1978/175

THE MARINE ENGINEERS EXAMINATION REGULATIONS 1966, AMENDMENT NO. 2

KEITH HOLYOAKE, Governor-General

ORDER IN COUNCIL

At the Government House at Wellington this 26th day of June 1978

Present:

HIS EXCELLENCY THE GOVERNOR-GENERAL IN COUNCIL

PURSUANT to the Shipping and Seamen Act 1952, His Excellency the Governor-General, acting by and with advice and consent of the Executive Council, hereby makes the following regulations.

REGULATIONS

1. Title and commencement—(1) These regulations may be cited as the Marine Engineers Examination Regulations 1966, Amendment No. 2, and shall be read together with and deemed part of the Marine Engineers Examination Regulations 1966* (hereinafter referred to as the principal regulations).

(2) These regulations shall come into force on the 1st day of August 1978.

2. Interpretation—(1) Regulation 2 of the principal regulations is hereby amended by inserting, after the definition of the term "certificate", the following definition:

" 'Marine Division' means the Marine Division of the Ministry of Transport:".

(2) The principal regulations (as amended by section 6 (2) (b) of the Ministry of Transport Amendment Act 1972) are hereby further amended—

(a) By omitting from the definition of the term "certificate" in section 2 the words "Ministry of Transport", and substituting the words "Marine Division":

*S.R. 1966/140
Amendment No. 1: S.R. 1969/247

(b) By omitting from regulations 7 (6), 31, and 57 the words "Ministry of Transport", and substituting in each case the words "Marine Division".

3. Certificates of service to naval personnel—The principal regulations are hereby further amended by revoking regulation 5, and substituting the following regulation:

"5. (1) An engineer officer who has attained the substantive rank of lieutenant or above on the General List in the Royal New Zealand Navy and has graduated, then taken the Marine Engineering Application Course (MEAC) at the Royal Navy Engineering College or equivalent, and who has performed not less than 24 months' qualifying sea service* as watchkeeping marine engineer officer, deputy marine engineer officer, or marine engineer officer since attaining that rank (temporary rank, if any, to count) and while in possession of (or eligible for) a second class certificate, may apply to be granted a certificate of service as first-class engineer without examination.

"(2) An engineer officer who has attained the substantive rank of sub-lieutenant or above on the General List, Supplementary List, or Special Duties List in the Royal New Zealand Navy and has performed not less than 24 months' qualifying sea service* as a watchkeeping marine engineer officer, deputy marine engineer officer, or marine engineer officer since attaining that rank (temporary rank, if any, to count) may apply to be granted a certificate of service as second-class engineer without examination.

"(3) Marine engineering artificers and marine engineering mechanicians who are fully professionally qualified for the first-class rating or above in the Royal New Zealand Navy and who have gained either—

(a) A charge certificate; or

(b) A unit watchkeeping certificate plus successful completion of the first 2 years of the New Zealand Certificate in Engineering or its equivalent,—

may apply to be granted a certificate of service as third-class steam engineer without examination.

"(4) Marine engineering officers of a Commonwealth country must apply through their respective Commanding Officer to be granted certificates of service if they have attained a rank and performed qualifying sea service corresponding to the ranks and service specified in subclauses (1) and (2) of this regulation. Reserve officers shall not be eligible for the granting of certificates of service unless they have previously attained a rank and performed qualifying sea service, on the Active List, specified in subclauses (1) and (2) of this regulation.

[*NOTES: 1. First-class qualifying service must be spent on steamships or motor ships of a power not less than 420 kW.

2. Second-class qualifying service must be spent on steamships or motor ships of a power not less than 280 kW.

3. Such qualifying sea service is to include—

(a) At least 6 months spent on boilers.

(b) At least 6 months spent on steam propelling machinery.

(N.B. (a) and (b) may be simultaneous, but must total at least 9 months).

(c) At least 6 months spent on motor propelling machinery.

(d) The remainder may have been spent as in (a), or (b), or (c) of this note, or on gas turbine machinery, or on auxilliary machinery of a steamship or motor ship, or on day work, as specified in regulation 34 hereof.

(e) Not less than two-thirds of the total time must have been spent actually at sea.

4. A certificate confirming this service, authenticated by the Commanding Officer, is to accompany the application.]"

"(5) A certificate of service shall, for the purposes of section 17 of the Act, be deemed to be a valid certificate of service of its respective grade to enable the holder to serve in a ship of the mercantile marine, however propelled.

"(6) Should qualifying sea service, as defined in paragraph (a) or paragraph (b) or paragraph (c) of note 3 to this regulation, be insufficient, a certificate of service for either steam or motor propelled ships shall be issued, provided not less than 21 months of the appropriate qualifying sea service has been performed.

"(7) The fee for a certificate of service as first-class engineer, or second-class engineer, or third-class engineer under this regulation shall be as prescribed by the Shipping (Fees) Regulations 1978*.

"(8) Application for certificates of service shall be made on form M.O.T. 5113 obtainable from the Chief Examiner of Marine Engineers, Ministry of Transport, Private Bag, Wellington, New Zealand, and forwarded as directed in that form."

4. Places and dates of examination—(1) The principal regulations are hereby further amended by revoking regulation 9, and substituting the following regulation:

"9. (1) Examinations for all marine engineers' certificates, except that for the extra first-class, shall be held at the places and commence on the days specified in the annual schedule obtainable from Mercantile Marine Offices and the Marine Engineer Examination Section of the Ministry of Transport (Wellington and Auckland only). The examination days specified in the schedule shall be liable to occasional alteration. Where any one of the days so specified is a public holiday, the examination shall commence on the first working day thereafter.

"(2) Examinations for certificates as extra first-class engineer shall be held at Wellington only, by arrangement with the Chief Examiner of Marine Engineers.

"(3) In addition, examinations for certificates as engineer of restricted-limit motor ship, river engineer, and second-class diesel trawler engineer may be held at the port at which the applicant wishes to be examined. Application should be made as set out in regulation 11. The place and commencement of the examination is to be arranged with the local Regional, District, or Senior Engineer Surveyor."

(2) Regulation 3 of the Marine Engineers Examination Regulations 1966, Amendment No. 1, is hereby revoked.

5. Examination location and timetables—The principal regulations are hereby further amended by revoking regulation 10, and substituting the following regulation:

"10. The exact location and timetables for all examinations shall be determined by the Chief Examiner, and shall be notified to candidates when permission to sit the examination is granted."

6. Application for examination—Regulation 11 (3) of the principal regulations is hereby amended by omitting the words "10 days", and substituting the words "10 working days".

*S.R. 1978/84

7. Examination of engine-room artificers and mechanicians—The principal regulations are hereby further amended by revoking regulation 15, and substituting the following regulation:

"15. Warrant marine engineering artificers and warrant marine engineering mechanicians who have been or are still employed in the naval forces of any Commonwealth country may be examined for certificates of competency on the same conditions as engineers in the mercantile marine."

8. Application by naval officers—Regulation 16 of the principal regulations is hereby amended—

(a) By omitting from subclause (1) the words "any of the naval forces specified in regulation 5 hereof", and substituting the words "the Royal New Zealand Navy":

(b) By omitting from subclause (2) and also from subclause (3) the words "Deputy Secretary of Defence (Navy)", and substituting in each case the words "Assistant Chief of Defence Staff (Personnel)".

9. Valuation of candidates' work for certificates of New Zealand validity—Regulation 20 (1) of the principal regulations is hereby amended by omitting the words "Partial passes may be granted in either Part A or Part B, subject to subclause (3) of this regulation", and substituting the words "If the candidate obtains at least 60 percent of total marks with a minimum of 50 percent for each paper in either Part A or Part B when attempting the whole of the examination, a partial pass may be granted for that part".

10. Nationality—(1) Regulation 22 (2) of the principal regulations is hereby amended by revoking paragraph (e), and substituting the following paragraphs:

"(e) Third-class steam engineer:

"(f) First-class diesel trawler engineer."

(2) Regulation 22 of the principal regulations is hereby further amended by inserting, after subclause (2), the following subclause:

"(2A) A person who is neither a British subject nor a British protected person and who complies with all the requirements of these regulations as to training and service may be examined for the following marine engineers' certificates of competency:

"(a) Second-class diesel trawler engineer:

"(b) Engineer of local motor ship:

"(c) Engineer of restricted-limit motor ship."

(3) Regulation 22 of the principal regulations is hereby further amended—

(a) By inserting in subclause (1), after the words "subclause (2)", the words "or subclause (2A)":

(b) By inserting in subclause (3), after the words "subclause (2)", the words "or subclause (2A)".

11. Knowledge of English—The principal regulations are hereby further amended by revoking regulation 24, and substituting the following regulation:

"24. All candidates must satisfy the Examiner that they can speak, write, and understand the English language sufficiently well to perform the duties required of them on board a Commonwealth ship."

12. Sea service—Regulation 32 of the principal regulations is hereby amended by inserting, after subclause (2), the following subclause:

"(2A) Where an engineer officer is required to be in sole charge of periodically unattended machinery spaces on any ship, every such continuous period of sea-service of not less than 24 hours performed by him shall be accepted as qualifying sea-service. Each on-call watch-keeping period shall count at one and a half rate, the remainder of the time on articles being considered as day work and accepted as qualifying sea-service calculated in accordance with regulation 34 of these regulations. The total sea-service so calculated shall be determined in accordance with this subclause or the time actually served on articles, whichever is the less."

13. Day work—The principal regulations are hereby further amended by revoking regulation 34, and substituting the following regulation:

"34. Day work, by which is meant engineering work carried out within the engine and boiler spaces of a steam, motor, or gas-turbine ship at sea, other than that performed on regular watch, shall be counted towards qualifying sea service at full rate up to a maximum of 8 months and any further period at half rate, the total service so calculated being limited to 12 months."

14. Assessment of power—The principal regulations are hereby further amended by revoking regulation 41, and substituting the following regulation:

"41. The brake, shaft, or total power of any ship, as shown in the ship's certificate of registry, may in all cases be accepted by the Examiner."

15. Calculation of service—Regulation 46 (2) of the principal regulations is hereby amended by adding the words "but all periods of recorded time-off shall be excluded".

16. First-class diesel trawler engineer—Regulation 61 (5) of the principal regulations is hereby amended by adding the words "using the S.I. system of units".

17. Engineer of local motor ship—Regulation 66 (4) (b) of the principal regulations is hereby amended by adding the words "using the S.I. system of units".

18. Second-class coastal motor—Regulation 67 (4) of the principal regulations is hereby amended by omitting the words "60 brake horsepower", and substituting the words "45 kW brake power".

19. First-class coastal motor—Regulation 68 (2) of the principal regulations is hereby amended by omitting the words "200 brake horsepower", and substituting the words "150 kW brake power".

20. Second-class steam—(1) Regulation 70 (3) of the principal regulations is hereby amended—

(a) By omitting the words "of not less than 66 nominal horsepower":

(b) By omitting the words "373 brake horsepower", and substituting the words "280 kW brake power".

(2) Regulation 70 of the principal regulations is hereby further amended by revoking subclauses (8) and (9), and substituting the following subclause:

"(8) The candidate must have completed satisfactorily a four-day fire-fighting course approved by the Director of the Marine Division of the Department."

21. Second-class motor—Regulation 71 (1) of the principal regulations is hereby amended by omitting the expression "(8), and (9)", and substituting the expression "and (8)".

22. Second-class steam and motor—Regulation 72 of the principal regulations is hereby revoked.

23. First-class steam—(1) Regulation 73 of the principal regulations is hereby amended—

(a) By omitting from subclause (2) the words "of not less than 99 nominal horsepower":

(b) By omitting from subclause (2) the words "560 brake horsepower", and substituting the words "420 kW brake power":

(c) By revoking subclause (5).

(2) Regulation 73 of the principal regulations is hereby further amended by adding the following subclause:

"(10) Candidates for the endorsement of a first-class motor certificate must have completed the same period of sea service, subsequent to obtaining the second-class certificate, as that required in regulation 70 (7) for the endorsement of a second-class motor certificate."

24. First-class motor—(1) Regulation 74 of the principal regulations is hereby amended by omitting from subclause (1) the expression "(1) to (5)", and substituting the expression "(1) to (4)".

(2) Regulation 74 of the principal regulations is hereby further amended by adding the following subclause:

"(3) Candidates for the endorsement of a first-class steam certificate must have completed the same period of sea service, subsequent to obtaining the second-class certificate, as that required in regulation 71 (3) hereof for the endorsement of a second-class steam certificate."

25. First-class steam and motor—Regulation 75 of the principal regulations is hereby revoked.

26. Syllabuses for examinations—The principal regulations are hereby further amended—

(a) By revoking the First Schedule, and substituting the First Schedule set out in the First Schedule to these regulations:

(b) By revoking the Third and Fourth Schedules, and substituting the Third and Fourth Schedules set out in the Second Schedule to these regulations.

SCHEDULES

FIRST SCHEDULE

Reg 26 (a)

NEW FIRST SCHEDULE TO PRINCIPAL REGULATIONS

"FIRST SCHEDULE

Regs. 70 (11), 71 (4), 73 (7), 74 (2)

SYLLABUSES FOR THE FIRST-CLASS AND SECOND-CLASS EXAMINATIONS (CERTIFICATES RECOGNISED BEYOND NEW ZEALAND)

PART A

FUNDAMENTAL KNOWLEDGE SUBJECTS

NOTES:

1. The problems will require a knowledge of the SI system.
2. The problems at second-class level will be such as can be solved by the knowledge of elementary algebra, geometry, and plane trigonometry.
3. Formulae that require for their development the use of mathematics beyond the syllabus and constants will be given.
4. Graphical solutions will be acceptable where the analytical solution is not expressly stated to be required.
5. Candidates may, if they wish, use slide rules or battery-operated calculators for their calculations; but in each case a full statement of the steps leading to the calculations must be shown.

SECOND-CLASS MATHEMATICS

Calculators may *not* be used for this examination

(One paper of 3 hours. Six questions only out of 9 to be attempted.)

Arithmetic—Ratio and proportion. Percentages. Variation, direct and inverse.

Algebra—Indices, including fractional and negative types. Use of common logarithms for multiplication, division, powers, and roots. Use of Naperian logarithms. Simplification of algebraic expressions. Addition, subtraction, multiplication, and division of algebraic functions. Re-arrangement of formulae. Factorisation. Algebraic fractions. Squares and cubes of polynomials such as $(a \pm b)^2$ and $(a \pm b)^3$. Simple equations. Quadratic equations and solution by factorisation or by completing the square, proof of general formula for solution. Simultaneous equations.

Graphical work—Simple graphs of statistics. The graph $y = ax + b$ either from calculated values or from experimental results. Calculation of constants from graphs. Graphical solution of simple simultaneous equations involving 2 unknowns. Graph of $y = ax^2 + bx + c$ and graphical solution of equation $ax^2 + bx + c = 0$.

Trigonometry—Measurement of angles in degrees and radians. Complementary and supplementary angles. Sine, cosine, and tangent

FIRST SCHEDULE—*continued*

of angles up to 360°. Proof of sine and cosine rules. Solution of triangles. Solution of simple trigonometric equations. Expansion of sin (A ± B) and cos (A ± B).

Geometry—Properties of triangles. Sum of the angles. Relation between exterior and interior angles. Isosceles and equilateral triangles. Similar and congruent triangles.

The circle. Properties of chords and tangents. Angles in the same segment. Angles at centre and circumference.

Mensuration—Areas of triangle, polygon, parallelogram, trapezium, circle, sector, and segment of a circle and ellipse. Areas of oblique sections of regular solids of uniform cross-section. Area and mean height by mid-ordinate rule and by Simpson's rules. Ratio of areas of similar figures. Volumes and surface areas of prisms, pyramids, frustums, spheres, cylinders, and cones. Ratio of masses and volumes of similar solids. Solids of revolution.

SECOND-CLASS APPLIED MECHANICS

(One paper of 3 hours. Six questions only out of 9 to be attempted.)

Statics—Force as a vector. Triangle and polygon of forces. Resultant and equilibrant of a system of concurrent coplanar forces. Equilibrium of 3 coplanar forces. Moment of a force. Couples. Moments of areas and volumes. Centroids and centres of gravity (limited to geometrical shapes). Conditions of equilibrium of solids. Necessary force applied parallel to an inclined plane to pull body up or down the plane, or to hold it stationary (including effect of friction). Work done at uniform speed up the plane.

Friction—Laws of friction for dry surfaces. Coefficient of friction. Friction angle. Energy and power lost due to friction in simple bearings.

Kinematics—Linear motion. Graphs and equations for displacement, speed, velocity, and uniform acceleration. Simple cases of vector change of velocity and the acceleration produced. Relative velocities in 1 plane only. Angular motion. Equations for displacement, velocity, and uniform acceleration.

Dynamics—Work and power. Problems with constant force or force with linear variation. Energy. Conservation of energy. Potential energy. Kinetic energy of translation. Newton's laws of motion. Momentum and rate of change of momentum. Centrifugal force and its application to conical pendulum, unloaded governor, curved tracks, and machine parts. Stress in thin rim due to centrifugal action.

Machines—Simple lifting machine. Graphs of load-effort and load-efficiency. Linear law. Velocity ratio, mechanical advantage, and efficiency of the following machines:—wheel and axle, differential wheel and axle, rope pulley blocks, differential pulley blocks, screw jack, Warwick screw, hydraulic jack, worm-driven chain blocks, and single and double purchase crab winches. Reduction gearing.

Stress and strain—Direct stress and strain. Shear stress. Hooke's law. Modulus of elasticity. Ultimate tensile stress. Yield stress. Limit of proportionality. Percentage of elongation and reduction of area. Working stress. Factor of safety. Stress due to restricted expansion or contraction of single members.

FIRST SCHEDULE—*continued*

Beams—Cantilevers and simply supported beams with concentrated or uniformly distributed loads. Shearing force and bending moment diagrams. Stress due to bending.

Torsion—Twisting moment due to engine crank mechanism. Strength and stiffness of solid or hollow shafts of circular cross-section. Stress due to torsion. Power transmitted by shafts. Coupling bolts.

Thin shells—Circumferential and longitudinal stress in thin cylindrical and spherical shells subject to internal pressure.

Hydrostatics—Equilibrium of floating bodies. Variation of fluid pressure with depth. Level control. Total force due to liquid pressure on immersed plane surfaces horizontal or vertical. Centre of pressure on a rectangular vertical plane surface or triangular plane surface, both with 1 edge parallel to the surface of the liquid.

Hydraulics—Full bore flow of liquid through pipes under constant head. Flow through orifice. Coefficients of velocity, contraction of area, and discharge.

SECOND-CLASS HEAT AND HEAT ENGINES

(One paper of 3 hours. Six questions only out of 9 to be attempted.)

Basic thermodynamic principles—Properties, energy, the First Law of Thermodynamics, flow and non-flow processes.

Elements—Temperature and its measurement. Linear, superficial, and volumetric expansion due to temperature changes. Coefficients and the relationship between them. Specific heat.

Heat transfer—Qualitative treatment of heat transfer by conduction, convection, and radiation. Laws of conduction and thermal conductance and applications to problems.

Mixtures—Heat and temperature problems involving change of phase and not more than 3 substances.

Gases—Boyle's and Charles' laws for perfect gases. Absolute temperature. Characteristic equation. Constant R and its use in simple problems. Isothermal and adiabatic expansion and compression. Relation between p, V, and T when pV^n = constant. Specific heats c_p and c_v and the relationship between them.

Air compressors—Elementary principles and cycles of operation. Calculation of work done. Indicator diagrams.

I.C. engines—Elementary principles and cycles of operation. Actual indicator diagrams. Work done and power developed. Fuel consumption.

Properties of steam—Change of enthalpy with and without change of phase. Specific volume of steam under various conditions. Throttling. Separating and throttling calorimeters. Boiler efficiency. Use of steam tables in problems referring to steam plant. Effect of air leakage into condensers.

Reciprocating steam auxiliary machinery—Mean effective pressure and work done. Advantages of using steam expansively. Steam consumption per hour and per power-hour. Thermal, mechanical, and overall efficiencies of engines.

FIRST SCHEDULE—*continued*

Boilers and engines—Boiler efficiency. Heat balance for engine and boiler trials.

Steam turbine—Elementary principles. Simple velocity diagrams. Thermal mechanical and overall efficiency. Steam consumption per hour and output.

Combustion—Solid and liquid fuels. Higher calorific value. Chemical equations for complete combustion. Theoretical minimum air required. Excess air.

Refrigeration—Vapour-compression cycle. Refrigerating effect. Cooling load. Use of tables of properties of refrigerants.

Boilers and evaporators—Change in dissolved solids due to contaminated feed. Blowing down.

DRAWING

(This subject is to be taken by candidates for second-class certificates only.)

(One paper of 4 hours.)

The Drawing paper will consist of a test of the ability to apply the principles of projection and candidates will be asked to draw a plan, elevation, or section, or a combination of these views, of a piece of marine machinery from information supplied. All the required information for the completion of the drawing will be given in the question paper.

FIRST-CLASS APPLIED MECHANICS

(One paper of 3 hours. Six questions only out of 9 to be attempted.)

Statics—Laws of equilibrium. Moments and couples. Polygon of forces. Rapson's slide.

Friction—Law of dry friction. Friction angle. Friction clutches. Friction on inclined plane. Friction on threads. Work done against friction.

Kinematics—Linear and angular motion with acceleration. Cams. Velocity-time and acceleration-time graphs.

Relative velocity and acceleration—Relative motion between bodies moving in different planes.

Dynamics—Newton's laws of motion. The force equation Atwood's machine. Acceleration of connected bodies. Effect of simple air resistance on motion under the effect of gravity. The torque equation. Conservation of momentum. Kinetic energy of translation and of rotation. Flywheels. Potential energy. Conservation of energy. Impulsive forces. Centrifugal force. Governors including sleeve friction. Simple harmonic motion. Simple pendulum. Simple vibrations. Dynamic balancing of masses rotating in 1 plane. Basic dynamics of the engine mechanism. Use of piston velocity and acceleration formulae. Derivation of piston displacement formula.

Stress and strain—Direct stress and strain and modulus of elasticity. Shear stress and strain and modulus of rigidity. Stresses on oblique planes. Strength of simple connections such as cottered or screwed joints. Resilience due to direct stress. Suddenly applied loads.

FIRST SCHEDULE—*continued*

Compound bars—Effect of direct loading and of temperature changes.

Beams—SF and BM diagrams for cantilevers and simply supported beams. Stresses in beams of simple section. Use of deflection formulae.

Torsion—Torsion equation for solid and hollow round shafts. Torsion of shaft fitted with liner. Power transmitted. Close coiled helical spring.

Struts—Eccentric loading of short columns. Use of strut formulae.

Hydrostatics—Flotation in 2 liquids of different densities. Total force and centre of pressure on immersed surfaces such as tanks and bulkheads.

Hydraulics—Bernoulli's equation and applications. Venturi meter. Flow through orifices under constant head. Force exerted by a jet. Blade angle diagrams for a centrifugal pump.

Control—Simple flow and control problems.

FIRST-CLASS HEAT AND HEAT ENGINES

(One paper of 3 hours. Six questions only out of 9 to be attempted.)

Elements—First and second laws of thermodynamics and applications. Work done associated with the formula $pV^n = C$.

Heat transfer—Conduction and thermal conductance (excluding log mean temperature difference). Radiation.

Properties of steam—Calculation of change of enthalpy, internal energy and entropy with and without change of phase. Use of steam tables and entropy. Throttling and separating calorimeter.

Mixtures of gases and vapours—Applications of Dalton's law of partial pressures.

Gases—Boyle's law. Charles' law. Characteristic equation. Relations between p, V, and T when $pV^n = C$. Determination of n from graph connecting p and V. Proof of the formula $c_p - c_v = \frac{R}{J}$. Calculations for expansions and compressions on air compressors, internal combustion engines, air pumps, and air storage.

Gas cycles—Use of entropy charts. Constant volume cycle. Diesel cycle. Dual cycle. Open and closed cycles for gas turbines. Indicated and brake thermal efficiencies. Mechanical efficiency. Overall efficiency.

Expansion of steam—Throttling, expansion, work done, and heat transfer.

Steam cycle—Use of entropy charts. Isentropic efficiency. Basic Rankine cycle. Heat drop in turbines. Effect on thermal efficiency of such modifications as superheating, reheating, and regenerative feed heating.

Boilers and evaporators—Basic calculations on the effect of condenser leakage and impure feed on the dissolved solids and scale in boilers. Basic calculations on evaporator and boiler performance.

Turbines—Basic cycle and its modifications. Flow through nozzles (excluding proof of critical pressure ratio). Blade diagrams for impulse

FIRST SCHEDULE—*continued*

and reaction turbines. Force on blades. Work done on blades. Use of enthalpy-entropy charts to determine steam condition at various stages.

Combustion—Combustion equations. Calculation of theoretical air required. Determination of calorific value. Avogadro's hypothesis. Basic analysis of exhaust gases. Relation between volumetric and mass analysis of a gas mixture. CO_2 content of exhaust gases.

Refrigeration—Reversed Carnot cycle. Vapour compression cycle. Use of vapour tables. Coefficient of performance.

PART B

PRACTICAL KNOWLEDGE SUBJECTS

NOTE—The notes under 'Fundamental Knowledge Subjects', Part A, apply equally to Part B

SECOND-CLASS ELECTROTECHNOLOGY

(One paper of 3 hours. Six questions only out of 9 to be attempted.)

General—Effects of electric current—chemical, magnetic, thermal. Production of light. Electric shock. Production of e.m.f. by chemical, magnetic, thermal, and light means. Electrical safety.

The electric circuit.—Units-ampere, ohm, and volt. Ohm's law. Series and parallel circuits of sources of e.m.f. and of resistances. Current distribution in simple circuits. Non-linear resistors in parallel with constant value resistors. Difference between e.m.f. and p.d. Power and energy. Relationships between heating, mechanical, and electrical units. Conductor resistance, effect of length, area, material, and temperature. Specific resistance. Temperature coefficient of resistance. Types of insulation. Wheatstone network bridge, slide wire bridge. Applications to steering gears, resistance pyrometers, strain gauges, etc.

Electrolytic action—Theory of electrolytic dissociation applied to common solutions, etc., aciduated water, copper sulphate, and salt water. Uses of electrolysis. Faraday's laws. Electro-chemical equivalent.

Cells—Primary (wet or dry Leclanché) and secondary (acid or alkaline) types. Construction and principles. Maintenance, charging. Watt-hour and ampere-hour efficiencies.

Magnetism and elecromagnetism—Simple magnetic theory. Magnetic field. Lines of force. Field strength. Field intensity. Magnetic fields due to current in straight conductors, loops, coils, and solenoids. Relative directions of current and field. Effect of iron. Flux density. Total flux. Reluctance. Permeability. Typical B/H and μ/B curves.

Electro-magnetic induction—Faraday's and Lenz's laws. Magnitude and direction of induced e.m.f. Force produced on a current carrying conductor.

Electronics—Qualitative treatment of: Atomic structure and bonding. Semi-conductors. Junction diodes, junction transistors and their operating characteristics. Simple transistor circuits. Conduction in gases, insulators, semi-conductors, and conductors. Rectification. Photo-electric effect.

FIRST SCHEDULE—*continued*

Alternating current theory—The sinusoidal wave, frequency, maximum, r.m.s. and average values. Phasor representation of a.c. quantities. Phase difference. The a.c. circuit. The inductor. Inductance and its effect on the circuit. The capacitor. Capacitance and its effect on the circuit. The general series and simple parallel circuit. Relationship between resistance, reactance, and impedance. Simple treatment of power factor.

Instruments—Principles and function of a.c. and d.c. switchboard indicating instruments. Moving-coil, moving iron, and dynamometer types. Uses of shunts and series resistances to increase the range. The current transformer and potential transformer for instrument work (description and simple explanation). Rectifiers and transducers.

Testing methods and measurements—Resistance measured by ammeter-voltmeter, by bridge, and by instrument. Simple ohmmeter and insulation testing. General insulation, continuity and millivolt-drop testing. Fault tracing. Temperature measurement by resistance and thermo-electric effects.

Circuits—Distribution systems for a.c. and d.c. installations. Use of fuses and circuit breakers. Use of earth lamps. Connection of shore supply. Single phase transformers.

D.C. machines—The principles, constructional details, and protection of series, shunt, and compound wound motors and generators. Self-excitation, e.m.f. and load voltage equations. Load characteristics. Methods of voltage control, paralleling procedures, and load sharing for generators. Need for and types of starter, speed, and torque equations, speed control of motors.

A.C. machines—The principles, constructional details, and protection of alternators and squirrel-cage induction motors. Parallel running and synchronising.

SECOND-CLASS NAVAL ARCHITECTURE

(One paper of 3 hours. Six questions only out of 9 to be attempted.)

General—Displacement. Wetted surface. Block, mid-section, prismatic and water-plane area coefficients. Tonne per centimetre immersion. Application of Simpson's First Rule to areas and volume.

Draught and buoyancy—Alteration of mean draught due to change in density of water. Buoyancy and reserve buoyancy. Effect of bilging amidship compartments.

Transverse stability—Shift of centre of gravity due to addition or removal of ballast, fuel, or cargo. Stability at small angles of heel (given the second moment of area of the waterplane or formulae). The inclining experiment.

Resistance and propulsion—Comparison of skin frictional resistance of hull with model at different speeds. $^{R}f = f.S.V^{n}$. and residual resistance. Admiralty and fuel coefficients. Relation between speed of vessel and fuel consumption with constant displacement and assuming that resistance varies as $(\text{speed})^{n}$. Elementary treatment of propeller. Pitch, apparent slip, real slip, wake, thrust, and power.

FIRST SCHEDULE—*continued*

Structural strength—Simple problems on strength of structural members to resist liquid pressure. Loading due to head of liquid.

Ship construction—Common terms used in the measurement of steel ships, e.g., length between perpendiculars, breadth overall, moulded depth, draught, and freeboard. Definitions of shipbuilding terms in general use. Descriptions and sketches of structural members in ordinary types of steel ships. Machinery seating arrangements. Watertight doors. Hatches. Rudders, Bow thrusters. Propellers, Stern tubes. Watertight bulkheads. Double bottoms. Anchors and cables. Precautions necessary before entering empty oil-fuel or ballast tanks. Descriptive treatment of the effect of free surface of liquids on stability.

The preservation in good condition of the ship's structure, in particular the bilges, bunkers, tanks under boilers, and watertight doors.

Ventilation arrangements (natural and mechanical) for pump rooms in tankers and for holds and oil-fuel tanks.

Arrangements for the carriage of dangerous goods in bulk.

Fire detection and extinction arrangements for passenger and cargo spaces. Fire precautions in port and dry dock.

Fore and aft peak tanks, double bottom and deep tank filling and pumping arrangements. Compartmental drainage. Levelling arrangements for damaged side compartments.

Dry docking and maintenance of underwater fittings.

FIRST-CLASS ELECTROTECHNOLOGY

(One paper of 3 hours. Six questions only out of 9 to be attempted.)

The magnetic circuit—B-H and B-At/m curves. Their effect on the design of simple magnetic circuits involving an air gap. Hysteresis.

Electromagnetism and electrostatics—Mutual inductance. Energy stored in an electric field and in a capacitor. Generation of static electricity. Descriptive treatment of voltage and current changes in an electric circuit involving inductance, capacitance, and resistance. Time constants.

The electric circuit—Kirchoff's laws. Network problems. Circuits involving non-linear elements.

A.C. circuit—Phasor representation of alternating quantities. Resistance, inductance, and impedance. Current and voltage relationships. power, apparent power (VA), reactive volt-amp and power factor applied to RLC circuits. The impedance triangle. Reactive and active components of current. Capacitance and the application of capacitors to power factor improvement. The desirability of high power factors.

Distribution problems—Volt-drop. Single and double fed distributors.

Distribution systems—D.c. 2-wire and 3-wire. A.c. single-phase and three-phase 3-wire and 4-wire.

D.C. machines—Parallel operation of shunt and compound generators. Equalising bar. Load sharing treated quantitatively. Applications of Ward Leonard systems. Steering gear. Suitability of d.c. motors for the various types of work.

FIRST SCHEDULE—*continued*

Faults and maintenance of machines—Overheating due to mechanical and electrical defects. Sparking at brushes. Loss of residual magnetism, etc. Testing machines—use of the megger.

Motor starters—Automatic types—reference to time and current control. The drum controller for series motors. Calculations on starters.

General A.C.—Production of an alternating waveform. Rectification. The sine law. Frequency; amplitude, instantaneous and maximum values. Relation between frequency, number of poles, and speed of a machine. R.m.s. average values and form factor.

Phasor representation of an alternating quantity to give instantaneous and r.m.s. values.

Electronics—Characteristics of electronic valves and transistors. Effect of voltage feedback on amplifier gain, input, and output impedances. Equivalent circuits. Rectification. Simple treatment of thyristors and zener diodes.

Three-phase systems—Star and delta (mesh) connections for supplies and loads. Phase and line relationships. Power. Three-phase 4-wire distributor. The production of rotating magnetic fields.

Alternators—Construction of salient pole, cylindrical rotor, and brushless machines. E.m.f. equation. Synchronising and load sharing. Automatic voltage regulators.

Induction motors—Construction. Slip. Reference to rotor e.m.f. and frequency. Typical torque-speed curves. Wound, slip ring, and cage types. Description of double wound type. Starting methods.

Synchronous motors—Construction. Starting methods. Reference to use for power factor correction.

Propulsion—Types using d.c. and a.c. machines. Turbo-electric drives; starting methods; speed changing. Advantages and disadvantages of electrical propulsion.

Single-phase motors—Description of general common types. Starting.

Instruments—Qualitative treatment of e.g. dynamometer, wattmeter, frequency meter, power factor meter, rotary synchroscope, reverse power relay, salinometer, telegraph.

Transformers—The principles and constructional details of single-phase transformers. The e.m.f. equation of efficiency. Auto-transformers and current transformers.

FIRST-CLASS NAVAL ARCHITECTURE

(One paper of 3 hours. Six questions only out of 9 to be attempted.)

General—Form coefficients. Wetted surface formulae. Simpson's rules applied to areas, moment of areas, second moments of areas, volumes, moments of volumes, centroids, and centres of pressure.

Transverse stability—Centre of gravity. Centre of buoyancy. Metacentre. Moment of statical stability. GZ curves. Cross curves of stability. Hydrostatic curves commonly supplied to ship. Effect of free liquid surface and subdivision of tanks. Dangers due to water accumulation during fire-fighting. Effect of suspended weights. Practical requirements to ensure stability at sea. Management of water and fuel tanks. Filling and emptying tanks at sea.

FIRST SCHEDULE—*continued*

Longitudinal stability—Longitudinal BM and GM and statical stability. Centre of flotation and its calculation. Moment to change trim by 1 centimetre.

Draught, trim, and heel—Changes due to adding or removing fuel ballast or cargo. Changes due to alteration in density of sea water. Changes due to bilging of compartments, using the lost buoyancy and added mass methods. Forces on rudder and stress in rudder stock. Heel when turning, including effect of centrifugal force and of rudder.

Resistance and propulsion—Derivation of Admiralty and fuel coefficients. The law of corresponding speeds. Froude's law of comparison. Simple problems on the prediction of full-scale resistance from model experiments. Simple problems involving the use of ep, dp, and QPC. Simple problems on propellers. Pitch ratio. Wake factor. True slip. Apparent slip. Thrust and power. Cavitation.

Ship construction—Forces on ship under various conditions, including the effect of panting and pounding. Construction of all parts of steel ships. Use of high tensile steel and aluminium. Structural fire-protection arrangements. Fire detection and extinction arrangements. Fire precautions in port and in dry dock. Arrangements for the carriage of dangerous goods in bulk. Bilge and ballast arrangements. Levelling arrangements for damaged side compartments. Dry docking. Ventilation of holds and oil-fuel tanks. Design features of ships for general and specialised trades.

Ship measurement and classification—Meaning of 'classed' and 'unclassed' ships. Common terms used in measurement of modern steel ships. Common terms used in tonnage measurements, e.g., gross tonnage, nett tonnage, propelling power allowance.

ENGINEERING KNOWLEDGE

(Second-class and First-class)

Candidates for a steam certificate or the steam endorsement of a motor certificate will not be examined in items (t) to (x) and those for a motor certificate or the motor endorsement of a steam certificate will not be examined in items (m) to (s).

Candidates for first-class certificates or first-class endorsements will be expected to display a fuller knowledge of the different items in the syllabus than candidates for a second-class certificate or second-class endorsement, and will also be liable to be examined in items (y) and (z).

NOTES—

1. The engineering knowledge to be shown by candidates is that which is required for the use, operation, and maintenance of the machinery, equipment, and ship structure usually in the charge of the engineer. A knowledge of the managerial responsibilities of a certificated engineer will be required.

2. Candidates for certificates and endorsements are required to take a written examination followed by an oral examination.

FIRST SCHEDULE—*continued*

3. The written examination for a steam or motor certificate consists of 2 papers of 3 hours each—6 questions only to be attempted out of 9 in each paper. One question in the morning paper will be compulsory for first-class candidates.

4. The written examination for a steam or motor endorsement consists of 1 paper of 3 hours—6 questions only to be attempted out of 9 in the paper.

5. Candidates may be required to illustrate their answers by means of free-hand sketches.

(a) A knowledge of the methods of manufacture of the various components, the general effects of various treatments on the physical properties of materials commonly used in the construction of marine engines and boilers and the mechanical tests to which these materials are normally subjected.

(b) The natural and desirable properties of steam, fuel lubricants, and other liquids, gases, and vapours used in machinery on board ship.

(c) The use, constructional details, and principles involved in the action of the pressure gauge, thermometer, pyrometer, barometer, salinometer, hydrometer, and other meters commonly used by engineers on board ship.

(d) Dissolved solids, scale formation, and feedwater treatment. Corrosion inhibition.

(e) The methods of dealing with wear and tear of machinery and boilers. The alignment of machinery parts. The correction of defects due to flaws in material or accident. Temporary or permanent repairs in the event of derangement or total breakdown.

(f) Constructional details and principles of action of pumps and oily water separators fitted in ships. The general requirements concerning feed, fuel, bilge, ballast, and fire pumping systems.

(g) The constructional arrangement, details, and working of steering machinery, refrigerating machinery, hydraulic and other auxiliary machinery, and such steam and internal combustion engines as are used for emergency and auxiliary machinery on board ship.

(h) (1) Application of the indicator. Fluctuation of pressure in the cylinder as shown by indicator diagrams. Interpretation of normal conditions. Candidates for first-class motor certificates and endorsements will be expected to illustrate, by means of sketches, the changes produced in the diagram due to an alteration in the setting or working of the valves or any other factors.

(2) Methods of determining engine shaft power. The principles of working and methods of calibration of dynamometers and torsion meters.

(i) Safeworking practices, overhauling machinery, mechanical safety in workshops, protective equipment, lifting tackle.

(j) Knowledge of the appropriate statutes that concern marine engineers (e.g., those dealing with oil pollution and clean air) is required.

FIRST SCHEDULE—*continued*

(k) (1) Precautions against fire or explosion. Flash point. Explosive mixtures of air and gas or vapour given off by fuel or lubricating oils. The danger of leakage from oil tanks, pipes, gas producers, and vaporisers, particularly in bilges and other unventilated spaces; sources of ignition. The action of wire gauze diaphragms and the places in which such devices should be fitted.

(2) Toxic and other dangerous properties of substances used in marine practice. Maintenance of plant associated with the carriage of dangerous cargoes.

(3) Fire detection. Methods of dealing with fire. Action and maintenance of mechanical and chemical fire extinguishers and other fire-fighting appliances, respirators, and safety lamps.

(l) Control systems, automation, and instrumentation. Periodically unmanned machinery spaces. Bridge control arrangements, alarm systems, operation techniques, and work practices.

(m) The methods of constructing marine steam turbines, gearing, and boilers, the processes to which the several parts are submitted, or which are incidental to their manufacture, and the methods employed in fitting the machinery on board ship.

(n) The various types of propelling and auxiliary machinery now in use, the functions of each important part, and the attention required by the different parts of the machinery on board ship.

(o) The methods of testing and altering the setting of the steam admission and exhaust valves of auxiliary machinery and the effect produced in the working of the engine by definite alterations in the settings of the valves.

(p) The constructional details and working of evaporators, feed water heaters, and feed water filters.

(q) Marine boilers of various modern designs, their construction and manner of attachment to ship.

(r) The use and management of boiler fittings and mountings, with special reference to water-gauges and safety valves. Precautions necessary when raising steam and operating stop valves with particular reference to the danger arising from water-hammer action.

(s) Constructional details, operation, and maintenance of installations generally employed for assisting draught, superheating steam, and burning fuel.

(t) The principles underlying the working of internal-combustion engines. The differences between various types of engines. Constructional details of internal combustion engines, gearing, and clutches in general use. The processes to which the several parts are submitted or which are incidental to their manufacture and the methods employed in fitting the machinery on board ship.

(u) The nature and properties of the fuel and lubricating oils generally used in internal-combustion engines. The supply of air and fuels to cylinders of engines of different types. The means of cooling the cylinders and pistons. Constructional details and working of air compressors.

(v) Starting and reversing arrangements and the various operations connected therewith.

FIRST SCHEDULE—*continued*

(w) The attention required for the operation and maintenance of the various parts of machinery. The use and management of valves, pipes, connections, and safety devices employed.

(x) Constructional details and management of auxiliary steam boilers, their fittings and mountings, with special reference to water-gauges and safety valves. Constructional details and management of auxiliary machinery. Draught, combustion equipment, oil-fuel equipment.

Candidates for First-class Certificates and Endorsements only

(y) The administrative duties of a Chief Engineer: organisation of his staff for emergency duties and the use of safety equipment: organisation of repairs and surveys. Reports to owners. Training marine engineer cadets.

(z) The recognition of irregularity in the performance of machinery. Analysis and interpretation of monitoring equipment and instrument readings to determine machinery condition and future availability. Diagnostic techniques to forestall breakdown.

ORAL EXAMINATION

The oral examination will be largely based upon the Practical Knowledge subjects of the examination, and will include questions on the management of engines and boilers, electrical machinery, prevention of fire and methods of fighting fires at sea, the duties of the supervising engineer, the work to be done to engines, boilers and auxiliary machinery in port, and the periodical examination of the working parts. Candidates should also be well acquainted with machinery and boiler casualties which may occur at sea and be able to state how these may be prevented and remedied."

SECOND SCHEDULE

Reg. 26 (b)

NEW THIRD AND FOURTH SCHEDULES TO PRINCIPAL REGULATIONS

"THIRD SCHEDULE

Regs 67 (10), 69 (9)

SYLLABUSES FOR THE THIRD-CLASS STEAM AND SECOND-CLASS COASTAL MOTOR EXAMINATION

[NOTES—1. All of Part A and the General Engineering Knowledge paper of Part B are common to both examinations.
2. A knowledge of the S.I. System is required.]

PART A

PRACTICAL MATHEMATICS

(One paper of 2½ hours. Six questions from 7 to be attempted.)

(a) Application of areas and volumes to problems such as the mass of machinery parts. Relative density. Simpson's first rule applied to areas and volumes.

SECOND SCHEDULE—*continued*

(b) Force. Gravitational units. Force as a vector. Triangle and polygon of forces. Moment of a force. Moments of areas and volumes. Centroids and centres of gravity (limited to geometrical shapes). Inclined plane.

(c) Laws of friction for dry surfaces. Coefficient of friction. Angle of friction. Energy and power lost due to friction in plain bearings.

(d) Linear and angular motions. Equations for displacement, velocity, and uniform acceleration. Relative velocities in 1 plane only.

(e) Velocity ratio, mechanical advantage, and efficiency of the following machines: Wheel and axle, rope pulley blocks, screw jack, Warwick screw, hydraulic jack, crab winches. Power transmitted by belt and gear drives.

(f) Direct stress and strain. Shear stress. Hooke's law. Young's modulus. Ultimate tensile stress. Yield stress. Limit of proportionality. Percentage elongation and reduction of area. Working stress. Factor of safety.

(g) Cantilevers and simply supported beams with concentrated and distributed loading. Calculation of shear forces and bending moments.

(h) Archimedes principle. Equilibrium of floating bodies. Pump power and efficiency.

(i) Temperature and thermometric scales. Linear expansion due to temperature change.

(j) Heat unit: the Joule. Specific heat capacity.

(k) Heat and temperature problems involving the mixture of not more than 2 substances. Water equivalent.

(l) Boyle's and Charles' laws for perfect gases. Combined equation. Absolute temperature and pressure.

(m) Sensible and latent heat. Wet, dry-saturated, and superheated steam, and the specific enthalpy involved. Use of steam tables. Specific volume of steam under various conditions.

(n) Engine-indicated and brake power (kW). Mechanical efficiency. Determination of crankshaft torque.

(o) Solid and liquid fuels. Calorific value. Fuel consumption in terms of power developed.

(p) Change of boiler density due to contaminated feed water. (p.p.m.).

(q) Electrical units: ampere, ohm, and volt. Ohm's law. Simple series and parallel circuits. Power and energy. Machine efficiency. Specific resistance. Temperature coefficient of resistance.

(r) Displacement of ships. Wetted surface. Block, mid-section, prismatic and waterplane area coefficients. Tonnes per cm. immersion.

(s) Relation between speeds of vessels and their fuel consumption assuming that resistance varies as $(\text{speed})^n$. Elementary treatment of propeller: Pitch, slip.

WORKING DRAWINGS

(One question of $3\frac{1}{2}$ hours.)

The drawing paper shall consist of a test of the ability of the candidates to apply the principles of projection. The candidates shall be required to produce drawings to scale and thoroughly understand

SECOND SCHEDULE—*continued*

the principles of projection. They shall be required to draw a plan, elevation, or section, or a combination of these views, of a piece of marine machinery from an isometric view or views supplied. All the required information for the completion of the drawing shall be given on the question paper.

PART B

ENGINEERING KNOWLEDGE

(General paper of 2½ hours for both third-class steam and second-class coastal motor candidates. Six questions from 7 to be attempted.)

The questions will be concerned with—

(a) Constituents and properties of the more common materials used in marine engineering. Basic welding and heat-treatment processes. Manufacture of simple components.

(b) The properties of steam, fuels, lubricants, and other liquids and gases used aboard ship.

(c) Elementary principles of steam turbines, boilers, I.C. engines, refrigerators, pumps, air compressors, and other auxiliaries used aboard ship.

(d) Simple constructional details of marine engines, boilers, thrust block, and shafting. Methods of maintenance and repair. Equipment for and the determination of indicated and brake power.

(e) The dissolved solids in seawater and their effect in boilers and evaporators (densities in ppm).

(f) The constructional details and use of pressure gauges, thermometers, pyrometers, barometers, salinometers, and hydrometers.

(g) Precautions against fire or explosion due to oil or gas. The dangers of oil or gas leakage, particularly in bilges and other unventilated spaces. The action of wire-gauze diaphragms. Flash point.

(h) Methods of dealing with fire aboard ship. Construction and operation of portable fire extinguishers and fixed smothering installations.

(i) The construction and maintenance of secondary electric cells.

(j) Basic principles, construction, and installation of ammeters and voltmeters. The use of fuses and circuit breakers.

(k) Basic principles and simple constructional details of electrical generators and motors. The need for motor starters.

(l) Explanation of the more common shipbuilding terms. Simple sketches and descriptions of rudders, propellers, stern tubes, and ships' side valves.

(m) Precautions before entering fuel and D.B. tanks.

(n) Basic control engineering: simple explanation of sensor, transducer, open and closed loop, feedback and desired value.

SPECIALISED PAPER FOR THIRD-CLASS STEAM ONLY

(Paper of 2½ hours. Six questions from 7 to be attempted.)

In addition to items (a) to (n), all third-class steam candidates are required to know—

(o) Construction and testing of boiler water-level gauge glasses.

SECOND SCHEDULE—*continued*

(p) Simple construction details of boilers in general use, tank, and watertube, riveted and welded.

(q) The use and management of boilers with special reference to boiler fittings and mountings. Precautions necessary when raising steam and blowing down and when operating stop valves. Water hammer. Effects of water shortage and emergency action to be taken.

(r) Elementary knowledge of boiler draught and oil-fuel burning equipment. Precautions before lighting boilers.

(s) Basic knowledge and main constructional details of auxiliary steam pumps and turbines, condensers, evaporators, feed water-heaters and filters, and other associated equipment.

SPECIALISED PAPER FOR SECOND-CLASS COASTAL MOTOR CANDIDATES ONLY

(Paper of 2½ hours. Six questions from 7 to be attempted.)

In addition to items (a) to (n), all second-class coastal motor candidates are required to know—

(t) Basic principles of the internal-combustion engine, main constructional details of engines in general use.

(u) The attention required in the operation and maintenance of I.C. engines, with particular reference to safety devices.

(v) Methods of starting and reversing I.C. engines.

(w) Construction and operation of engine-fuel mechanisms, such as pumps and injectors. Fuel system from bunker to injector.

(x) Methods of lubricating and cooling the various engine parts.

(y) The care and attention required in the use of air compressors.

"FOURTH SCHEDULE

Reg. 68 (6)

SYLLABUS FOR THE FIRST-CLASS COASTAL MOTOR EXAMINATION

PART A

PRACTICAL MATHEMATICS

Problems set will require a knowledge of the S.1. system of units

(Two papers of 2½ hours each. Five questions from 6 to be attempted.)

The questions shall be concerned with—

(a) Application of areas and volumes to problems dealing mainly with the mass of machinery parts. Simpson's First Rule as applied to areas and volumes.

(b) Force. Gravitational units. Force as a vector. Triangle and polygon of forces. Moments of forces, areas, and volumes. Centroids and centres of gravity (limited to geometrical shapes). Conditions for the equilibrium of solids.

(c) Laws of friction for dry surfaces. Co-efficient of friction. Angle of friction. Friction on the inclined plane. Energy and power lost due to friction in plain bearings.

SECOND SCHEDULE—*continued*

(d) Linear and angular motion. Equations for displacement, velocity, and uniform acceleration. Relative velocities in 1 plane only.

(e) Velocity ratio, mechanical advantage, and efficiency of simple machines.

(f) Direct stress and strain. Shear stress. Hooke's law. Young's modulus. Limit of proportionality. Yield stress. Ultimate tensile stress. Percentage elongation and reduction of area. Factor of safety. Stress due to restricted expansion or contraction of single members.

(g) Cantilevers and simply supported beams with concentrated and distributed loading. Calculation of shear forces and bending moments. Stress due to bending, given the fundamental formulae. S. F. and B. M. diagrams.

(h) Torque and stress relationship in circular shafts given the fundamental formula. Determination of engine crankshaft torque. Power transmitted by shafts, coupling bolts, gear, and belt drives. Centrifugal force.

(i) Archimedes principal. Equilibrium of floating bodies. Relative density. Variation of fluid pressure with depth. Total force due to liquid pressure on horizontal and vertical immersed surfaces. Pump power and efficiency.

(j) Temperature and thermometric scales. Heat units. Specific heat capacity.

(k) Heat and temperature problems involving the mixture of not more than 2 substances. Water equivalent.

(l) Boyle's and Charles' laws for perfect gases. Combined equation. Absolute temperature and pressure. Isothermal and adiabatic expansion and compression. Specific heat capacity c_p and c_v.

(m) Sensible and latent heat. Wet, dry-saturated, and superheated steam and the specific enthalpy involved. Use of steam tables. (S.I.). Specific volume of steam under various conditions. Equivalent evaporation.

(n) Engine-indicated and brake power. Mechanical efficiency. Indicated and brake thermal efficiencies.

(o) Liquid fuels. Higher and lower calorific values. Fuel consumption in terms of power developed.

(p) Change of boiler and evaporator densities due to contaminated feed. (ppm).

(q) Refrigerating effect. Capacity of refrigerating machines expressed as 'tonne of ice per 24 hours from and at 0°c'. Use of tables of properties of refrigerants.

(r) Electrical units. Ohm's law. Simple series and parallel circuits with sources of e.m.f. and resistance. Current distribution in simple circuits. Relationship between heat, mechanical, and electrical units. Difference between e.m.f. and p.d. Power and energy. Conductor resistance, effect of length, area, material, and temperature. Specific resistance. Temperature co-efficient of resistance.

(s) Displacement of ships. Wetted surface. Block, mid-section, prismatic, and waterplane area co-efficients. Tonne per cm immersion.

(t) Relationship between speeds of vessels, their thrust power and fuel consumption, assuming that resistance varies as $(\text{speed})^n$. Admiralty and fuel co-efficients. Elementary treatment of propeller.

SECOND SCHEDULE—*continued*

WORKING DRAWING

(One question of 4 hours.)

The drawing paper shall consist of a test of the ability of the candidates to apply the principles of projection. The candidates shall be required to produce drawings to scale and thoroughly understand the principles of projection involved. They shall be required to draw a plan, elevation, or section, or a combination of these views, of a piece of marine machinery from information supplied. All the required information for the completion of the drawing shall be given on the question paper.

PART B

ENGINEERING KNOWLEDGE

(Two papers of 2½ hours each. Five questions from 6 to be attempted.)

The questions shall be concerned with—

(a) Constituents and properties of the more common materials used in marine engineering. Manufacture of various components.

(b) The properties of steam, fuels, lubricants, and other liquids, vapours, and gases used aboard ship.

(c) Working principles and main constructional details of I.C. engines in general use.

(d) Construction and operation of engine fuel pumps, injectors, and fuel systems.

(e) Methods of supercharging and scavenging I.C. engines.

(f) Means employed for starting and reversing I.C. engines.

(g) Methods of lubricating and cooling I.C. engine parts.

(h) Determination of engine-indicated and brake power. Faults detected by the examination of indicator diagrams.

(i) Working principles and constructional details of pumps fitted in ships. General requirements concerning feed, fuel, bilge, and ballast pumping systems.

(j) The constructional arrangement, details, and working of steering gears, air compressors and receivers, refrigerating and other auxiliary machinery used aboard ship.

(k) Constructional details and management of auxiliary steam-boilers, their fittings and mountings, with special reference to water gauges and safety valves.

(l) Methods of dealing with the wear and tear of machinery and boilers. The correction of defects due to flaws in material or accident. Temporary and permanent repairs.

(m) Equipment used in the preparation of fuel and the care of lubricating oil.

(n) The principles, constructional details, and the use of pressure gauges, pyrometers, and other instruments commonly used by engineers aboard ship.

SECOND SCHEDULE—*continued*

(o) Precautions against fire or explosion at sea, in port, and in drydock. Flashpoint. The dangers of oil or gas leakage, particularly in bilges or other unventilated spaces.

(p) Methods of dealing with fire. Action and maintenance of fire-extinguishing apparatus. Fire detection.

(q) Constructional details of D.C. generators and motors. Lap and wave winding. Action of commutator. Methods of supplying field. Parallel operation of generators. Need for motor starters and their construction.

(r) D.C. circuits. Action of fuses and circuit breakers. Use of earth lamps.

(s) Principles and construction of switchboard indicating instruments. Simple ohmmeter and insulation testing.

(t) Basic principles of A.C. circuits, motors and alternators. Paralleling and synchronising procedure. Use of earth lamps.

(u) Construction and maintenance of secondary electrical cells.

(v) Explanation of more common shipbuilding terms. Sketches and descriptions of thrustblocks, shafting, propellers, stern tubes, rudders, and structural members in ordinary types of steel ships. Machinery-seating arrangements.

(w) Precautions before entering tanks or other enclosed spaces.

(x) Drydocking and maintenance of underwater fittings.

(y) Control, automation, and instrumentation. Knowledge of elementary pneumatic, electrical, and hydraulic systems. Meaning of terms sensor, transducer, open and closed loop, feedback, and desired value. Safety requirements in periodically unmanned machinery spaces.

(z) The administrative duties of a chief engineer officer. Reports to owners. Knowledge of statutes concerning pollution of the sea and air."

P. G. MILLEN,
Clerk of the Executive Council.

EXPLANATORY NOTE

This note is not part of the regulations, but is intended to indicate their general effect.

These regulations make miscellaneous amendments to the Marine Engineers Examination Regulations 1966.

The principal amendments are—

(a) The provisions as to the granting of certificates of competency to suitably qualified Royal New Zealand Navy personnel are replaced in an amended form.

(b) The provisions as to nationality are amended by removing the requirement for 1 year's residence in a Commonwealth country in the case of non-British applicants for certificates as second-class diesel trawler engineer, or engineer of local motor ship, or engineer of restricted-limit motor ship.

(c) Provisions as to minimum age, sea service on day work, and on unattended machinery space (V.M.S.) classified ships, and fire-fighting courses are amended in order to conform to Commonwealth validity requirements.

(d) The method of assessing sea service is amended by providing that periods of recorded time-off are to be excluded.

(e) The provisions as to the method of assessing the power of a ship are replaced.

(f) New examination syllabuses are prescribed except that for the extra first-class examination.

(g) The provision that the holding of a third-class steam certificate is a prerequisite before attempting the examination for a second-class steam certificate is revoked.

Issued under the authority of the Regulations Act 1936.
Date of notification in *Gazette*: 29 June 1978.
These regulations are administered in the Ministry of Transport.