoeuvring data.

12. An overall assessment of the intended passage should be made by the master, in consultation with the navigating officer and other deck officers who will be involved, when all relevant information has been gathered. This appraisal will provide the master and his bridge team with a clear and precise indication of all areas of danger, and delineate the areas in which it will be possible to navigate safely taking into account the calculated draught of the ship and planned under-keel clearance. Bearing in mind the condition of the ship, her equipment and any other circumstances, a balanced judgement of the margin of safety which must be allowed in the various sections of the intended passage can now be made, agreed and understood by all concerned.

Planning

13. Having made the fullest possible appraisal using all the available information on board relating to the intended passage, the navigating officer can now act upon the master's instructions to prepare a detailed plan of the passage. The detailed plan should embrace the whole passage, from berth to berth, and include all waters where a pilot will be on board.

14. The formulation of the plan will involve completion of the following tasks:

(a) Plot the intended passage on the appropriate charts and mark clearly, on the largest scale charts applicable, all areas of danger and the intended track taking into account the margins of allowable error. Where appropriate, due regard should be paid to the need for advance warning to be given on one chart of the existence of a navigational hazard immediately on transfer to the next. The planned track should be plotted to clear hazards at as safe a distance as circumstances allow. A LONGER DISTANCE SHOULD ALWAYS BE ACCEPTED in preference to a shorter more hazardous route. The possibility of main engine or steering gear breakdown at a critical moment must not be overlooked.

(b) Indicate clearly in 360 degree notation the true direction of the planned track marked on the charts.

(c) Mark on the chart those radar-conspicuous objects, marks or recons, which may be used in position fixing.

(d) Mark on the charts any transisit marks, clearing bearings or clearing ranges (radar) which may be used to advantage. It is sometime possible to use two conspicuous clearing marks where a line drawn through them runs clear of natural dangers with the appropriate margin of safety; if the ship proceeds on the safe side of this transit she will be clear of the danger. If no clearing marks are available, a line or lines of bearings from a single object may be drawn at a desired safe distance from the danger; provided the ship remains in the safe segment, she will be clear of the danger.

(e) Decide upon the key elements of the navigational plan. These should include but not be limited to:

(i) Safe speed having regard to the manoeuvring characteristics of the ship and in ships restricted by draught, due allowance for reduction of draught due to squat and heel effect when turning;

(ii) speed alterations necessary to achieve desired ETA's on route, e.g. where there may be limitations on night passage, tidal restrictions etc.;

(iii) positions where a change in machinery status is required;

(iv) course alteration points, with wheel-over position; where appropriate on large scale charts taking into account the ship's turning circle at the planned speed and the effect of any tidal stream or current on the ship's movement during the turn;

(v) minimum clearance required under the keel in critical areas (having allowed for height of tide);

(vi) points where accuracy of position fixing is critical, and the primary and secondary methods by which such positions must be obtained for maximum reliability;

(vii) contingency plans for alternative action to place the ship in deep water or proceed to an anchorage in the event of any emergency necessitating abandonment of the plan.

15. Depending on circumstances, the main details of the plan referred to in paragraph 14 above should be marked in appropriate and prominent places on the charts to be used during passage. These main details of the passage plan should in any case be recorded in a bridge notebook used specially for this purpose to allow reference to details of the plan at the conning position without the need to consult the chart. Supporting information relative to the passage such as times of high and low water, or of sunrise or sunset, should also be recorded in this notebook.

16. It is unlikely that every detail of a passage will have been anticipated, particularly in pilotage waters. Much of what will have been planned may have to be changed after embarking the pilot. This in no way detracts from the real value of the plan, which is to mark out in advance where the ship must not go and the precautions which must be taken to achieve that end, or to give initial warning that the ship is standing in danger.

Execution

17. Having finalised the passage plan, and as soon as estimated times of arrival can be made with reasonable accuracy, the tactics to be used in the execution of the plan should be decided. The factors to be taken into account will include;

(a) the reliability and condition of the ship's navigational equipment;

(b) estimated times of arrival at critical points for tide heights and flow;

(c) meteorological conditions, particularly in areas known to be affected by frequent periods of low visibility;

(d) day time versus night time passing of danger points, and any effect this may have upon position fixing accuracy;

(e) traffic conditions, especially at navigational focal points.

18. It will be important for the master to consider whether any particular circumstance, such as the forecast of restricted visibility in an area where position fixing by visual means at a critical point is an essential feature of the navigation plan, introduces an unacceptable hazard to the safe conduct of the passage; and thus whether that section of the passage should be attempted under the conditions prevailing, or likely to prevail. He should also consider at which specific points of the passage he may need to utilise additional deck or engine room personnel.

Monitoring

19. The close and continuous monitoring of the ship's progress along the pre-planned track is essential for the safe conduct of the passage. If the officer of the watch is ever in any doubt as to the position of the ship or the manner in which the passage is proceeding he should immediately call the master and, if necessary, take whatever action he may think necessary for the safety of the ship.

20. The performance of navigational equipment should be checked prior to sailing, prior to entering restricted or hazardous waters and at regular and frequent intervals at other times throughout the passage.

21. Advantage should be taken of all the navigational equipment with which the ship is fitted for position monitoring, bearing in mind the following points:

(a) Visual bearings are usually the most accurate means of position fixing;

(b) every fix should, if possible, be based on at least three position lines;

(c) transit marks, clearing bearings and clearing ranges (radar) can be of great assistance;

(d) when checking use systems which are based on different data;

(e) positions obtained by navigational aids should be checked where practical by visual means;

(f) the value of the echo sounder as a navigational aid;

(g) buoys should not be used for fixing but may be used for guidance when shore marks are difficult to distinguish visually; in these circumstances their positions should first be checked by other means;

(h) the functioning and correct reading of the instruments use should be checked;

(i) an informed decision in advance as to the frequency with which the position is to be fixed should be made for each section of the passage.

22. On every occasion when the ship's position is fixed and marked on the chart in use, the estimated position at a convenient interval of time in advance should be projected and plotted.

23. Radar can be used to advantage in monitoring the position of the ship by the use of parallel indexing techniques. Parallel indexing, as a simple and most effective way of continuously monitoring a ship's progress in restricted conspicuous waters, can be used in any situation where a radar navigation mark is available and it is practicable to monitor continuously the ship's position relative to such an object.

LIST OF PUBLICATIONS AND CHARTS REQUIRED TO BE CARRIED ONBOARD FOR THE PASSAGE

Safe practice require the following British Admiralty publications to be carried onboard :-

1. Relevant charts of adequate scale corrected up to date for the area;
2. Sailing Directions with latest supplements;
3. List of Lights and Fog Signals:
4. Notices to Mariners including Preliminary (P) or Temporary (T) Notices;
5. List of Radio Signals as follows:-

   Volume 1 - Coast Radio Stations (NP281, Parts 1 & 2)

   Volume 2 - Radio Navigational Aids (NP282)

   Volume 3 - Radio Weather Services and Navigational Warnings (NP283, Parts 1 & 2)

   Volume 4 - Meteorological Observation Stations (NP284)

   Volume 5 - Global Maritime Distress and Safety System (NP285)

   Volume 6 - Pilot Services and Port Operations (NP286 Parts 1 & 2)

   Volume 7 - Vessel Traffic Services and Reporting Systems (NP287 Parts 1 & 2)

   Volume 8 - Satellite Navigation System (NP288)
6. Ocean Passages for the world
7. The Abridged Nautical Almanac for the year
8. Admiralty Tide Tables Volume 1, 2, 3 and 4 for the year;
9. Catalogue of Admiralty charts (NP 131);
10. Mariner's Handbook (NP100);
11. Admiralty Tidal Stream Atlas (if available for the area);
12. Admiralty Distance Tables;
13. Mariner's Routing Guide Charts for the area, if available;
14. Radio Navigation Warnings.

In addition to the above, the following publications should also be carried:-

1. Comparable charts and publications to the British Admiralty ones, published by relevant national Hydrographic offices, if available;
2. International Code of Signals;
3. I.M.O's Ship's Routing;
4. Ship's Manoeuvring Data giving Turning Circle and Squat;
5. Latest Weather Reports;
6. Operating Instructions of the electronic navigational equipment onboard.

PASSAGE PLANNING IN PRACTICE

The practical responsibility for safe navigation rests on master and navigating officers. For the effective management and supervision of the navigation of the ship, no restraints should be placed on the master's professional judgement by owner or charterer which is likely to endanger the ship.

Human failure is one of the major causes of the vessel's casualties. Passage planning cannot prevent such failures, but it can reduce their likelihood and very much reduce the chance of any failure, human or otherwise escalating into a navigational accident.

THE CHOICE OF THE ROUTE

Fundamentally the choice of a route lies between the shortest way, the quickest way and the simplest way.

The shortest way is a great circle route and appears on the Mercator's chart as a curved line. The great circle track takes the ship into higher latitude and thus ship may encounter bad weather. In the northern hemisphere, for example, the North Atlantic great circle route takes the vessel into higher latitudes than necessary and possibly in the winter vessel will encounter worst weather than she might encounter if the vessel kept further south. Thus the shortest route may not be the quickest way. The great circle route also involves frequent alterations of course and it requires a relatively sophisticated navigator, if any significant advantage is to be gained over the simple thumb line route.

Least time routing or weather routing is a modern technique and is only as good as the accuracy of long range weather forecasts. Considerable saving in time can be claimed by weather routing services as much as there may be least damage to the hull, engine and cargo.

The simplest route speaks for itself. Whenever the navigator has a choice, he would prefer a route which is navigationally simpler with plenty of navigational aids and lesser navigational hazards. There are various other factors like insurance policies and charter parties which have also to be considered. The possibility of fog, ice, ship's draft maneouvring ability and the navigational aids onboard must be considered. The minefields and military exercises areas have to be avoided. Concentration of small fishing boats, some with dimly lit nets extending upto 3 miles can create a problem.

BERTH TO BERTH COVERAGE

It is fundamental that any navigational regime instituted for avoiding of the navigational accidents from human failure that every passage between any two places, no matter how short, must be properly planned and the ship's progress monitored during its execution to ensure that plan decided upon is being followed. Every plan for the navigation of a ship must cover the entire passage from berth to berth and include also those areas where the ship will have a pilot onboard. It should also provide, as far as possible for contingencies. The amount of planning involved depends upon the length of time that passage is expected to take and the complexity of the navigation which will be involved. However, before any actual planning of a passage is begun, it is essential that an appraisal is made of all the information available which relates to the route to be taken. The information given in the various volumes of sailing directions read in conjunction with the relevant charts, will be vital for identifying dangers which must be avoided and also navigational marks by means of which the navigator may fix position of the ship. The Admiralty Pilot books give good sailing

directions for making landfalls, for proceeding coastwise from place to place and for approach to the Pilot stations and ports. Thus these volumes provide useful advice for planning of passages.

If the passage to be made includes an ocean crossing, the information on recommended routes given in the Admiralty publication "Ocean Passages for the World" linked with information provided by Admiralty Sailing Directions complete the advice on passage to the navigator . These publications also include much useful data on climatical conditions, wave heights, currents and tidal phenomena, while more general information on a variety of related navigational matters is given in the Mariner's Handbook. The charts required for the passage should be arranged in sequential order and checked up to date in accordance with available Notices to Mariners including any radio navigational warnings which are in existence. Up to date list of lights, current and tidal atlases and publications detailing traffic separation and routing schemes should be at hand, together with particulars and coverage of radio aids to navigation over the route to be taken.

NO GO AREAS

To start the detailed passage plan is to mark out on various charts those areas into which the ship must not go, taking into account the maximum projected draft and desired under keel clearance. With the assistance of the Admiralty Pilot, the charts should be studied for banks, shoals and isolated dangers which are near the intended course line and their extent outlined in pencil and lightly hatched in. If this is done properly, it will be possible to identify at a glance those areas where the ship must not go and also assist in deciding strategy to be adopted in the navigation of any particular section of the passage. The ranges of the lights should also be drawn in pencil on the chart. Among the fundamental issues of strategy to be decided will be the margin of safety to be given to the avoidance of particular dangers, bearing in mind the direction and rate of currents or tidal streams affecting the ship.

Alter course positions will be another important point which should be decided early in the navigation plan. These to a large extent are dictated by the shape of the coastline and existence of off lying dangers, but other factors, such as the presence of traffic separation schemes and the availability of fixed objects in the vicinity for accurate position fixing, will influence their number and precise location. A check should be made to see whether any transit, clearing bearings or light sector changes are established in the vicinity to assist with the establishment of the ships position at these important points.

The course lines can then be drawn in, checked and their direction indicated clearly (in three figures notation) on the chart at suitable points.

On larger scale charts wheel over position will need to be marked to take account of the ship's manoeuvring characteristics for accurate positioning of the ship on the next course line. Reference should be made to the ship's turning circle data for 15 degrees of rudder angle to obtain the advance distance required, this angle giving approximately half rudder, which may be varied as necessary in practice during the turn to keep the ship on the intended track.

MONITORING POSITION

Every section of the intended passage should now be looked at to ascertain the means available for monitoring the ship's position under different conditions - i.e. in daylight, in darkness and during restricted visibility. The position of prominent features on the chart which will be suitable for position fixing during daylight, including points of land, headlands, islands, lighthouses, beacons, conspicuous chimneys and similar objects should be located. Those which will be particularly useful for visual observation will be referred to in the relevant volume of the Admiralty Pilot, and when identified on the chart, they should be circled in pencil for ease of future reference.

In restricted visibility reliance will need to be placed upon ranges and bearings of radar conspicuous objects or other means of position fixing independent of visual bearings or horizontal or vertical angles. A note should be made of these radar conspicuous navigation marks which are available for position fixing and of those which are convenient to use for continuous position monitoring by means of parallel indexing.

Whenever possible the position of the ship should be determined by visual means, using the projected D.R. or estimated position and radar or other electronic navigational aids as a check to ensure that any error made in plotting visual bearings or angles does not go undetected. The value of echo-sounding equipment in this connection should always be borne in mind. When radar or any other electronic navigational aid becomes the primary means for position fixing, as would be the case in restricted visibility, the accuracy of the back up navigational information used to check the fixes obtained must be taken into account and caution exercised accordingly. Wherever possible the back up position fixing system should be based upon different data from that used for the primary.

DAYLIGHT AND DARKNESS

The state of visibility in certain restricted or otherwise difficult to navigate areas, with its consequential effect upon the overall accuracy of the navigation which can be practised in those circumstances, may well be a factor which would dictate the conditions under which the transit of that area should be undertaken. Even the difference between the accuracy of daylight visual fixes viz-a-viz those obtainable in darkness may be sufficient to call into question the prudence of a night transit of the area. The possibility of main engine or steering gear malfunction at a critical moment must not be overlooked when consideration is being given to these matters.

TIDES AND TIDAL STREAMS

The direction and rate of the tidal stream and the height of tide at any point where depth is critical for the maintenance of under-keel clearance are important factors to take into consideration when deciding upon the manner in which the passage is to be executed. Little mention has so far been made of tides and tidal streams because we are more concerned with their effects at the time of making the passage rather than in the planning stage where the actual date and time when the ship will be in a particular area is still unknown.

It is, however, appropriate to draw attention at the planning stage to such features on the chart as tidal diamonds which appear on or near to the course line and to any navigation warnings which refer to tidal effects. A note of the heights and times of the tide at the standard port to which they relate, together with corrections to apply for any specific area, should in due course be prepared and pinned up adjacent to the chart in use. If the course line runs athwart to the direction of a current or tidal stream at any point, a pencilled note should be made on the chart to draw attention to this fact.

Pencilled notations should also be made on the chart in positions where it is intended that the engine room is to be given early notice of manoeuvring where it is intended that speed should be reduced for any reason – e.g. approaching a pilot station, crossing a river bar or to reduce the amount of squat or heel effect on draft when turning in areas where under keel clearance is critical; where hand steering will be required if this has not already been engaged; where a particular VHF channel should be switched in; and any other reminder considering the safe navigation of the ship which might in the event be overlooked due to the work load involved in navigation and collision avoidance requirements, or simply to the human failure of the officer concerned. It is good practice to make a note of these and other details of the passage plan in the bridge note book to enable reference to be made to the main points of the plan at the conning position without the need to consult the chart.

The value of making a careful assessment if that will be required for the safe navigation of the ship during the entire passage and then drawing up a comprehensive plan for its accomplishment lies in giving advance warning to all concerned of the various factors involved and the dangers which will exist. The requirement for this awareness becomes increasingly important in respect of those sections of the passage where freedom for manoeuvres is restricted and where accuracy of navigation is vital in the planned margin of safety is to be maintained. Navigation safety can only be achieved by properly planning a passage, and then supporting that plan with a bridge procedural system which will detect any human error made by those involved with the monitoring of progress during its execution in sufficient time to enable an accident to be avoided.

NOTES ON PLANNING A COASTAL PASSAGE

Scheme of Work

There are several distinct stages to any coastal passage plan:

1. Appraisal of all available information.
2. Deciding on the basis of this information the route that will be followed.
3. Laying off courses and marking chart with relevant data.
4. Compiling the Bridge note book.
5. Monitoring ship's position as she progresses during the passage.
6. Completing any questions called for by the question.

Appraisal

Appraisal of Sailing Directions

Pilot Book extracts and perhaps a supplement will be provided covering the whole of the chart in use and is printed in complete chapters, i.e. there is a mass of irrelevant information. You must find the relevant data as quickly as possible. To do this, note from the question and chart the approximate route to be followed. (It may help at this stage to rough in on the chart the section of the approximate track you expect to follow), and read this section of the extracts only; making use of any index and section headings. Transter the relevant information to a rough sheet titled 'Appraisal' either complete or as page and line references.

Rough Track

Use of Index

Be on the lookout for the following items:

a. recommend routes and traffic regulations

b. limiting draughts

c. tidal data

d. pilotage information

e. local climatological data

f. buoyage not shown on chart

g. radar conspicuous targets and navigational aids data.

Lights and Ranges

For a night time passage there is a possibility of being given an extract from the light lists which will give you details of the buoyage. Ranges of the lights generally remain a problem as you are seldom given a height of eye with which to calculate a visible range. In which case the quoted nominal ranges must be used when deciding on which navigation lights to make use of. Similarly in reduced visibility without the luminous range diagram precise ranges are impossible to predict. If you wish to make assumptions in these circumstances be aware of implications of these limitations, i.e. make a note on your plan.

Radio Sigs. vol. 6

Sometimes extracts from Radio sigs. Vol. 6 have been given which will provide the pilotage, communications and traffic regulations.

Tide Tables

Tide Tables are always provided. There are no seasonal corrections for secondary European ports and take care not to confuse feet and metres.

Use of Tidal data

If no draught is given in the question then you cannot work out heights of tide or underkeel clearances. If no time is given the only information to be used is the

times of high and low water so that the tidal diamonds may be used. In the event of no time being given, mark the tidal diamonds adjacent to your track with arrows indicating the approximate directions of flood and ebb with approximate maximum rates. Use tidal set and rates as general directions and approximate speeds remembering that accuracy of this data is not that great, i.e. sets as NNEly not 022 T and rates as 1½ kt and 1.3 kt etc.

Appraisal of chart

Areas to note

Study of the chart will also provide notes for your Appraisal Sheet. It will show some areas of difficult navigation conditions, i.e. heavy traffic concentrations, traffic streams, danger areas where high position fixing accuracy, is required, areas of inadequate position accuracy, areas where the frequency of position fixing should be increased, areas where expected low visibility could cause inadequate position fixing accuracy.

Route through traffic

When deciding on the route through congested waters join a traffic stream at as narrow an angle as possible and cross the traffic at as broad an angle as possible. This is particularly important near the ends of traffic separation schemes. When passing near navigational dangers in traffic pursue a course that leaves adequate sea room for anti-collision manoeuvres.

Testing of Gear

At some stage during the approach to a port steering gear and engines must be tested. Make sure that your route allows this to be done safely, i.e. in clear water away from the traffic.

Testing of Manual Steering before entering areas of danger	Before entering an area where navigation requires special caution (restricted visibility, high traffic density, routing schemes, approaching navigational danger, restricted waters) the steering gear must be operated in Manual with both motors on. Thereafter if Auto is used the helmsmen must be standing by ready to take over steering within 30 seconds.
Advise to E.R.	Similarly Engineers should be advised of the situation and the possibility of an emergency manoeuvre especially on vessels with unmanned engine rooms.
Testing when on continuous manual steering	Before entering an area where due to navigational restrictions manual steering is to be employed continuously the full steering gear and associated instruments should be checked and full rudder movement tested.
S.B.E.	Prior to entering a region where it is known that engine manoeuvre will be required, then the engineering staff will
Testing of engines	be given sufficient notice to man the E.R. and prepare the engine. After speed has been reduced and before entering the area of restricted sea room then the stopping and astern capability of the engine will be tested.
Safe speed	Give careful thought to the safe speed for each leg of the route bearing in mind the size of your vessel and the distance needed to run off that speed when approaching the pilot for example.
Positions for tests	Places where all the afore mentioned checks and manoeuvres can be safely carried out should be identified during the appraisal stage and incorporated into the passage plan.

Planning

Obscuring of data	The courses are now laid off on the chart and marked in 360° notation alongside. Note clearly on the chart without obscuring important navigational information or obscuring the track itself, all other relevant data, such as:
Marking of chart	1. Tide and current arrows and rates where they will effect the course keeping or ship speed to a significant degree.
	2. Circle navigational points that are being made use of – This includes those used for parallel indexing.
	3. Highlight navigational dangers near track, especially shoal waters.
Margins of Safety	4. Insert lines to indicate margins of safety. These only apply if the vessel is liable to stray into a danger during the course of an anti-collision manoeuvre or between successive fixes. In most full away situations a danger area would extend about two miles around the danger; again size and type of vessel should be related to this distance.
	Do not insert a margin of safety unless it is necessary and make sure it does not obliterate significant navigational information.
Clearing bearings	5. Put on clearing bearings and transits where they will assist the O.O.W in assessing at a glance that he is clear of a particular danger or when he is approaching an area of reduced safety margins.

Underkeel clearances	6.	Calculated underkeel clearance at a/c positions and shoal patches.
	7.	Visible ranges of lights being used.
W.O.P.	8.	Mark the point on the track when steering gear is to be tested, manual steering employed, engines ready for manoeuvring, engines tested for astern capability, increased bridge manning (i.e master on bridge), parallel indexing begins, reduce speed and wheel over positions when the scale of the chart justified it. Indicate this W.O.P. with a clearing range or bearing.

Bridge Note Book — The chart having been marked there remains the Bridge Note Book to be completed with all information that will help the O.O.W. to follow the desired track, bringing to his attention all items of importance to be met, without the need to keep referring back to the chart.

Layout of N.B. — The layout of the Bridge Note Book sheets provided by the college is only a suggestion and will in some situations be inadequate and therefore must be amended. Do not provide a column for which you have no applicable information, neither should there be any blanks in a column being used, i.e. if the data is unchanged then write ditto or if the data is zero or insignificant then enter NIL.

Positions as Ranges and Brgs. — Position should always be given as ranges and bearings from easily identifiable objects. The course entered should always be that to make good. The O.O.W. has responsibility for any adjustments needed to counteract leeway and set, provided the possible need for this has been brought to his attention by a note in the Remarks.

Speed for N.B. — The speed is the best estimation of likely progress taking into account current etc. and is needed to work out E.T.A.'s at various critical points in the passage such as sunset, turn of tide, arrival at pilot.

Prime Position Fixing System — Careful judgement is needed when deciding on the prime position fixing system, giving due regard to what is available and their relative accuracies.

Updating — These factors may be changing constantly and it is necessary to asses them for every part of the proposed track. Always be on the lookout for a more accurate or reliable fixing system.

Frequency of Fixing — Specify in the remarks the frequency at which a position should be fixed on the chart bearing in mind the possible divergence from the track due to currents etc.

Discrepancies of data — Don't take the information in the Pilot Book on Radio Nav. Aids as gospel, as you will know that this source of Radio Aids information is the most out of date. If there is a discrepancy between the Pilot Book information and what you know to be true, comment on the Appraisal Sheet that you would check the information in the current relevant volume of A.L.R.S. Similarly any information discrepancy which affects your passage should be commented on with a reference given to the best source of information.

Identification of Nav. Aid

The navigation aid used for fixing the position must be identified precisely by name (and characteristic if it is a sectored light). These same points are highlighted on the chart. Do not leave the problem of identifying suitable visual or radar targets to the O.O.W.

Check Systems

The secondary position fixing check system will be identified in the same way remembering that Parallel Indexing is always a check and not a prime system.

Parallel Indexing

When parallel indexing the indexing radar target must be clearly marked on the chart and the point on the track where indexing is to begin with is also identified. In the note book the name of the target and the range in use needs to be entered opposite the estimated time of beginning P.I.

SUGGESTED BRIDGE NOTE BOOK (SHEET NO.)

Draft: F .... A .... M .... Passage From: .... To: .... Nominal Speed: .. Kts .... Sunrise: .... HW .... LW .... Sunset: .... HW .... LW ....

Sr. No.	Actual Time	Est. Stream-ing Time	A/C Positions and Way Points	Course To make good	Dist. to next A/C	Current set and rate	Est. Spd. over ground	Prime Position Fixing System and Accuracy	Position Fixing Check Systems	Remarks

CONTINGENCY PLAN.

ROUTINE BRIDGE CHECK LIST

Familiarisation with Bridge Equipment

a) Operation of Gyro Compass and Repeatens/Errors

b) Operation of Magnetic Compasses/Errors/Deviation Cards

c) Operation of Speed/Distance Recorders/Logs etc.

d) Operation of Echo-Sounders

e) Operation of Radars, changing scale and tuning/Shadow areas/limitations

f) Operation of Electronic Navigational Fixing Aids-Decca, Satnav, Omega, Loran-C

g) Operation of Direction Finder/Caliberation Table

h) Operation of Steering Gear, manual, auto-pilot, electornic/hydraulic and other means of control, with change-over arrangements

i) Operation of Navigation lights, emergency navigation lights, "Not Under Command" lights and other signal lights

j) Knowledge of Bridge Controls of main Engines, telegraphs, switches etc.

k) Operation of deck, overside and bridge lights/anchor lights

l) Operation of internal communication facilities from bridge to Engine Room, Forward, Aft, Steering Gear Room, Cabins and other important points.

m) Operation of external communication facilities from Bridge-VHF, R/T, W/T Walkie-Talkie, Aldis Lamp, Megaphones, Loud-hailers etc.

n) Emergency change-over arrangements in case of Power failure from mains

o) Position and operation of Alarms and other safety equipment.

p) Hazard monitoring equipment situated on the bridge

q) Knowledge of location and operation of ancillary bridge

equipment – Whistles, Smoke-detectors, Exhaust Vents, Hold fans, CO2 Valves, WT doors devices etc.

r) Knowledge of Charts, Folios, hydrographic and nautical publications, Almanacs, Tables, log books, Sounding Books, Gyro/Magnetic Comp. Error books, Chronometer Error books, Bridge Note Books, Engine Movement books & their stowage arrangements.

s) Knowledge of Meteorological equipment

t) Origination for the operation of water-tight doors, Bilge and Ballast Lines.

u) Knowledge of Master and Company's Standing Orders.

CHAPTER XIX

TIDES

Periodical rise and fall of the tide increases and decreases the depth of water throughout the day at any one place. The soundings printed on the navigational charts cannot, therefore, represent the actual depths of water at any given time.

The chart soundings are depths below a selected level of the sea called "Chart Datum" which is generally the lowest level to which the tide falls viz. Lowest Astronomical Tide (L.A.T.). Thus the actual depth of water at any place at any given time is the sum of the charted depth plus the height of the tide at that time.

SOME DEFINITIONS AND ABBREVIATIONS ABOUT TIDES

1. **The height of Tide** at any given time is the height water level above "chart datum" i.e. Actual depth minus the charted depth of water.

2. **High Water (H.W):-** It normally refers to the time of high water. It is also used to express the rise of the tide i.e. height of the "High Water level" above the chart datum.

3. **Low Water (L.W.):-** Similarly, low water refers to the time of low water level as well as height of tide at low water time.

4. **Range of Tide:-** It is the difference between high water and low water heights. Low water tidal level may, on rare occasions, fall below the chart datum. In such a case, the low water height would naturally be a negative (–) quantity and the range of the tide will be the arithmetic sum of the high water and low water heights.

Duration of Rise of Tide:- It is time the tide takes to rise from low water level to high water level i.e. the interval between low water time and the next high water time or simply the duration of the tide.

Duration of the Fall of Tide:- Similarly the time interval between the high water and the next low water is called the duration of the fall of the tide or simply the duration of the tide.

M.H.W. represents the Mean High water.
M.L.W. represents the Mean Low water.
M.H.W.S. represents the height of Mean of High water Spring Tides.
M.L.W.S. represents the height of Mean of L.W. Spring Tides.
M.H.W.N. represents the height of Mean of H.W. Neap Tides.
M.L.W.N. represents the height of Mean of L.W. Neap Tides.
M.H.H.W. represents the height of Mean Higher High water.
M.L.H.W. represents the height of Mean Lower High water.
M.H.L.W. represents the height of Mean Higher Low water.
M.L.L.W. represents the height of Mean Lower Low Water.

STANDARD PORTS:-

A List of "Standard Ports" arranged alphabetically is given on the back of the cover page of each of the three volumes of "Admiralty Tide Tables".

Data concerning daily predictions of times and heights of high water and low water for standard ports are given in the main body of the Tide Tables.

Predictions for standard ports are generally based on continuous observations of the tide over a period of at least one year and average meteorological conditions.

METEOROLOGICAL EFFECTS ON TIDES: Meteorological conditions, which differ from the average will cause corresponding differences between the predicted and actual tides, particularly in high water and low water heights. Variations in heights are mainly caused by strong or prolonged winds and or extreme variations in atmospheric pressure. Wind also affects the times of high and low water.

Shallow Water Corrections: At some ports where shallow water effects are noticeable and can reasonably be represented by a table of shallow water correction, then the corrections for the same are included in Part II of the Admiralty Tide Tables. Shallow water corrections are given only in Volumes II, III & IV of Admiralty Tide Tables.

Seasonal Changes in Mean Sea Levels

If the maximum variation in the monthly variations of the mean sea levels is greater than 0.1 metre from the mean values, the same are also tabulated in Part II alongwith the data on secondary ports. These corrections are also valid and are thus given only for ports covered in Vol. II and III of Admiralty Tide Tables.

Time and Time Differences in the Predictions

The time of standard port predictions are given in the normal standard (zone) time kept by the port and is given at the top of each page. Thus if a ship is keeping different time then the predicted times must be corrected for Longitude in the normal manner.

To Find Times, Heights of High and Low Water

Times and Heights of high and low water for standard ports are tabulated for every day of the year in the main body of the Tide Tables.

Necessary time corrections for variations from the tabulated zone time must, of course, be made to obtain true predictions.

To convert Standard Time into Local Time

Rule:- "When the ship's meridian is to the East of the Zone time meridian, ADD the difference in time and if to the West SUBTRACT." This rule is to be reversed, when converting ship's (Local) time into zone time. It must always be borne in mind that the ship's clocks are advanced as she sails East and clocks are retarded as she sails West.

Example I.

Find the local mean time of high water and low water at Colombo, on Jan. 16th given the following extracts from Admiralty Tide Tables :-

Extracts from A.T.T.	
Zone Time	– 0530
H.W	0231
L.W	0846
H.W	1456
L.W	2010

Solution:

Mean Long. of the Zone Time	= 82° 30'E
Long. of Colombo	= 79° 51'E
D'Long.	= 2° 39'W
	x 4
	= 10m 36s
	= 11m (approximately)

Colombo Jan. 16th	H.W.	L.W.	H.W.	L.W.
Zone time	0231	0846	1456	2010
Long. Correction	–0011	–0011	–0011	–0011
Local Mean Times	0220	0835	1445	1959

Ans.

Example II.

Find the Local Mean times of high water & low water on board a ship at Singapore, on 19th May, given the following extracts from Admiralty Tide Tables:-

Extracts from A.T.T.	
Zone Time	–0730
H.W	0218
L.W	0930
H.W	1632
L.W	2137

Solution:

Long. of the Zone Time	= 112° 30'E
Long. of Singapore	= 103° 51'E
D'Long	8° 39'W
	x 4
Correction for Long.	= 34m 36s = 35m (approx.)

	H.W.	L.W.	H.W.	L.W.
Singapore May 19th				
Zone times	0218	0930	1632	2137
Correction for Long.	–0035	–0035	–0035	–0035
Local Mean Times	0143	0855	1557	2102

Ans.

Example

Find the local mean times of H.W. and L.W. on board a ship at Belfast on 10th October given the following extracts from the Adm. Tide Tables:-

Extracts from A.T.T.		
Zone Time		–0100
	H.W	0110
10	L.W	0703
W	H.W	1328
	L.W	1931

Solution:

Long. of Zone Time = 15° E
Long. of Belfast = 5° 55'W
D'Long. 20° 55'W
x 4

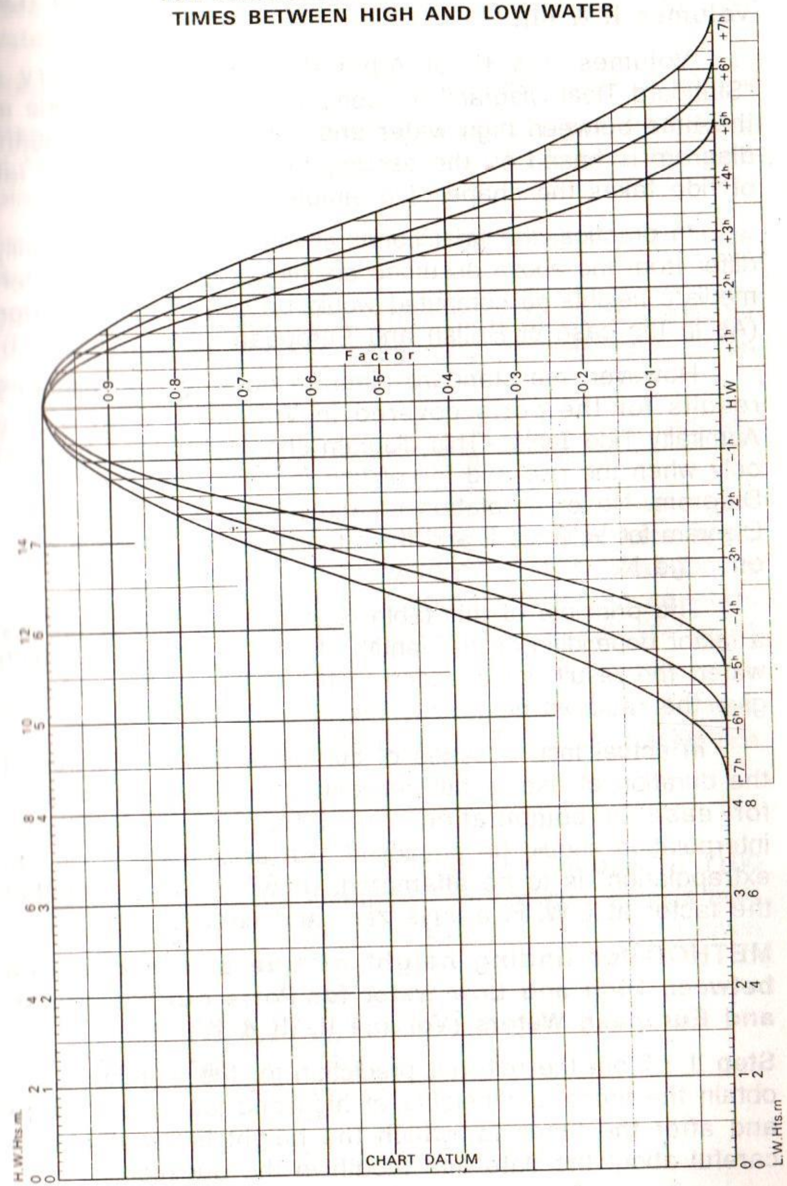
Correction for Long. –1h 23m 40s = –1h 24m (approx.). The correction is minus because Belfast meridian is WEST of the Zone time meridian.

	H.W.	L.W.	H.W	L.W.
Belfast Oct. 10th				
Zone times	0110	0703	1328	1931
Correction for Long.	–0124	–0124	–0124	–0124
Local Mean Times	9th2336	10th0539	10th1204	10th1807

NOTE:

It must be borne in mind that a tide occuring just after midnight with minus correction for Long. may be turned into a tide of the previous day if expressed in local mean time or if occurring just before midnight, it may be turned into a tide on the following day should a plus correction have to be applied to turn into local mean time.

FOR FINDING THE HEIGHT OF THE TIDE AT TIMES BETWEEN HIGH AND LOW WATER



To find the height of tide at times between high and low water for Ports outside British and European water (i.e. Volumes II & III).

Volumes II & III of Admiralty Tide Tables carry a "Standard Tidal Diagram" for computing the height of tide at the time between high water and low water. This standard diagram is based on the assumption that the rise and fall of tide takes the shape of a simple cosine curve.

In practice, the tidal curve at many places may easily differ from the above assumed cosine curve, when the intermediate heights so computed would be considerably in error. (As in the case of British and European ports - Volume I).

However, the standard diagram does give satisfactory results for the ports covered in Volume II & III of the Admiralty Tide Tables. This diagram should, however, be used only when the rise and fall of tide is within the limits of the Diagram. No extrapolation should be attempted. Standard Diagram for Volumes II and III of the Admiralty Tables is given on page No. 171

The principle of this table is to multiply the "range" by a factor depending on the length of time before or after high water; the result being added to the height of low water to give the required height of tide.

In actual fact, a series of curves at hourly intervals of the duration of rise or fall between 5 to 7 hours, are given for ease in computation. For intermediate durations, interpolation should be employed. But as stated earlier "No extrapolation" is to be attempted. (It will be observed that the factor at L.W. is always zero and unity at H.W.).

METHOD for finding height of tide at a given time between High and Low water for Ports outside British and European Waters (Volume II, III & IV)

Step 1 : From the relevant prediction for the standard port, obtain the times and heights of high and low water before and after the times for which the height is required (Be careful about the date and month in the question.)

Step 2 : Find the duration of rise or fall of the tide as the case may be, from the predicted time of high water and low water.

Step 3 : Similarly compute the predicted range of tide.

Step 4 : On the diagram, given on Page 171 plot the heights of H.W. and L.W. occuring either side of required time and join by slopping line.

Step 5 : Enter H.W. time and sufficient others to embrace required time on the diagram.

Step 6 : From required time, proceed vertically to curve for Duration, interpolating as necessary between curves on diagram.

Step 7 : Proceed horizontally to slopping line, thence vertically to height scale. Read off height from the diagram.

Note I : This method is only suitable when duration of rise or fall is between 5 and 7 hours and where there is no shallow water correction. If the duration of rise or fall is less than 5 hours or more than 7 hours, Harmonic constant method should be used to determine the height of tide at a given time.

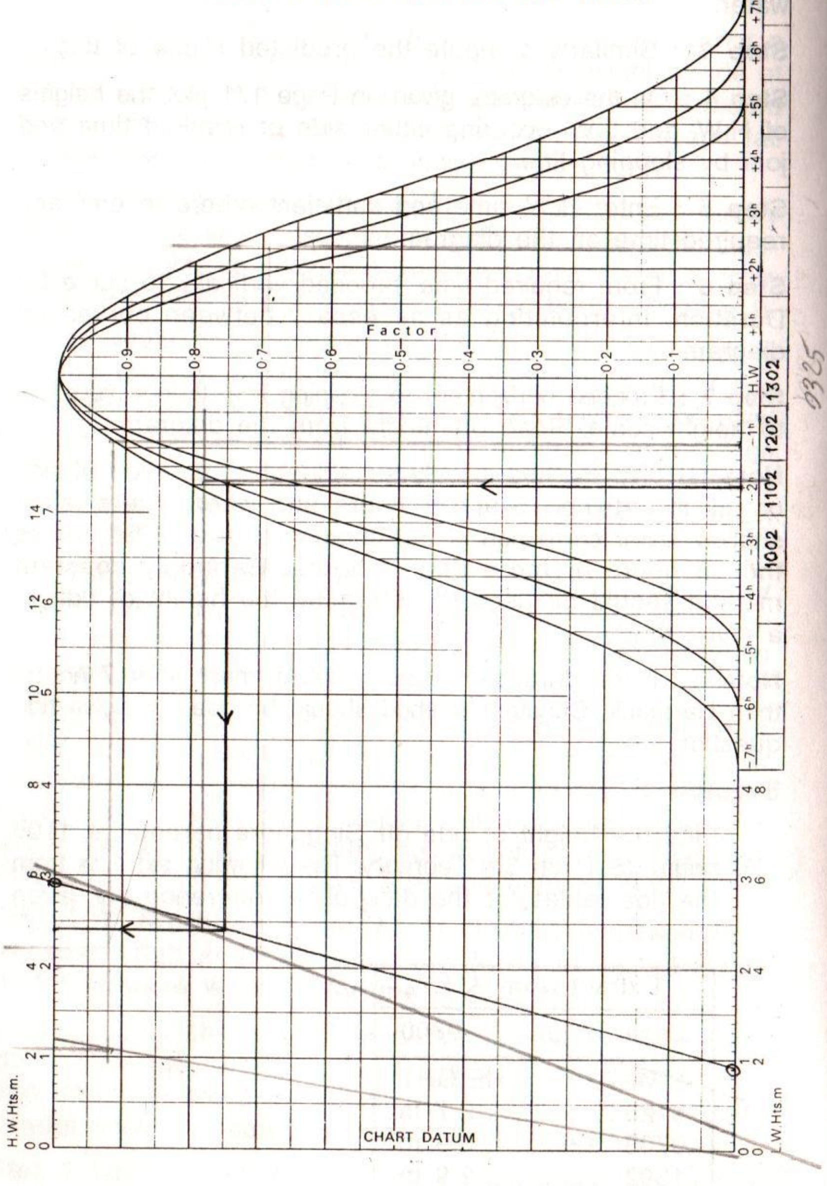
Note II : If the duration of rise or fall is more than 7 hours, then Harmonic Constant method should be used to solve tide question.

Example I.

Find the height of tide off Singapore harbour at 1100 hours. (S.T) on 3rd February. The following extracts from the tide tables for the date under reference are given below:-

Extract from A.T.T.	
Zone Time	– 0800
TIME	HEIGHT
0123	2.7 m
0703	0.9 m
1302	2.9 m
1930	0.5 m

FOR FINDING THE HEIGHT OF THE TIDE AT
TIMES BETWEEN HIGH AND LOW WATER



Solution:

Time in question	=	1100 hrs.
Low Water Time	=	0703 hrs.
High Water Time	=	1302 hrs.
Duration of rise of tide	=	1302 – 0703 = 05h 59m
Interval before High Water	=	1302 –1100 = 2h 02m
Predicted height of Low Water	=	0.9 m.
Predicted height of High Water	=	2.9 m.
Range of tide	=	2.0 m

From the diagram, using the duration of rise of 5h 59m and time 1100 hrs, we determine the height of tide is 2.4 m

Ans.

Example II.

Find the height of tide and depth of water at 1430 hrs. on March 2nd, at a position off Singapore, where charted depth is 4 metres. Extracts from the Tide Tables for the day under reference are given below :-

Extracts from A.T.T.	
Zone Time	–0800
TIME	HEIGHT
0014	2.7 m
0603	0.8 m
1209	2.9 m
1830	0.6 m

Solution :

	Time	Height
High Water	1209	2.9m
Low Water	1830	0.6m

Duration of fall = 0621hrs. Range of tide = 2.3m
High Water time = 1209hrs.
Tide time required = 1430hrs. (as per question)
Interval from High Water = 2h 21m

From the diagram using the duration of fall 6h 21m and time 1430hrs, we determine the height of tide is 2.21m

Height of tide at 1430hrs.	=	2.21m.
Charted depth	=	4.0m
Total depth of water	=	6.21m.

Ans.

Example III.

Given the following extracts from the Tide Tables, find the standard time during the afternoon on 28th February at which there will be 5 Metres of water over a shoal patch where the chart shows 2 metres sounding, off the Port of Darwin (Australia).

Extracts from A.T.T.	
	TIME....HEIGHT
28 M	0018.........2.7 M
	0557.........6.2 M
	1223.........1.5 M
	1832.........7.0 M

Solution:

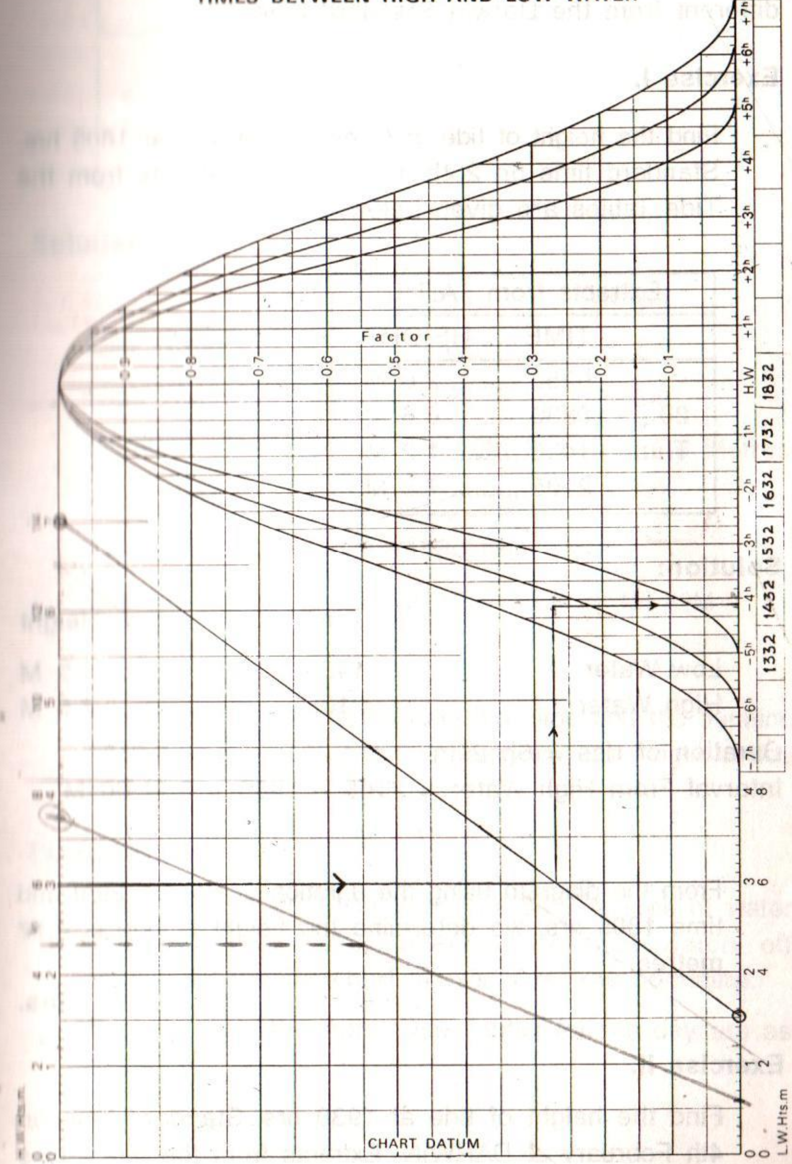
	Time	Height
Low Water	1223	1.5 M.
High Water	1832	7.0 M.

Duration of rise = 06H 09M Range = 5.5 Metres.
Height of tide required = 5.0 – 2.0 = 3.0 M.

From the diagram using the duration of tide as 06h 09m and height of tide as 3.0m we determine the time is 1427hrs. Hence at 1427 hrs. (Darwin Time) there will be 5.0m sounding over 2.0 m shoal.

Ans.

FOR FINDING THE HEIGHT OF THE TIDE AT TIMES BETWEEN HIGH AND LOW WATER



Note : In practice the Standard time may be converted into the ship's time if the Standard time kept on the ship was different from the Darwin Standard time.

Exercise I.

Find the height of tide at Darwin (Australia) at 1805 hrs. Standard time on 20th January. The extracts from the Tide Tables are given below:-

Extracts from A.T.T.	
	TIME ..... HEIGHT
	0250.......... 2.0 M
20	0830.......... 6.6 M
Thu.	1436.......... 1.2 M
	2105.......... 7.5 M

Solution:

	Time	Height
Low Water	1436	1.2 M
High Water	2105	7.5 M

Duration of rise = 6h 29m Range = 6.3M

Interval From High Water = 2105 – 1805 = 3 H 00 M

From the diagram using the duration of rise 6h 29m and time 1805 hrs, we determine the height of tide is 4.72 metres.

Ans.

Exercise II.

Find the height of tide at 1930 hrs. Standard time on 4th February at DARWIN. Extracts from the tide tables for the day under reference are as under:-

Extracts from A.T.T.	
	TIME HEIGHT
	0315..........1.7 m
4	0904..........6.5 m
Fri.	1502..........1.9 m
	2112..........6.9 m

Solution :

		Time	Height
Low Water		1502	1.9
High Water		2112	6.9

Duration of rise = 6H 10M Range = 5.0 Metres

High Water = 2112 hrs.

Time required = 1930 hrs.

Interval from H.W. = 2112 – 1930 = 1H 42M

From the diagram, using 1930 hrs. time and the duration of rise as 6 hrs. 10 min, we determine the height of tide is 6.0m

Exercise III.

Find the time at which there will be 7 Metres of water in the afternoon of 27th April on a shoal patch, off Darwin where the chart shows 3 Metres sounding.

Extracts from the Adm. Tide Tables for the day are as follows:-

Extract from A.T.T.		
	TIME	HEIGHT
	0550........	6.6 m
27	1157........	2.5 m
Thu.	1743........	6.3 m

Solution :

	Time	Height
Low Water	1157	2.5
High Water	1743	6.3

Duration of rise = 05H46M Range = 3.8 M

Height of tide required = 7.0 — 3.0 = 4.0 M.

From the diagram, using 4.0m as height of tide and duration of rise as 5h 46m, we determine the time as 1428 hrs.

Hence at 1428 hrs. there will be 7 metres of water on the Shoal patch.

Ans.

Excercise IV

Find the height of tide at 1800 hours G.M.T. on 2nd August at Prince Rupert (B.C). The extract from the A.T.T. for the day under reference are given below:

Extract from A.T.T.		
Time Zone		+ 0800
	TIME	HEIGHT
	0025.......	1.6 m
2	0625.......	5.0 m
W	1210.......	2.3 m
	1840.......	5.9 m

Solution :

G.M.T.	1800 hrs.	
Zone Time	0800	
Standard Time	1000 hrs.	
High Water	0625 hrs.	Height 5.0 m
Low Water	1210 hrs.	Height 2.3 m
Duration of fall	5H 45M	Range 2.7 m

Time in question 1000 hours

Interval after highwater = 1000 hours – 0625 hours

= 3H 35M

From the diagram, using 1000 hrs. time and the duration of fall of 5h 45m, we determine the height of tide is 3.137m

Height of tide = 3.137 m

Ans.

Exercise V

Find the height of tide at 0920 hours S.M.T. off Golden Gate on 23rd June. The extracts from A.T.T. for the day under reference are given below :-

Extract from A.T.T.		
Lat 37° 48′N		
Long 122° 27′W		
Time Zone + 0800		
	TIME	HEIGHT
	0342....	–0.1 m
23	1042......	1.2 m
F	1428......	0.9 m
	2101......	1.8 m

Solution:

S.M.T.	09H	20M	
L.I.T.	+8H	10M	(West)
G.M.T.	17H	30M	
Time Zone	08H	00M	
Standard Time	09H	30M	

Thus we must find the height of tide at 0930 hours Standard Time.

Low Water	03H 42M	Height	–0.1 m
High Water	10H 42M	Height	1.2 m
Duration of rise	7H 00M	Range	1.3 m
Time in question		09H 30M	

Interval before highwater = 1042 hours – 0930 hours

= 1H 12M

From the diagram using 0930 hrs. time and duration of rise of 7h 00 m, we determine the height of tide is 1.10 metres.

Height of tide = 1.10 metres

Ans.

Exercise VI

Find the earliest time on 17th June, a vessel off BOSTON, drawing 3.4 metres will be able to cross a bar marked 2 metres, with a clearance of 1 metre under her keel. The extract from A.T.T. are given below:

Extract from A.T.T.

	TIME	HEIGHT
16 F	0229	3.1 m
	0848	–0.1 m
	1508	2.9 m
	2109	0.2 m
17 Sa	0325	3.0 m
	0939	0.0 m
	1601	2.8 m
	2205	0.3 m

Solution

Draft of ship	= 3.4 m
Clearance required under the keel	= 1.0 m
Total depth of water required	= 3.4 + 1.0 = 4.4 m
Depth over the bar	= 2.0 m
Height of tide required	= 4.4m – 2.0m = 2.4m
On 17th, earliest highwater	= 0325hrs. Height 3.0m
On 16th previous low water	= 2109hrs. Height 0.2m
Duration of rise	= 6H16M Range = 2.8m

From the diagram, using 2.4m as height of tide and duration of rise 6h16m, we determine the time as 0129 hrs. on 17th June

The earliest time, the vessel will be able to cross the base on 17th June will be 0129 hrs.

Ans.

Exercise VII

Find the error to be applied to the sounding after taking a cast of lead off Bombay at 1451 hours L.M.T. on the 1st March, before comparing it with the chart. The extract from the A.T.T. for the day under reference are given below:-

Extract from A.T.T.		
	Lat 18° 55′N	
	Long 72° 50′E	
Time Zone – 5H 30M		
	TIME	HEIGHT
	0049........	4.4 m
1	0700........	0.9 m
W	1300........	4.2 m
	1851........	1.0 m

Solution:

L.M.T.	1451
L.I.T.	– 451 (East Long.)
G.M.T.	1000
Zone	530
Standard Time	1530 hours.

Hence we must find the height of tide at 1530 Hours.

High Water	1300 hrs.	Height 4.2 m
Low Water	1851 hrs.	Height 1.0 m
Duration of fall 5H 51M		Range 3.2 m

High Water = 1300 hours.

Time in question = 1530 hours.

From the diagram, using 1530 hrs. time and duration of fall as 5h 51m, we determine the height of tide is 2.98 m. Hence 2.98 metres is the correction to be applied to the sounding at 1451 hrs. L.M.T. before comparing it with the Chart.

Exercise VIII

Find the depth of water a vessel drawing 6.4 metres will have under her keel when crossing 5.4 metres patch at Vancouver Harbour on 12th May at 1400 hours Standard Time. The extract from the A.T.T. for the day under reference are given below:-

Extract from A.T.T.		
	Lat. 49° 17′N	
	Long 123° 07′W	
Time Zone + 0800		
	TIME	HEIGHT
	0445..........	4.4 m
12	1120..........	0.3 m
F	1810..........	4.3 m
	2315..........	3.0 m

Solution:

Low Water	1120	Height 0.3 metres
High Water	1810	Height 4.3 metres
Duration of rise	6H 50M	Range 4.0 metres.
Time in question		1400 hours

From the diagram, using 1400 hrs. time and the duration of rise 6H 50M, we determine the height of tide is 1.70 metres.

Total depth of water above shoal	=	5.4 + 1.70
	=	7.10m
Draft of the ship	=	6.4 m
Under keel clearance	=	0.70 metres

Ans.

Exercise IX

Find the height above sea level of a lighthouse whose charted height is 41 metres at DARWIN (Australia) at 2400 hrs. GMT on 21st November. The extracts from A.T.T. are as follows:-

Time Zone — 0930 hrs.	
	Lat 12°28′S
	Long. 130°51′E
	0107.....2.4 m
22nd.	0634.....6.5 m
Thurs.	1312.....0.5 m
	1947.....7.6 m

MHWS + 6.9 metres. at DARWIN.

Solution :

Time GMT	21d	2400 hrs.
Time difference		0930 hrs.
Standard Time	22d+	0930 hrs.

To find the height of tide at 0930 hrs on 22nd November

High water	0634	6.5 m
Low water	1312	0.5 m
Duration of fall	0638 hrs	Range 6.0m.

From the diagram, using 0930 hrs. time and the duration of fall as 6H 38M, we determine the height of tide is 4.04 m.

Height of tide at 0930hrs.		4.04m
Difference between MHWS and height of tide	=	6.9–4.04
	=	2.86 m.
Charted height of light house	=	41.0 m
Exact height of the lighthouse at 0930 hrs.	=	43.86m

Note :- The charted height of the lighthouse is always the height above Mean High Water springs. So the difference between MHWS height and height of tide at a particular time is added to the charted height of lighthouse in order to get the exact height of the lighthouse at that time.

Exercise X

A ship went ashore off the outer harbour of Port Adelaide (Australia) on the Morning of 3rd March at 01 hour 14 minutes before low water. Find the increase in her freeboard at Low water and what is the earliest time she would refloat. The extracts from A.T.T. are as follows:-

Time Zone - 0930		
Lat. 34°47′S		
Long 138°29′E		
	TIME	HEIGHT
	0018..........	0.5 m
3	0622..........	2.3 m
Th	1220..........	0.4 m
	1837..........	2.5 m

Time of Low Water		1220 hrs.	
Time of grounding		1106 hrs.	
To find the height of tide		1106 hrs.	
High Water	0622	Height	2.3 m.
Low Water	1220	Height	0.4 m.
Duration of fall	5 H 58 M	Range	1.9 m.

From the diagram, using 1106 hrs. time and the duration of fall as 5H 58M, we determine the height of tide is 0.59m.

∴ Height of tide at 1106 hrs. = 0.59m

Thus at low water increase in freeboard

= 0.59 − 0.40 = 0.19 metres.

Now calculate the time of refloating between 1220 hrs. and 1837 hrs.

Low water	1220	Height	0.4 m.
High water	1837	Height	2.5 m.
Duration of rise	6H 17M	Range	2.1 m.

Height of tide required for vessel to refloat = 0.59 m. From the diagram, using 0.59 m as height of tide and duration of rise as 6H 17M, we determine the time as 1335 hrs.

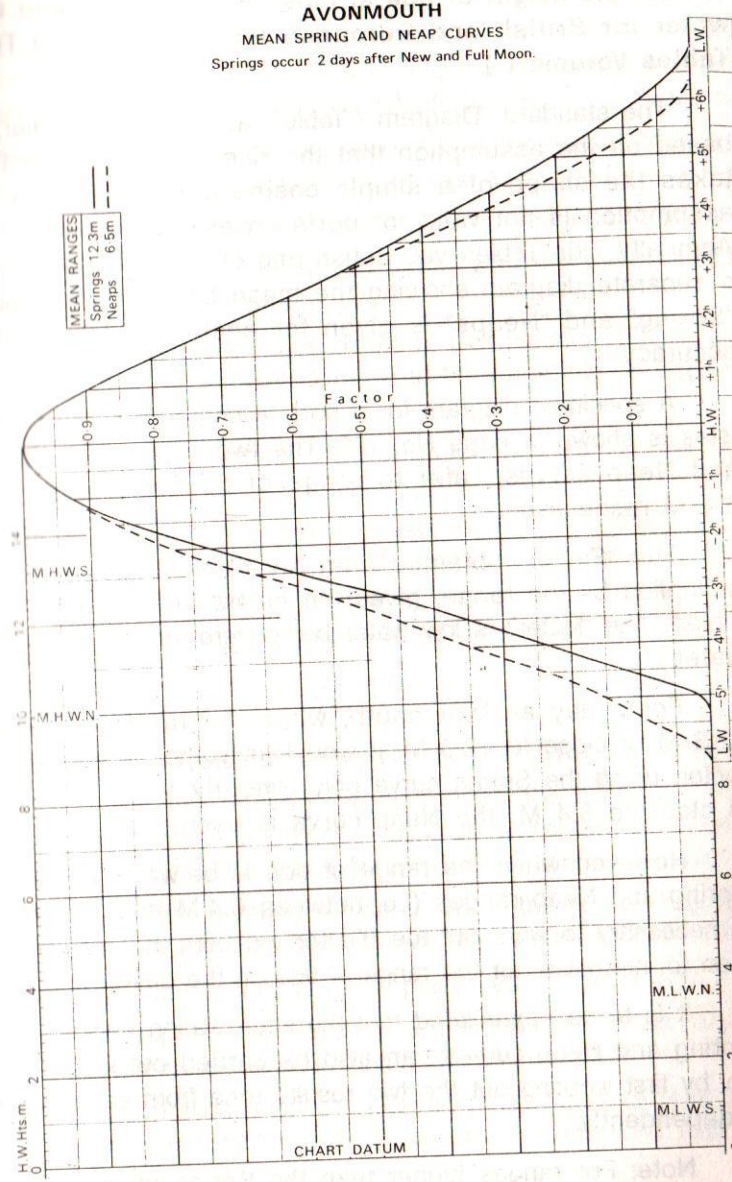
Thus earliest time of refloating will be just after 1335 hrs on 3rd March.

Ans.

AVONMOUTH

MEAN SPRING AND NEAP CURVES

Springs occur 2 days after New and Full Moon.



To find the height of tide at times between high and low water for British and European Ports. (Admiralty Tide Tables Volume I)

The standard "Diagram / Table", as explained earlier, is based on the assumption that the rise and fall of the tide takes the shape of a simple cosine curve. As such an assumption is not valid for ports covered by Volume I of Admiralty Tide Tables viz. British and other European ports, a separate diagram showing the mean tidal curves at both "Spring" and "Neaps" is given for each port for greater accuracy.

A specimen diagram for a port, Avonmouth in the British Isles is shown in page No. 189. The two curves, viz. Spring and Neap curves, refer to range of tide of 12.3 M and 6.4 M respectively.

The "Factor" obtained from the relevant 'curve' when multiplied by the range, gives the height of tide above low water. (The "factor" at low water being 'zero' and 'one' at high water.)

For a day at Avonmouth, when the range of tide is 12.3 M or close to 12.3 M, it would be sufficient to find the factor, using the Spring curve only. Similarly, when the range is close to 6.4 M, the Neap curve is used.

However, when the range of tide is between the mean Spring and Neap ranges (i.e. between 6.4 M and 12.3 M) it is necessary to work out the "Factor" on both the curves and then to interpolate for the range of tide on the day in question.

It is to be appreciated that the interpolation between the Spring and Neap curves can also be carried out in the end i.e. by first working out the two results (one from each curve) independently.

Note: For ranges higher than the Spring range, Spring curve can be used. Similarly, Neap curve is used when range of tide is less than neap range.

Order of Working :

Step1 From the relevant prediction for the standard port, obtain the times and heights of high water and low water before and after the times for which the height is required.

Step 2 Find the duration of rise or fall of the tide as the case may be, from the predicted time of high water and low water.

Step 3 Similarly compute the predicted range of tide.

Step 4 Compare the predicted range with the mean ranges (spring and neap ranges) given on the diagram.

Step 5 On Standard Curve diagram, plot heights of H.W. and L.W. occuring either side of required time and join by slopping line.

Step 6 Enter H.W. time and sufficient others to embrace required time.

Step 7 From required time, proceed vertically to curves, using heights plotted in No. 5 to assist interpolation between springs and Neaps. DONOT extrapolate

Step 8 Proceed horizontally to slopping line, thence vertically to height scale.

Step 9 Read off the height.

To Find the Time for a Given Height (Standard Port) :

Step1 From the relevant prediction for the standard port, obtain the times and heights of high water and low water before and after the times for which the height is required.

Step 2 Find the duration of rise or fall of the tide as the case may be, from the predicted time of high water and low water.

Step 3 Similarly compute the predicted range of tide.

Step 4 Compare the predicted range with the mean ranges (spring and neap ranges) given on the diagram.

Step 5 On Standard Curve diagram, plot heights of H.W. and L.W. occuring either side of required event and join by slopping line.

Step 6 Enter H.W. time and those for half-tidal cycle covering required event.

Step 7 From required height, proceed vertically to sloping line, thence horizontally to curves, using heights plotted in 5 to assist interpolation between Springs and Neaps. Do NOT extrapolate

Step 8 Proceed vertically to Time scale.

Step 9 Read off time.

Example 4

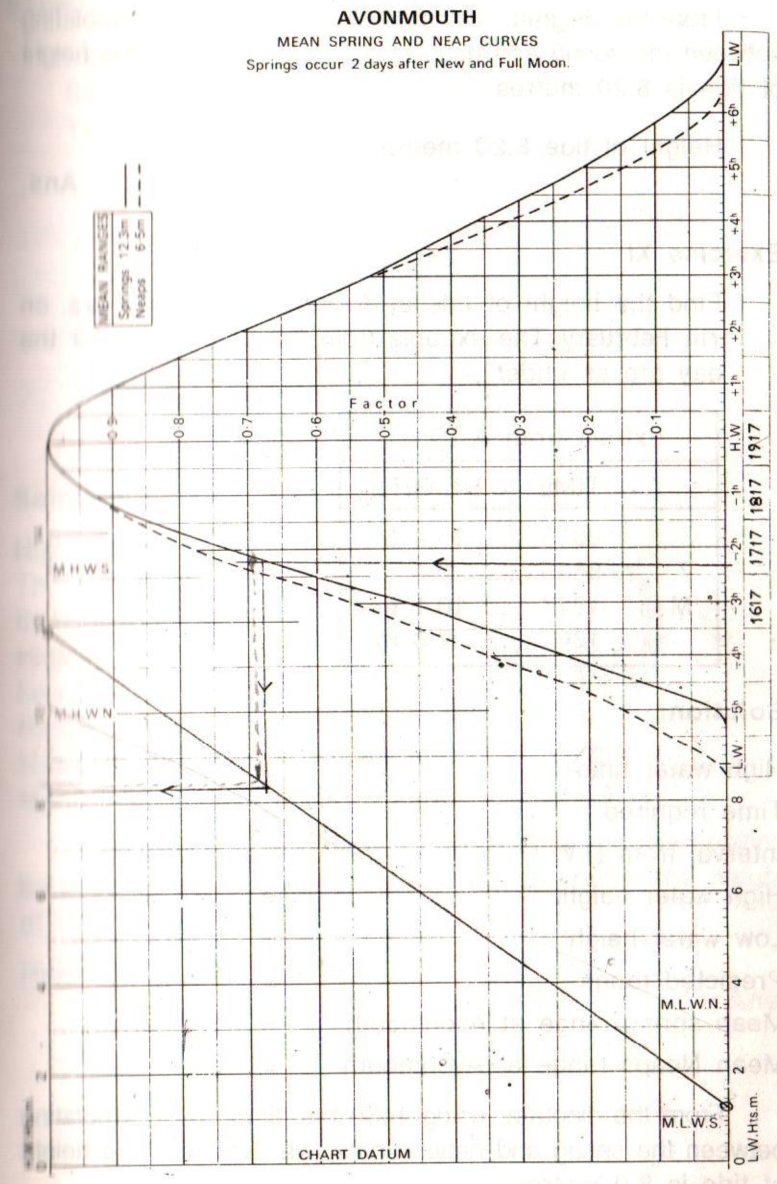
Find the height of tide at Avonmouth at 1700 hrs. on 27th March. The extracts from the Admiralty Tide Tables for the day under reference are given below:-

Extract from A.T.T.		
	TIME	HEIGHT
	0111	1.7 m
27	0653	11.6 m
M	1351	1.2 m
	1917	11.8 m

Solution:

High Water Time	= 1917
Time for which height of tide is required	= 1700
Interval from High water	= 2H 17 M
Highwater height	= 11.8 M
Lowwater height	= 1.2 M
Range of tide	= 10.6 M
Mean spring range at Avonmouth	= 12.3 M (from the Diagram)
Mean Neap range at Avonmouth	= 6.4 M (from the Diagram)
Predicted range for the day	= 10.6 M

As the range for day is not close to either mean spring or neap range, we have to use both the curves and then interpolate between the two.



From the diagram, using 1700 hrs. time and interpolating between the spring and neap curves, we determine the height of tide is 8.20 metres.

Height of tide 8.20 metres

Ans.

Exercise XI

Find the height of tide at Avonmouth at 1430 hrs. on 7th February. The extracts from the Tide Tables for the day are as under :-

Extract from A.T.T.		
	TIME	HEIGHT
	0013........	10.4 m
7	0635..........	2.4 m
M	1227........	10.1 m
	1845..........	2.8 m

Solution:

High water time	=	1227
Time required	=	1430
Interval from H.W.	=	2H03M
High water height	=	10.1 M
Low water height	=	2.8 M
Predicted range	=	7.3 M
Mean spring range at Avonmouth	=	12.3 M
Mean Neaps range at Avonmouth	=	6.4 M

From the diagram, using 1430 hrs. time and interpolating between the spring and neap curves, we determine the height of tide is 8.0 metres.

Height of tide 8.00 metres

Ans.

Exercise XII

Find the height of tide at Avonmouth at 0900 hrs. on 5th January, given the following extracts from Admiralty Tide Tables.

Extract from A.T.T.		
	TIME	HEIGHT
	0536	1.3 m
5	1102	12.2 m
Wed	1758	1.5 m
	2325	11.6 m

Solution

High Water time	=	1102
Time required	=	0900
Interval from H.W.	=	2H02M
High Water height	=	12.2 M
Low Water height	=	1.3 M
Range predicted	=	10.9 M
Mean spring range at Avonmouth	=	12.3 M
Mean neaps range at Avonmouth	=	6.4 M

From the diagram, using 0900 hrs. time and interpolating between spring and neap curves, we determine the height of tide is 9.2 metres.

Height of tide 9.2 metres

Ans.

SECONDARY PORTS

The names of the secondary ports and their serial number are given in the alphabetical order under the "Geographical Index" at the end of the Admiralty Tide Tables. The "Secondary ports" are arranged numerically in Part II of the Tide Tables.

Predictions for secondary ports are made by applying time and height differences to predictions at a selected standard port. These are tabulated in Part II of the Admiralty Tide Tables.

The data on which these differences are based are extremely variable but generally, they rely on at least one month's observations.

The term "secondary port" hence does not necessarily imply that the place concerned must necessarily be of lesser importance than the standard port.

The standard port chosen in Part II is such that it has tidal characteristics similar to those of the "Secondary port". Hence in some cases the secondary port may be seen to be some distance away from the standard port.

To find times and heights of high and low water

The times of high and low water are obtained by applying the time difference tabulated in Part II.

Time and Time difference in Predictions

In the secondary ports, it must be noted that time differences given in Part II, when applied to times of high water and low water at standard ports will give the times of high and low waters at secondary ports "IN THE ZONE TIME TABULATED FOR THE SECONDARY PORT". (The zone time of the secondary port is given in Part II printed directly above the respective secondary port).

Hence any difference in the zone time at the standard port or any difference between the zone times at standard and secondary ports has no significance on the predicted value.

However, if the zone time at the secondary port is different from those tabulated, the same must be corrected for. In other words should a ship be keeping different zone time, from the zone time listed for the secondary port in Part II of A.T.T; Longitude correction must be applied in the usual manner. In A.T.T Volume I, predictions which fall between the times given for the Standard Port at the head of each column can be obtained by simple interpolation between the columns. Time differences must not be extrapolated but only interpolated between the given values for Times at Standard Port which gives values throughout a 24 hour period. Thus for Secondary port referred to Avonmouth.

	H.W		L.W.	
523 Avonmouth	0600 and 1800	1100 and 2300	0300 and 1500	0800 and 2000
514 Cardif	–0015	–0015	–0100	–0030

the H.W. time difference for a tide which occurs at Avonmouth at 1320 hrs. must be interpolated between the values tabulated for 1100 hrs. and 1800 hrs. High Waters which occur at Avonmouth at both 2330 hrs and 0300 hrs. must have their time differences interpolated between those values tabulated for 2300 hrs and 0600 hrs.

Height difference in Predictions

The heights of high and low water are obtained by using the height difference tabulated in Part II.

These differences are given for mean spring and mean neap levels at the standard port. It is normally assumed that there is a linear variation between spring and neaps. Hence the differences for other heights are obtained by simple interpolation or extrapolation. The height of tide so obtained will obviously be with reference to the chart datum of the secondary port.

Seasonal Variations.

It is to be noted that predictions for standard ports of the Admiralty Tables include the "seasonal variations" for those ports. These variations may differ from seasonal variations for the secondary ports.

Hence the first step is, therefore, to SUBTRACT algebraically the seasonal variation for the standard port from the predicted heights obtained from Part I. Height differences for the secondary ports are then applied to them in the usual manner. The final step is to apply i.e. add algebraically the seasonal variation for the secondary port.

Whilst applying the seasonal variation, one must, ofcourse be careful to ensure that the signs of the seasonal variations are correctly applied. Where no seasonal variations are given or they are less than 0.1 M, they can be ignored.

Example V.

Find the times and heights of high and low waters at Mangalore port, on March 10. The extract from Admiralty Tide Tables is given below:

Extracts from Part II of Adm. Tide Tables.

Place	Position		Time difference		Height differences			
	Lat.	Long	MHW	LLW	MHHW	MLHW	MHLW	MLLW
Standard Port 4322 **Karachi**	N	E	–	–	2.7	2.4	1.1	0.4
Secondary port 4385 **Mangalore**	12°51'	74°50'	+0035	+0025	–1.2	–1.1	–0.2	–0.0

Seasonal Changes in Mean Level

	Jan.	Feb.	March	April	May	June	July	Aug	Sep.	Oct.	Nov.	Dec.
Standard Port :-	0.0	0.0	–0.1	0.0	+0.1	+0.1	+0.1	0.0	–0.0	–0.0	0.0	0.0
Secondary Port :-	+0.1	+0.1	+0.1	0.0	0.0	0.0	0.0	–0.1	–0.1	–0.1	0.0	+0.1

Extract from Part - I		
STANDARD PORT		
	TIME	HEIGHT
	0016.............	1.8 M
10	0420.............	2.0 M
F	1226.............	0.8 M
	2013.............	2.3 M

Solution:

	HW	HW	LW	LW
Predicted times at standard Port	0420	2013	0016	1226
Time difference at Secondary Port	+0035	+0035	+0025	+0025
Predicted times at Secondary Port	0455	2048	0041	1251
Predicted height at standard Port	2.0	2.3	1.8	0.8
Seasonal change of M.L. Standard Port	∓0.1	∓0.1	∓0.1	∓0.1
Predicted height less seasonal change (corrected heights at Standard Port)	2.1	2.4	1.9	0.9
Interpolated height difference at Secondary ports	-1.0	-1.1	-0.4	-0.1
Uncorrected heights at Secondary Port	1.1	1.3	1.5	0.8
Seasonal change of M.L. at Secondary Port	+0.1	+0.1	+0.1	+0.1
Predicted height at Secondary Port	1.2	1.4	1.6	0.9

NOTE: (1) Computation of high water is done from the two values of high water tabulated. Similarly, low water is computed from the two tabulated values of low water.

(2) It may be noted in the above question that the zone time at the standard port is –5h00m whilst the zone time at the secondary port is –5h30m. However, as stated earlier, the time difference given in Part II, when applied to times of H.W. & L.W. at standard ports will give the times of high & low waters at Secondary Ports in the zone time tabulated for secondary port (i.e. 5h30m time zone in this case).

Exercise XIII

Using the extracts of Part II A.T.T. given in Example V, and the following extracts of Standard port, find the heights of high water and low water at Secondary Port on 20th March.

EXTRACTS FROM PART - I
STANDARD PORT
Month March

Extracts from A.T.T.
TIME...........HEIGHT
0113.................... 2.8
0759.................... 0.0
1441.................... 2.5
2019.................... 1.3

Solution:

	H.W.	H.W.	L.W.	L.W.
Predicted times at Standard Port	0113	1441	0759	2019
Times difference at Secondary Port	+0035	+0035	+0025	+0025
Predicted height at Secondary Port	0148	1516	0824	2044

	H.W.	H.W.	L.W.	L.W.
Predicted height at Standard Port	2.8	2.5	0.0	1.3
Seasonal change of M.L. at Standard Port	∓0.1	∓0.1	∓0.1	∓0.1
Corrected height at Standard Port	2.9	2.6	0.1	1.4
Interpolated height difference at Secondary Port	-1.3	-1.2	+0.1	-0.3
Uncorrected height at Secondary Port	1.6	1.4	0.2	1.1
Seasonal Change of M.L. at Secondary Port	+0.1	+0.1	+0.1	+0.1
Predicted heights at Secondary Port	1.7	1.5	0.3	-1.2]

Exercise XIV

Find the height of tide at 1230 hrs. standard time at MINABETSU on 17th December. The extracts from A.T.T. are as follows :-

Extracts from Part I
Sandakan Standard Port
Time Zone - 0800 5°50'N 118°07'E
0330............. 0.7 0937............. 1.4 17 1441............. 1.0 Sat. 2105............. 2.1

Extracts from Part II of Adm. Tide Tables

Standard Port	Position		Time Difference		Height Difference			
Sandakan	Lat. N	Long. E	MHW	MLW	MHHW	MLHW	MHLW	MLLW
	–	–	–	–	1.9	1.2	0.8	0.4
Secondary Port								
Minabetsu	46°23'	143°35'	–0707	–0636	–0.8	–0.5	–0.1	–0.1

Seasonal Changes in Mean Level.

	October	November	December	January
Standard Port	0.0	+0.1	+0.1	+0.1
Secondary Port	NIL	Negligible.	NIL	NIL

Solution

	LW	HW
Predicted times at Standard port	1441	2105
Time difference at Secondary port	– 0636	– 0707
Predicted times at Standard port	0805	1358
Predicted height at Standard port	1.0	2.1
Seasonal Correction Standard Port	(–) + 0.1	(–) +0.1
Uncorrected height at Standard port	0.9	2.0
Height difference at Standard port	– 0.1	– 0.8
Uncorrected height at Standard port	0.8	1.2
Seasonal Correction at Secondary port	+ 0.0	+ 0.0
Height at Secondary port	0.8	1.2

Duration of rise = 1358 – 0805 = 05 hrs. 53 mins.
Range = 1.2 – 0.8 = 0.4
Interval from H.W. = 1358 – 1230 = 1 hrs. 28 mins.

From the diagram, using 1230 hrs. time and the duration of rise as 5H 53M, we determine the height of tide is 1.14 metres.

Height of tide = 1.14 metres **Ans.**

Exercise XV

Calculate the depth of water 19th June at 0000 hrs. GMT at a place off TANJONG SORONG where the charted depth is given as 'dries 0.5 metres". The extracts from A.T.T. are as follows:-

Extracts from Part I			
SINGAPORE Standard Port.			
Time Zone – 0800 hrs.		Lat 01°16′N – 103°51′E	
	0339 .... 2.4		0458 ....2.2
	1044 .... 0.4	19th	1151 ....0.6
18th	1736 .... 2.2	Sun	1835 ....2.2
Sat	2315 .... 1.2		

Extracts from Part II of Adm. Tide Tables.

Standard Port	Position		Time Diff.		Height Difference			
Singapore	Lat	Long.	MHW	MLW	MHWS	MHWN	MLWN	MLWS
	—	—	—	—	2.8	2.1	1.1	0.6
Secondary Port								
Tanjong Sorong	0°50′S	131°13′E	+0818	+0820	–1.2	–0.8	–0.4	–0.2

Time Zone for Tanjong Sorong – 0900 hrs.

Seasonal Changes in Mean Level.

	April	May	June	July
Standard Port	0.0	0.0	0.0	– 0.1
Secondary Port	NIL	Negligible	NIL	NIL

Solution

Secondary Port Time 0000 hrs on 19th.
Zone Time Difference + 0900 hrs.
Standard Time at Secondary Port 0900 hrs on 19th June.

	LW	HW
Predicted time at Standard Port	18d. 2315	19d 0458
Time difference at Secondary Port	+ 0820	+ 0818
Predicted time at Secondary Port	19d 0735	1316
Predicted height at Standard Port	1.2 m	2.2 m
Seasonal Correction Standard Port	(–) 0.0	(–) 0.0.
Uncorrected height at Standard Port	1.2	2.2.
Interpolated height difference at Secondary Port	– 0.46	– 0.89.
Uncorrected height at Secondary Port	0.74	1.31.
Seasonal correction Secondary Port	+ 0.0	+ 0.00.
Predicted height at Secondary Port	0.74 m	1.31 m.

Duration of rise = 1316 – 0735 = $5^H\ 41^M$
Range = 1.31 – 0.74 = 0.57.
Interval from HW = 1316 – 0900 = 4H 16M.

From the diagram, using 0900 hrs time on 19th June and the duration of rise as 5H 41M, we determine the height of tide is 0.82 metres.

Height of tide	=	0.82 m
Drying Height	=	– 0.5 m

Depth of water at patch dries 0.5 m = 0.32 Metres. **Ans.**

Note : Drying Heights. A drying height is a sounding on a chart of a point which lies above the level of chart datum. The height of the point above chart datum will give the height of tide above chart datum when the point dries on a falling tide or covers on a rising tide.

Exercise XVI

A Super tanker has to enter the waters off LADY MUSGRAVE ISLAND (Australia) on 28th May at 1800 hrs. The patch at the entrance has charted depth of 28.2 metres whilst the tanker in drawing 27.2 metres and needs 2.3 metres under keel clearance. At what time will the required depth of water be available. The extracts from A.T.T. are as follows :-

Extracts from Part I	
Standard Port Brisbane Bar	
Time Zone – 1000 2722S 153°10′E	
	0442 .... 0.5
28	1016 .... 1.8
SA.	1609 .... 0.4
	2247 .... 2.4

Extracts from Part II of Adm. Tide Tables.

Standard Port	Position		Time Diff.		Height Difference			
Brisbane Bar	Lat.	Long.	MHW	MLW	MHWS	MHWN	MLWN	MLWS
	—	—	—	—	2.1	1.7	0.7	0.3
Secondary Port Lady Musgrave Island	23°5′S	152°23′E	–0125	–0125	+0.1	0.0	+0.2	+0.1

Seasonal changes in Mean Level.

	April 1st	May 1st	June 1st
Standard Port	+ 0.1	+ 0.0	+ 0.0
Secondary Port	+ 0.1	– 0.1	– 0.1

Solution

Draft of the ship	27.2 metres.
Under keel clearance	2.3 m.
Total depth of water required	29.5 m.
Chart datum	28.2 m.
Height of tide required	1.3 metres.

	LW	HW
Predicted time at Standard Port	1609	2247
Time difference at Secondary Port	– 0125	– 0125
Predicted times at Secondary Port	1444	2122
Predicted heights at Standard Port	0.4 m	2.40 m
Seasonal correction at Standard Port	(–) 0.00	– 0.00
Uncorrected heights at Standard Port	0.4 m	2.4 m
Interpolated or Extrapolated height difference at Secondary Port	+ 0.13 m	+ 0.18 m
Uncorrected height at Secondary Port	0.53 m	2.58 m
Seasonal Correction at Secondary Port	– 0.1	– 0.1
Corrected height at Secondary Port	0.43 m	2.48 m

Duration of rise	=	2122 – 1444 = 06 hrs. 38 min.
Range	=	2.48 – 0.43 = 2.05 m
Height of tide required	=	1.30 m

From the diagram, using 1.30 metres as height of tide and duration of rise as 6H 38M we determine the time as 1742 hrs.

∴ Required depth will be available at 1742 hrs.

Ans.

Exercise XVII

Determine the ETD in local time from Singapore in order to arrive off YOKKAICHI with an under-keel clearance of 2.0 metres where the charted depth is 8.0 metres during the A.M. falling tide on 10th April. Given the Vessel's speed 15.0 knots. Distance to go 2340 miles, maximum draft 7.20 metres. The extracts from A.T.T. are as follows :-

Extracts from Part I	
Standard Port Yokohama	
Time Zone – 0900 36°26′N 139°40′E	
	0357............1.6 m
10	0942............0.7 m
Su	1534............1.5 m
	2152............0.3 m

Extracts from Part II of Adm. Tide Tables.

Standard Port	Position		Time Diff.		Height Difference			
Yokohama	Lat.	Long.	MHW	MLW	MHHW	MLHW	MHLW	MLLW
	—	—	—	—	1.7	1.6	0.9	0.3
Secondary Port								
Yokkaichi	34°57′S	136°38′E	+0100	+0100	+0.2	+0.3	0.0	0.1

Seasonal changes in Mean Level.

	March 1st	April 1st	May 1st	June 1st
Standard Port	– 0.1	– 0.1	– 0.1	0.0
Secondary Port	– 0.1	– 0.1	– 0.1	0.0

Solution

Draft	=	7.20 metres
Required Under keel clearance	=	2.00 metres.
Total depth of water	=	9.20 metres.
Charted depth	=	8.00 metres.
Height of tide required	=	1.20 metres.

	HW	LW
Predicted time at Standard port	0357	0942
Time difference at Secondary port	+ 0100	+ 0100
Predicted times at Secondary port	0457	1042
Predicted height at Standard port	1.6	0.7
Seasonal correction at Standard port (–)	– 0.1	– 0.1
Uncorrected height at Standard port	1.7	0.8
Height difference at Secondary port	+ 0.20	+ 0.02
Uncorrected height at Secondary port	1.90	0.82
Seasonal correction at Secondary port (+)	– 0.10	– 0.10
Correct height at Secondary port	1.80	0.72

Duration of fall = 1042 – 0457 = 05 hrs. 45 Min.

Range = 1.80 – 0.72 = 1.08 m.

Required height of tide at Yokkaichi = 1.20 m.

From the diagram, using 1.20 metres as height of tide and duration of fall as 5H 45M, we determine the time as 0757 hrs.

∴ Required time = 0757 hrs Local Standard Time

Distance to Go = 2340 miles speed 15 knots.

$$\text{Time taken} = \frac{2340}{15} = 6 \text{ days } 12 \text{ hours.}$$

Required time at Yokkaichi 10d 0757 hrs. in time Zone – 0900 hrs.

Steaming Time 6d 12 hrs.

∴ Departure time at Singapore 3d 1957 hrs in Time Zone – 0900 hrs.

Departure time in GMT at Singapore 3d 1057 hrs. as Singapore is – 0800 hrs ahead of GMT.

∴ Departure time at Singapore is 3d 1857 hrs.

ETD Singapore 1857 hrs. on 3rd April. **Ans.**

Exercise XVII

On 23rd December at SHIMIZU KO port, find the timings to load upto 1900 hrs when the freeboard deck and the wharf are the same level, if the vessel has a freeboard of 2.25 metres and the wharf is 2.2 metres in height above MHHW. The extracts from A.T.T. are as follows :-

Extracts from A.T.T. Part I		
Standard Port Yokohama		
Time Zone – 0900 36°26′N 139°40′E		
	0047..............	– 0.1
23	0759..................	1.8
Fr.	1307..................	1.1
	1820..................	1.8

Extracts from A.T.T. Part II

Standard Port	Position		Time Diff.		Height Difference			
Yokohama	Lat.	Long.	MHW	MLW	MHHW	MLHW	MHLW	MLLW
	—	—	—	—	1.7	1.6	0.9	0.3
Secondary Port Shimizu Ko	35°00′N	138°30′E	+0037	+0035	–0.3	–0.2	–0.1	0.0

Seasonal changes in Mean Level.

	November	December	January
Standard Port	0.0	0.0	0.0
Secondary Port	0.0	0.0	0.0

Solution

Freeboard of the ship = 2.25 m.

Height of wharf above MHHW = 2.20 m.

∴ Tide has to fall below MHHW = 0.05 m then freeboard deck will be in line with wharf.

MHHW at Secondary Port 1.7 – 0.3 = 1.4 m

Ht. of tide required for the wharf to be in line with freeboard deck = 1.4 – 0.05

= 1.35 metres.

	LW	HW	LW	HW
Predicted time at Standard Port	0047	0759	1307	1802
Time difference at Secondary Port	+ 0035	+ 0037	+ 0035	+ 0037
Predicted times at Secondary Port.	0122	0836	1342	1857
Predicted height at Standard Port	(–) 0.1	1.8	1.1	1.8
Seasonal correction at Standard Port	(–) 0.0	0.0	0.0	0.0
Uncorrected height at Standard Port	(–) 0.1	1.8	1.1	1.8
Interpolated/Extrapolated height difference	0.00	– 0.4	– 0.1	– 0.4
Uncorrected height at Secondary Port	– 0.1	1.4	1.0	1.4
Seasonal correction at Secondary Port	(–) + 0.0	+ 0.0	+ 0.0	+ 0.0
Corrected height at Secondary Port	– 0.1	1.4	1.0	1.4

(a) To calculate the timings of loading between 0122 hrs. and 0836 hrs:-

Duration of rise = 7H 14M.

The time the freeboard deck will be in line with the jetty cannot be worked out as the interval between low water and high water is more than 7 hours and hence this part of the question should be done by Harmonic constants.

(b) To find the time when the height of tide is 1.3 metre between 0836 hrs. and 1342 hrs.

High water	0836	Height 1.4 m.
Low water	1342	Height 1.0 m.
Duration of fall	$5^H 06^M$	Range 0.4 m.

From the diagram, using 1.35 metres as height of tide and duration of fall as 5H 06M, we determine the time as 0946 hrs. Hence jetty will be in level with freeboard deck at 0946 hrs.

Hence jetty will be in level with freeboard deck at 0946 hrs.

Ans.

(c) To find the time between 1342 hrs. and 1857 hrs. when height of tide will be 1.35 m.

Low water	1342	Height 1.0 m.
High water	1857	Height 1.4 m.
Duration of rise	0515 hrs.	Range 0.4 m.

From the diagram, using 1.35 metres as height of tide and duration of rise as 5H 15M, we determine the time as 1749 hrs.

Hence jetty will be in level with freeboard deck at 1749 hrs.

∴ Jetty will be in level with freeboard deck at 0946 hrs. and 1749 hrs. on 23rd December upto 1900 hrs.

Ans.

Exercise XIX

A light house at Broome has a charted elevation of 41 metres. What will be its actual elevation at 1630 hrs. (Standard Time) on 3rd September. The extracts from A.T.T. are as follows :-

Extracts from part I.		
Standard Port. Port Head Land		
Time Zone – 0800		
20°18'S 118°35'E		
	TIME	HEIGHT
	0308	5.7 m
3	0942	2.7 m
TU	1549	4.6 m
	2135	3.3 m

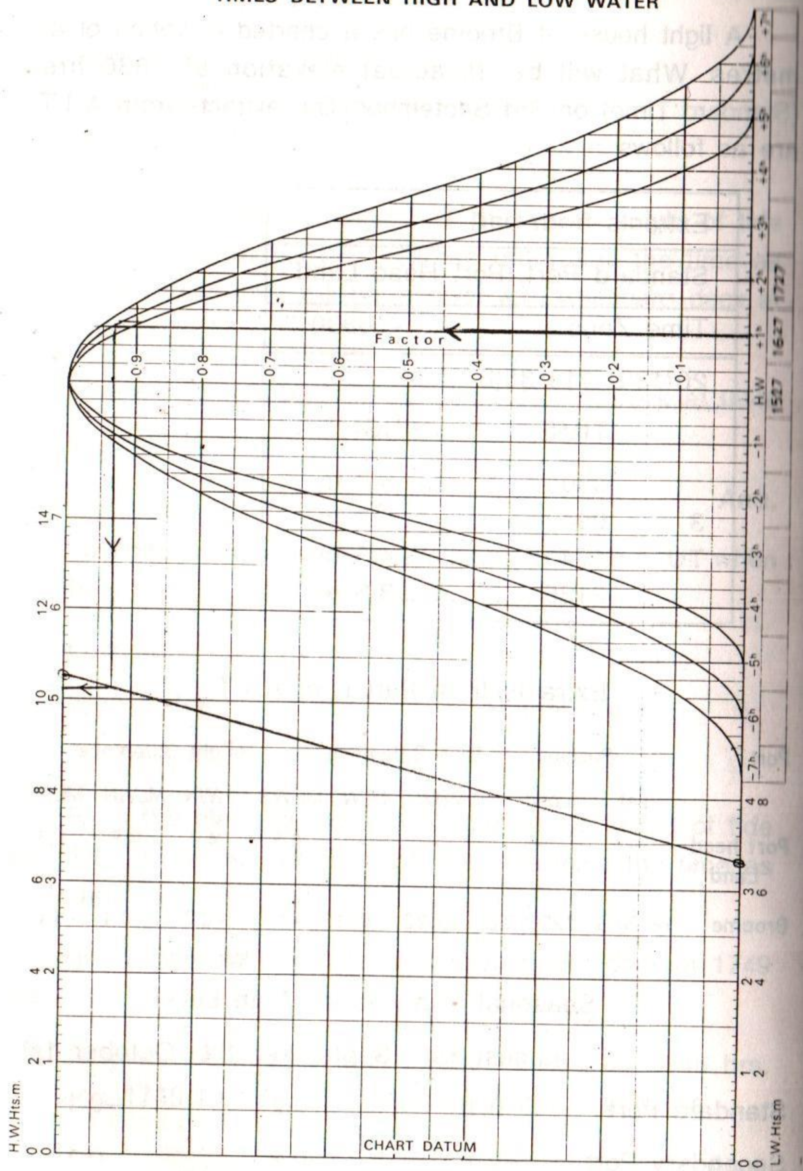
Extracts from Part II of A.T.T.

Port	Position		Time Difference		Height Difference			
	Lat	Long	MHW	MLW	MHWS	MHWN	MLWN	MLWS
Port head Land	–	–	–	–	6.8	4.7	3.5	1.3
Broome	18°00'S	122°13'E	–0022	–0012	+1.7	+0.7	+0.1	–1.0

Seasonal Changes in Mean Level

	August 1st	September 1st	October 1st
Standard Port	–0.1	–0.2	–0.1
Secondary Port	–0.1	–0.2	–0.1

FOR FINDING THE HEIGHT OF THE TIDE AT TIMES BETWEEN HIGH AND LOW WATER



Solution :

Predicted time at Secondary Port	1630 hrs.	
	H.W	L.W.
Predicted time at Standard Port	1549	2135
Time difference at Secondary Port	–0022	–0012
Predicted time at Secondary Port	1527	2123
Predicted height at Standard Port	4.6m	3.3m
Seasonal Correction at Standard Port(-)	∓ 0.2	∓ 0.2
Uncorrected heights at Standard Port	4.8m	3.5m
Interpolated or extrapolated height difference at Secondary Port	+0.66	+0.00
Uncorrected height at Secondary Port	5.46m	3.5m
Seasonal Correction at Secondary Port (+)	–0.2	–0.2
Corrected height at Secondary Port	5.26m	3.3m

Duration of fall = 2123 – 1527 = 5 hrs. 56 min

Range = 5.26 – 3.3 = 1.96m

From the diagram using 1630 hrs. time and the duration of fall as 5H 56M, we determine the height of tide is 5.1 metres.

Height at Tide	= 5.1 metres.
Standard Port MHWS	= 6.8m.
Height Difference	= +1.7m.
Secondary Port MHWS	= 8.5m.
Height of Tide	= 5.1m.
Tide has fallen below MHWS	= 3.4m.
Charted height of Lighthouse	= 41.0m.
Actual height of lighthouse	= 44.4 metres

Ans.

Exercise XX

Find the earliest possible time on 14th March to cross under the bridge with 1 metre clearance above the masthead at Chinula Point, if the vessel has a draft of 22 metres and the height of the mast in 40 metres above the keel, height of the bridge is 17 metres. The extracts from A.T.T. are as follows :-

Extracts from Part I.		
Standard Port. Prince Rupert		
Time Zone +0800		
54°19′N 130°20′W		
	TIME	HEIGHT
14	0023..........	5.9 m
Th	0620..........	2.0 m
	1224..........	6.2 m
	1841..........	1.2 m

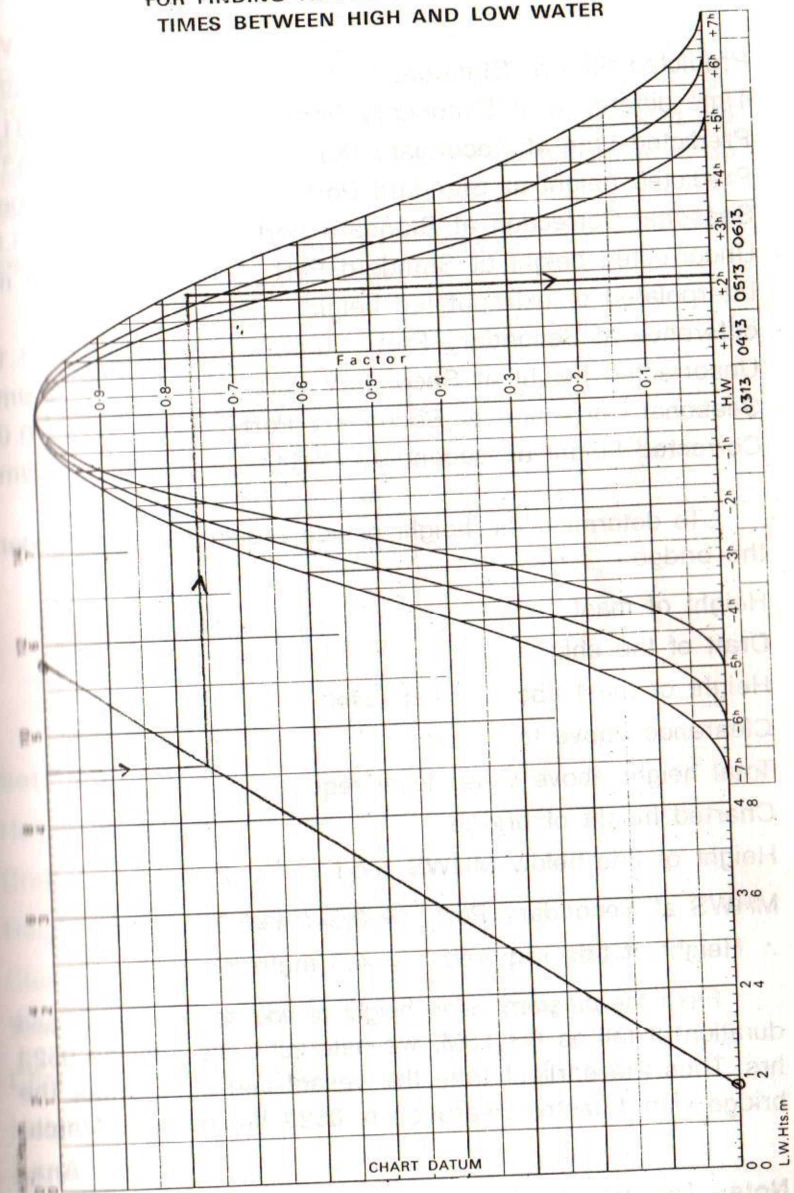
Extracts from Part II of A.T.T.

Standard Port	Position Lat	Long	Time Difference MHW	MLW	Height Difference MHWS	MHWN	MLWN	MLWS
Prince Rupert	–	–	–	–	6.5	5.2	2.5	1.2
Secondary Port								
Chinula Point	60°31′N	151°18′W	+0250	+0311	+0.1	–0.4	–0.8	–1.6

Seasonal Changes in Mean Level.

	February	March	April
Standard Port	+0.1	0.0	0.0
Secondary Port	0.0	0.0	–0.1

FOR FINDING THE HEIGHT OF THE TIDE AT TIMES BETWEEN HIGH AND LOW WATER



Solution :

	H.W.	L.W.
Predicted time at Standard Port	0023	0620
Time difference at Secondary Port	+ 0250	+ 0311
Predicted time at Secondary Port	0313	0931
Predicted height at Standard Port	5.9m	2.0m
Seasonal Correction at Standard Port	(-) 0.0	0.0
Uncorrected height at Standard Port	5.9m	2.0 m
Interpolated or extrapolated height difference at Secondary Port	−0.13	−1.1
Uncorrected height at Secondary Port	5.77m	0.9m
Seasonal Correction at Secondary Port	(+) 0.0	0.0
Corrected height at Secondary Port	5.77m	0.9m

To determine the height of tide required to pass under the bridge:-

Height of mast	40 metres
Draft of the ship	22 metres
Height of mast above water level	18 metres
Clearance above the mast	1 metre
Total height above water level reqd.	19 metres
Charted height of bridge	17 metres
Height of tide below MHWS reqd	2 metres

MHWS at Secondary Port = 6.5+0.1=6.6 metres.

∴ Height of tide required = 4.6 metres.

From the diagram using height of tide as 4.6 metres and duration of fall as 6H 18M, we determine the time as 0523 hrs. Thus the earliest time the vessel can pass under the bridge with 1 metre clearance is 0523 hrs on 14th March.

Ans.

Note:- The vessel will normally try to pass under the bridge on a falling tide.

Exercise XXI

Find the earliest time after first high water on 13th September at DARWIN, a vessel can cross below the bridge if her draft is 14 metres and the height of the mast is 50 metres with a minimum clearance of 1.5 metres between the mast and the bridge. The charted height of the bridge is 35 metres.

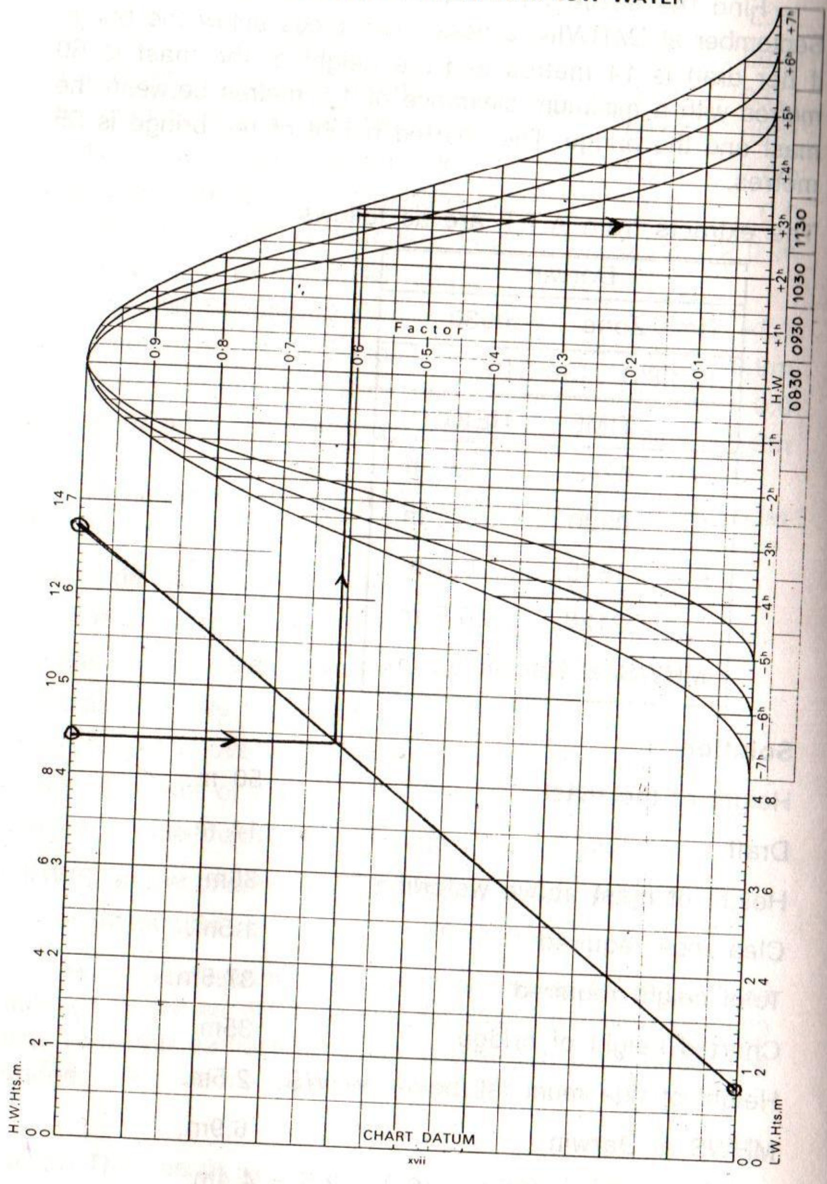
The extracts from A.T.T. are as follows :-

Darwin		
Time Zone − 0930		
12°28′S 130°51′E		
	TIME	HEIGHT
	0245	1.9 m
13	0830	6.7 m
F	1515	0.8 m
	2128	6.5 m
MHWS at Darwin 6.9 m.		

Solution :

Height of the mast	50 m.
Draft	14 m.
Height of mast above waterline	36m.
Clearance required	1.5m.
Total height required	37.5m.
Charted height of bridge	35m.
Height of tide must fall below MHWS	2.5m.
MHWS at Darwin	6.9m.
Height of tide required	6.9 − 2.5 = 4.4m.

FOR FINDING THE HEIGHT OF THE TIDE AT TIMES BETWEEN HIGH AND LOW WATER



H.W	0830 hrs.	Height	6.7m.
L.W.	1515 hrs.	Height	0.8m.
Duration of fall	6H 45M	Range	5.9m.

From the sloping curve, using height of tide required 4.4 m and duration of fall as 6H 45M we get the time as 1124 hrs.

Thus the vessel can cross the bridge at the earliest time after first high water is 1124 hrs. on 13th September.

Ans.

Exercise XXII

A vessel with LBP 157m and her draft is For'd 3.78 m and Aft. 5.90m. she has a gantry crane with a height 34.0 m above the keel and is placed 85 metres from the stem. Determine the earliest time on 3rd August when the vessel may pass under a power cable with 3.0 metres clearance at Bangkok Bar. The charted height of the cable is 30.572 metres. The extracts from A.T.T. are as follows:-

Bangkok Bar		
Time Zone – 0700 hrs.		
13°27′N 100°36′E		
	TIME	HEIGHT
2 F	0306	1.7 m
	0858	3.1 m
	1440	2.0 m
	2046	3.5 m
3 Sat	0339	1.6 m
	1003	3.0 m
	1507	2.4 m
	2057	3.4 m
MHWS at Bangkok Bar is 3.5m.		

Solution :

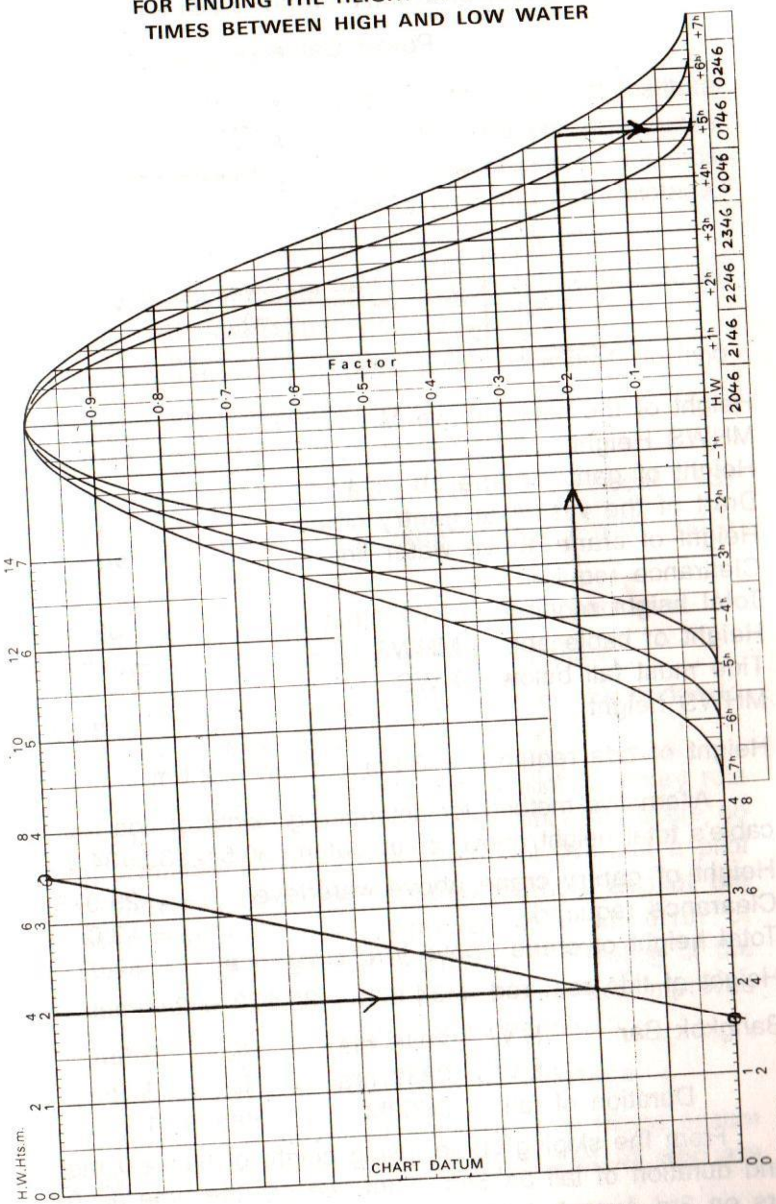
Draft F 3.78m A 5.90m Trim=5.90-3.78=2.12m LBP=157m. Gantry crane is 85m from stem.

For 157m length difference in draft = 2.12m.

for 1m lenght difference in draft = $\frac{2.12}{157}$

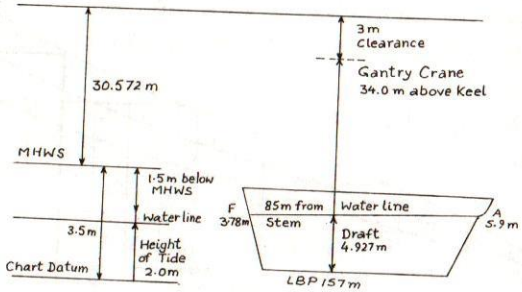
For 85m lenght difference in draft = $\frac{2.12}{157} \times 85 = 1.147\text{m}$

FOR FINDING THE HEIGHT OF THE TIDE AT TIMES BETWEEN HIGH AND LOW WATER



Draft of the vessel at Gantry crane=3.78+1.147=4.927m

Power Cable



Height of the cable above MHWS	30.572m.
MHWS Height	3.5m.
Height of gantry crane above keel	34.0m.
Draft of the vessel at gantry crane	4.927m.
Height of crane above water line	29.073m.
Clearance required	3.0m
Total height required	32.073m
Height of cable above MHWS	–30.572m.
Tide must fall below MHWS	1.501m.
MHWS height	3.50m.

Height of tide required = 3.5m – 1.5m = 2.0m.

Alternative method for determining height of tide required cable's total height above chart datum=30.572+3.5=34.072m.

Height of gantry crane above waterlevel	= 29.073m.
Clearance required	= +3.0m.
Total height of crane above W/L clearance	= 32.073m.

Height of tide required = 34.072 – 32.073 = 2.0 metre

Bangkok Bar	H.W.	2046 hrs.	Ht.	3.5m.
	L.W.	0339 hrs.	Ht.	1.6m.
Duration of fall		6H53M	Range	1.9m.

From the sloping curve, using height of tide 2.0 metres and duration of fall as 6hrs. 53m, we get the time as 0136 hrs on 3rd August. Hence the earliest time the vessel can pass under the cable is 0136 hrs. or 3rd August. **Ans.**

CHAPTER XX

PILOTAGE

Why are pilots engaged

The Command Working Group of The Nautical Institute identified the following as some of the reasons why pilots are engaged and observed that the order of priority depends upon circumstances. They may be divided into pure pilotage, liaison, shiphandling, and bridge support.

1. For their ability to anticipate accurately the effects of currents and tidal influences.
2. For their expertise in navigating in close proximity to land and in narrow channels.
3. For their understanding of local traffic.
4. For their ability to work effectively with the local VTS.
5. For their language ability when dealing with shore services.
6. For their expertise in handling tugs and linesmen.
7. To support the master and to relieve fatigue.
8. To provide an extra person or persons on the bridge to assist with navigating the ship.

The question as to whether or not a pilot's primary role is to improve safety is difficult to answer since there are no measures available to verify this statement. Without a pilot a shipmaster may be more cautious. Without a pilot the shipmaster may be more prone to make an error of judgement at a critical point of approach. The feeling of the group was that the influence of a pilot on board improves both the safety and efficiency of the operation.

Duty of the Master and Crew During Pilotage

The master of a ship must amongst other things ensure the safety of the ship, of all on board and of all who are threatened in any way by the proximity or operations of other ships. In the execution of his duties, he is entitled to the full co-operation and assistance from his officers and other members of his crew. All on board must go about their tasks in accordance with those ordinary practices of seamen that have been tried and tested over a long period of time i.e., the well understood standards of seamanship that safeguard against accident or error. It is the master's responsibility to ensure that the crew support the pilot in his duties and the master may delegate the authority for this to the officer of the watch or other appropriate officers.

It is the responsibility of the master, officers and other members of the crew to pass on all relevant information, including defects and peculiarities, to the pilot and to keep a proper lookout. Such a duty has been interpreted by the courts to include the duty to report all material circumstances and facts which might influence the pilot's actions, even if the pilot is in a position where he ought to be able to see things clearly for himself.

Where, in the masters's opinion, the situation developing is obviously dangerous, it is his duty to draw the pilot's attention to the risk and, if necessary in his judgement, take over the conduct of the vessel. The master is not justified in doing nothing.

The duty of the pilot is to direct the navigation of the ship, and to conduct it so far as the course of the ship is concerned. He has no other power on board. The common law relationship between master and pilot is such that, when the latter is legally responsible for his own actions and the master's right to interfere, without incurring his own liability, is restricted to circumstances where there is clear evidence of the pilot's inability or incompetence.

The legal position of the pilot on board a vessel is aptly summarised by the Canadian Royal Commission on Pilotage, Ottawa 1968, as follows:

'to conduct a ship' must not be confused with being 'in command of a ship'.

The first expression refers to action, to a personal service being performed; the second to a power. The question whether a pilot has control of navigation is a question of fact and not of law. The fact that a pilot has been given control of the ship for navigational purposes does not mean that the pilot has superseded the master. The master is, and remains, in command; he is the authority to aboard. He may, and does, delegate part of his authority to subordinates and to outside assistants whom he employs to navigate his ship i.e., pilots. A delegation of power is not an abandonment of authority, but one way of exercising authority.

However, laws of most foreign countries provide that a pilot whose employment is compulsory is not regarded as having control of navigation of ship, but has his duties restricted to advising the master of local conditions affecting safe navigation.

Voluntary and Compulsory Pilots

The pilot must, of course, possess many of the mariner's skills including a knowledge of the Rules of the Road, navigation, and the use of all forms of navigation equipment. A clear distinction must be made between voluntary and compulsory pilots.

A voluntary pilot is one engaged for the convenience of the vessel. A North Sea pilot employed to take a ship between the Rotterdam and Bremerhaven sea buoys would be one example of a voluntary pilot. No statue requires a ship to have a pilot aboard but the master or owner hires the pilot to aid in making the passage expeditiously.

The owner, through the master, has great control over the voluntary pilot. The pilot need not be hired in the first place, or the pilot's services can be rejected during the passage and the vessel continue to her destination. The voluntary pilot is in a significantly different position aboard ship than the compulsory pilot. Practically speaking the master can feel much more free to advise or relieve a voluntary pilot-the voluntary pilot is in much the same position as the ship's mates.

A compulsory pilot, on the other hand, is one that is required by law to be aboard while the ship is navigating certain specified areas. Penalties such as fines or imprisonment, or both, are the hallmarks of compulsory pilotage laws. If a ship is allowed by statute to refuse the services of a pilot provided she pays a portion of the pilotage fee and the pilotage is not compulsory.

The relationship between master and compulsory pilot is in many ways unique in that it is usually defined by custom, practice, and statute rather than contract. While the pilot is generally neither an employee of the ship nor a member of her crew, he is ultimately subordinate to the master, although the degree of subordination is less than

popularly perceived. The public and the industry benefit equally from this working arrangement and from the degree of overlapping responsibility that compels both pilot and master to be concerned about a vessel's safety.

The compulsory pilot is not aboard in a purely advisory capacity. That pilot is in charge of the navigation of the ship while aboard and the ship's crew is required to obey the compulsory pilot's orders relating to navigation unless the master determines it is necessary to intercede for reasons yet to be discussed. A compulsory pilot is responsible for his own actions and receives a significant fee because of this responsibility. In the presence of the compulsory pilot, a master's responsibility is not total and forever. Both master and pilot have a job to do and bear an unusual degree of responsibility not only to the vessel, cargo, and crew, but also the public.

An exception is found to the traditional master/pilot relationship at the Panama Canal. The Panama Canal Commission accepts a greater degree of liability in exchange for greater control of ships' navigation in that strategic waterway. Inside the locks of the Panama Canal, Commission is liable for payment for injuries to the vessel, cargo, crew, or passengers arising out of a passage through the locks under the control of employees of the Commission, unless the Commission shows that the injury was caused by a negligent act of the vessel. Outside the locks the Commission is liable for payment for injuries to a vessel, cargo, crew, or passengers when such injuries are proximately caused by the negligence or fault of a Canal Commission employee... provided that in the case of a ship required to have a Panama Canal pilot on duty, damages are only payable if at the time of injury the navigation was under the control of the Panama Canal pilot.

Shipmasters should be aware of the manner in which the traditional master/pilot relationship is distorted in the special circumstance.

The Master's Responsibilities in Pilotage Waters

The master retains overall responsibility for the vessel and her operation, for having a competent watch on duty and seeing that they perform their work efficiently, for being sure a proper lookout is maintained, and for compliance with all regulations and statues including the Rule of the Road (COLREGS). The master's authority is never completely in abeyance even while a pilot (compulsory or not) has immediate charge of the ship's navigation. The master is also responsible for his own professional competence, including having sufficient knowledge and experience to be able to judge the pilot's performance and recognize significant pilot error, and to have studied and the local waters and be able to recognize known and published dangers.

The master has a duty to advise or relieve a pilot in cases of:

1. Intoxication.
2. Gross incompetence to perform the task at hand.
3. When the vessel is standing into danger that is not obvious to the pilot
4. When the pilot's actions are in error due to a lack of appreciation of particular circumstances, including the limitations of the particular ship being handled.

In carrying out these responsibilities the master may either advise or relieve the pilot, at the master's discretion. In practice, there is a real burden upon the master to justify relieving the pilot should some casualty result so the action of relieving must not be arbitrary. There are several ways to do a job and, while admittedly some are more expeditious than others, the master must not relieve the pilot simply because he feels that he can do a better job - the pilot should only be relieved when the master feels, based upon professional experience and training, that the vessel, crew, or cargo is being placed in real and imminent danger because

of that pilot's present course of action. On the other hand, the master is negligent if action is not taken when required. The master first objects to an action, then recommends an alternative and only in the rare case when the pilot refuses to accept a recommendation does the master relieve a pilot in a timely manner - while it is still possible to avoid an accident.

The decision about when to become involved is more difficult than the absolute problem of whether it is necessary to do so. There is a natural reluctance to act because of the ramifications in case of a casualty, yet the question of timing is most critical. Relief usually occurs when it is too late - when the situation has deteriorated so far that even the most competent shiphandler could not correct matters and the master's efforts then only complicate an already bad situation. There is no equipment that a ship be in extremis before the pilot is relieved, only that the master forsees danger should a present course of action continue.

It is imperative that the master be sufficiently skilled in shiphandling to recognize a problem early, and have sufficient confidence in those skills to take prompt and decisive action if it is necessary to relieve a pilot. The correctness of action taken reflects the training and experience that a master has had, and it is too late to compensate for years of neglect in this area at such a time. The decision to relieve a pilot is not an easy one, but a master who instead stands by as the vessel heads for certain catastrophe remains a responsible party and must take action. It is a judgement that can only be made based on professional experience and is but one example of why the title "shipmaster" bears a connotation of unusual responsibility.

Release from liability forms

Occasionally a master is presented with a form to be signed releasing the pilot from liability. These forms may be based on local practice or special circumstances such as a tugboat strike. The validity of these forms in a particular case is questionable and depends on local laws and regulations of which the master cannot reasonably be expected to have knowledge.

In as much as the master may be under pressure not to delay the vessel, and may not be able to consult with anyone about the advisability of signing a release, he may elect to sign and note over the signature that the release is "Signed under protest so that the vessel may proceed." An entry to that effect should be made in the ship's log. Forward a copy of the release to the owners so they can advise you about signing such documents in the future.

In any case, the form will have no immediate practical effect since the master has ultimate responsibility for the ship in any case, and the document in no way alters the master's conduct during the docking or other work at hand.

Master/Pilot Information Exchange

a) Pilot supplied by Master with relevant ship-handling information (draught, trim, turning circles, peculiar manoeuvring characteristics in restricted water depth/ channel width and other data). This information may be displayed at the conning position.

b) Proposed track, plan, alternative plan, and available anchor berths along route explained by Pilot and agreed with Master, Charts compared with the Pilot's charts.

c) If required, appropriate Master/Pilot information exchange from may be used.

d) Safe progress of the ship in relation to agreed track and plan monitored by Master and Officer of the Watch and the execution of orders checked.

e) Berthing/unberthing plan, including the availability and use of tugs and other external facilities agreed by Pilot and Master.

f) Tide, set, wind force and direction, visibility expected along route.

g) Pilot informed of position of life-saving appliances provided for his use.

Check List of Items to be agreed between the Master and the Pilot

1. **Navigation Advice to Pilot**
    a. Vessel's heading, speed, r.p.m's (speed increasing/ decreasing).
    b. Distance off/bearing of nearest appropriate navigation aid or landmark.
    c. ETA at next course change position, next course/ heading.
    d. Point out converging and close-by traffic.
    e. Depth of water under the keel.
    f. Any other items.

2. **Reach Agreement on Underway Procedures**
   a. Manoeuvres for narrows, bends, turns, etc.
   b. Courses/headings, distance off danger areas, maximum speed.
   c. Restrictions: day versus night movement/berthing.
   d. Tide and current conditions not acceptable.
   e. Minimum acceptable visibility at any point.
   f. Use of anchor (planned, emergency).
   g. Manoeuvres not requiring tugs.
   h. Manoeuvres requiring tugs.
   i. Number of tugs required (and when).
   j. Source of tug securing lines: ship or tug.
   k. Push/pull power of required tugs.
   l. Communications procedure between vessel and tugs.
   m. Placement of tugs alongside.
   n. Crew standby requirements - numbers available and stations.
   o. Expected time vessel has to arrive at berth/turning basin at high / low / slack water - average speed to this position.
   p. any other items.
3. **Reach Agreement on Mooring/Unmooring Procedures**
   a. Maximum acceptable wind force and direction.
   b. Unmooring procedures without tugs in event of emergency.
   c. Sequence of running out/retrieving mooring lines, wires.
   d. Mooring lines to be run out by launch and time to run lines.
   e. Provision for dock linehandlers.
   f. Determine which side to.
   g. Fire wires required.
   h. Any other items.

Master / Pilot Information Exchange Form
(Information to be Provided by Master)

Master ____________________ Date __________

Please provide the following information about your vessel:

VESSEL PARTICULARS

Vessel ss/mv	Displacement	Draft Fwd	Aft	Midships
L.O.A.	Breadth	Distance bow to manifold	Tankers only	Distance manifold to bridge

Main Engine Turbine Diesel Bridge Control of Engines Yes No

Manoeuvring Speed/Revolutions Critical RPMs __________

Full Speed	Half Speed	Slow	Dead Slow
Knots	Knots	Knots	Knots
Revolutions	Revolutions	Revolutions	Revolutions

Maximum astern revolutions ____________________

Max. time main engines can go astern ____________________ minutes.

If necessasry to exceed manoeuvring full ahead allow __________ minutes for slowing down.

Sea speed loaded :__________ Sea Speed Ballast:__________

Present state of M.E/Telegraphs: ____________________

Ship Handling information and peculiarties of Ship.

Navigation Aids

__________cms Radar on__________Range Display Mode__________

__________cms Radar on__________Range Display Mode__________

Other Navigational Aids Available :-

VHF on channel____________________Gyro error __________

Equipment Defects/Limitations which may effect pilotage

Navigational Advice :-

(1) Vessel's heading speed, R.P.M.

(2) Point out converging & close by traffic

GENERAL INFORMATION TO PILOT e.g. L.S.A. for Pilot's use.

INFORMATION TO BE PROVIDED BY PILOT

Pilot Mr.________________ Date__________

Please provide following information to the Master:

1. Intended navigation plan for the passage.
2. Speed(s) required at different stages of the passage.
3. Any navigation restrictions:- Dry versus night navigation etc.
4. Status of navigational aids in Pilotage waters.
5. Tides, currents, weather anticipated.
6. Expected traffic conditions.
7. Any other information critical to the safe passage.
8. Contigency plans, alternative routes (if available).
9. Minimum visibility acceptable at any time.
10. Use of anchor/anchors (planned or emergency).
11. E.T.A. at critical points of navigation.
12. Any special local regulations.
13. Latest charts for pilotage area.
14. Number of tugs required for berthing and which side alongside.
15. Communication system between tugs and the ship.
16. Any special requirements? If so, describe:

TEST PAPER I

[English Channel (Eastern Portion) B.A. Chart No. 2675]

(DEVIATION CARD II)

I. (a) At 1530 hrs., while heading 200° (C) St. Catherine Point Lt. Ho. bore 315° (C) and Nab Tower bore 027° (C). Find the ship's position.

(b) From the position obtained at 1530 hrs. find a compass course to steer to pass Start Point Lt. Ho. 7 miles off to starboard, counteracting a current setting 155° (M) at 4 knots. Wind North. Leeway 3°.

(c) Find the time when Bill of Portland Light will be abeam. (Engine speed 13 knots. Variation 5° E)

II At 1100 hrs. the following compass bearings were obtained:-
Casquets Lt. Ho. bore 234°(C)
Alderney Lt. Ho. bore 179°(C)
C. de La Hague Lt. Ho. (F1. 18 M) bore 131°(C).
Find the ship's position at 1100 hrs. and also the Deviation of the compass, if Variation was 2° East.

III At 0900 hrs., a ship in D. R. Lat. 49°45'N Long. 3°00'W a sun's sight gave Azimuth 235°(T) Intercept 4' AWAY and at the same time D.F. bearing of Casquet's Radio Beacon was 36°(Relative) on the starboard bow. The ship was steering 058°(T). Find the ship's position at 0900 hrs. Calibration Error NIL.

IV At 1300 hrs. Anvil Point Lt. Ho. was 9 miles off on radar and at 1400 hrs. Bill of Portland Lt. Ho. was 7 miles off on the radar. During this period if the vessel made good a course of 262°(T). and the current was setting 140°(T) at 4 knots. and her engine speed was 12 knots. Find the compass course steered by the ship during this period and vessel's position at 1300 hrs. and 1400 hrs.(Variation 6° W)

ANSWERS – TEST PAPER I.

(a)	Ship's Head	200° (C)
	Deviation	10° W
	Variation	5° E
	Compass Error	5° W
	Compass bearing of St. Catherine Pt. Lt. Ho	315° (C)
	Compass Error	5° W
	True bearing of St. Catherine Pt. Lt. Ho.	310° (T)
	Compass bearing of Nab Tower	027° (C)
	Compass Error	5° W
	True bearing of Nab Tower	022° (T)
	Ship's Position at 1530 hrs:-	
	Lat. 50°28'N Long 1°	05.5' W
(b)	Current	155° (M)
	Variation	5° E
	True current	160° (T)
	True course to steer to counteract current	275° (T)
	Leeway (Wind North)	+3°
	True course to steer to counteract current and leeway	278° (T)
	Variation	5° E
	Magnetic course	273° (M)
	Deviation	2.1° E
	Compass course to steer to counteract current and leeway	270.9° (C)
	Course made good	257° (T)
	Speed made good	12 knots.

(c) Beam bearing of Bill of Portland Lt. = 278° + 90°
= 008°(T)

Distance from 1530 hrs. Position to beam bearing = 55.8 Miles

Speed made good = 12 knots.

$$\text{Time Taken} = \frac{55.8}{12} = 4H\ 39M$$

Bill of Portland will be abeam at 2009 hrs.

II	Horizontal angle between Casquets Lt. Ho. and Alderney Lt. Ho.	55°
	Complement = 90° – 55°	35°
	Horizontal angle between Alderney Lt. Ho. and C. de La Hague Lt. Ho.	48°
	Complement = 90° – 48°	42°
	Ship's position at 1100 hrs.	
	Lat. 49°49.5'N Long. 02°11'W	
	(From the Chart) True bearing of Casquets Lt. Ho.	230° (T)
	Compass bearing of Casquets Lt. Ho.	234° (C)
	Compass Error	4° W
	Variation	2° E
	Deviation	6° W
III	Ship's Head	058° (T)
	D.F. Relative bearing of Casquets D.F. Station	036°
	D.F. Bearing of Casquets D.F. Station	094° (T)

To find Half Convergency :-

Casquets D.F. Station	49° 43'N	02° 23'W
D.R. Position	49° 46.5'N	02° 55'W

$$\text{Half Convergency} = \frac{\text{D'Long. X Sine Mean Lat.}}{2}$$

$$= 0.2°$$

True Mercator's bearing of Casquets D.F. Station 094.2° (T)

Ship's Posn. at 0900 hrs. Lat. 49° 45'N Long. 02°53'W

IV	Course made good	262° (T)
	Current 140°(T) Drift in 1hour	4 miles
	Distance steamed in 1hour	12 miles
	Course Steered	278° (T)

Variation	6° W
Mag.Course	284° (M)
Deviation	3.6° E
Compass Course Steered	280.4° (C)

1300 hrs. Posn. 50°27'N 02°05'W

1400hrs. Posn. 50°26.5'N 02° 18.8'W

TEST PAPER II

[English Channel (Eastern Portion) B.A. Chart No. 2675]

(DEVIATION CARD II)

I (a) At 0600 hrs. a vessel steering 245° (C), Royal Sovereign Lt. Vsl. bore 028° (C) and Beachy Head Lt. bore 328° (C), find the ship's position.

(b) From 0600 hrs. position, find the compass course to steer to pass Casquets Lt. Ho. 9 Miles off, counteracting a current setting 274° (T) at 2.5 knots. Wind North. Leeway 4°. Find also the course and speed made good.

(c) Find the time and the distance off when Alderney Lt. Ho.. will be abeam. (Ship's speed 15 knots. Variation 6° W)

II At 2100 hrs. Pte. de Barfleur Lt. was 209°(T) distance 13 miles by radar. From this position set a compass course so as to sight Cap d' Antifer Lt. right ahead in meteorological visibility of 5 miles with current setting 315°(T) at 4 knots.
(Variation 6° W, Engine speed 12 knots.)

III On a voyage from Southampton to Bristol, a vessel steering 250° (C), at 2100 hrs. Bill of Portland Lt. bore 303° (C) and at 2200 hrs. the same light bore 033° (C). During this time, the current was known to be setting 016° (M) at 3 knots. Find the ship's position at 2100 hrs. and also at 2200 hrs.

(Ship's engine speed 11 knots. Variation 6° W)

IV From a ship, the following horizontal sextant angles were observed. St. Catherine Lt. Ho. 41° Needles Lt. Ho. 50° Anvil Point Lt. Ho. Find the ship's position.

ANSWERS - TEST PAPER II

I (a)

Ship's Head	245° (C)
Deviation	1.7° W
Variation	6° W
Compass Error	7.7° W
True bearing of Royal Sovereign Lt. Vessel	020.3° (T)
True bearing of Beachy Head Lt.	320.3° (T)

0600 hrs. Ship's Position.
Lat. 50°37.2'N Long. 00°24'E

(b)

True course to steer to counteract current	243° (T)
Leeway (Wind North)	+ 4°
True course to steer to counteract Current and Leeway	247° (T)
Variation	6° W
Magnetic course	253° (M)
Deviation	0.6° W
Compass course to steer to counteract Current and Leeway	253.6° (C)
Course made good	247° (T)
Speed made good	17.3 knots

(c)

Beam bearing of Aldernay Lt.	157° (T)
Distance from 0600 hrs. to beam bearing Position	111 mile
Time when Alderney Lt. Ho. abeam	1225 hrs.
Distance off when Alderney Lt. Ho. is abeam	11.8 Miles.

II

Nominal range of Cap d'Antifer Lt.	26 miles.
Meteorological Visibility	5 miles.
Luminous range	15 miles
Time taken to steam 15 miles	1H 15 mins
Current for 1H 15 M	5 miles
Current	315° (T)
True course to steer	111° (T)
Variation	6° W

Magnetic Course	117° (M)
Deviation	7.7° W
Compass course to steer	124.7° (C)
Course made good	100° (T)

III

Compass course	250° (C)
Deviation	1° W
Variation	6° W
Compass Error	7° W
True course	243° (T)
At 2100 hrs. True bearing of Bill of Portland Lt.	296° (T)
At 2200 hrs. True bearing of Bill of Portland Lt.	026° (T)
True current	010° (T) at 3 knots

Ship's position at 2200 hrs. :-
Lat. 50°25.5'N Long. 02°31.5'W
Ship's position at 2100 hrs :-
Lat. 50°27.7'N Long 02°17'W

IV Complement of St. Catherine Pt. & Needles Lt. Ho. = 90° - 41° = 49°
Complement of Needles Lt. Ho. & Anvil Point Lt. Ho = 90° - 50° = 40°
Ship's Position Lat. 50° 22.4'N Long. 1° 41'W

TEST PAPER III

[English Channel (Eastern Portion) B.A. Chart No. 2675]

(DEVIATION CARD II)

I (a) At 1600 hrs., vertical sextant angle of Bill of Portland Lt. Ho. (145 feet or 44.2 metres) was 00° 20' and the bearing of the same light house was 000° (T). Find the ship's position.

(b) From 1600 hrs. position, find the compass course to steer so as to pass Start Point 6 miles off, counteracting a current known to be setting 135°(T) at 2.5 knots and leeway 3° Wind North.

(c) Find the time and distance off when Berry Head Lt. is abeam.
(Variation 2°E, Engine Speed 10 knots, Index Error 3' on the arc.)

II (a) On 20th January, at 2100 hrs. a ship steering 105° (C) at 12 knots. Pte. de Barfleur Lt. bore 156°(C) and at 2200 hrs. the same light bore 221°(C). During this time, the ship experienced a current setting 044°(M) at 3 knots. Wind North. Leeway 3°. Find the ship's position at 2200 hrs. and 2100 hrs.

(b) Find the estimated time and the distance off when C. d'Antifer Light will be abeam. (Variation 2° West)

III From a ship at anchor, the following compass bearings were observed :-

Needles Lt. Ho.	329° (C)
St. Catherine Pt. Lt. Ho.	001° (C)
Nab Tower	041° (C)

Find the ship's position and the deviation for the ship's head, if Variation was 2° East.

IV On a voyage from London to Le Harve, at 1845 hrs. in D.R. LAT. 50°30.5'N Long. 00° 16'W, a star sight gave observed Longitude 00°12'W and Azimuth 249° (T). Find the safe true courses to steer, so as to pick up Le

Havre light vessel right ahead. Also find the distance to steam on the first course. What is the principle involved in your courses?

ANSWERS – TEST PAPER III

I (a) Vertical sextant angle 0°20'
Index Error 3'on the arc.
Observed Vertical Sextant angle 0°17'
Distance off Bill of Portland Light House 4.8'
1600 hrs. Ship's position:-
Lat. 50°26'N Long. 2°27.2'W

(b) True course to steer counteracting current 260° (T)
Leeway (Wind North) +3°
True course to steer counteracting current & Leeway 263° (T)
Variation 2° E
Magnetic course 261° (M)
Deviation 0.5° E
Compass course to steer counteracting current & Leeway 260.5° (C)

(c) Course made good 247° (T)
Speed made good 8.9 knots
Beam bearing of Berry Hd. Light 353° (T)
Distance from 1600 hrs. Position to
Beam bearing position of Berry Head = 41'
Time taken at 8.9 knots = 4H 36 M
Time when Berry Head light will be abeam 2036 hrs.
Distance off when Berry Head Light is abeam 14 Miles.

II (a)

Compass course	105° (C)
Deviation	4.2° W
Variation	2° W
Compass Error	6.2° W
True Course	098.8° (T)
Leeway (Wind North)	+3°
True course after Leeway	101.8° (T)

At 2100 hrs. Compass bearing of
Pte. de Barfleur Lt. 156° (C)
At 2100 hrs. True bearing of
Pte. de Barfleur Lt. 149.8° (T)
At 2200 hrs. Compass bearing of
Pte. de Barfleur Lt. 221° (C)
At 2200 hrs. true bearing of
Pte. de Barfleur Lt. 214.8° (T)
Current 042°(T) at 3 knots.
Ship's position at 2200 hrs:-
Lat. 49°52'N Long. 1°04'W
Ship's position at 2100 hrs.
Lat. 49° 52.8'N Long. 1° 25.6'W

(b) Beam bearing of C. d'Antifer Lt. 188.8° (T)
Distance from 2200 hrs. Position to beam bearing of C. d'Antifer Lt = 49 Miles.
Speed made good = 14.2 knots
Time taken = 3 hours 27 minutes.
Estimated time when C. d'Antifer Lt. will be abeam = 0127 hrs. on 21st January.

III Horizontal angle between Needles Lt. Ho. and St Catherine Pt. Lt. Ho. = 32°
Complement angle = 90° – 32° = 58°
Horizontal angle between St. Catherine Pt. Lt. Ho. and Nab Tower = 40°
Complement angle = 90° – 40° = 50°
Ship's position Lat. 50° 23.5'N Long. 1° 16.8' W
True bearing of Needles Lt. Ho 324° (T)
Compass bearing of Needles Lt. Ho 329° (C)
Compass error 5° W
Variation 2° E
Deviation 7° W

IV Azimuth = 249° (T)
Position line = 159°(T) and 339° (T)
1st course = 249°(T) for 20 Miles.
2nd course to pickup Le Havre Lt. Vessel right ahead =159° (T)

TEST PAPER IV

[English Channel (Eastern Position) B.A. Chart No. 2675]

(DEVIATION CARD II)

I (a) At 1600 hrs. a ship steering 250° (C) St. Catherine Point Light house bore 323° (C) and Nab Tower bore 022° (C). Find the ship's position.

(b) From the position at 1600 hrs., find the compass course to steer so as to raise Start Point Light (Gp. Fl. (3) 20M) 20° on the Starboard bow. Find the position at which Start Point Light, (as stated above) will be raised and at what distance do you expect to pass the same light when abeam, while on the above course.

(c) Also find the time when Start Point Light will be abeam. (Ship's speed 13 knots, H.E. 10.67 metres or 35 feet. Variation 6° East)

II (a) At 2000 hrs. Les Sept. Iles Light dipped bearing 175° (T). From this position, find compass course to steer to pass Casquets Lt. 5 miles off counter-acting a current setting 114° (M) at 3 knots. Wind North West, gale force. Leeway 3°.

(b) Find the course and speed made good and also the time when Casquets light will be abeam.

(Ship's speed 15 knots, H.E. 12.19 Metres or 40 feet, Variation 6° East).

III (a) At 0900 hrs. a ship steering 092° (C) at 13 knots engine speed, Alderney Light house bore 226° (C) and at 1100 hrs. Pte. de Barfleur Lt. Ho. was abeam. A current was known to be setting 334° (M) at 2 knots throughtout. Find the ship's position at 0900 hrs. and at 1100 hrs.

(b) At 1100 hrs. while steering the same course, engine speed was reduced to 10 knots due to Engine trouble. The current continued to be the same as before in (a). Find the time when C. d'Antifer Lt. Ho. will be abeam and also the distance of this Lt. Ho. when abeam.

(Variation 6° East).

ANSWERS - TEST PAPER IV

I (a)

Ship's Head	250° (C)
Deviation	1° W
Variation	6° E
Compass Error	5° E
True bearing of St. Catherine Point Lt. Ho.	328° (T)
True bearing of Nab Tower	027° (T)

Ship's Position at 1600 hrs:-
Lat. 50° 26'N Long. 01° 09.2'W

(b)

Visibility of Start Point Lt.	20 Miles
For H.E. 4.57 Metres (15 feet)	– 4.4'
Visibility of Lt. at sea Level	15.6'
For 10.67 Metres	+6.8
Raising distance of Start Point Lt.	22.4

By Traverse Tables, in order to raise the light 20° on the starboard bow at 22.4', the beam distance off the light will be 7.66 Miles. Hence find a course from 1600 hrs. position, so as to pass Start Point Lt. when abeam at 7.66 Miles.

True course to steer	258° (T)
Variation	6° E
Magnetic course	252° (M)
Deviation	0.6° W
Compass course to steer	252. 6° (C)

Position when Start Point Light will be raised:-
Lat. 50°10.4'N Long. 03° 03.2'W

(c) Distance from 1600 hrs. to beam position of Start Point Light = 95 Miles.
Time required to cover this distance

$$= \frac{95}{13} = 7H.\ 18.M$$

Hence Start Point Light will be abeam at 2318 hrs.

II (a)

Visibility of Les Sept. Iles Lt.	20 Miles.
For H.E. 4.57 Mtrs. (15 feet)	– 4.4 Miles.
Visibility of the Les Sept Iles Lt. at sea level	15.6 Miles.
For H.E. 12.19 Metres. (40 feet)	+ 7.4 Miles
Dipping distance of Light	23.0 Miles
Current	120° (T)
True course to steer to counteract Current	042° (T)
Leeway (Wind NW)	-3°
True course to steer counteracting Current & Leeway	039° (T)
Variation	6° E
Magnetic course	033° (M)
Deviation	10.1° E
Compass Course to steer counteracting Current & Leeway.	022.9° (C)

II (b)

Course made good	052.5° (T)
Speed made good	16.0 knots.
Beam bearing of Casquets Lt.	129° (T)
Distance till Casquets Lt. abeam	51.5 Miles.
Time taken to cover 51.5 Miles @	16 knots.
	= 3 hours 13 minutes.
Casquets Lt. will be abeam at	2313 Hrs.

III (a)

Compass course	092° (C)
Deviation	2.3° W
Variation	6° E
Compass Error	3.7° E
True course	095.7° (T)
True bearing of Alderney Lt. Ho.	229.7° (T)
Beam bearing of Pte. de Barfleur Lt.	185.7° (T)
True Current	340° (T)

Position at 1100 hrs.
Lat. 49°55'N Long. 1°14.5'W

Position at 0900 hrs.
Lat. 49°53.2'N Long. 1°53'W

		Course made good	086° (T)
		Speed made good	12.6 knots.
III	(b)	Course made good after 1100 hrs. Position	083° (T)
		Speed made good after 1100 hrs Position	9.4 knots.
		Beam bearing of C. d'Antifer Lt.	185.7° (T)
		Distance to C. d'Antifer Lt. abeam	56.0 Miles
		ETA when C. d'Antifer Lt. is abeam	1657 Hrs.
		Distance off when C. d'Antifer Lt. is abeam	= 19.8 Miles

TEST PAPER V

[English Channel (Eastern Position) B.A. Chart No.2675]

I A ship steering 074°(G) in the English Channel, Pte. de Barfleur light bore 117°(G). After 1 hour's steaming at 15 knots, the same light bore 188° (G). Find the ship's position at the time of taking first and the second bearing, if the current during the period was setting 035°(T) at 3 knots. (Gyro Error 1 Low).

II (a) At 2000 hours, C. de Le Heve Light bore 143°(G) and C. d'Antifer Light bore 103°(G). Find the ship's position. From the position obtained at 2000 hours, find the gyro course to steer so as to pass Bassurelle Light Vessel 7.2 Miles off when 30° on the port bow.

(b) Find the course and the speed made good by the above vessel, if the current was setting 180° (T) at 2.5 knots and a strong wind was blowing from a North Westerly direction. Leeway 5°.

(c) Find the time and the distance off when Pte. d'Ailly Light will be abeam. (Engine speed 15 knots. Gyro Error 1°Low).

III (a) Find the gyro compass course to steer from a position at 1900 hours with Beachy Head light bearing 000° (T) at 10 Miles to a position 12 miles off St. Catherine Point light when abeam, allowing for the current setting 315° (T) at 2 knots and leeway of 3°. Wind South.

(b) Whilst on the above course Nab Tower light is expected to be raised at a distance of 19 Miles. Find the time and the relative bearing when the light is raised.

(Ship's speed 12 knots. Gyro Error 2° High).

IV At 0600 hours, a ship in D.R. Lat. 49°50'N Long. 3° 40'W, a star sight gave an intercept of 6.1' AWAY and Azimuth of 050°(T). The ship then continued on her course 065°(T) at 12 knots until 1000 hrs. when "The Shambles" D.F. Beacon. gave a relative D.F. bearing as 15° (Red). Find the ship's position at 1000 hours.

ANSWERS - TEST PAPER V

I Gyro Course steered 074° (G)
Gyro Error 1° Low
True course steered 075° (T)
Current 035°(T) at 3 knots.
1st True bearing of Pte. de Barfleur Lt. 118° (T)
2nd True bearing of Pte. de Barfleur Lt. 189° (T)
Ship's Position at 2nd bearing:-
Lat. 49° 55.8'N Long. 1° 12.5'W
Ship's position at 1st bearing:-
Lat. 49° 49.5'N Long. 1° 38'W

II (a) True bearing of C. de Le Heve light 144° (T)
True bearing of C. d'Antifer light 104° (T)
Ship's Position at 2000 hours:-
Lat. 49°44.5'N Long. 00° 10.8'W
When Bassurelle Lt. Vessel is 30° on the bow at 7.2 Miles.
Distance off when abeam = 3.6 Miles
True course to steer 045° (T)
Gyro Error 1° Low
Gyro course to steer 044° (G)

(b) True course made good after allowing for Leeway 050° (T)
Current 180°(T) at 2.5 knots.
Course made good 058° (T)
Speed made good 13.65 knots.

(c) Beam bearing of Pte. d'Ailly Light 135° (T)
Distance from 2000 hrs. Position to beam bearing = 40 Miles.
Speed made good =13.6 knots.
Time when Pte. d'Ailly light will be abeam 2257 hours.

Distance off when Pte. d'Ailly light is abeam 14.4 Miles.

III (a) True course to steer to counteract current 250° (T)
Leeway (Wind South) – 3°
True course to steer counteracting current and Leeway = 247° (T)
Gyro Error 2° High
Gyro course to steer counteracting. Current and Leeway = 249° (G)

(b) Speed made good 13 knots.
Distance made good when Nab Tower is raised 31.2 Miles.
Time required = 2 hours 24 minutes.
Hence Nab Tower light will be raised at 2124 hours.
True bearing when light is raised 311° (T)
Gyro bearing when light is raised 313° (G)
Gyro course 249° (G)
Relative bearing 64° (Green)

IV Azimuth of the star = 050° (T)
∴ Position line = 140°(T) and 320° (T)
D.R. Position at 1000 hrs:-
Lat 50° 06'N Long. 2° 39'W
Position of "The Shambles":-
Lat. 50° 31'N Long. 2° 20'W
Mean Lat. 50° 18.5'N
D'Long = 19'W
Half Convergency = NIL
True D.F. bearing = 050° (T)
Ship's Position at 1000 hrs:-
Lat. 50 15'N Long. 2° 51'W

TEST PAPER VI

[English Channel (Eastern Position) B.A. Chart No.2675]

DEVIATION CARD II

I From a position, at 1800 hrs. with Pte. de Barfleur Lt. bearing 180°(T) distance 10 miles, find the compass course to steer to a position 180°(M) 4 Miles off from Le Havre light vessel, counteracting a current setting 160° (M) at 2½ knots and adjusting the engine speed so as to arrive at her destination at 2200 hours. (Variation 6°W).

II At 0800 hours, a ship in D.R. Position Lat 50° 08'N Long 00°04'W, an observation of the Sun gave an intercept of 4' TOWARDS and P.L. was 050°(T) and 230°(T). The ship then steered 118°(C), through a current setting 220°(M) at 4 knots. Ship's speed through the water 15 knots. Wind North. Leeway 5°. At 0900 hours, Pt. d'Ailly Lt. Ho. bore 135°(T). Find the ship's position at 0800 hrs and 0900. (Variation 6° W).

III A ship steering 260°(C) at 12 knots, at 0900 hours St Catherine Point Light bore 333½°(C) and at 0930 hours it bore 005½°(C) and at 1010 hours it bore 031½°(C). At the time of taking the third bearing Anvil Point light bore 305½°(C). Find the course made good, position at the time of second bearing and the set and drift of the current between 0900 hrs. and 1010 hours. (Variation 6°W).

IV (a) On 20th December, a ship steering 230°(C) at 11 knots at 2000 hours Anvil Point Lt. bore 052.5°(C) and Bill of Portland light bore 326.5°(C). Find the ship's position, and from this position find the compass course to steer so as to pass Start Point light 10 miles off when 30°on the starboard bow.

(b) Find the course and speed made good if she experienced a current setting 200°(T) at 2 knots.

(c) Find the time and distance off when Berry Head light will be abeam (Variation 6°West).

ANSWERS – TEST PAPER VI

I

Magnetic bearing of Le Havre Lt. Vsl	180° (M)
Variation	6° W
True bearing of Le Havre Lt. Vsl	174° (T)
Magnetic current	160° (M)
True current	154°(T) at 2½ knots.
Total distance required to be covered in 4 hrs	= 45 Miles.
Therefore speed made good required	= 11¼ knots.
True course to steer counteracting the current	101° (T)
Variation	6° W
Magnetic course to steer	107° (M)
Deviation	5.5° W
Compass course to steer counteracting current	112.5° (C)

Engine speed to be adjusted to 9.7 knots.

II

P.L. = 050°(T) & 230°(T)	
∴ Azimuth	= 140° (T)
Compass course	118° (C)
Deviation	6.6° W
Variation	6° W
Compass error	12.6° W
True course	105.4° (T)
Leeway (Wind North)	+ 5°
True course after allowing for Leeway	110.4° (T)
True current	214°(T) at 4 knots.
Engine speed	15 knots.

Ship's Position at 0900 hrs:-
Lat. 50°07.2'N Long. 00°39.0'E

Ship's Position at 0800 hrs:-
Lat. 50°15.8'N Long. 00°21'E

III

Compass course	260° (C)
Deviation	0.5° E
Variation	6° W
Compass error	5.5° W
True course	254.5° (T)
1st True bearing of St. Catherine Pt. Lt.	328° (T)

2nd true bearing of St. Catherine Pt. Lt.	000° (T)
3rd true bearing of St. Catherine Pt. Lt.	026° (T)
Anvil Point Lt. True bearing	300° (T)
Distance steamed between 1st and 2nd bearing	6 Miles.
Distance steamed between 2nd and 3rd bearing	8 Miles.
Course made good	245° (T)

Ship's Position at 0930 hrs.:-
Lat. 50°27'N Long. 01°17.4'W

Current set	097 ½° (T)

Drift of the current 4.6 Miles in 1 hr. 10 min.

IV (a)

Compass course	230° (C)
Deviation	4.5° W
Variation	6° W
Compass error	10.5° W
True bearing of Anvil Point Light	042° (T)
True bearing of Bill of Portland light	316° (T)

Ship's Position at 2000 hrs.:-
Lat. 50°23'N Long. 02°15.5'W

When Start Point light will be 30° on the Stbd. bow at 10 miles, it will be abeam at 5 miles.

True course to steer	254° (T)
Variation	6° W
Magnetic course	260° (M)
Deviation	0.5° E
Compass course to steer	259.5° (C)

(b) Current 200°(T) at 2 knots.

Course made good	246 ½° (T)
Speed made good	12.2 knots.

(c)

Beam bearing of Berry Hd. Lt.	344° (T)
Distance off when Berry Hd. light abeam	19.8 Miles
Distance from 2000 hrs. to beam bearing Posn.	= 45.6 Miles
Speed made good	12.2 knots
Time when Berry Hd. light will be abeam	2345 hrs.

TEST PAPER VII

[English Channel (Eastern Portion) B.A. Chart No. 2675]

(DEVIATION CARD II)

I. A vessel is steering 276°(C). At 1230 hrs. St. Catherine Point bore 311°(C) and at 1300 hrs. it bore 352°(C) and again at 1340 hrs. the same lighthouse bore 042°(C). During this period, the current was setting 210°(T), at 4 knots. Find the course made good, the vessel's position at 1340 hrs. and 1230 hrs. and the engine speed of the vessel. (Variation 6°W)

II. At 1730 hrs. in D.R. Pos. 49°33' N 03°47' W; a star sight gave an intercept of 9' away with an Azimuth of 208°(T) and the ship was steering 065°(T) at 12 knots. Thereafter the visibility reduced to 5 miles and at 1900 hrs. Channel Lt. Vsl. Lt. was first sighted. Find the vessel's position at 1900 hrs. if the current during this period was setting 343°(T) at 3 knots.

III. (a) At 1900 hrs. a ship steering 072°(C) and Ile de Batz. Lt. bore 204°(C) and Les Sept. Iles Lt. bore 129°(C). Find the vessel's position. From 1900 hrs. position, find the compass course to steer so as to sight Les Hanois Lt. 20 miles off when 30° on the starboard bow.

(b) Find the course and speed made good if ship experienced a current setting 027°(M) at 3 knots.

(c) Find the time and distance off when Les Roches Douvres Lt. will be abeam.
(Variation 6° W, Engine Speed 12 knots)

IV. (a) A vessel steering 263°(C) Anvil Point Lt. bore 044°(C) and Bill of Portland Lt. bore 320°(C), find the vessel's position.

(b) From the position obtained in (a), set a course by compass so as to sight Start Point Lt. right ahead in meteorological visibility of 4' with current setting 200°(T) @ 5 knots.
(Variation 6°W, Engine Speed 12 knots)

ANSWERS -- TEST PAPER VII

I	Ship's Head			276° (C)
	Deviation			2.9° E
	Variation			6° W
	Compass Error			3.1° W
	True Course			272.9° (T)
		1st brg.	2nd brg.	3rd brg.
	Compass brg.	311° (C)	352° (C)	042° (C)
	Compass Error	3.1° W	3.1° W	3.1° W
	True brg.	307.9° (T)	348.9° (T)	038.9° (T)
	Current			210° (T)
	Drift for 1H10M			4.67 miles
	Time ratio			3 : 4
	Course made good			259° (T)

1340 hrs. Posn. 50°24.8'N01°30'W

1230 hrs. Posn. 50°28'N01°04.5'W

Engine distance in 1H10M =13.8 Miles@11.83 knots

II Azimuth 208°(T) PL : 118° & 298°

Intercept 9' AWAY

Distance steamed in 1½ hrs. 18 miles

Current 065° (T) Drift 4.5'

Nominal range of Channel Lt. Vsl. 25'

Luminous range of Channel Lt. Vsl. = 14'

1900 hrs. Posn. 49°51.5'N03°14'W

III	(a)	Compass course	072° (C)
		Deviation	0.7° E
		Variation	6° W
		Compass Error	5.3° W

True Course	066.9° (T)
Ile de Batz Lt. Compass brg.	204° (C)
Ile de Batz Lt. True brg.	198.9° (T)
Les Sept. Ile lt Compass brg.	129° (C)
Les Sept. Ile lt. True brg.	123.9° (T)

1900 hrs. Posn. 49° 03' N 03° 52.7' W

Beam distance when Les Hanois Lt. is 30° on the bow distance 20' = 20' Sine 30° = 10 miles.

	True Course to steer	052° (T)
	Variation	6° W
	Magnetic Course	058° (M)
	Deviation	4.3° E
	Compass course to steer	053.7° (C)
(b)	Current	027° (M)
	Variation	6° W
	True Current	021°(T) at 3 knots
	Course made good	045° (T)
	Speed made good	14.7 knots
(c)	Course steered	052° (T)
	Beam brg. 052° + 90° =	142° (T)
	Distance off abeam	27 miles
	Distance to beam brg. Posn.	35.7 miles

ETA at beam brg. Posn. 35.7/14.7 = 2H 26M

= 2126 hrs.

IV	(a)	Ship's Head	263° (C)
		Deviation	1° E
		Variation	6° W

Compass Error	5° W
Anvil Point true brg.	039°(T)
Bill of Portland true brg.	315° (T)
Ship's Position 50°22.2'N 02°14.2'W	

(b)

Nominal range of Star Point Lt.	25 miles.
Luminous range in met. visb. 4' = 11.6 miles	
Engine speed	12 knots
Time to cover 11.6'@ 12 knots	58 min.
Drift in 58 min@ 5 knots	4.83 miles
Current	220° (T)
Course made good	256° (T)
True Course to steer	276° (T)
Variation	6° W
Mag Co.	282° (M)
Daviation	3.2° E
Compass Course	278.8° (C)

TEST PAPER VIII

[English Channel (Eastern Portion) B.A. Chart No. 2675]

(Deviation Card II)

I. (a) Onboard a ship at 1000 hrs. the following compass bearings were observed:-

Needles Point Lt. Ho.	319° (C)
St. Catherine Point Lt. Ho.	359° (C)
Nab Tower Lt. Ho.	050° (C)

Find the ship's position and the Deviation if the Variation was 6° W.

(b) From 1000 hrs. position obtained in (a), set a course by compass to pass Start Point Lt. 10 miles off counteracting a current setting 125° (T) at 3 knots and wind Northerly force 6 leeway 4°.

(c) Find the time and distance off when Bill of Portland Lt. Ho. will be abeam.
(Variation 6° W Engine speed 12 knots)

II. At 0630 hrs. a vessel is in D.R. 48°34'N 06°29'W, a star sight gave an intercept of 8' AWAY and Azimuth was 311°(T). Just after that fog set in and the radar was not functioning properly. Set your safe true courses to steer so as to pass 7 miles off Creach Lt. (at Ile D' Quessant). Also find the distance to steam on the first course. What is the principle involved in setting your own courses?

III (a) A ship steering 106°(C) at 12 knots. At 0900 hrs. Pte. de Barfleur Lt. Ho. bore 145°(C) and at 1100 hrs. the same light house was abeam. A current was known to be setting 346°(M) at 2 knots throughout. Find the vessel's position at 0900 hrs. and 1100 hrs.

(b) At 1100 hrs. while steering the same course, engine speed was reduced to 10 knots due to engine trouble. The current continued to be the same as before in (a), find the time and distance off when C. de Antifer Lt. Ho. will be abeam. (Variation 6°W)

IV A vessel was steering 270°(C). At 1000 hrs. Lizard Point Lt. bore 314°(C) and at 1040 hrs. it bore 359°(C) and again at 1140 hrs. Lizard point Lt. bore 066°(C). During this period the current was setting 042°(T). Find the course made good and the vessel's position at 1140 hrs. and also the drift of the current.
(Ship's engine speed 12 knots, Variations 6°W)

ANSWERS -- TEST PAPER VIII

I. (a) Horizontal Angle St. Catherine and Needless — 40°
Base Angle — 50°
Horizontal Angle St. Catherine and Nab Tower — 51°
Base Angle — 39°
Posn.@ 1000 hrs. 50°28'N 001°17'W
True brg. of St. Catherine Pt. Lt. Ho. 355° (T)
Compass brg. of St. Catherine Pt. Lt. Ho. — 359° (C)
Compass Error — 4° W
Variation — 6° W
Deviation — 2° E

(b) True course to steer counteracting current — 266° (T)
Wind North Leeway — + 4°
True Co. to steer counteracting current & Leeway — 270° (T)

Variation — 6° W
Mag. Co. — 276° (M)
Deviation — 2.5° E
Compass Co. to steer counteracting Current & Leeway — 273.5° (C)

(c) True Co. steered — 270° (T)
Beam brg. = 270° + 90° = — 000° (T)
Distance off when abeam — 15.4 miles
Distance made good till Lt. abeam — 46.2 miles
Speed made good — 9.9 knots
Time taken = 46.2/9.9 = — 4H40M
Time Lt. will be abeam — 1440 hrs.
Distance off abeam — 15.4 miles

II Azimuth — 311° (T)
Position line 041° (T) and 221° (T)
First course to steer — 131° (T)
Distance to steam on this course — 30 miles
Second course to steer — 041° (T)
Distance to steam — unknown

III (a) Course steered — 106° (C)
Deviation — 4.4° W
Variation — 6° W
Compass Error — 10.4° W
0900 hrs. True brg. of Pt. de Barfleur — 134.6° (T)
1100 hrs. Beam brg.= 095.6°+90°= 185.6° (T)
Current — 346° (M)

	Variation	6° W
	True current	340° (T)
	Posn. at1100 hrs. 50°3.5'N 001°13.5'W	
	Posn. at 0900 hrs. 50°02.5'N 001°48'W	
(b)	True Course steered	095.6° (T)
	Beam brg. = 095.6°+90°	185.6° (T)
	Distance off abeam	16.8 miles
	Speed made good	9.3 knots
	Distance to beam brg. posn.	56.5 miles
	Time taken to cover = 56.5/9.3 = 6H05M	
	ETA at beam brg.	1705 hrs.
IV	Compass Course	270° (C)
	Deviation	2° E
	Variation	6° W
	Compass Error	4° W
	True Course steered	266° (T)
	Time Ratio 40 minutes : 60 minutes, or 2 : 3	
	Course Made good	273° (T)
	Drift of the current 3.2 miles in 1H40M	2 knots
	Posn. at 1140 hrs. 49°52'N 05°27.2'W	

TEST PAPER IX

[English Channel (Eastern Portion) B.A. Chart No. 2675]

(Deviation Card II)

I (a) At 1400 hrs. Les Sept. Isles Lt. bore 167°(T) 12 miles off by radar. From this position set a course by compass to a position with Les Hanois Lt. brg. 180°(T) 10 miles counteracting a current setting 288°(T) at 3 knots wind NNW force 5 and leeway 3°.

(b) Find the time and distance off when Les Roches Douvres Lt. will be abeam.
(Ship's speed 12 knots, Variation 6°W)

II (a) At 1630 hrs. a vessel was steering 088°(C) and she observed Pt. De Barfleur Lt. Ho. bearing 220°(C) and vertical sextant angle was 00°24' Index Error 2' on the arc. Height of Pt. de Barfleur Lt. Ho. was 295 feet. Find the ship's position.

(b) The vessel continued on the above stated course in (a) until 1900 hrs. when Cap d' Antifer Lt. was sighted brg. 144°(C) in meteorological visibility of 5 miles. Determine the vessel's position at 1900 hrs.

(c) Find the set and drift of the current and the course made good.
(Engine speed 12 knots, Variation 6° W)

III (a) From a vessel steering 094°(C) at 12 knots, position at 2000 hrs. was found with Casquets Lt. brg. 199°(C) and Aldernay Lt. brg.. 153°(C). Find the ship's position.

(b) The vessel continued on this course and she experienced a current setting 022°(M) at 3 knots and Southerly wind force 7 caused a leeway of 6°. Find the course and speed made good.

(c) Calculate the time and distance off when Pte. De Barfleur Lt. will be abeam.
(Variation 6° W, Engine speed 12 knots)

IV A vessel was steering 239°(T) at 12 Knots At 0930 hrs. Lizard Point Lt. bore 321°(C) and at 1010 hrs. it bore 358°(C) and again at 1120 hrs. Lizard Point bore 042°(C) and at the same time Wolf Rock Lt. bore 337°(C). Find the course made good and the position of the vessel at 1010 hrs. and at 1120 hrs. Also find the set and drift of the current between 0930 hrs. and 1120 hrs. (Variation 6°W)

ANSWERS -- TEST PAPER IX

I	(a)	True Course to steer counteracting Current	058° (T)
		Wind NNW'ly Leeway	– 3°
		True Co. to steer counteracting Current & Leeway	055° (T)
		Variation	6° W
		Mag. Course	061° (M)
		Deviation	3.5° E
		Compass Course to steer to counteract current	057.5° (C)
	(b)	Course steered	055° (T)
		Beam brg. 055°+90°	145° (T)
		Speed made good = 20.5/2 =	10.25 knots
		Distance to beam brg.	26 miles
		Time abeam = 26/10.25 = 2H27M =	1624 hrs.
		Distance off abeam	19.4 miles
II	(a)	Compass Course	0.88° (C)
		Deviation	1.7° W
		Variation	6° W

		Compass Error	7.7° W
		True Course	080.3° (T)
		Sextant altitude	00°24'
		Index Error	2'on the arc
		Sex. alt.	00°22'

$$\text{Distance off} = \frac{\text{Ht. of object (in ft.)} \times 0.565}{\text{Sex. alt. (in minutes)}}$$

$$= \frac{295 \times 0.565}{22} = 7.57 \text{ miles}$$

		Compass brg. of Pt. De Barfleur	220° (C)
		Compass Error	7.7° W
		True brg.	212.3° (T)
		Position at 1630 hrs. 49°48.3'N 01°9.6'W	
	(b)	Luminous Range of The Cap d' Antifer @ met. visibility 5 miles = 14.7 miles	
		Compass bearing	144° (C)
		Compass Error	7.7° W
		True brg.	136.3° (T)
		Posn. at 1900 hrs. 49° 51.5'N 00°04.8'W	
	(c)	Set	099° (T)
		Drift 12.8' in 2H30M@ 5.12 knots	
		Course made good	085°
III	(a)	Ship's Head	094° (C)
		Deviation	2.6° W
		Variation	6° W
		Compass Error	8.6° W
		Compass brg. of Casquets Lt.	199° (C)

	True brg. of Casquets Lt.	190.4°	(T)
	Compass brg.. Aldernay Lt.	153°	(C)
	Compass Error	8.6°	W
	True brg. Aldernay Lt.	144.4°	(T)
	Posn. at 2000 hrs. 49°53'N 02°20'W		
(b)	Current	022°	(M)
	Variation	6°	W
	True Current 016° (T)@3 knots		
	Compass Co.	094°	(C)
	Compass Error	8.6°	W
	True Co.	085.4°	(T)
	Wind S'ly Leeway	– 6°	
	Leeway Track	079.4°	(T)
	Course made good	068°	(T)
	Speed made good	13.7	knots
(c)	Course steered	085.4°	(T)
	Beam brg. 085.4° + 90° =	175.4°	(T)
	Distance off abeam	26.3	miles
	Distance to beam brg.	41.8	miles
	Speed made good	13.7	knots
	Time Lt. abeam	2303	hrs.
IV	Compass Course	239°	(C)
	Deviation	2.7°	W
	Variation	6°	W
	Compass Error	8.7°	W
	True Course	230.3°	(T)

	1st brg.	2nd brg.	3rd brg.
Compass brg.	321° (C)	358° (C)	042° (C)
Compass Error	8.7° W	8.7° W	8.7° W
True brg.	312.3° (T)	349.3° (T)	033.3° (T)

Wolf Rock Compass brg.	337°	(C)
Compass Error	8.7°	W
Wolf Rock True brg.	328.3°	(T)
Course made good	248°	(T)
1120 hrs. Posn. 49°38.8'N 05°31.7'W		
1010 hrs. Posn. 49°44.7'N 05°08'W		
Current	307°	(T)
Total drift	7.8	miles

TEST PAPER X

[Bristol Channel Chart No. L (DI) 5047]

(Deviation Card No. II)

I At 1400 hrs. Foreland Point Lt. (51°15'N003°47' W) was 5 miles off and at 1440 hrs. Bull Point Lt. (51°12'N004°12'W) was 7 miles off. During this period, the vessel steered a course of 261°(C) and she experienced a current setting 025°(T) at 3 knots and Northerly wind caused a leeway of 3°. Find the vessel's position at 1400 hrs. and 1440 hrs.
(Engine speed 12 knots, Variation 6°W)

II A vessel was steering 115°(C). At 0900 hrs. North Lundy Island Lt. Ho. (51°12'N04°40'W) bore 130°(C) and at 0920 hrs. it bore 172°(C) and at 0950 hrs. the same lighthouse bore 262°(C). If the current during this period was setting 040°(T) at 3 knots, find the course made good, the engine speed and the vessel's position at 0920 hrs. (Variation 6°W)

III At 1900 hrs. Nash Point Lt. (51°24.2'N003°33' W) bore 016°(T) and was 5.2 miles off by radar. From this position set a course by compass so as to sight Scar weather Lt. Vsl. (51°27'N003°56'W) right ahead in meteorological visibility of 5 miles with the current setting 180°(T) at 3 knots.
(Variation 6°W, Engine speed 12 knots)

IV From a vessel at anchor, the following bearings were observed :-

Watch Tower (51°42'N 004°20'W)	051°	(C)
Rhossili Down Tr. (181) (51°35'N 004°17'W)	111°	(C)
Helwick Lt. Vsl. (51°31'N 004°25'W)	175°	(C)

Find the vessel's position and the Deviation for the ship's head if Variation was 6°W.

ANSWERS - TEST PAPER X

	Course steered	261°	(C)
	Deviation	0.65°	E
	Variation	6°	W
	Compass Error	5.35°	W
	True Course steered	255.65°	(T)
	Wind N'ly Leewy	– 3°	
	Leeway Track	252.65°	(T)
	Distance steamed in 40 minutes 8 miles		
	Drift in 40 minutes	2	miles
	Position at 1440 hrs. 51°16.8'N 004°04.6'W		
	Position at 1400 hrs. 51°17.6'N 003°53.8'W		
II	Compass Course	115°	(C)
	Deviation	6°	W
	Variation	6°	W
	Compass Error	12°	W
	True Course	103°	(T)
	Time Ratio 20 min : 30 min = 2 : 3		
	Course made good	094°	(T)
	Distance steamed in 50 min	12.7	miles
	Engine speed	15.3	knots
	Position at 0920 hrs. 51°15.2'N04°42.4'W		
III	Luminous Range of Scarweather Lt. Vsl. 13.8'		
	Time taken to cover 13.8'@12kts	1H09M	
	Drift in 1H09M@3 knots	3.5'	
	Course to steer to sight Lt. Vsl. right ahead	303°	(T)

	Variation	6°	W
	Magnetic Course	309°	(M)
	Deviation	7.4°	E
	Compass course to steer	301.6°	(C)
	Course made good	289°	(T)
	Distance made good in 1HO9M12.3@10.7 knots		

IV Horizontal Angle between Watch Tower and Rhossili Down Tr = 111°–51° = 60°

Base Angle = 90°–60° = 30°

Horizontal Angle between Rhossili Down Tr and Helwick Lt. Vsl. = 175°–111° = 64°

Base Angle = 90°–64° = 26°

Anchor Position 51°36.8'N 004°28'W

True brg. of Watch Tower	043°	(T)
Compass brg. of Watch Tower	051°	(C)
Compass Error	8°	W
Variation	6°	W
Deviation	2°	W

TEST PAPER XI

[Bristol Channel B.A. No. L (DI) 5047]

(Deviation Card II)

I At 1700 hrs. Nash Point Lt. (51°24.2'N03°33'W) was 6 miles off by radar and at 1745 hrs. Scarweather Lt. Vsl. (51°26.8'N03°56.2'W) was 4 miles off by radar. During this period, the vessel steered a course of 290°(C) and she experienced a current setting 170°(T) at 4 knots and Northerly wind caused a leeway of 5°. Determine the vessel's position at 1700 hrs and 1745 hrs. (Variation 6°W, Engine speed 12 knots)

II At 1800 hrs. Bull Point Lt. Ho. (51°12'N004°12'W) bore 155°(T) 7 miles off by radar. From this position set a course by compass so as to sight Foreland Point Lt. Ho. (51°15'N003°47'W) right ahead in meteorological visibility of 3 miles with current setting 310°(T) at 5 knots (Variation 6°W, Engine speed 12 knots)

III (a) At 1300 hrs. Caldey Islands Lt. (51°38'N04°41'W) bore 301°(T) and the sextant altitude of the same lighthouse was 00° 20'. Index Error 2' on the arc. Assume the charted height of Caldey Island Lt. Ho. to be 54 metres and the tide having fallen 2 metres below MHWS, find the vessel's position.

(b) From 1300 hrs. position, set a course by compass to pass 4 miles off St. Gowan Lt. Vsl. (51°30.5'N 000°50'W) on the Southern side counteracting a current setting 176°(M) at 2 knots and Northerly wind force 6, leeway 4°.

(c) Find the time and distance when Caldey Island Lt. Ho. will be abeam.

(d) State the time and position when you will first sight St. Gowan Lt. Vsl. if the meteorological visibility is 2 miles.
(Variation 6°W, Engine speed 12 knots.)

IV A vessel was steering 239°(C) at 12 knots. At 1000 hrs. North Lundy Island lighthouse (51°12.2' N 004°40.5'W) bore 237°(C) and at 1025 hrs. it bore 173°(C) and again at 1115 hrs. the same light house bore 083°(C). Find the course made good and the position of the vessel at 1000 hrs. and at 1115 hrs. and the drift of the current which was known to be setting 180°(T). (Variation 6°W)

ANSWERS - TEST PAPER XI

I

Compass Course	290° (C)
Deviation	5.5° E
Variation	6° W
Compass Error	0.5° W
True Course	289.5° (T)
Wind N'ly L'way	– 5°
Leeway Track	284.5° (T)
Distance for 45 minutes	9 miles
Current 170° (T) drift for 45 minutes	3 miles
1745 hrs. Posn. 51°23'N 03°55.6'W	
1700 hrs. Posn. 51°23.4'N 03°42.6'W	
Course made good	266° (T)

II

Luminous Range of Foreland Pt. Lt. is 9.6 miles when met. visibility is 3 miles	
Time taken to steam 9.6 miles@12kts	48 min
Drift for 48 min@ 5 kts	4 miles
Course made good	94° (T)
True course to steer	109° (T)
Variation	6° W
Magnetic Course	115° (M)
Deviation	7.4° W
Compass Course To Steer	122.4° (C)

III

(a)

Sextant alt.	0° 20'
Index Error	2' off the arc
Sex. altitude	0° 18'
Actual Height of Lt. Ho.	56 meters
Distance off by Sex. alt.	5.8 miles
1300 hrs. Pos. 51°35'N 04°33'W	

(b)

True Course to steer counteracting	
Current	250° (T)
Wind N'ly Leeway	+ 4°
True course to steer to counteract Current and leeway	254° (T)
Variation	6° W
Magnetic Course	260° (M)
Deviation	0.4° E
Compass course to counteract Current and Leeway	259.6° (C)
Speed made good	12.4 knots

(c)

Beam brg. of Cadley IS.Lt.	344° (T)
Beam distance off	5.1 miles
Distance from 1300 hrs. Posn. to beam brg.	4.1 miles

Time abeam = 4.1/12.4 = 20 min = 1320 hrs.

(d)

Luminous Range when visb. is 2 miles	7 miles
Posn. when St. Gowan Lt. Vsl. first sighted 51°21.1'N 04°50.6'W	
Distance from 1300 hrs. Posn. till abeam	11.2 Miles
∴ St. Gowan Lt. first sighted	1355 hrs.

IV

Compass Course	277° (C)		
Deviation	3° E		
Variation	6° W		
Compass Error	3° W		
True Course steered	274° (T)		

	1st brg.	2nd brg.	3rd brg.
Compass Course	237° (C)	173° (C)	083° (C)
Compass Error	3° W	3° W	3° W
True brg.	234° (T)	170° (T)	080° (T)

Time Ratio 25 : 50 or 1 : 2

Course made good	251° (T)
Distance steamed in 1H 15M	15 miles
Drift in 1H 15M	3.7 miles

1115 Position 51°10.4'N 04°57'W

1000 Position 51°15.6'N 04°33'W

TEST PAPER XII

[Bristol Channel B.A. Chart No. L (DI) 5047]

(DEVIATION CARD II)

I At 0100 hrs. Nash Point Lt. (51°24'N 03°33'W) bore 354°(T) and distance off by radar was 4 miles. From this position set a course by compass so as to sight Scarweather Lt. Vsl. (51°27'N 03°56'W) right ahead at 8 miles with the current setting 220°(T) @ 4 knots. Also determine the time when Scarweather Lt. VSl. will be sighted right ahead
(Engine speed 12 knots)

II A vessel is in D R Posn. 51°36'N 004°26'W observed the following bearings :-

Worm Head Point (51°34'N04°20'W)	066° (C)
Helwick Lt. Vsl. (51°31'N04°25'W)	183° (C)
DZ4 Fl. y 5 sec (51°35.8'N04°30'W)	313° (C)

Find the ship's position and deviation for the ship's head if variation is 6° West.

III (a) A vessel steering 043°(T) and bound for Bideford fairway pilot station (51°05'N 004°15'W) observers Hartland Point Lt. (51°01'N 004°32'W) to bear 082° (T) at 1800 hrs. After half an hour the same light bore 138°(T). If the current was setting 299°(T) @ 3 knots, find the vessel's position at 1830 hrs.

(b) From 1830 hrs. position obtained in (a) find the course and engine speed so as to arrive the above stated pilot station at 1915 hrs. if the current now is estimated to set 045°(T) at 4 knots from 1830 hrs. (Engine spead 12 knots)

IV A vessel was steering 025°(T) at 12 knots. At 2230 hrs. she sighted Lundy Island South Light (51°00'N004°39.0'W) for the first time when the meteorological visibility was 4 miles only. The vessel continued on her course and at 2310 hrs.

the same light became obscured. If the current was estimated to set 245°(T) at 3 knots, find the vessel's position at 2310 hrs. and 2230 hrs. (Engine speed 12 knots).

ANSWERS -- TEST PAPER XII

I Time taken to steam 8 miles@12 kts. = 40 mins

Drift for 40 min@ 4 knots	2.6 miles
Current	220° (T)
Course made good	286° (T)
Speed made good	12.75 knots
Course to steer	304° (T)
Variation	6° W
Mag. Co.	310° (M)
Deviation	7.5° E
Compass Co. to steer	302.5° (C)
Distance from 0100 hrs. Posn.	8.6 miles

Steaming time to sight Lt. Vsl. right ahead 8.6 miles@12.75 knots = 41 min

Time Scarweather Lt. Vsl. will be sighted right ahead 0141 hrs.

II Horizontal Angle between Helwick Lt. Vsl. and DZ4 Fl.y 5 sec buoy. = 313°–183° = 130°

Base Angle = 130° – 90°= 40°

Horizontal Angle between Helwick Lt. Vsl. and Worm Head Point = 183° – 066°=117°

Base Angle = 117° – 90° = 27°

Ship's Position 51°32.6'N 04°25.4'W

True brg. of Helwick Lt. Vsl.	186° (T)

Comp brg. of Helwick Lt. Vsl.	183° (C)
Compass Error	3° E
Variation	6° W
Deviation	9° E

III (a) 1830 hrs Posn. 51°05.6'N 04°38.0'W

(b) Course to steer to arrive Pilot station

at 1915 hrs.	103° (T)
Course made good to Pilot station	094° (T)
Distance to cover in 45 min	12.43 miles
Engine spead	16.57 knots

IV

Nominal range of Lundy Island South Lt.	24 miles
Luminous range of Lundy Island South Lt.	11.5 miles
Course steered	025° (T)
Distance steamed in 40 min	8 miles
Current	245° (T)
Drift in 40 mins	2 miles
Course made good	013° (T)

Luminous Range of Lundy Island South Lt.11.5'

2310 hrs. Posn.51°07.8'N 04°49'W

2230 hrs. Posn. 51°01.2'N 04°51'W

TEST PAPER XIII

[Bristol Channel B.A. Chart No. L(DI) 5047]

(DEVIATION CARD NO. II)

I A vessel was steering 034°(T) at 12 knots. At 0430 hrs. she sighted Lundy Island South Light (51°09.7'N 004°39'W) for the first time when the meteorological visibility was 5 miles only. The vessel continued on her course and at 0506 hrs. the same light became obscured. If the current was estimated to set 338°(T) at 3 knots, find the vessel's position at 0430 hrs. and 0506 hrs. (Engine speed 12 knots)

II At 1800 hrs. a ship passed Bristol Pilot station (51°20.7'N003°19'W) and was steering 263°(T) and her engine speed was 12 knots. At 1830 hrs. Nash Point Lt. (51°24'N03°33' W) bore 337°(T) and at 1845 hrs. it bore 029°(T). Find the following :

(i) Position of ship at 1845 hrs.

(ii) Course made good and speed made good.

(iii) Set and drift of the current.

III At 1300 hrs. Caldey Island Lt. (51°38'N04°41'W) bore 242°(T). Just then the visibility became poor, set your own safe courses by compass so as to pass 4 miles Southwards of St. Gowan Lt. Vsl. (51°30.5'N005°00'W) counteracting a current setting SW'ly at 2 knots Also estimate the time of final alteration of course.

(Engine speed 12 knots.)

IV At 1800 hrs. Bull Point Lt. Ho. (51°12' N 004°12'W) bore 123°(T) 5 miles off by radar. From this position, set a course by compass so as to sight Scarweather Lt. Vsl. (51°27'N 003°56'W) right ahead in meteorological visibility of 3 miles with current setting 270°(T) @ 4 knots. Also estimate the time when the Scarweather Lt. Vsl. will be sighted right ahead.

ANSWERS -- TEST PAPER XIII

I

Nominal Range of Lundy Island South Lt.	24'
Luminous Range of Lundy Island South Lt.	13.8'
Course steered	034° (T)
Distance steamed in 36 mins	7.2 miles
Current	338° (T)
Drift in 36 mins	1.8 miles
Course made good	024° (T)

0506 hrs. Posn. 51°07.8'N 04°49.6'W

0430 hrs. Posn. 51°00.4'N 04°55.1'W

II (a) 1800 hrs. bearing of Nash Point Lt. from Pilotstation 291° (T)

Now by 3 point brg. method Course made good 269° (T)

Position @ 1845 hrs. 51°20.5'N 03°36.4'W

(b) Course made good 269° (T)

Distance made good in 45 mins 10.9 miles

∴ Speed made good 14.53 knots

(c) Set of current 293° (T)

Drift in 45 min 2.2 miles @2.93 knots

III 1st course to be made good 152° (T)

Distance to be made good on 1st course 5 miles

2nd course to be made good 242° (T)

Distance to be made good on 2nd course unknown

1st course to counteract current 143° (T)

Variation 6° W

Magnetic Course 149° (M)

Deviation 12.1° W

1st Compass course to counteract current 161.1° (C)

Speed made on 1st course 12.5 knots

Distance to be made good for a/c Posn. 5 miles

Time for final alteration of course 24 min or 1324 hrs.

2nd Final course to counteract current 245° (T)

Variation 6° W

Magnetic Course 251° (M)

Deviation 0.7° W

Final Course (Compass) to steer 251.7° (C)

Distance on final course unknown

IV

Nominal Range of Scarweather Lt. Vsl. 24 miles

Luminous Range of Scarweather Lt. Vsl.9 miles

Steaming time for 9 miles @ 12 knots 45 min

Drift in 45 min @ 4 knots 3 miles

Course made good 043° (T)

Course to steer 057° (T)

Variation 6° W

Mag. Course 063° (M)

Deviation 3° E

Compass Course to steer 060° (C)

Distance made good in 45 mins 6.7 miles

Speed made good 8.9 knots

Distance to be made good from 1800 hrs. to sighting Scarweather Lt. Vsl. rt. ahead 9.9 miles

Time taken = 60/8.9 X 9.9=67 minutes = 1H07M

Time of sighting Lt. Vsl. right ahead 1907 hrs.

TEST PAPER XIV

[FALSTERBO TO OLAND CHART NO. L (D0-D7) 5072]

(DEVIATION CARD NO. II)

I. A vessel steering 067°(C), at 1000 hrs. Utklippan Lt. Ho. (55°57'N 15°42'E) bore 037°(C) and at 1030 hrs. it bore 000°(C) and again at 1110 hrs. it bore 311°(C). During this period the current was setting 192° (M) at 4 knots. Find the vessel's position at 1110 hrs., the engine speed and the course made good. (Variation 6°W)

II. a) A vessel steering 300°(C), Dueodde Lt. (54°59.5'N 15°04.5'E) bore 256°(C) and Svaneke Lt. (55°07.8'N 15°09.5'E) bore 290°(C), find the vessel's position.

b) From the position obtained in (a), set a course by compass so as to sight Christianso Lt. (55°19.2'N 15°11.5'E) right ahead in meteorological visibility of 2 miles and current setting 062° (T) at 4 knots. (Variation 6°W, Vessel's speed 12 knots.)

III. a) At 1400 hrs., the following bearings were observed

Abbekas Lt. (55°23'N 13°37'E)	306° (C)
Ystad South Lt. (55°25'N 13°49'E)	010° (C)
Kasehuvud Lt. (55°23'N 14°04'E)	070° (C)

Find the ship's position and Deviation if Variation was 6° W.

(b) From the 1400 hrs. position obtained in (a), set a course by a compass so as to pass Hammerodde Lt. (55°18'N 14°47'E) 3 miles off counteracting a current 170° (M) at 3 knots and Wind NNW force 6 Leeway 5°.

(c) Find the time and distance off when Sandhammaren Lt. (55°23'N 14°11.8'E) will be abeam.
(Variation 6°W, Engine Speed 12 knots.)

IV. (a) At 1800 hrs., a vessel steering 212°(C) Gasfeten Lt. (56°07.4'N 15°13.5' E) bore 057°(C) and Tarno Lt. (56°06.8'N 14°58.2'E) bore 325°(C). Find vessel's position. The vessel continued on her course and ship experienced a current setting 290°(T) at 2 knots and Easterly wind caused a leeway of 5°. Find the course and speed made good.

(b) Find the time and distance off when Lagerholmen Lt. (55°58'N 14°28.5' E) will be abeam.
(Engine speed 12 Knots, Variation 6°W)

ANSWERS -- TEST PAPER XIV

I.

Ship's Head	067° (C)
Deviation	1.6° E
Variation	6° W
Compass Error	4.4° W

	1st brg.	2nd brg.	3rd brg.
Compass brg.	037° (C)	000° (C)	311° (C)
Compass Error	4.4° W	4.4° W	4.4° W
True brg.	032.6° (T)	355.6° (T)	306.6° (T)

Current Magnetic	192° (M)
Variation	6° W
True Current	186° (T)

Drift for 1H10M@4 Kts = 4.7 miles

Time ratio 3 : 4.

True Course steered	062.6° (T)
Course Made Good	081.5° (T)
Engine Speed 13.7 miles in 1H10M =	11.7 knots

Vessel's Posn.@1110 hrs. 55° 51.7'N 15°55'E

II. (a)	Compass Course	300° (C)
	Deviation	7° E
	Variation	6° W
	Compass Error	1° E
	Compass brg. Dueodde Lt.	256° (C)
	True brg. Dueodde Lt.	257° (T)
	Compass brg. Svaneke Lt.	290° (C)
	True brg. Svaneke Lt.	291° (T)
	Ship's Posn. 55°03'N 15°32'E	

(b) Christian so Lt. Nominal Range= 19 M

Luminous Range @ 2 miles Visb.= 5.5 miles

Time to steam 5.5'@12 kts. = 28 minutes

Drift for 28 mins @ 4 kts. = 1.85 miles

Current	062° (T)
True Course to steer	310° (T)
Variation	6° W
Magnetic Course	316° (M)
Deviation	8.5° E
Compass Course	307.5° (C)
Compass Course to Steer	307.5° (C)

so as to sight Christian Lt. rt. ahead.

III. (a)	Ystad South Lt.	010° (C)
	Abbekas Lt.	306° (C)
	Horizontal angle	64°
	Base angle	26°

Kasehuvud Lt.	070° (C)
Ystad South Lt.	010° (C)
Horizontal angle	60°
Base angle	30°

1400 hrs. Posn. 55°19.5'N 13.47.6'E

True brg. Ystad South Lt.	009° (T)
Compass brg. Ystad South Lt.	010° (C)
Compass Error	1° W
Variation	6° W
Deviation	5° E

(b)	True Current	164° (T)
	True Course to steer	073° (T)
	Wind NNW Leeway	5°
	True Course to Steer to Counteract Current and Leeway	068° (T)
	Variation	6° W
	Magnetic Course	074° (M)
	Deviation	0.4° E
	Compass Course to Counteract Current and Leeway	073.6° (C)

(c) Beam brg. of

Sandhammaren Lt. = 068°–90°= 338° (T)

Distance off abeam	3.5 miles
Distance to beam brg.	15.2 miles
Speed made good	12.25 (T)kts.

	Time taken	$= \frac{15.2}{12.15}$ =1H15M
	Time Lt. will be abeam	1515 hrs.
IV. (a)	Compass Course	212°(C)
	Deviation	7.7° W
	Variation	6° W
	Compass Error	13.7° W
	True Course	198.3°(T)
	Compass brg. Gasfeten Lt.	057° (C)
	Compass Error	14° W
	True brg. Gasfeten Lt.	043° (T)
	Compass brg. Tarno Lt.	325° (C)
	Compass Error	14° W
	True brg. Tarno Lt.	311° (T)
	1800 hrs. Ship's Posn.56°02.8'N	15°06.2'E
	Course Steered	198° (T)
	Wind East Leeway	+ 5°
	Leeway Track	203° (T)
	Course made good	213° (T)
	Speed made good	12.3° kts
b)	Beam brg. of Lagerholmen Lt.	288° (T)
	Distance off abeam	15.6 miles
	Speed made good	12.3 kts
	Distance to beam brg.	11.7 miles
	Time to abeam posn.	$= \frac{11.7}{12.3}$ = OH57M
	Lagerholmen Lt. will be abeam	1857 hrs.

TEST PAPER XV

[FALSTERBO TO OLAND CHART NO. L (D0-D7) 5072]

(DEVIATION CARD NO. II)

I. A vessel was steering 287°(C). At 0600 hrs. Utklippan Lt. (55°57'N 15°42'E) bore 310°(C) and at 0640 hrs. it bore 351°(C) and again at 0710 hrs. it bore 036°(C). During this period the current was setting 186°(M) at 4 knots. Find the vessel's position at 0710 hrs. and at 0600 hrs. and also the engine speed and the course made good. (Variation 6° W)

II. a) The following bearings were observed at 0200 hrs.-

Abbekas Light (55°23'N 13°37'E)	313° (C)
Ystad South Light (55°25'N 13°49'E)	350° (C)
Kasebarga Lt. (55°23'N 14°04'E)	046° (C)

Find the Ship's position and the Deviation for the Ship's head.

(b) From 0200 hrs. Posn. the vessel steered 084°(C) and she experienced a current setting 290°(T) @ 3 knots and strong Northerly wind caused a leeway of 3°. Find the time and distance off when Sandhammaren Lt. Ho. will be abeam.

(Ship's engine speed 12 knots, Variation 6° W)

III. (a) A vessel steering 000°(C) Dueodde Lt. (54°59.5'N 15°04.5'E) bore 266°(C) and Svaneke Lt. (55°07.8'N 15°09.5'E) bore 309°(C). Find the vessel's position.

(b) From the posn. obtained in (a) set a course by compass so as to sight Christianso Lt. (55°19.2'N 15°11.5'E) right ahead in meteorological visibility of 3 miles and current setting 096°(T) at 5 knots. (Engine speed 12 knots, Variation 6°W)

IV. (a) At 1700 hrs. Hano Lt. Ho. (56°01'N 14°50.8'E) bore

355°(T) and the vertical sextant angle of the same Lt. Ho. was observed to be 00°25' Index Error 2' off the arc and the height of tide at that moment was 2 m below MHWS. Find the vessel's position at 1700 hrs.

b) From the position obtained at 1700 hrs. in (a), set a course by compass so as to sight Simrishamn Lt. (55°33.3'N 14°21.7'E) 30° on the bow when it is 16 is miles off.
(Engine speed 12 knots, Variation 6°W)

ANSWERS - TEST PAPER XV

I.

Compass Course	287° (C)
Deviation	5.0° E
Variation	6° W
Compass Error	1° W
True Course	286° (T)

	1st brg.	2nd brg.	3rd brg.
Compass brg.	310° (C)	351° (C)	036° (C)
Compass Error	1° W	1° W	1° W
True brgs.	309° (T)	350° (T)	035° (T)

Ratio = 40:30 or 4:3

Drift in 1H10M 4.67 miles

Course made good 272° (T)

0710 hrs. Posn. 55° 47.5'N 15°29.8'E

0600 hrs. Posn. 55°46'N 16°06.5'E

Engine Speed 20.7 miles in 1H10M = 17.7 knots

II. (a) Horizontal Angle between Abbekas Lt. and Ystad South Lt. = 350° − 313° = 37°

Base Angle = 53°

Horizontal Angle between Ystad South Lt. and Kasebarga Lt. = 350° − 046° = 56°

Base Angle = 34°

0200 hrs. Position 55° 16'N 13° 53.2'E

True brg. of Ystad Lt.	346° (T)
Compass brg. of Ystad Lt.	350° (C)
Compass Error	4° W
Variation	6° W
Deviation	2° E

(b)

Compass Course	084° (C)
Deviation	1.1° W
Variation	6° W
Compass Error	7.1° W
True Course	076.9° (T)
Wind Northerly Leeway	+3°
Leeway Track	079.9° (T)
Current	290° (T)@ 3 knots
Course made good	071° (T)
Speed made good	9.4 knots

Beam brg. of Sandhammaren Lt. 347° (T)

Distance from 0200 Posn. to beam brg. Posn. 12 miles

Time when Sandhammaren Lt. will a beam

$= \frac{12}{9.4} =$ 1H16 Mins = 0316 hrs.

Distance off when Lt. will be abeam = 3.2 miles

III.	a)	Compass Course	000° (C)
		Deviation	12.5° E
		Variation	6° W
		Compass Error	6.5° E
		True brg. of Dueodde Lt.	272.5° (T)
		True brg. of Svaneke Lt.	315.5° (T)
		Posn. of the Vsl.	54° 59.3'N 15°25'E
	b)	Nominal Range of Christianso Lt.	19 miles
		Luminous Range of Lt.@3 miles visb.	7.7 miles
		Time to steam 7.7 miles@ 12 kts.	38 mins
		Drift for 38 minutes@ 5 knots	3.3 miles
		True Course to Steer	324° (T)
		Variation	6° W
		Magnetic Course	330° (M)
		Deviation	10° E
		Compass Course to Steer	320° (C)
IV.	a)	Charted height of Lt. Ho.	70 m.
		Tide has fallen below MHWS	2 m
		Actual height of Lt. Ho.	72 m.
		Sextant altitude	00° 25'
		Index Error	2' off the arc
		Actual sextant alt.	00° 27'

Distance off by vertical sext. angle = 5 miles

Posn. at 1700 hrs. 55°55.8' N 14°51.7'E

b)	Distance off when 30° on the bow =	16 miles
	Distance off when abeam =16 sine 30°=	8 miles
	True Course to Steer	201° (T)
	Variation	6° W
	Magnetic Co.	207° (M)
	Deviation	7.3° W
	Compass Course to Steer	214.3° (C)

Electronic Chart Information Display System

The latest Electronic Chart Information Display System will revolutionise the navigation in future. The system using Satellite tracking and shore based beacons shows the crucial data on an electronic chart through a single computer screen with an accuracy of about 20 metres. The electronic charts designed to replace centuries old paper charts under this system are already on trial in some advanced maritime countries.

The electronic chart can display the same information on the computer screen as shown on the original paper chart. The electronic chart has programming on it by which a selected area of the chart can be enlarged by a zoom facility that has a warning to remind the navigatior that the scale is different. The programme in the electronic chart also enables different categories of informations like depth marks, topographical contours etc. which can be removed or replaced at will to avoid overcluttering the screen and thus only provide the details required. The changes can be made at will with unlimited scope for future adaptations, innovations. The navigator can add any information he wishes, such as anchorages, uncharted wrecks. The electronics chart is provided in a disk with all necessary information on it and it is upto the navigator to display as much of it as he needs. Each disk contains few hundred charts. Both automatic and manual chart correction facilities are provided and care is being taken to make it easy to use than a paper chart.

The other navigationnal aids like satellite navigator and ARPA are integrated on this Electronic Chart Informations Display System. The ARPA can be displayed with serial numbers, time vectors; guard lines or zones can be set up. The symbol denoting own ship is always shown at the right relative place.

Dual tracks of own ship are displayed by position derived from an electronic navigation processer like satellite navigatior, and along with also Dead Reckoning or Estimated Position is displayed to assure the navigator that the prime navigation system is operating correctly. The voyage planning is greatly assisted by automatic timing markers e.g. every 30 minutes, that so the navigator can know his ship's position. The navigator can alter the scale, zooming into parts of charts or move to a new part without changing operating mode. The chart number is displayed permanantly so that quick reference to the paper chart can be made. The symbol used on the electronics charts are the same as those on a paper chart and thus operator has no familiarisation problem.

The voyage planning is made easier by this system. The sequentially numbered way points entered earlier are automatically displayed on request. Thus revised ETA at destination and way points can also be obtained by feeding correct ETA at one of the way points.

A separate database is compiled, containing all navigational warnings that relate to the chart or area the ship is transiting and built in parameters are provided to ensure that any route chosen does not put the vessel inside the danger limits such as shallows. The danger areas along the routes are highlighted.

Steering data for each leg is provided to the auto pilot and a signal given to auto pilot when way point is reached without over shooting. The course to steer signal will also reflect constant radius twins from electronic chart, which may he required around the headland or a bend at the entrance to a port.

It must be emphasized that it is still an aid to navigation and must be used in conjunction with a paper chart.

The tests are now being conducted on ECDIS by various countries like England, United States of America, Canada, Netherlands and Norway. The results of the tests will be sent to IMO so that ECDIS standards can be prepared which will be acceptable to maritime nations and shipping companies. However, it may be sometime before ship masters will trust their vessels to this high tech devices. There is also a growing concern among those watching the development of international standards for the ECDIS units that ships officers might tend to watch a computer screen rather than looking through the bridge windows to see where they are sailing by.

DEVIATION CARD I

Ship's Head by Compass	Deviation	Ship's Head by Compass	Deviation
000°	2.0°W	180°	2.0°E
010°	3.5°W	190°	3.5°E
020°	5.5°W	200°	5.0°E
030°	7.0°W	210°	7.0°E
040°	9.0°W	220°	8.5°E
050°	10.0°W	230°	10.0°E
060°	11.5°W	240°	11.0°E
070°	12°W	250°	12.0°E
080°	12.5°W	260°	13.0°E
090°	12.5°W	270°	12.5°E
100°	11.5°W	280°	11.5°E
110°	10.5°W	290°	10°E
120°	9.0°W	300°	8°E
130°	7°W	310°	6.5°E
140°	5°W	320°	4.5°E
150°	3°W	330°	2.5°E
160°	1°W	340°	1.0°E
170°	0.5°E	350°	0.5°W
180°	2.0°E	360°	2.0°W

DEVIATION CARD II

Ship's Head by Compass	Deviation	Ship's Head by Compass	Deviation
000°	12.5°E	180°	12.5°W
010°	11.5°E	190°	11.5°W
020°	10.5°E	200°	10.0°W
030°	9.0°E	210°	8.0°W
040°	7.0°E	220°	6.5°W
050°	5.0°E	230°	4.5°W
060°	3.0°E	240°	2.5°W
070°	1.0°E	250°	1.0°W
080°	0.5°W	260°	0.5°E
090°	2.0°W	270°	2.0°E
100°	3.5°W	280°	3.5°E
110°	5.0°W	290°	5.5°E
120°	7.0°W	300°	7.0°E
130°	8.5°W	310°	9.0°E
140°	10.0°W	320°	10.0°E
150°	11.0°W	330°	11.5°E
160°	12.0°W	340°	12.0°E
170°	13.0°W	350°	12.5°E
180°	12.5°W	360°	12.5°E

DEVIATION CARD III

Ship's Head by Compass	Deviation	Ship's Head by Compass	Deviation
000°	4.6°E	180°	4.5°W
010°	4.4°E	190°	4.4°W
020°	4.1°E	200°	4.3°W
030°	3.7°E	210°	4.0°W
040°	3.1°E	220°	3.7°W
050°	2.8°E	230°	3.4°W
060°	1.6°E	240°	2.0°W
070°	0.6°E	250°	2.5°W
080°	0.6°W	260°	1.9°W
090°	1.6°W	270°	1.2°W
100°	2.3°W	280°	0.4°W
110°	2.9°W	290°	0.5°E
120°	3.4°W	300°	1.3°E
130°	3.9°W	310°	2.1°E
140°	4.1°W	320°	2.8°E
150°	4.4°W	330°	3.4°E
160°	4.6°W	340°	3.9°E
170°	4.6°W	350°	4.3°E
180°	4.5°W	360°	4.6°E

LUMINOUS RANGE DIAGRAM