

65. Paper 3.**NAVIGATION.** (3 hours.)

A comprehensive knowledge of modern navigational methods and facility in their use, together with—

Determination of error of chronometer by the use of an artificial or natural horizon. Proofs of methods and formulæ in use in modern navigational practice. Comparison of different methods of determining observer's position. Equivalent of position lines determined by any recognized method. True position from several observations. The "cocked hat" and the limited area, most probable position. True position when errors occur in estimated position. Altitudes or time. Selection of heavenly bodies for observations. Selection of objects for fixes. Good and bad fixes. Various methods of fixing ship. Accuracy and limitations. Most favourable conditions. Theory of sextant and vernier. Errors of collimation and parallelism. Description and use of all apparatus to safeguard navigation in the open sea and coastwise—*e.g.*, sounding-machines, including sonic sounding gear, wireless navigational instruments and methods, &c. Theory of tides. Tidal tables and their use, including the harmonic method of prediction. Tidal streams. Abnormal tides. The behaviour of a freely mounted gyroscope and effect of suspension. Precession. The earth's rotation and its influence on a gyroscope. Principles of the gyro compass. Damping. Course and speed errors. Ballistic deflection.

66. Paper 4.**CHART WORK.** (2 hours.)

A complete knowledge of charts and information given by a chart. All methods of fixing ship by observations of terrestrial objects and a combination of observations on celestial and terrestrial objects. The principles of navigation in pilotage waters and avoidance of danger, both in clear weather and fog. The laying-off of great circle and composite tracks on Gnomonic and Mercator's charts and the use of Great Circle tables.

67. Paper 5.**CHART-CONSTRUCTION AND MARINE SURVEYING.** (3 hours.)

The theory and construction of charts on Mercator's principle. Candidates may be asked to construct and use such a chart. The principles of the construction of a Gnomonic chart (without proof) and the special case of Polar charts. Candidates will *not* be asked to construct such a chart.

Elementary hydrographic surveying. Charting on an existing chart of objects useful for navigation. Scale-making and the laying-off of angles. Methods of fixing position. Method of running lines of soundings.

68. Paper 6.**MAGNETISM AND ELECTRICITY, INCLUDING THE MAGNETIC COMPASS.** (3 hours.)

Electric currents and their production. Simple cells. Electromotive force, resistance and current. Ohm's Law. Polarization. Magnetic fields and lines of force. Induced magnetism. Hard and soft iron. The magnetic field of conductors. Carrying current. Solenoids and electro-magnets. Terrestrial magnetism. Horizontal force, vertical force, and dip. The effect of magnetic fields of all descriptions on the compass needle. Elementary principles of dynamos and motors. Application to winches. Electric lighting and arc lights.

A fuller knowledge of the syllabus in Compass Correction for Master, with, in addition, the correction of coefficient E. The components of the permanent magnetism of the ship, P, Q, and R; the soft iron rods, a, c, e, and k. The relation severally of these components and rods to the various coefficients and to heeling error.

Swinging ship. Construction of deviation tables by bearings of a distant object, reciprocal bearings and azimuths of a heavenly body. Practical analysis of a deviation table and practical compass correction.