

Apprentices' Handbook.

## TRAINING of OFFICERS

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**Syllabus of Instruction**

with

**Notes for use of Apprentices**

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*Prepared by*

MERCHANT NAVY OFFICERS' TRAINING  
BOARD.

### Notes for Apprentices.

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These notes have been written to explain the course of instruction, which you will undergo as an apprentice, and to help you in carrying out your duties to your best advantage.

The purpose of apprenticeship is to give the apprentice the opportunity of qualifying as a ship's officer. He starts his career as a junior member of the ship's crew, and has to learn the practical part of an officer's duties by working as a member of the crew under the master and officers of his ship. The bookwork necessary to qualify him will be dealt with in detail later. The following general observations as to the conduct of an apprentice must be kept in mind and carefully followed.

One of the fundamental requirements for the control of a ship's crew, and for the management of the ship, is discipline. Every officer, and every member of the crew, must know what discipline means, and must take his proper part in maintaining discipline. Primarily, discipline means the prompt and willing submission to the orders of those in authority over

you. But it also means that you should bear in mind that you are a unit of a ship's company, and that you must always be ready to work loyally with your shipmates in the successful prosecution of the voyage in progress. You have a share in the responsibility for the safety and maintenance of the ship, and it is your duty as a matter of discipline to do all you can within the limits of the work which may be assigned to you by your officers, to show your interest in that particular work and to do it as well as you can. You can be sure that the work given to you is necessary work, and that in doing it you will be fitting yourself, when the time comes, to supervise others who will have to do the same thing. Discipline includes courteous respect to your officers, and tolerance of what you may perhaps dislike in the manners of those with whom you may have to associate. A "happy" ship depends on discipline properly administered.

You must carefully cultivate cleanliness, personal and otherwise. In the restricted area of a ship this is particularly important. Personal uncleanliness is an unpleasant habit which may easily be acquired by carelessness. It is unhealthy and uncomfortable for the victim, and particularly disagreeable for those who have to live in close association with him.

You should be careful to keep your clothes clean, especially your uniform and under-clothes, and equally careful to see that your quarters are regularly cleaned out and kept in an orderly and tidy condition. This will be primarily for your own comfort, but it is also a part of discipline. Your quarters are part of the ship, and, as such, must be clean and properly kept.

Always be punctual. The whole organisation of the ship may be put out of gear by the unpunctuality of a single person. Casual unpunctuality is a common source of ill-temper and waste of time. Habitual unpunctuality disqualifies a man from most positions of responsibility.

Take every opportunity of getting to know your ship thoroughly. You should soon get to know the various parts and the main principles of her construction. You will be allowed in the engine room from time to time, and during the loading and discharge of the ship you will have opportunities of examining the holds and learning what is required for the safe carriage of the particular cargo which is being handled. On these occasions you will be able to realise clearly the object for which the ship has been built and for which she is maintained, namely, to convey economically

from one port to another her various cargoes in safety, and land them in as good condition as when received. These cargoes must be properly and carefully stowed, with all necessary precautions according to the nature of the cargo, the period of the year, the duration of the intended voyage, the weather likely to be met, and the facilities in existence at the port of discharge. You will soon discover that this is a very difficult and complicated business, which requires knowledge, skill and experience, and you will see that there is much that an officer has to know beyond being able to navigate his ship at sea. A master has to have his mind on his cargo all the time. His ship was built to carry it, and it is upon her, and other ships like her, that the great international trade of the world depends. When the ship is in dry-dock, make the most of the chance to examine her hull and under-water parts.

Something should be said about your relations with the fore-castle hands. They will know far more than you about the work you have before you when you join, unless you have had previous technical training, but, in any case, if you keep on good terms with them, there is much in the detailed work of the ship that they will teach you. Join with them in

your daily work, which will, for some time, be the same as theirs, and keep up a spirit of good fellowship. When your seamanship has made practical progress, you will be entrusted by the officers with some degree of responsibility, and if you are tactful and discreet, there should be no difficulty in finding your proper level with the men. Watch the way in which your officers treat the men. You have to learn the art of leadership, and this is a difficult thing to learn. Leadership cannot be imposed, but must be inspired by confidence. One of the essentials of leadership is that the leader should himself thoroughly understand the jobs that he has to supervise and would do them himself if necessary. One of the things that plays no part in leadership is an offensive or overbearing manner towards one's subordinates.

When you go ashore in your time off duty, the master will probably require you to wear uniform, which must always be clean and tidy. Ashore, especially in foreign parts, be careful of the company you keep or you may find yourself in serious trouble in one way or another. Don't get mixed up in rows. Behave decently and remember that you belong to a British ship. Don't do anything to disgrace your ship.

Health is a matter of first importance. You have probably been taught the elementary precautions necessary to preserve your health. Whilst you should not be fussy, you should not take unnecessary risks which might cause illness. Above all, do not try to doctor yourself. If you feel distinctly unwell, or observe signs of any ailment, do not hesitate to report promptly to the ship's surgeon, if there is one on board, or to an officer. This is a duty you owe, not merely to yourself, but to others. The surgeon or master will probably be able to give you advice, or a dose from the ship's medicine chest. If necessary you will be sent to a doctor in port. Cleanliness and health are closely connected. If you can't swim, take the first opportunity of learning.

The following observations apply to the book work which will be required from you. A boy cannot, of course, learn to be a seaman except on the sea. That is what the word implies. A seaman is one of the few people who derives his fundamental education from direct contact with nature. He cannot possibly learn to understand the ways of the sea, and the combined effects of sea and weather upon a ship, except by long and intelligent observation from the deck of a ship, and no classroom

teaching can take the place of actual experience of the endless situations which a seaman has to anticipate and to meet. The education upon which you are about to enter is, therefore, intended to give you experience in the actual work of a ship, and at the same time to help you to observe nature intelligently, and to profit by the lessons which she teaches. Christopher Columbus and Sir Francis Drake performed wonderful feats of seamanship and navigation, which have never been surpassed, with little aid from science or from books, but every officer is not a Columbus or a Drake, and you cannot afford to neglect the great assistance which is now offered by the progress of science and engineering, and by the application of mathematics to the daily problems of navigation.

The Merchant Navy Officers' Training Board have, therefore, drawn up a Syllabus of Instruction which will be used in this ship. The Syllabus is printed on pages 11 to 29 of this book, and, you will observe, covers a period of four years. Some of the subjects will be familiar to many boys, but to others with less technical education the Syllabus will probably appear alarming. The officers who have charge of your instruction will take every opportunity of helping you, and, so far as circumstances permit,

there will be regular times allotted for study under the guidance of an officer, either in your mess-room or such other place as the master may find convenient. Apart, however, from the verbal instruction in your bookwork, which the officers will give you, they will advise you as to the books you should read, and will be ready to answer your questions, and to illustrate in the course of your work on deck the meaning and purposes of what you learn in your hours of study. You should give up as much time as you can to reading, and the master will probably arrange for you to do paper work from time to time, to show what progress you are making in your work. Essays on general subjects will be set occasionally to give you practice in expressing yourself in clear English, and to encourage you to take an intelligent interest in what is going on around you. An important part of an officer's duty is to make written reports on various subjects and occasions, and essay writing will give an apprentice valuable practice in expressing himself lucidly and in keeping to the point. It is very desirable that you make written notes of interesting things that occur either on board or in port. For example, you might write an account of a call at an interesting foreign port, describing the inhabitants, the construction or arrangement of the port, and

its appliances for loading and discharge. If you visit another ship, it might give you something to write about, or you might have to take a disabled vessel in tow, or you might go through a gale of unusual severity, or some particularly difficult piece of navigation which you could describe. It will be well worth your while to practice drawing, and you should always, when you can, illustrate your notes by sketches, or plans, or diagrams. You will find it extremely valuable, when you become an officer, to be able to illustrate reports in this way, apart from the amusement you will get as you become more proficient.

At the end of each year's work, you will have a set of examination papers upon your work presented to you, and will have to do your best to show that you have made the most of the instruction you have received. The papers will be set by the Officers' Training Board, and the same papers will be sent to all ships working under this scheme, so that your progress may be compared with that of other apprentices in other ships. Your answers will be sent to the owners, who will pass them on to the Officers' Training Board to be marked. The result will be communicated to you in due course.

If you make the most of your time, you should be able to pass the Board of Trade

Examination for Second Mate on the completion of your apprenticeship. The Syllabus contains all that will be necessary for your Board of Trade Examination, and, moreover, what you learn will, of course, be essential to you in your daily work as an officer. There is nothing in it that you can regard as superfluous. It has been specially drawn up by officers with long sea experience. It is, therefore, in your own interest to co-operate with the officers who have the task of instructing you, and to make their task as easy and congenial as possible.

You should have, for yourself, the following books :-

- Nicholls's Concise Guide, Volumes 1 and 2.
- Nicholls's Seamanship.
- Norie's or Inman's Nautical Tables.

In addition, the officers who are instructing you may advise you to obtain other books of reference, and there will probably be suitable books for consultation in the ship's library.

**Do not lose this small book.**

## Syllabus.

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### I.—PRACTICAL SEAMANSHIP.

*It is quite impossible to prescribe the order in which the apprentice will in fact learn his practical seamanship. The order must vary from vessel to vessel according to circumstances.*

*The following division into annual sections is, therefore, intended only to show in what years formal instruction on the different items should be stressed, and upon what items questions may be asked in the annual test papers.*

#### FIRST YEAR.

Learn the compass in points and degrees.

Whipping a rope; bends, hitches and knots; different kinds of rope and small stuff; seizings and rackings; eye splice and short splice; worm parcel and serve; common, round and square sennit.

Blocks, tackles, ropes and their use; Spanish windlass; length and size of strops, slings, belts and nets used in handling cargo. The names of the different kinds of lines and ropes in general use, the nature of the materials of which they are made, the forms of their make, the uses to which they are put, and the means to be adopted to ensure their long life.

Handling and upkeep of patent logs and patent sounding machines. Marks on hand lead and hand log lines.

Learn to repeat the Articles of the Rule of the Road. Different rigs of sailing boats and sailing ships; different types of steamers; the rigging of steamers.

Signalling by morse and semaphore.

The flags of the International Code of Signals.

Preparation of holds for cargo.

Cleaning of bilges.

Clearing of bilge suction rose boxes.

Closing and battening down hatches and gangway doors. Draft marks on stem and stern posts; loadline marks.

A portion of some of the day watches at the wheel in fine weather away from the land.

SECOND YEAR. (*In addition to previous year.*)

Care and overhauling of cargo gear; duration of life of cargo gear; safe working load of rope, wire and chain. Hold ventilation and dunnaging cargo.

The necessity for dunnage and its proper use.

Shifting boards and feeders.

Separation cloths, mats and other means of separating parcels of cargo when such are carried.

The need for and the preparation of cargo plans.

Long splice in rope and eye splice in wire.

Seaming and roping palms; sewing canvas, awnings and tarpaulins.

Different grades of canvas and their uses.

Paint and paint mixing; quantity of paint required to cover various parts of the ship. Precautions taken to prevent rust forming – on shell plating – deck plating, and in the holds. Use of cement and cement wash; cleaning paintwork and bright work. Rigging of stages, painting down masts and funnels, and overside.

Handling and management of boats under oars and sails. (Officer in charge.)

Duties with carpenter, lamp trimmer and boat-swain. Ship routine.

Anchors and cables.

A full knowledge of the contents and application of the Regulations for Preventing Collisions at Sea.

Responsibility (under an officer) for gear of one boat and its readiness at all times for boat drill, which must always be attended.

Responsible (under an officer) for logs and lines, hand lead and line and sounding machine.

On duty near an officer on all occasions entering or leaving port or anchorage and when shifting ship in port.

Night watches to be kept on the bridge.

THIRD YEAR. (*In addition to previous years.*)

Fire-fighting appliances – their care and maintenance; fire and boat drill; boat stations; lifeboat equipment, life buoys, life belts and their tests.

Use and upkeep of engine-room and other telegraphs. Knowledge of use and maintenance of deck appliances and steering gear; different types of steering gear; relieving tackles.

Fitting of rigging, turning in dead eyes or hearts; use and overhaul of rigging screws; setting up rigging; rattling down.

Bending, setting and taking in fore and aft sails; sending topmasts, gaffs and signal yards up and down.

Tallying of cargo. Mates' receipts, their value and need for accuracy. Protests, their meaning and value.

Deck cargoes. Live stock. Dangerous cargoes, stowage and precautions. Parcels of cargo liable to damage other cargo, precautions to be taken.

The nature of pigments and oils and varnishes used in ship work, together with explanations as to the reasons for using different types of paints, compositions and varnishes for certain parts of the ship. Bituminous compounds, their uses and reason for same.

A portion of some of the day watches on the bridge in narrow waters.

Precautions to be taken with bad weather approaching; hatches, ventilators and life lines. Precautions to be taken before nightfall. Use of oil in bad weather.

Safety requirements under Factories Acts as applied to ships.

First aid.

FOURTH YEAR. (*In addition to previous years.*)

Preparations and precautions for getting under way. Duties prior to proceeding to sea; keeping an anchor watch; dragging anchor; duties of officer of the watch; use of compass to ascertain risk of collision.

Distress and pilot signals; penalties for misuse. Notices to mariners; uniform system of buoyage in the United Kingdom. Rocket and line throwing apparatus.

Ship hygiene and fumigation.

Morse and semaphore at International Code speed. Flags of all nations.

The arrangements of derricks and cargo working gear. Rigging and working of heavy weight derrick.

Refrigerated cargoes.

Launching of boats at sea and getting away from ship's side during heavy weather.

Sea anchors, types and uses.

Precautions before entering, while in, and before leaving dry dock. Inspection of ship under-water parts in dry dock. Ranging of chain cables in dry dock.

The use of Commercial Code Books.

## II.—MATHEMATICS, NAVIGATION AND NAUTICAL ASTRONOMY.

*It is of great importance that all the data used should be thoroughly understood, paying due regard to the definitions of any terms used in navigation, and that all problems in Nautical Astronomy should be worked direct from the figure. No short cuts should be allowed or indulged in – once the subject is mastered, the methods of short cuts with tables, etc., will suggest themselves.*

*The necessary Tables to be used in connection with this Syllabus are :– Norie's or Inman's Tables; the Nautical Almanac, abridged for the use of seamen; Admiralty Tide Tables, Part I. and Part II. It would be a great help to the apprentice if he were to study carefully the explanation and illustrations given in each of these publications.*

*The text books required will be recommended from time to time by the Officers' Training Board.*

### FIRST YEAR.

Algebraic processes: factors, the difference of two squares: fractions, multiplication and division, addition and subtraction: transformation of equations, e.g., given  $A = \pi (R^2 - r^2)$ , find  $r$ : simultaneous equations in two unknowns of the first degree.

The construction of triangles from given particulars. The congruence of triangles. Parallel lines and transversal. Exterior angle equal to sum of interior and opposite. Angle sum of triangle. Similar triangles and the ratios of corresponding sides. Proportionality of sides and areas of similar triangles and polygons. Properties of circles, chords, tangents and rectangles; angle in a semi-circle; angles subtended by any chord of a circle. Angle between tangent to a circle and chord through point of contact. Great and small circles. Spherical angles and tangent planes. Angular distance. Length of small arc.

To draw a quadrant with any convenient radius and from the centre lay off any angle and then, without the aid of tables, find the natural sine, cosine, tangent, cosecant, secant and cotangent.

Measurement of angles. Circular measure. Approximation for ratios of small angles. Parallax and Dip.

The practical use of logarithms to base 10; their use in simple calculations involving multiplication, division, simple powers and roots. Simple identities. Solution of right-angled triangles.

To draw figures and prove the rules for Plane, Parallel and Middle Latitude sailings, and to understand their practical value.

To find course and distance, departure and difference of latitude between two points by means of the Traverse Table.

Plotting graphs of a statistical and experimental nature. Practice in understanding graphs; their uses.

To find the course and distance between two points by the use of Meridional parts (Mercator's Sailing).

## SECOND YEAR.

Indices; explanation of methods of logarithmic calculation from the law of indices.

The day's work. To find position by Dead Reckoning and by account (estimated position).

Trigonometrical ratios up to one complete revolution. Plotting of trigonometrical functions, *e.g.*,  $\sin. A$ ,  $\cos. A$ ,  $\tan. A$ . Area of a triangle. Solution of oblique triangles by triangle formulae.

Chart work – the principle of the Mercator Chart and plan. The signs and abbreviations; unit of measurement. To find the true course and distance between two points; given the variation and deviation of the compass to find magnetic and compass course to steer. To fix position by cross bearings, or by wireless cross bearings, applying the necessary corrections. To fix position by bearings of a single object with run between, allowing for a current. To find course to steer between two points making allowance for current and wind. Station pointer, danger angles.

Projection of lines and areas; the meaning of versine  $A$ , haversine  $A$ . More difficult identities; Mensuration of the Circle.

Surface areas and volumes of prisms, pyramid, right circular cylinder, cone and sphere.

Knowledge of celestial sphere including celestial poles, celestial meridian, celestial equator and horizon. Apparent movements of heavenly bodies. Ecliptic and the first point of Aries: declination: amplitude: azimuth: right ascension. Real movement of Earth, Moon and Planets: altitude and zenith distance: Prime Vertical: circles of Altitude: Time: apparent Time: Mean Time: Sidereal Time: Equation of Time: hour angle.

Stereographic projections on the Planes of the Horizon, the Meridian and Equinoctial.

The quadratic equation; solution by factors and completing the square. Graphical solutions.

Use of, and adjustments of the Sextant. To take vertical and horizontal angles. Chronometers: stowage at safe distance from magnetic and electrical instruments: management and care: handling, winding, comparing: value of daily comparisons: wireless and other time signals for rating.

To know the names of the principal Stars and their constellations.

To find the latitude by the Meridian Altitudes of the Sun, Moon, Stars and Planets.

## THIRD YEAR.

To calculate approximate time of high water by the use of the high water full and change constant. To find the time and height of high and low water at standard ports (Admiralty Tide Tables). To find the height of tide at a given time intermediate between high and low water, and thence by use of diagram to determine approximate corrections to soundings and height of objects above sea level taken at such intermediate times. Chart datum. The intelligent use of sailing directions.

NOTE.— At this stage an apprentice should be taught how to correct his charts from Notices to Mariners.

Elementary properties of spherical triangles: Proof of the cosine formula :—  $\cos a = \cos b \cos c + \sin b \sin c \cos A$ . Deduction of the Natural and Log Haversine Formulae. Solution of right-angled and quadrantal spherical triangles: Napier's Rules. Solution of spherical triangles.

To find deviation of the compass by Amplitudes and Azimuths. Use of Azimuth mirror, pelorus, or other instrument for taking bearings.

The principle of position circles. Position line. Intercept. To find longitude by Chronometer by altitude of the Sun, Star, Moon and Planets, thence to find a position line. Latitude by Ex Meridian of the Sun. More difficult nautical problems of the solution of oblique spherical triangles.

## FOURTH YEAR.

The inclination of the apprentice in his fourth year will be to prepare himself solely for his Board of Trade examination, and on this account it is thought better to put all the necessary syllabus into three years, leaving the fourth year for recapitulation work.

### III.—SHIP CONSTRUCTION.

#### FIRST YEAR.

Deck sheathing and waterways.

Sounding pipes. Air pipes.

Steel and wooden masts and derricks with their attachments, and standing and running rigging and gear.

Hatch coamings. Hatchways and covers, both wood and steel.

#### SECOND YEAR. (*In addition to previous year.*)

Tank top plating.

Rudders of various types.

Plating of shell, bulkheads and decks.

Bilge and tank pumping arrangements.

Carling beams and partners.

Pillaring and stanchion arrangements.

Local stiffening at ends of vessel and under boilers, engines, winches, windlass, etc.

#### THIRD YEAR. (*In addition to previous year.*)

Names of the principal parts of a ship, *e.g.* :—

Keel (bar and plate).

Floors (solid and skeleton) and double bottom.

Centre girder or keelson.

Side and bilge keelsons.

Stem bar, stern post, body post, stern frame and stern tube.

#### FOURTH YEAR. (*In addition to previous year.*)

The construction of the cellular double bottom with its various members.

A ship as a girder.

Stresses a ship has to resist, longitudinal, transverse, collapsing, local.

Longitudinal and transverse systems of framing.

Beams and knees.

Stringers and stringer plates and methods of attachment of the various parts and names of the various types of rivets and reasons for these.

Parts of ships, particularly liable to corrosion and methods of dealing with it, in peaks, bunkers, double bottom tanks, etc.

#### **Special types of ships for special cargoes:**

*(The following section is inserted as it is necessary that an apprentice's knowledge should not be confined to the type or types of vessel upon which he happens to have served.)*

TANKERS. General arrangement of ship and tanks, and cargo arrangements, pipes and valves; precautions against admixture of cargo.

REFRIGERATED AND INSULATED SHIPS. General elementary principles of refrigeration.

Different temperatures for different cargoes, such as chilled meat, frozen meat, dairy produce and various kinds of fruits.

General elementary principles and methods of insulation.

TIMBER CARRIERS. Deck loads and methods of securing.

LOAD LINES. Ordinary; special load lines for tankers and timber-laden ships, and reasons for variations.

#### IV.—MISCELLANEOUS KNOWLEDGE.

##### FIRST YEAR.

Buoyancy: flotation and its application at sea. Use of load lines.

Specific gravity: use of hydrometer. Draught of a ship.

Pressure in liquids: variation with depth and application to sounding machines.

Action of forces in a derrick. Resolution of forces. Moments of forces as applied to levers and capstan.

Centre of gravity: simple examples.

Knowledge of simple machines, *e.g.*, tackles, capstan and winches: meaning of mechanical advantage. Strength of rope, wire and hemp.

##### SECOND YEAR.

Meaning of temperature. Construction of a thermometer.

Centigrade, Fahrenheit and Reamur scales: conversion from one to the other: maximum and minimum thermometers.

Air pressure: construction of a barometer. Measurement of air pressure: units, *e.g.*, bar, milli-bar.

The marine barometer, aneroid barometer, barograph.

Variation of air pressure with height and latitude.

Boyle's and Charles' Laws: absolute zero: absolute scale of temperature, sounding machines.

The atmosphere and its humidity. Vapour pressure and dew point: the wet and dry bulb hygrometer, and its principles and uses.

Reflection of light by plane mirrors. Effect on reflection by rotation of mirror as in the sextant.

Refraction of light by azimuth mirror. Atmospheric refraction.

Formation of images by lenses: Magnification of a telescope. Sextant errors and their correction.

#### THIRD YEAR.

Estimating weights of simple parts of ship structure.

Displacement and sinkage of box forms. Centre of buoyancy and centre of flotation.

Calculations of displacement using a block coefficient. Tons per inch (T.P.I.) calculations.

Definition of "metacentre" and "metacentric heights." Stiff and tender ships.

Effect of filling and emptying ballast and other tanks on centre of gravity as a whole.

Plotting T.P.I. and displacement curves.

Deadweight scales.

#### FOURTH YEAR.

Recapitulation for 2<sup>nd</sup> Mate's examination.

### V.—ENGINEERING KNOWLEDGE.

*The purpose of this subject is not to provide an apprentice with a detailed knowledge of engineering, but to enable him to appreciate the functions of the various engineering appliances on board ship in a simple manner.*

#### FIRST YEAR.

Use of instruments and scales.

The sketching of such objects as nuts, bolts, rivets and simple engine parts, *e.g.*, a winch piston, a stop valve, a connecting rod for a small engine.

Drawing in plan and elevation.

How drawings are dimensioned.

Practice in this work by making a dimensioned sketch from a given object.

Simple ideas of the working of a reciprocating engine, *e.g.*, winch; names of essential parts and method of lubrication.

How a steam windlass works. Differences between gear wheels and worm gear.

Simple ideas on the general construction of marine boilers.

How to operate a steam valve. How pipe lines are drained. Danger of frost on pipe lines and winch cylinders.

How steam is produced in a steam boiler. How it works the engine.

## SECOND YEAR.

Steering gears, their types and the various means of operation.

The various pumps on board ship, *e.g.*, feed, ballast and bilge, and how they are worked.

The pipes and valves for pumping out bilges, ballast and oil tanks.

The shafting from engine to propeller and the means by which the thrust of the propeller is transmitted to the hull of the ship.

How coal and oil are burned in the furnace of a marine boiler.

Danger of fire and the means of preventing, detecting and extinguishing it.

How a refrigerating machine works; the importance of insulation; how the chambers are cooled.

Simple idea of how a steam turbine works.

Simple idea of how a Diesel engine works.

## THIRD YEAR.

How electrical pressure, current and resistance are measured. Ohm's law. Some idea of the size of the units by reference to ships' lighting and power supply. Dangerous voltages (dry and wet body).

What a current of electricity can do: simple ideas of magnetic, heating and chemical effects.

Heating effect of a current – how it increases with an increase in the strength of the current.

Melting of substances: effect of temperature upon conducting and insulating properties of substances. How insulated cables tend to insulate heat and so raise temperature. Fuses.

Primary and secondary batteries. Care and use of accumulators. Electrical corrosion.

Why a ship's supply must have a constant pressure. Building up a simple lighting circuit. What candle power is – how C.P. depends upon electrical power – how it varies in different types of lamps – how lamps are rated. Lamps in series and in parallel.

How an electro-magnet works: the electric bell and buzzer, telephone, microphone and moving iron ammeter.

How a D.C. electric motor works. Application in the construction of moving coil ammeter.

Simple ideas of the principle and construction of a dynamo. The spring cut-out as safety device. Direct and alternating current. The transformer.

Different types of motors used in ships: the functions of the starter.

Electrical heating and lighting appliances found aboard ship. The measurement of energy in watts, Board of Trade units: the relation of watts to horse-power.

Simple ideas on the main parts of a ship's wireless apparatus.