EXECUTIVE COUNCIL.

No. 73.

Rules for the Examination of Engineers in the Mercantile Marine made by the Governor-in-Council under Section 4 (8) of the Merchant Shipping Ordinance, 1899, (Ordinance No. 10 of 1899), on the 2nd day of June, 1909, and amended by the Governor-in-Council on the 7th day of September, 1909.

CHAPTER I.

General Rules.

Authority for Regulations.

1. These regulations are issued in pursuance of the Merchant Shipping Consolidation Ordinance No. 10 of 1899.

In accordance with section 4 (2) of that Ordinance, "Every British and every Colonial ship exceeding 60 tons when leaving any Port in the Colony must be provided with officers duly certificated according to the following scale :—

* * * * *

(*d.*) If the ship is a steamship of one hundred nominal horse-power or upwards, with at least two Engineers, one of whom shall be a First Class, and the other a First Class or Second Class Engineer, duly certificated.

(*e.*) If the ship is a steamship of less than one hundred nominal horse-power, with at least one Engineer who is a First Class or Second Class Engineer duly certificated."

An officer is not duly certificated unless he is the holder for the time being of a valid Certificate of Competency under the Merchant Shipping Act or a Colonial Certificate of Competency declared by order of His Majesty in Council to be of the same force as if it had been granted under the said Act, of a grade appropriate to his station in the ship or of a higher grade.

If any person, having been engaged as one of the above-mentioned officers goes to sea as such officer without being duly certificated, or employs a person as an officer, in contravention of the above provisions without ascertaining that the person so serving is duly certificated, that person shall be liable for each offence to a fine not exceeding two hundred and fifty dollars.

By section 4 of Ordinance 10 of 1899 provision is made for holding examinations for the grant of Certificates of Competency, and power is given to regulate the conduct of the examinations and the qualification of the applicants.

How to apply.

2. Candidates for examination must fill up a form of application (form Exn. 3) at the Harbour Office. The form, properly filled in, together with the candidate's certificate of apprenticeship, testimonials, and discharges, must be lodged with the Harbour Master not later than the day before the day of examination.

The Examiner should be particularly careful to ascertain that there are no gaps in the Candidate's service which are not properly accounted for, before he is allowed up for examination.

Age.

3. Should any doubt exist as to the age of a candidate he will be required to produce a certificate of birth.

Fraud and misrepresentation.

4. It is provided by section 4 of the Ordinance that any person who makes, assists in making, or procures to be made, any false representation for the purpose of procuring either for himself or for any other person a Certificate of Competency, shall in respect of each offence be guilty of a misdemeanour, which is punishable, on summary conviction, with imprisonment for a term not exceeding six months, with or without hard labour, or with a fine not exceeding one thousand dollars.

5. All candidates will be required to produce, in addition to the official discharge certificates, testimonials as to their workshop service and as to their service at sea. The testimonials as to workshop service must be signed by the employer, and must testify to the candidate's conduct and ability, and state what kind of work he was engaged on (*e.g.*, fitting, erectiug, etc.), and for how long. Testimonials: shore service.

6. Testimonials as to service at sea must testify to the applicant's sobriety, experience, ability, and general good conduct for at least the last twelve months' service at sea preceding the date of application to be examined. They must be signed by the Master and Chief Engineer (or in the case of testimonials to Chief Engineers, by the Master and Superintending Engineer) and must clearly state whether the applicant was on regular watch, and in regular charge of a watch on the main engines or boilers. It is desirable that testimonials of candidates should be endorsed by the Superintending Engineer. No time spent in clerical work will be allowed to count. Testimonials: sea service.

7. Candidates who have neglected to join their vessels after having signed articles, or who have deserted their vessels after having joined, or who have been found guilty of gross misconduct on board, will be required to produce satisfactory proof of two years' subsequent service and good conduct at sea unless the Harbour Master, after having investigated the matter, should see fit to reduce the time. Penalty for misconduct.

8. In cases where a testimonial from the Chief Engineer, or from the Master, is for any sufficient reason not obtainable, one may be submitted from the Superintending Engineer in place of that of the Chief Engineer, and one from the Managing Owner or Secretary or Chairman of a large Company in place of that of the Master ; but in every such instance the testimonial must declare that the facts stated are in accordance with the reports made by the Chief Engineer or the Master, as the case may be, or else that the facts are within the writer's personal knowledge. Further as to testimonials.

9. When a candidate is observed to be hard of hearing, or is labouring under any other obvious physical defect, the signatories of his testimonial are required to mention that defect specifically, and to state whether it in any way interfered with the efficiency of the candidate as an Engineer on watch. When these modified testimonials are such as to completely satisfy the Examiner that the defect is not such as to interfere with the efficient discharge of the applicant's duties as Engineer, the examination is proceeded with ; otherwise the case is referred to the Harbour Master. Candidates afflicted with nervous impediment in speech may write their answers to *viva voce* questions. Physical defects.

10. The testimonials of service of Foreign Engineers and of British Engineers serving in foreign vessels, which cannot be verified by the Harbour Master, must be confirmed either by the Consul of the country to which the ship in which the candidate served belonged, or by some other recognized official authority of the country ; or by the testimony of some credible person on the spot having personal knowledge of the facts required to be established. The production, however, of such proofs will not of necessity be deemed sufficient. Each case must be decided on its own merits ; and if the sufficiency of the proofs given appears to be at all doubtful, the point will be referred to the Governor. Foreign Engineers: foreign service.

11. Service which cannot be verified by proper entries in the articles of agreement of the ships in which the candidates have served cannot be counted. Service must be verified.

12. Foreign Engineers must prove to the satisfaction of the Examiners that they can speak and write the English language sufficiently well to perform the duties required of them on board a British vessel. In every case, before failing a candidate for insufficient knowledge of the English language the Examiner should refer the matter to the Harbour Master. Foreign Engineers must know English.

13. If the candidate passes he will receive a Certificate signed by the Governor. Issue of Certificate.

14. If after a candidate has passed the examination it is discovered on further investigation that his services are insufficient to entitle him to receive a Certificate of the grade for which he has passed, the Certificate will not be granted to him ; Service found to be insufficient.

but if the Governor is satisfied that the error in the calculation of the candidate's services did not occur through any fault or wilful misrepresentation on his part, he will have the fee returned to him. Should his service entitle him to a Certificate of a lower grade it may be granted to him, and the difference, if any, between the fee paid by him for the superior Certificate and the fee payable for the inferior Certificate will be returned to him. The superior Certificate will not be granted until the candidate has performed the amount of service in which he was deficient, and has been re-examined in all the subjects, unless the Governor sees fit to dispense with the re-examination.

Failure in examination.

15. If the candidate fails in practical knowledge he may not present himself for re-examination until he can produce proofs of three months' further service at sea as Engineer on watch on the main engines or boilers from the date of failure. If he fails in arithmetic, elementary questions, or drawing only, he may come up again at any time.

Fee must be paid first.

16. Candidates for examination, in making their application on the form Exn. 3, will be required to pay the examination fee before any step is taken towards inquiring into their service or testing their qualifications, &c. If the candidate is found not to be qualified, the fee will be returned to him.

Fees not returned on failure.

17. If a candidate fails in his examination, no part of the fee he has paid will be returned to him.

Table of fees.

18. The fees are as follow :—

Second Class Engineer's Certificate.....$15

First Class Engineer's Certificate.....$20.

CHAPTER II.

Qualifications Required for the Various Grades.

Second Class.

19. *Second Class Engineer.*—A candidate for a Second Class Engineer's Certificate must be 21 years of age :—

(*a.*) He must have served as an Apprentice Engineer for four years at least, and prove that during the period of his apprenticeship he has been employed on the making or repairing of steam engines, boilers, &c. Three years of the apprentice time must have been passed in the fitting or erecting shops, or in both. In calculating the four years of artisan service which are to constitute the required apprenticeship, which should not begin at an earlier age than 15, time spent at a technical school (recognised by the Board of Trade as suitable) where there is an engineering laboratory, may be taken into account and accepted as equivalent to artisan service at the ratio of three years in the technical school to two in artisan service, provided that the applicant was over 15 years of age, and can produce the Principal's Certificate for regular attendance and satisfactory progress, and provided also that in such case the other portion of the time was spent in the fitting or erecting shops of an Engineer, as indicated above.

Time spent in a technical school cannot be accepted as equivalent to more than two years' artisan service, and time spent in foreign technical schools can in no circumstances be recognised.

Journeyman's time will be considered as equivalent to apprenticeship.

Every applicant must produce testimonials of ability as an Engineer workman to the satisfaction of the Harbour Master.

On and after January 1st, 1910, if the candidate has served as an apprentice Engineer or Journeyman, under the conditions above prescribed for less than four years, he will be required to

make up the deficiency or to complete this period of four years by service as Engineer at sea on regular watch on the main engines or boilers (1) of a foreign-going steamer of not less than 66 nominal horse-power, or (2) of a home trade steamer of not less than 66 nominal horse-power, such service to be counted as equivalent in the case of (1) to two-thirds, and in the case of (2) to four-ninths, of service as apprentice Engineer or as Journeyman.

If the candidate has not served at all as apprentice Engineer or as Journeyman, he will be required to have served at sea, in lieu thereof, as Engineer on regular watch on the main engines or boilers, six years in a foreign-going steamer of not less than 66 nominal horse-power, or nine years in a home trade steamer of not less than 66 nominal horse-power.

(*b.*) In addition to the apprenticeship as above described, or the alternative sea service, the applicant must have served one year at sea as Engineer on regular watch on the main engines or boilers of a foreign-going steamer of not less than 66 nominal horse-power; or eighteen months in a home trade steamer of not less than 66 nominal horse-power.

(*c.*) He must be able to give a satisfactory description of boilers, and the methods of staying them, together with the use and management of the different valves, cocks, pipes, and connections.

(*d.*) He must understand how to correct defects from accident, decay, &c., and the means of repairing such defects.

(*e.*) He must understand the use of the water gauge, pressure gauge, barometer, thermometer, and salinometer, and the principles on which they are constructed.

(*f.*) He must state the causes, effects, and usual remedies for incrustation and corrosion.

(*g.*) He must be able to explain the method of testing and altering the setting of the slide valves, and method of testing the fairness of shafts and adjusting them.

(*h.*) He must be able to calculate the suitable working pressure for a steam boiler of given dimensions, and the stress per square inch on crank and tunnel shafts when the necessary data are furnished.

(*i.*) He must understand the construction of steering engines, evaporators, feed filters, and feed heaters.

(*j.*) He must understand the construction of centrifugal, bucket, and plunger pumps, and the principle on which they act.

(*k.*) He must be able to state how a temporary or permanent repair could be effected in case of derangement of a part of the machinery, or total breakdown.

(*l.*) He must write a legible hand, and have a good knowledge of arithmetic up to and including vulgar and decimal fractions and square root. He must also understand the application of these rules to questions about safety valves, coal consumption, consumption of stores, capacities of tanks, bunkers, &c.

(*m.*) He must be able to pass a creditable examination as to the various constructions of paddle and screw engines in general use; as to the details of the different working parts, external and internal, and the use of each part.

(*n.*) He must possess a creditable knowledge of the prominent facts relating to combustion, heat and steam.

20. First Class Engineer.—A candidate for a First Class Engineer's Certificate must be not less than 22 years of age. First Class.

In addition to the qualification required for a Second Class Engineer,

(*a.*) he must:—

(1.) have served at sea for 12 months, with a Second Class Certificate of Competency or service, as Senior Engineer in charge

of a watch on the main engines or boilers of a foreign-going steamship of not less than 99 nominal horse-power ; or

(2.) have served at sea for 18 months, with a Second Class Certificate of Competency or service, as First Engineer of a home trade steamer of not less than 99 nominal horse-power; or 2 years as Second Engineer of a home trade steamer of not less than 99 nominal horse-power, with a Second Class Certificate of Competency ; or

(3.) have served 2½ years, with a Second Class Certificate of Competency or service, as Third Engineer of a home trade steamer of not less than 99 nominal horse-power, if, during the whole of that period he has been the Senior Engineer in charge of a watch on the main engines and boilers ; or

(4.) possess, or be entitled to, a First Class Certificate of Service.

(*b.*) He will be required to make an intelligible hand sketch, or a working drawing of some one or more of the principal parts of a steam-engine, and to mark in, without a copy, all the necessary dimensions in figures, so that the sketch or drawing could be worked from.

(*c.*) He must also be able to take off and culculate indicator diagrams.

(*d.*) He must be able to calculate safety-valve pressures, and the strength of the boiler shell, stays, and riveting.

(*e.*) He must be able to state the general proportions borne by the principal parts of the machinery to each other, and to calculate the direct stress, the torsional stress, and the bending stress in round bars, and the direct stress and the bending stress in rectangular bars with given loads.

(*f.*) He must be able to explain the method of testing and altering the setting of the slide valves, and to sketch about what difference any alteration in the slide valve will make in the indicator diagram, and also the method of testing the fairness of shafts, and of adjusting them.

(*g.*) He must be conversant with surface condensation, superheating, and the working of steam expansively.

(*h.*) His knowledge of arithmetic must include the mensuration of superficies and solids and the extraction of the square and cube root, and the application of these rules to questions relating to the power, duty, and economy of engines and boilers, and to the stresses in rods, shafts, and levers of the engine.

(*i.*) He must understand the construction of, and be able to maintain in working condition the auxiliary machinery which is placed under his charge, viz.: refrigerating machinery, electric light engines, and dynamos, electric motors fitted to ships' boats, hydraulic machinery, and the various descriptions of steering engines, &c.

Workshop service where engines are not made.

21. When the workshop service has been performed in a place where steam engines are not made or required, and the class of work done is similar to that required in engine making, the service may be accepted with an additional year of qualifying service ; that is, four years' workshop service and two years in the engine room (of which one year must have been at sea), or one year at engine fitting in a suitable marine engine workshop and one year at sea in the engine room. The approval of the Harbour Master must be obtained in every such case before the candidate is examined.

Workshop service other than fitting or erecting.

22. When the workshop service has been performed in a place where engines are made, and the department in which the applicant has been principally engaged is not "fitting" or "erecting", the case must be specially considered. If the service be such as is useful training for an Engineer, the service may be accepted, but in every such case the applicant must prove additional engine room or marine engine workshop service as required above.

23. In the case of candidates for First Class Certificates qualifying service means service on regular watch as Senior Engineer in charge of the main engines or boilers. During the whole of the period claimed, candidates must have been in possession of Second Class Certificates. Qualifying service defined.

In the case of candidates for Second Class Certificates, qualifying service means service as Engineer on regular watch on the main engines or boilers. In no case will time spent in clerical work be allowed to count.

24. In all cases the candidates' names must have been duly entered on the ship's Articles as Engineers in their proper ratings. Names on Articles.

25. Foreign Engineers cannot be examined for a First Class Certificate unless they have performed the sea-service stated in paragraphs 20 with the requisite British Certificate. The service may have been performed in foreign vessels if the candidate can produce satisfactory testimonials as to conduct and character, and is able to prove that the service has been in the required capacities, and that during the period of service he has held a British Certificate of Competency of the rank required by the Regulations (*see* para. 10). Foreign Engineers.

26. Being on regular watch means being on watch for at least eight hours a day. Regular watch.

27. Only such service as gives the experience required to make a man thoroughly competent as a sea-going Engineer is accepted as qualifying service. Even for a Second Class Certificate the candidate must prove to the satisfaction of the Examiner that he is qualified by experience and knowledge to act as Chief Engineer in an under-powered steamer of 99 nominal horse-power on a voyage, say, England to Egypt, taking full responsibility for engines and boiler. Further as to qualifying service.

28. The sea-service required by these Regulations is, unless otherwise stated, service performed in foreign-going ships. Sea service.

29. Service in the home or coasting trade is regarded as being equivalent to two-thirds of the same period of time served in the foreign trade. Home trade service.

30. Service as watchkeeper on a lake or river steamer of not less than 66 nominal horse-power may be accepted under the following conditions :— Lake or river service.

(1.) the service will only count half as much as sea service ; *i.e.*, every two months of lake or river service is only equivalent to one month's sea service ;

(2.) candidates for Second Class Certificates must prove, in addition to lake or river service, at least three months' qualifying service at sea in a steamship of not less than 66 nominal horse-power ;

(3.) candidates for First Class Certificates must prove, in addition to lake or river service in vessels of 99 nominal horse-power, at least six months' qualifying service at sea, with a Second Class Engineer's Certificate, in vessels of not less than 99 nominal horse-power.

31. Service performed on board auxiliary screw whalers and other vessels with auxiliary steam power of not less than 66 nominal horse-power in the capacity of Engineer may be allowed to count towards qualifying candidates for examination for Second Class Engineers' Certificates of Competency to the extent of one-half the time the vessel is actually at sea. If the candidate is able to prove a larger amount of time under steam, he will be allowed to count the whole of such extended time. Service in auxiliary screw steamships.

32. Service in sea-going steam dredgers, fishing-boats, or tug-boats and in sea-going pilot vessels when on their station or when going to or returning from the same may be accepted under the following conditions :—Two months of such service is only equivalent to one month's qualifying service. Candidates for Second Class Certificates may perform all their sea service in sea-going steam dredgers, fishing-boats, tug-boats, or pilot vessels but they must have been on regular watch on the main engines or boilers, and the vessels must not be less than 66 nominal horse-power. Candidates for First Class Certificates must have served Service in dredgers, trawlers or tug-boats.

in vessels of at least 99 nominal horse-power, and have been in charge of a watch on the main engines or boilers. They must, in addition, have served in a qualifying capacity for at least six months in a foreign-going cargo or passenger steamship, or nine months in a home trade cargo or passenger steamship.

Service in yachts.

33. Service performed in steam yachts, either within or beyond home trade limits, may be accepted as equivalent to two-thirds of the time performed in foreign-going trading vessels, provided that the candidate's name is entered on the vessel's Articles, and that he can prove, to the satisfaction of the Harbour Master, that the time claimed was actually served at sea.

Candidates for Second Class Certificates may perform all their service in yachts, but the candidate must have been on regular watch on the main engines or boilers, and the vessels must be of not less than 66 nominal horse-power.

Candidates for First Class Certificates must have served on vessels of not less than 99 nominal horse-power, and must have been in regular charge of the main engines or boilers. In addition they must have served for at least three months in a qualifying capacity on board a foreign-going trading or passenger steamship. This additional service will, however, not be required in the case of a candidate who has served for 18 months as First Engineer, or for 2 years as Second Engineer, of a steam yacht of the requisite power.

Certificates of service.

34. An Officer who has attained the rank of Engineer Lieutenant or Engineer Sub-Lieutenant in His Majesty's Navy or the rank of Engineer or Assistant Engineer in the Indian Marine Service, is entitled without examination, if an Engineer Lieutenant or Engineer, to a Certificate of Service as First Class Engineer, and if an Engineer Sub-Lieutenant or Assistant Engineer, to a Certificate of Service as Second Class Engineer. These Officers may be examined for a Certificate of Competency on the same conditions as Engineers of the Mercantile Marine.

An Officer who has attained the rank of Chief Artificer Engineer in His Majesty's Navy is also entitled without examination to a Certificate of Service as Second Class Engineer.

Examination of Engine Room Artificers.

35. Artificer Engineers, Chief Engine Room Artificers, and Engine Room Artificers in the Royal Navy, may be examined for Certificates of Competency on the same conditions as Engineers of the Mercantile Marine.

Application by Naval Officers.

36. The Lords Commissioners of the Admiralty have directed that applications from Officers of the Navy for Certificates of Service or for permission to be examined for Certificates of Competency must, in the case of Officers on the active list, be made through the Commanding Officer to the Secretary to the Admiralty, and in the case of Officers on half pay or who have retired direct to the Secretary to the Admiralty, who in either case will forward the application to the Harbour Master.

Certificates.

37. The term "Certificate" in these Regulations means a Certificate issued by the Board of Trade, or by a British Possession under the provisions of the Merchant Shipping Act. A list of the Colonial Certificates so issued is given in Appendix D.

Colonial Local Certificates.

The holder of a Colonial Certificate of Competency not granted under the Merchant Shipping Act, or of a Certificate of Competency granted after examination on board one of His Majesty's Ships, who wishes to be examined for a Board of Trade Certificate of the same grade, must prove that he has performed the amount of service required by these Regulations for that grade, and complied with the conditions laid down as to testimonials. No fee will be demanded for the first attempt, but if the canditate fails the usual fee will be demanded on any subsequent attempt.

CHAPTER III.

Conduct of the Examinations.

Commencement and duration of examinations.

38. The examinations will commence early in the forenoon, and will be continued from day to day until all the candidates are examined.

Candidates to be punctual.

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

Tables cleared.

40. Before commencing the examination, the tables and desks must be cleared of all scraps of paper, or books that are not used in the examination, and care should be taken that the candidates do not bring into the examination-room any book or paper.

Strangers not admitted.

41. No persons will be allowed in the rooms during the examinations other than those whose duties require them to be present.

No Instructors will be allowed on the premises.

Blotting paper.

42. A sheet of blotting paper will be issued to each candidate with the first examination paper, and it must be returned to the Examiner when the last paper is completed each day. The Examiner will be careful to see that the blotting paper has not been used by the candidate in solving his problems, or for conveying information to other candidates.

All work to be shown.

43. No candidate will be allowed to work out his problems on a slate or on waste paper, or to write on the blotting paper supplied for his use in the examination. Violation of this rule will subject the candidate to all the penalties of a failure.

Additional sheets of paper will be supplied by the Examiner if required, but they must be attached to, and form part of, the examination papers.

Books and paper strictly forbidden.

44. All books necessary for the use of candidates under examination will be provided by the Harbour Department, and candidates are prohibited from bringing into the examination room books or papers of any kind whatever. The slightest infringement of this regulation will subject the offender to all the penalties of a failure, and he will not be allowed to present himself for re-examination for a period of three months.

Drawing instruments.

45. Candidates for First Class Certificates have to pass an examination in rough working drawing, which may, in the candidate's option, be either hand sketches clearly dimensioned and complete in the necessary views and sections, or drawings to a scale. Drawing boards and T squares will be provided by the Harbour Department, but the applicants will have to bring with them any drawing instruments they may require.

Candidates' places.

46. Candidates should be so placed as to prevent one copying from another, and no communication whatever between the candidates should be allowed.

Penalty for copying, &c.

47. In the event of any candidate being discovered referring to any book or paper, or copying from another, or affording any assistance or giving any information to another, or communicating in any way with another, during the time of examination, or copying any part of the problems for the purpose of taking them out of the examination rooms, he will subject himself to all the penalties of a failure, and will not be allowed to be examined for a period of six months.

Leaving room or building.

48. No candidate may leave the examination room without permission and without giving up the paper on which he is engaged. Under no circumstances will the same paper be returned to him, but the Examiner may substitute other data, or another question.

Injury to books.

49. If a candidate defaces, blots, writes in, or otherwise injures any book or form belonging to the Harbour Department, his paper will be retained until he has replaced the damaged book or document. He will not be allowed to remove the damaged book or document, and will be subjected to all the penalties of a failure.

Penalty for breach of rules.

50. Any candidate violating any of the regulations, or being guilty of insolence to the Examiner, or of disorderly or improper conduct in or about the room, will render himself liable to the postponement of his examination, or, in the event of his having passed, to the detention of his Certificate for such period as the Governor may direct.

Order of examinations.

51. The examination of candidates for Second Class Certificates consists of three parts : arithmetic, elementary questions, and *vivâ voce* ; and that of candidates for First Class Certificates of four parts : arithmetic, drawing, elementary questions, and *vivâ voce*. *See* paras. 18 and 19.

Arithmetic.

52. When the number of marks obtained in arithmetic amounts to 28, that is two-thirds of the maximum, the candidate passes in arithmetic.

If the marks obtained amount to 21, but not to 28, and if the applicant has had long sea experience, his testimonials should be taken into account, and his examination continued, if deemed advisable by the Examiner, and he may be passed or failed, having due regard to his practical knowledge, and to whether he is being examined for second class or first class.

Elementary questions.

53. All Engineer applicants presenting themselves for examination will be required to give written answers to ten questions selected from Elementary Questions shown in Appendix B. These questions are intended to furnish a record to some extent of candidate's knowledge at the time of his examination, and also to induce the candidates to pay more attention to their handwriting and spelling. Examiners will require all candidates to fill up a form H 137, Exn. 3.

The questions for both classes of Engineers will be taken from the same series of Elementary Questions ; and candidates for first class certificates are expected to show their superiority by giving answers more complete than those of the other candidates.

Vivâ voce.

54. Having regard to the fact that when the oral examination is held, the candidate has already passed in artithmetic, and, if a first class candidate, in drawing, and has also written answers to the elementary questions, the Examiners will deal with practical, rather than theoretical, questions in the division of the examination ; and no candidate should be failed without having been well cross-questioned on the points for which failure takes place.

The elementary questions to be answered on Form Exn. 15*b* are good starting points in *vivâ voce* examinations. With the candidates' written answers before the Examiner, the same question can be put in a way requiring an answer in another form. Each question may be developed into several according to the circumstances of the case, *e.g.*: —

1. What is made of ? Of what parts does it consist ?
2. What is its use ?
3. What attention does it require at sea ?
4. What attention does it require in port ?
5. When it becomes defective, what is it that principally goes wrong with it ?
6. How is it repaired ?
7. What alteration may prevent a recurrence of the defect ?

It is considered of great importance that Engineers presenting themselves for examination should have an extensive knowledge of the particulars of actual casualties which have occurred at sea, and be able to state how these might have been prevented, and how remedied. Sometimes an Engineer presents himself who has had no personal experience of any defects, and who can tell nothing about casualties to machinery which have occurred in the experience of others ; such candidates should be closely questioned as to their knowledge of boiler and engine construction and the repairs of same.

The management of engines and boilers at sea, the duties of the Engineer on watch, the work to be done to the engines, boilers, and auxiliary machinery in port, and the periodical examinations of the working parts, form part of the *vivâ voce* examination.

C. CLEMENTI,
Clerk of Councils.

COUNCIL CHAMBER,
7th September, 1909.

Appendix A.

Form to be filled up by the Candidates at the commencement of the examination (Form Exn. 15*b*).

Port ..... Class for which examined .....

Date ..... Candidate's Name .....

A. Where and how long did you serve in works at the making or repairing of engines and boilers ?

B. How long and in what capacity did you serve in works on shore other than at the making or repairing of engines and boilers ?

C. How long have you served in the engine-room at sea, and in what capacities ?

D. With what descriptions of engines have you served at sea ? What sizes were the engines ?

E. With what descriptions of boilers have you served at sea ?

F. What engine defects, or defects to auxiliary machinery, have come under your notice, what caused these defects, and how were they remedied ? Give the names of the steamers for verification.

G. What boiler defects have come under your notice, what caused these defects, and how were they remedied ? Give the names of the steamers for verification.

Appendix B.

Elementary Questions.

1.

What parts of an engine are generally made of wrought iron ?

2.

What parts of an engine are generally made of cast iron ?

3.

For what parts of an engine is steel sometimes used ?

4.

What parts of an engine are generally made of brass or gun metal ?

5.

Where is "white metal" sometimes used ? On account of what property possessed by it is it adopted ? What objection is there to its more general use ?

6.

For what parts is Muntz metal sometimes used ? Is it malleable ? For what properties is it valued ?

7.

What difference is there in the composition of cast iron, of wrought iron, and of steel ?

8.

How can cast iron, wrought iron, and steel be distinguished from each other ?

9.

What are the different properties of cast iron, of wrought iron, and of steel ?

10.

What is meant by the terms "breaking stress", "proof stress", "safe working stress"?

11.

What is the cohesive strength, or breaking stress, of good ordinary wrought iron ?

12.

Tempering steel ; how is it done, and in what order do the colours come ?

13.

What is case-hardening ?

14.

Which of the common metals or alloys can be forged, and which of them are brittle or "short" ?

15.

What is meant by "welding" ? Which of the common metals can be welded ?

16.

The expansion of metals by heat ; give examples of this in the engine and in the boiler.

17.

In the construction of steel cylindrical marine boilers for what parts have the plates to be worked hot ? What precautionary treatment of these plates is afterwards necessary ?

18.

In what parts of cylindrical marine boilers is the strongest riveting employed ? In which of the shell seams is it most necessary ?

19.

What is "caulking", and how are seams prepared for caulking ?

20.

Describe the different way of fastening the ends of the main stays of a boiler. What are the merits of, or objections to, the different plans ?

21.

What stress per square inch is allowed on boiler stays ?

22.

Describe a riveted stay, and state where such stays are commonly used.

23.

Where are thin plates to be looked for in a boiler as it wears, and how is the thinness to be detected ?

24.

How are boiler tubes fixed ? What are "stay tubes", and how are they secured ?

25.

Where is it generally that boiler tubes leak ? How is this defect repaired ? What are the causes of this leaking ?

26.

What are the causes of cracked tube plates ? Where are the cracks situated ? How are they repaired ?

27.

What is the difference between a "dry uptake" and a "wet up-take" ? Which requires more repair ? Why ? Where have you seen a wet uptake ?

28.

What is a superheater ? What is its construction ? What valves are on it ? There is sometimes a gauge glass on it ; what is that for ? Are superheaters now in general use ?

29.

What parts of a marine multitubular boiler are first injured by shortness of water ?

30.

Where are angle irons sometimes used in the construction of a boiler, and where are flanged plates used ?

31.

Priming ; to what causes is it attributed ? What means are applied to prevent it ? What evils may be produced by it ?

32.

Funnel draught ; what makes it ? What checks it ?

33.

Flame sometimes is seen at the top of the funnel ; what causes this appearance ? Is it beneficial or is it detrimental ? Why so ?

34.

A blast pipe ; what is its construction ? Where is it placed ? For what is it used ?

35.

How many bottom blow-off cocks are generally fitted to each boiler, and why are they so fitted ?

36.

Blow-off cocks are sometimes fitted with a spanner guard ; for what purpose is this ? Describe how the guard is formed.

37.

Water-gauge test-cocks ; where are they placed ? At what heights ? Must the cocks themselves be at those heights ? What provision is made for cleaning these cocks should they ever become choked ? When there are no test cocks how is the height of the water ascertained ?

38.

What is a dead-weight safety valve ? Of what are the rubbing surfaces formed ? How is a lock-up-valve arranged to admit of lifting it or of turning it round, and to prevent adding to the weight ?

39.

About what area of safety valve is now required by the Board of Trade ? What is the effect of suddenly opening a safety valve when steam is up ? To about what extent do safety valves rise when blowing off without being eased by hand ?

40

Spring-loaded safety valves ; what advantages have they that are not possessed by dead-weight valves ? What are the disadvantages, if any, as compared with dead-weight valves ?

41.

Of what pieces does a glass water gauge mounting consists ? How does it act ? Where is it placed ? At what height ? Is it liable to derangement ? How is its working tested ?

42.

Glass water gauges have sometimes pipe connections top and bottom ; what is the object of this arrangement ? Should there be cocks at the extremities of these pipes ? Why ? or why not ?

43.

Describe a Bourdon steam gauge. Some gauges have an inverted syphon pipe below them ; what is its use ?

44.

Why is a small cock sometimes put on the pipe leading to a steam gauge ? Where should it be placed, and what error might be made by omitting to use it ?

45.

Do steam gauges indicate the total pressure of the steam, or only a portion of that pressure ? What is the pressure measured from ?

46.

What is meant by the salting of the boiler ? How is this prevented ? What is the density of ordinary sea water ? How is the density ascertained ? What is the difference between the formation of scale and the salting of the boilers? What is the maximum density at which boilers should be worked at sea ? In the event of condenser tubes leaking, what is the minimum density at which boilers should be worked ? Give your reasons.

47.

Scum cocks and pipes ; how are they arranged ? Where are they placed ? At what height in the boiler ? When are they used ? When must they be shut ? Neglect of these cocks lead to what dangers ?

48.

Of what does scale consist ? Where is it most objectionable ? How is it removed ? How is its formation prevented ? What evil effects are produced by it ?

49.

What is a Salinometer ? Of what does it consist ? How does it act ? How is it graduated ? Can it be used at any temperature indiscriminately ?

50.

What harm may be done through the check valve of one of a set of boilers being defective while under way ? How would you work to avoid this harm ?

51.

How is the leak from a split tube stopped in a boiler at sea ? Describe the operation.

52.

What is the use of dampers ? Where are they fitted ? When should they be used ?

53.

When there are no dampers fitted what is used instead ? What evil to the boiler is sometimes attributed to this ? When the heating surfaces are clean does this occur ?

54.

Describe the piston of a steam cylinder, with its different rings and their uses. There are generally round pieces let in flush on one side of a piston ; what are they ? How are these pieces fixed ?

55.

Cylinder drain cocks ; what is their use ? There is sometimes a valve upon each cock ; what purpose does it serve ?

56.

Cylinder escape valves ; of what do they consist ? How protected ? How regulated ? When are they most needed ? To what danger do they expose the engineer ? What precaution is sometimes used to obviate this danger ?

57.

What is a compound engine ? What different kinds are there for screw steamers, in respect to the number and arrangement of their cranks and cylinders ? What is a triple expansion engine ?

58.

What is link motion ? What are some of its advantages ? In modern engines for the screw propeller, when there is no link motion, what takes its place ?

59.

What is a separate expansion valve ? Why is it not fitted to all engines ? What effect has an expansion valve upon the starting and upon the reversing of the engine ?

60.

What arrangement is applied to reduce the friction of a slide valve ? To what is the friction due ?

61.

Describe a loose eccentric ; how does it act ? In what engines are the loose eccentrics still employed ?

62.

What is the travel of the eccentric rod ? How is it measured on the eccentric ? What is the travel of the slide valve when the link motion is in mid gear, and the engine still moving ?

63.

What are "double beat valves" ? What objections are there to their use ?

64.

What is a circulating pump ? Is it always worked by the main engine ? Give an example from your last steamer of the three water temperatures generally noted by careful engineers.

65.

An air valve is sometimes fitted to a circulating reciprocating pump ; what purpose does it serve ?

66.

What is the difference between a bucket air-pump, a piston air-pump, and a plunger air-pump ?

67.

Are double-acting air-pumps made with plungers, with pistons, or with buckets ? Describe the construction and action of circulating pumps.

68.

What is an air-pump trunk ? When is it necessary ? How is it attached to the bucket ? Centrifugal pumps ; describe their construction, and mode of working.

69.

What class of air-pump requires both foot and delivery valves, and in what other class can either of these valves be in some cases dispensed with ?

70.

What are marine governors ? What is their general construction ? How do they act ?

71.

With a surface condenser and a single acting air-pump, what is the effect of a leaky foot valve, and what is the effect of a leaky bucket when there is also a foot valve ?

72.

Where is the air-pump pet cock or valve placed ? How does it act ? What is its object ? Does it in every case reduce the effective capacity of the pump ? Is it equally applicable to double-acting pump ?

73.

At what temperature is the hot well worked ? What is the effect of higher temperatures ? What is the effect of lower temperatures ? What limits the lowness of temperature ? Has a very low temperature any disadvantages ?

74.

Bilge injection with common condensers ; what are the fittings required ? When is it used ? What precautions are necessary in using it ?

75.

When surface condensers are used what takes the place of the bilge injection ? To what is the connection made ? How is its valve formed ? Why is this necessary ?

76.

What are the practical guides to the proper amount of opening of the inlet valve for the circulating pump ?

77.

Feed-pump pet cock or valve ; where is it placed ? What is its use ? How does it act ? Is it always a necessary fitting ?

78.

What are some of the ways of fastening the ends of surface condenser tubes ? About what size and about what thickness are condenser tubes ? What parts of a surface condenser are made of brass ?

79.

What is a blow-through valve or cock ? To what is it attached ? There is sometimes a valve that when opened admits steam from the slide valve casing to the exhaust port ; what is its use ? To which cylinder is it fitted ?

80.

What are snifting valves ? Why are they generally omitted now ?

81.

What connections are generally fitted to the donkey pump, and to what services can it be applied ?

82.

When the engines are stopped in harbour with steam up, what are to be shut and what are to be opened ?

83.

How is an engine heated up before starting? What precautionary examinations are made before starting?

84.

What is an interceptor or catch-water? Where is it fixed, what is its construction, how does it act, and what attention does it require?

85.

Describe an air-pump bucket, with its valve or valves and its packing. Of what are the valves generally made?

86.

Of what materials are air-pump rods made? Why?

87.

What is the racing of the engine? When does it occur? What danger attaches to it? What is done to prevent it?

88.

When under way, when the air-pump bucket is at the top of its stroke, at what height is the water in the condenser?

89.

What is meant by the "pitch" of a screw propeller? How is it measured?

90.

Explain the difference between a "right hand" and a "left hand" propeller, and state how each of them revolves.

91.

What is the slip of a screw propeller? How is its amount expressed in figures?

92.

Which of the valves about engines and boilers have to be worked by hand, which of them work self-actingly, and which are worked by the motion of the engine?

93.

Why is soda sometimes put into a boiler, and how is it put in when under way? What is the kind of soda used?

94.

Tallow cups for cylinders were sometimes made with two small cocks, or with only one small cock, or with one large hollow plug cock, or with one small cock and a valve; which of these is suitable for a high-pressure cylinder, and which for the cylinder of a condensing engine? Describe how the cup with only one small cock is used. What is now generally used instead of these? How has this change come about?

95.

Does a cylinder escape valve, self-acting, allow all the water to escape, if not how much is left in the cylinder?

96.

What is a "Steam Lubricator" (sometimes called an Impermeator)? Explain its action. To what part of the engine is it connected? Will throwing cold water over it make it work faster or slower? Describe the one used in your last steamer?

97.

A common paddle wheel; of what is the centre made? Of what are the arms formed? What is the form of the bolts which attach the floats to the arms? How are the arms attached to the centres?

98.

Why have some paddle wheels one or more cast-iron floats in each wheel? With what engines are these most required? At what part of the circumference are they placed?

99.

Why are paddle wheel floats sometimes made of different breadths in the same wheel? With what description of engine is this most needed? Where are the broad floats placed and where are the narrow floats placed in the circumference of the wheel?

100.

What difference is there between a radial paddle wheel and one with feathering floats? What is the object of feathering floats? Are all the eccentric rods attached in the same way, and are they all of the same form?

101.

Whereabout is the centre of the eccentric of a paddle wheel with feathering floats placed? In that case are the feathering levers on the striking face or on the back of the float? When the paddle shaft has an outer bearing how is the eccentric made?

102.

Of what materials are the working surfaces of a paddle wheel with feathering floats? How are they lubricated?

103.

What is a "Disconnecting Paddle Engine"? At what place is the disconnecting effected? How is it accomplished? In which of the cranks of a disconnecting engine are the crank pins fixed?

104.

Is link motion valve gear or the loose eccentric generally used for disconnecting paddle engines? For what steamers are disconnecting paddle engines frequently employed?

105.

What are expansion joints? Where are they necessary? What attention do they require? Of what should the working surfaces be made?

106.

What omission in the construction of expansion joints may lead to a serious accident when steam is first applied? How is this prevented in the construction of a steam trunnion pipe for an oscillating engine?

107.

Describe an oil cup with a syphon worsted. How is the worsted arranged? How is it cleaned? How far down the tube does it extend?

108.

Describe a thrust bearing; which of the surfaces wears? Why are there sometimes a number of oil tubes for one thrust bearing?

109.

What parts of a screw shaft are generally covered with brass? Why is this necessary? About what thickness is the brass?

110.

What is the stern tube or screw shaft pipe? Why is a pipe of such a length required? Of what is it made? How is it fixed at each end?

111.

What is a lignum vitæ bearing? How is the wood fitted? Where is such a bearing generally used?

112.

How is a screw propeller fixed on the shaft? What means are used to prevent its getting loose at sea?

113.

Where are sluice valves placed? What large sluice valve is there in almost all screw steamers? From what position should this valve be worked? Why so? What attention should it receive?

114.

With a condensing engine, what valves or cocks are on the skin of the ship in the engine room and in the stokehole?

115.

What are the necessary fittings of a marine boiler?

116.

With a surface condensing engine; what cocks or valves are opened some time before the engine is started so as to be ready for starting whenever the order is given?

117.

What is a steam jacket? What cocks are on it? In what engines are jackets most generally used? Do they require to be felted?

118.

What parts of an engine or its fittings should be felted or otherwise protected from radiation?

119.

What are the small cylinders sometimes fitted on the slide valve casing cover of vertical engines? Explain their action. To what are they connected by a pipe? Why so?

120.

Name the principal pipes in connection with the engines and boilers of a steamer, and state to what the ends of these pipes are connected?

121.

Through what cocks or valves, pipes and chambers does the water pass on its way from the sea inlet rose plate to the water space of the boiler, with a jet condenser?

122.

Through what cocks or valves, pipes and chambers does the circulating water of a surface condenser pass?

123.

Through what cocks or valves, pipes and chambers does the steam pass from the boiler until it is in the form of water in the hot well?

124.

Name the pieces of the engine through which the pressure of the steam is transmitted from the piston to the screw propeller. Name them in the order in which they act.

125.

What is an air vessel? How does it act? At what parts of an engine or of its fittings are air vessels generally applied?

126.

What is the construction of a mudbox? Where should mudboxes be placed? Why are they necessary? How should the space be divided by the rose plate, and why?

127.

What is a trunk engine? Why has it fallen into disuse?

128.

What is an oscillating engine? For what steamers are oscillating engines generally adopted? Why? How is the steam conveyed to and from the slide valve casing?

129.

Of what parts does the valve motion gear of an oscillating engine consist?

130.

For what have geared engines sometimes been used? Of what were the cogs of the large wheel made?

131.

At what part of a screw steamer is the pressure that propels it applied to the hull?

132.

At what part of a paddle steamer is the pressure that propels it applied to the hull?

133.

About how much fuel per indicated horse-power per hour is required by modern steam engines. common, compound, and triple expansion?

134.

What is the explanation of the economy of the surface condenser?

135.

What is the construction of a surface condenser? Of what are its tubes made? How are they fixed? How are they kept tight? What is done with a split tube?

136.

Where do surface condensers foul? How are they cleaned?

137.

What non-conducting substances are employed to prevent radiation, and how are they applied?

138.

In the construction of smoke-box doors and of dry uptakes, what provision is made to lessen the amount of radiation ?

139.

How can the formation of black smoke be prevented ? Describe smoke preventing apparatus.

140.

What is meant by "circulation" in a boiler, and what are the results of defective circulation ?

141.

What means are sometimes adopted to improve the circulation in a boiler ?

142.

By what arrangement is the circulation promoted in a "hay stack" boiler ?

143.

Describe a ship's side air-pump discharge valve, in what respects does it sometimes differ from a common stop valve, and what attention does it require ?

144.

What is the construction of a feed escape valve, to what is its discharge connected, and how is its loading regulated ? Where should the escaping water flow ?

145.

When there is no feed escape valve what is the arrangement of the feed valves or cocks ?

146.

What is the measure of a horse-power ? How is indicated horse-power ascertained ?

147.

Has "nominal horse-power" a fixed meaning ? What is the use of this expression ? What is generally taken as the measure of one horse-power nominal ?

148.

What is "back pressure" in a cylinder ? About how much is it in each of the cylinders in your last steamer ? Is excessive cushioning ever a trouble under certain conditions in modern engines ? Say when and why and in which cylinder this occurs ?

149.

What is meant by "speed of piston" ? About how much is the speed of piston in modern marine engines ?

150.

What is "atmospheric pressure" ? What is its average amount ? What instrument tells this amount ?

151.

What is "gross pressure" or "absolute pressure" ? What pressure is it that is shown by the steam gauge ?

152.

What is meant by "cutting off" steam ? How is it done ? What part of the valve regulates the cut off ?

153.

What is a piston slide valve ? Describe its construction. Why are such frequently employed in place of the common slide valve ? Have they any disadvantages compared with a common slide valve ? If so, name them.

154.

What fixes the time of closing the exhaust ? After the exhaust is closed and before the port opens for steam, what becomes of the steam that is in the cylinder ?

155.

What is the "lead" of the valve ? What is its object ? About what amount is it ?

156.

What is the "cover" or "lap" of the valve ? What is its object ? About what proportion of the stroke of the valve is it made ?

157.

What is the "exhaust cover" of a slide valve? What is its effect upon cushioning and upon exhaust?

158.

What is "minus cover" or "minus lap" on the exhaust? What is its effect upon the exhaust and upon cushioning?

159.

What is "cushioning" or "compression" in a steam cylinder? How is it affected by the amount of cover or of minus cover there may be upon the exhaust? How is it affected by the exhaust pressure?

160.

What is "mean effective pressure"? How is its amount ascertained?

161.

What is a dial vacuum gauge? What is its construction? For what is it used? About what amount should it show when the engine is working all right? What effect has the variations it indicates on the performance of the engine?

162.

Does the vacuum gauge enable you to tell what pressure there is in the condenser, or must you have recourse also to the barometer to arrive at that? How would you ascertain the actual amount of back pressure there is in the condenser?

163.

What is a barometer? What is its construction? Is a barometer sometimes used instead of a vacuum gauge? In what respect does the weather barometer differ from the vacuum gauge barometer?

164.

The common vacuum gauge and the common steam gauge; in which of them are the graduations marked from atmospheric pressure? Does either of them tell what is the true actual pressure in the boiler or in the condenser?

165.

Do steam and vacuum gauges vary with the variations of the weather barometer? When the weather barometer varies from 29 to 31 how much will the vacuum gauge vary and how will that affect the working of the engine? Why?

166.

Vacuum is generally stated as so many inches. What is meant by, say, 20 inches vacuum? What does that tell us about the absolute pressure of the vapour then in the condenser?

167.

From what depth will a pump draw water? Is there any limit? Why?

168.

What is vacuum? Can vacuum move a piston? When the temperature of the water in the condenser is 212°, what is the greatest degree of vacuum there can then be in the condenser?

169.

What is a thermometer? What is its construction? What is the property of matter that is the principle of its construction? What temperatures are regularly noted by careful engineers?

170.

What is the temperature of (1) melting ice, (2) boiling water, (3) steam about 60 lbs. pressure by the steam gauge, (4) steam about 100 lbs., (5) steam about 150 lbs., (6) smoke in the funnel, (7) water in the hot well?

171.

What is meant by the "conduction" of heat? Give examples of it in the boiler and in the engine?

172.

What is meant by the "convection" of heat? Give examples of it in the boiler and in the engine?

173.

What is meant by "radiation" of heat? Give examples of it in the boiler and in the engine?

174.

Which is convection, which is radiation, and which is conduction in the following cases :—(1) Heat from the glowing fuel to the furnace crown? (2) Heat passing from one side of the furnace crown plate to the other? (3) Heat passing from the steam pipes in the engine room? (4) The heat of evaporation?

175.

What are the effective heating surfaces of a marine boiler?

176.

What parts of a marine engine are exposed to danger when the temperature is below freezing point?

177.

What precautions are necessary in cold climates when the temperature is below freezing point?

178.

State as many ways as you can by which a boiler might not get its full feed. A boiler, or one of a set of boilers, gets short of water although the feed valve is open its proper amount; to what causes might this be due?

179.

Of what are furnace bars generally made? About what thickness are they at the top? About what space is between them? Are the bars put further apart for Newcastle coal than for Welsh coal?

180.

Which burns faster, Newcastle coal or Welsh coal? Which is the flaming coal? Which makes more smoke?

181.

About how many tons of steam coal will be burnt per day in four furnaces, each 3′ 0″ wide, and of about the usual length? On what grounds do you say so?

182.

About how many tons of steam coal will be burnt per day with good triple expansion engines to drive an ordinary steamer of 40 ft. beam 10 knots an hour by steam alone? On what grounds do you say so? What percentage more coal would be required to propel the same steamer one knot faster?

183.

About how many tons of steam coal will be burnt per day with a good triple expansion engine, surface condensers, the low pressure cylinder 60 inches diameter, doing average work? On what grounds do you say so?

184.

A pair of inverted cylinder direct acting engines; there is a liner half an inch thick between the ahead eccentric rod and the eccentric strap, in overhauling the engine this piece is lost and forgotten; What difference will its omission make in the working of the engine, on the admission, on the cut off, and on the exhaust of the steam? Which will take place earlier and which later, distinguishing between the up stroke and the down stroke?

185.

A pair of inverted cylinder direct acting engines driving a righthand screw; on which of the crosshead guide bars is the pressure greatest in the up stroke, and on which in the down stroke?

186.

A screw propeller is getting loose, it has a little play on the shaft, sideways on the key or feather; how will this show in the engine room?

187.

How would you prove whether the centre line of the trunnions of an oscillating cylinder be fair with the centre line of the main shaft?

188.

How can the fairness of a line of screw shafting be tested without lifting the shafts?

189.

Where are steel forgings generally used in marine engines?

190.

What is the composition of nickel-steel? Where is it sometimes used in engines and boilers?

191.

How is forced draught generated on board ship and supplied to boiler-furnaces? Is the air heated before delivery? If so, how?

192.

What is "induced" draught? Compare the merits of "forced" and of "induced" draughts.

193.

How is the intensity of forced or induced draught measured? What is the usual pressure employed in the mercantile marine?

194.

An explosive gas is liberated from bunker coal. Usually in well ventilated bunkers this gas escapes into the atmosphere without doing harm. In ill-ventilated bunkers the gas after mixing with a certain proportion of common air has been known to explode when a naked light has been brought into contact with it. What is the composition of the gas? Where is it found, in bunkers, 'tween decks, pockets, and coal shoots? How may it be got rid of as soon as it evolves from the coal? How many cubic feet of air to one of the gas forms a violent explosive mixture?

195.

A lighted lamp or candle has sometimes been lowered into an apparently empty paraffin tank and produced an explosion resulting in injury to the person holding the light. What did the tank probably contain, and what produced the explosion?

196.

In vessels carrying coal-cargoes it has been observed that, generally speaking, the gas which escapes from the body of the coal is found more abundantly at the forward end of the hold than at the after end. Why should this be so?

197.

In recently opened ballast tanks, double-bottoms, and boilers, a light lowered into either has sometimes been extinguished. What would, in all probability, cause this?

198.

In double-bottom steamers where does the bilge water lie, and where are the roses of the bilge pipes fitted?

199.

What is the advantage of a large rose over a small one?

200.

Why, especially in vessels carrying cargoes liable to shift, should engine bilge suctions be fitted to both wings of the bilge?

201.

In a heavily listed vessel, why is it difficult to keep steam?

202.

If the engine pumps got choked and water accumulates in the stokehold bilges, what effect does the water have upon the bilge boards and stokehold plates, when the ship is rolling violently?

203.

In a triple expansion engine, what spare gear do you consider necessary in the case of a foreign-going ship? Also what stores would you provide for a voyage to New Zealand?

204.

What means are sometimes provided for temporarily coupling together the broken parts of, say, a tunnel-shaft? Describe the fitting.

205.

Does the pressure on the thrust-collars vary with the horse-power, or with the speed of the ship, or how?

206.

If the holding-down bolts of a thrust-bearing should become slack, what effect would it have upon the working of the engines?

207.

In an engine with three cranks, which of the three is subject to the greatest torsional stress (1) in going ahead (2) in going astern?

208.

Is it usual to make the crank shaft of a triple or quadruple expansion engine in one piece? And is the diameter of the shaft uniform from end to end? Give your reasons for the practice which obtains

209.

In a "built" crank shaft how are the webs rigidly secured to the pins and to the body of shaft?

210.

There are various descriptions of donkey engines in use on board ship for pumping purposes. Some pumps are fitted with escape-valves, some are not. Why should this be?

211.

Explain the function of an air-vessel fitted to a feed pump. Make rough hand sketches of (1) a satisfactory vessel, (2) an unsatisfactory vessel, where, say, the air-spring has been destroyed by carelessness, or has never been properly provided.

212.

Should cocks or escape-valves be fitted to air-vessels? Why, or why not?

213.

Where, by preference, should the escape-valve of a feed pump be placed? Why?

214.

Scum cocks are sometimes fitted to boiler-shells at a height convenient for Engineers to manipulate when standing in the stokehold; the scum pipes in such cases are led upward, inside the boiler, to a little above the combustion chamber tops. What danger may arise from this arrangement?

215.

Cocks for testing the water level of boilers are sometimes fitted within reach of the Engineer who is standing in the stokehold. These may have internal pipes leading upward and terminating at various levels. Under what circumstances may these become misleading?

216.

Why should the pipe which leads from the bottom of the water-gauge column to the bottom of the boiler-front, or back, be covered with non-conducting material? Why also should it never have lengthy horizontal bends?

217.

In your own experience, how frequently is this pipe removed and cleared?

218.

Why, even with the best of water-gauges, is it advisable to occasionally use the drain-cock?

219.

Steam loops have sometimes been inadvertently made in the length of piping leading from the top of the water-gauge column to the top of the boiler. Roughly sketch such a loop and explain the danger arising from its existence.

220.

Describe your method of thoroughly testing the water-gauge system to satisfy yourself that all the cocks and pipes are clear. Your answer can be written on a supplementary sheet of foolscap, which the Examiner will hand you. Hand sketches, mere lines indicating pipes, and circles indicating cocks, should be made. Identify the cocks and pipes by letters or numerals.

221.

Describe the construction of a water-tube boiler, mentioning the type selected.

222.

In a water-tube boiler, how is an economiser fitted, and what is its duty?

223.

How is the water-gauge fitted? Are glass-gauges used?

224.

The pressure of the steam in water-tube boilers is sometimes greater than at the engines. Why is this, and what percentage above the engine pressure does it amount to? How is this difference of pressure maintained?

225.

Describe any automatic method of feeding water-tube boilers. Of what material are the tubes made?

226.

Describe the construction of any steam turbine you are acquainted with, which is used on board ship. How is the expansion of steam effected? How many propeller shafts are employed, and how many propellers?

227.

Is the same power in a steam turbine available to go astern as to go ahead?

228.

Of what material are the propellers made in a steam turbine?

229.

How many pounds of coal per indicated horse-power per hour are burnt with this type of engine? Name the type of boiler in use?

230.

Describe one of the several classes of refrigerating machinery in use on board ship. Several types exist, one being more economical than the rest. Which is it?

231.

Describe the defects to which the selected type is subject. How are the defects overcome?

232.

How frequently are the parts opened out for examination? Name the parts?

233.

How frequently are the condensers of refrigerating plants opened for examination? How frequently are the coils tested by hydraulic pressure? On which side of the coil is corrosion most commonly found? Why should this be so?

234.

Where ammonia is used in refrigerating machinery, should the machinery by preference be isolated? Why? In reply, give what information you possess bearing on the matter, naming the ships for purposes of identification.

235.

Explain how the ammonia is removed from the tubes in which it is supplied, and how passed into the refrigerating machine.

236.

What objection is there to the presence of water in the ammonia?

237.

Describe the ammonia process of refrigeration.

238.

Of what material are the parts made which are in contact with the ammonia?

239.

Are escape-valves fitted to the compressors of ammonia machines?

240.

What is the maximum pressure found in the compressors of ammonia machines?

241.

What kind of pressure and other gauges are used in ammonia machines?

242.

Explain how carbonic acid is removed from the tubes in which it is supplied, and how passed into the refrigerating machine.

243.

What objection is there to the presence of water in the carbonic acid?

244.

Describe the carbonic acid process of refrigeration.

245.

Of what material are the parts made which are in contact with the carbonic acid?

246.

Are escape-valves fitted to the compressors of carbonic acid machines?

247.

What is the maximum pressure found in the compressors of carbonic acid machines?

248.

What kind of pressure and other gauges are used in carbonic acid machines?

249.

In which type of machine is brine used? What is its density? Where does it circulate?

250.

Are fans for circulating air used in any of these processes? If so, why are they necessary?

251.

What means are in some cases employed for ascertaining the temperatures of refrigerating chambers without entering them?

252.

What effect may the swabbing of the compressor-piston rods have upon the working of refrigerating machinery?

253.

What is a rectifier? Explain its use?

254.

Describe the cold-air process of refrigeration.

255.

Of what material are the air suction and delivery valves made? How are the valves kept on their seats?

256.

How many compressors are there to a cold-air machine?

257.

What is the duty of the expansion cylinder of a cold-air machine?

258.

What objection is there to the presence of moisture in the air passed through the cold-air machine?

259.

How is water to some extent removed from the air? What is the minimum temperature of the air?

260.

What is the maximum pressure found in the compressors of cold-air machines?

261.

What kind of pressure and other gauges are used in cold-air machines?

262.

In refrigerating engines generally, to where is the exhaust steam led?

263.

Cold-air chambers on board ship are insulated. How and why?

264.

Is it prudent to allow the wires of an electric circuit to pass through the insulation? Explain fully.

265.

Describe the construction of a feed water-heater and give the name of its manufacturer.

266.

Describe any well-known ash ejector.

267.

Describe any well-known independent feed pumps.

268.

Are independent feed pumps automatic in their action ? Explain the action.

269.

What advantage, if any, have independent feed pumps over feed pumps worked by the main engines ?

270.

To about what temperature is the feed water raised by passing through a feed-heater ?

271.

What fittings are usually placed on a feed-heater ? Why are they necessary ?

272.

Describe the construction of a feed-filter, enumerating its valves and cocks.

273.

How can the filter be cleaned ? What ingredients are generally removed when cleaning takes place ?

274.

What is the intercepting material in a filter made of ? How is it fitted ?

275.

Describe an evaporator, and mention the type.

276.

What fittings are necessary with evaporators ?

277.

How is the brine got rid of in an evaporator ?

278.

How may the evaporator coils be cleaned ?

279.

What is a dynamo ? Describe its various parts. For what is it used ?

280.

In what respect does an electric motor differ from a dynamo ? Where are electric motors sometimes used on board ship ?

281.

Describe a system of electric lighting employed on board ship.

282.

How is the position of a fault in the electric circuit discovered ?

283.

What is "sparking", and may it under some circumstances (naming them) be a danger ?

284.

What is "short-circuiting", and to what evil may it give rise ?

285.

What means are employed to prevent any part of the circuit becoming overheated ?

286.

Describe the features of an arc lamp.

287.

Describe the construction of a glow-lamp.

288.

What is the usual candle-power of the small glow-lamps in general use on board ship ?

289.

Define the following terms:—Ampère, volt, ohm, watt. What is the measure of an electrical horse-power?

290.

Explain the uses of switches, brushes, commutators, cut-outs, field-magnets, armatures and resistance-coils.

291.

Why is it desirable to fit a dynamo in a cool place on board ship?

292.

What undersirable effect will ultimately occur to an electric wire, whose sectional area is constantly diminishing, say, through corrosion?

293.

What danger might arise from leading electric wires through coal bunkers?

294.

Is it better to lead electric wires above or below side-scuttles? Why?

295.

What instruments are used on board ship to ascertain the strength of an electric current?

296.

Many ocean-going steamers are fitted with hydraulic cranes, &c. Where do they obtain their power? How is the hydraulic pressure kept at a relatively constant amount?

297.

Is any difficulty experienced in working hydraulic cranes in frosty weather? If so, why?

298.

Describe any steam steering gear you are acquainted with.

299.

When the helm is put hard over and the ship is going full speed ahead, what prevents the rudder returning to the amidship position?

300.

In the case of a steamship under way does the officer, or man manipulating the steam steering wheel overcome any resistance exerted by the rudder?

301.

Explain clearly what is being done by a helmsman manipulating the wheel of a steam steering engine.

302.

Is there any difference between the amount of horse-power required to put a helm hard over, in a given time, when the vessel is going full speed ahead, and when she is going full speed astern? This question refers to the case of a steamer fitted with one rudder only, and demands a more complete answer than merely "yes" or "no".

303.

What precautions should be taken before removing a manhole-door of a steam boiler? In the absence of such precautions what casualties might occur?

304.

Describe the chief features of the engine-governor fitted to a steamer you have served in. Describe its action. Give the maker's name, and name of ship.

NOTE.—The following six questions refer to oil-motors fitted to launches which carry passengers:—

305.

Name the principal parts of an oil-motor, and briefly state their functions. Give the name of the makers of the motor.

306.

What kind of oil is usually employed in oil-motors? What is its flash-point? What is its specific gravity? What its calorific power? What precautions are taken in its storage to guard the public against casualty by fire or explosion?

307.

How many cylinders are generally used in oil-motors? What kind of pistons are fitted? How frequently (measured in revolutions) is explosion per cylinder effected? How is explosion in the cylinder carried out?

308.

Describe how an oil-motor is started. If starting prove difficult, where would you chiefly look for defects? How is piston speed modified? How is the speed of vessel varied? How is reversing effected?

309.

Before examining an oil-motor with a naked light, what steps should be taken for safety's sake?

310.

How frequently should an oil-motor, working 12 hours a day, be opened up for examination, cleaned, and its parts readjusted? What difficulty arises when the internal parts become foul with carbonized oil?

NOTE.—Questions isolated from their context should be read in the light of the context. Thus the "sparking" referred to in question 283 relates to the sparking in an electric lighting circuit on board ship. *See* question 281.

Appendix C.

EXAMINATION IN ROUGH WORKING DRAWING FOR A FIRST CLASS ENGINEER'S CERTIFICATE OF COMPETENCY.

1. The regulations of the Board of Trade in regard to the qualifications of a candidate for a First Class Engineer's certificate of competency specify that,—

> "He must be able to make rough working drawings of the different parts of the engines and boilers.
>
> "He must be able to state the general proportions borne by the principal parts of the machinery to each other."

2. In accordance with these clauses, a candidate for a First Class Certificate is required to make a rough working drawing of the parts. An Engineer who has been some years in charge of marine engines and boilers ought to have familiarly in his mind the general construction of at least one set of engines and boilers, say that set he was last with. Fine drawing is not expected, and in the proportions of the parts a wide margin will be allowed; absurd dimensions will be failure in practical knowledge.

3. The drawing must, however, be practically a working drawing, giving a sufficient number of views to show the parts fully—sections, plans, or elevations, just as the candidate would require to be supplied to him if he had to make the parts to the design of another person.

4. A clear hand sketch showing the constructions completely, and fully dimensioned, will be accepted if the candidate prefers this alternative.

5. A portion only of the parts specified may be accepted in place of the whole, if that portion is sufficient to show that the candidate has a good practical idea of the construction of the parts, and a fair notion of their general proportions or dimensions.

6. Candidates are hereby cautioned not to put on paper what they have not fully considered, and deliberately intend to be understood, as their statement of what they know about the construction of any part required.

7. The statements given in by a candidate may be in themselves, apparently, of little importance, but, as sample material from which the state of the candidate's knowledge of engines and boilers is to be inferred, every detail which is glaringly inconsistent with a sound knowledge of the use of the part, or in which an essential consideration has evidently been overlooked, is an important element in the description which the candidate is giving of his own qualifications.

8. The candidate is advised not to begin more than he can clearly finish in the time allowed. An important object in this part of the examination is to ascertain whether the candidate can be trusted to mark all necessary dimensions upon a sketch or a drawing. The test of this is, practically, the making of the part from the sketch without having to supply additional dimensions, and without measuring the drawing. To prove this ability the candidate must fully dimension the parts, shown in his sketch or drawing, notwithstanding that the parts may be correctly drawn to scale. A drawing is fully dimensioned when no part of it is left to the option of the party who is to work to the drawing.

9. To prevent misunderstanding, however, when the candidate has been led into showing more of the details than he has time fully to finish, he should name, ineth statement on the other side. the particular parts which he has fully dimensioned.

10. All dimensions should have lines and darts, to indicate distinctly the points between which the dimensions are given.

11. Beware of writing cross dimensions upon centre lines, or upon longitudinal dimension lines. This is not an order but a recommendation.

12. The candidate is not expected to design anything; he has merely to sketch or draw something with which he is expected to be already familiar. At the same time he should call attention to any defect in the design of the article or apparatus. Omission to do so will imply want of practical knowledge.

13. Pencil in nothing after half-past three; all the dimensions, the figures, and the darts must be inked in; employ the remaining time in examining the drawing and in inking in any figures which may have been before overlooked, and in checking the dimensions.

14. Make sure that you will have sufficient room on the drawing sheet to show all the necessary views. You can have another sheet of drawing paper if necessary. All the paper used must be forwarded with the drawing.

Note.—For the "Reading of the Water Gauges" candidates are referred to Appendix "E" of the "*Regulations relating to the Examination of Engineers in the Mercantile Marine*" issued by the Board of Trade, which can be had from local booksellers.

Appendix D.

LIST OF COLONIAL CERTIFICATES ISSUED UNDER ORDER IN COUNCIL, which are of the same force as those granted by the BOARD OF TRADE.

Colony.	Certificates.		Date of original Order in Council.	Date from which Order in Council takes effect.
	By whom granted in Colony.	Description.		
Victoria ...	* Marine Board ...	Master; 1st Mate; Only Mate; 2nd Mate; 1st Class Engineer; 2nd Class Engineer.	30 March 1871	4 January 1870
Canada	The Minister of Marine & Fisheries.	Master; Mate † — — 1st Class Engineer; 2nd Class Engineer.	19 August 1871 10 Nov. 1886	19 August 1871 1 January 1887
New Zealand...	Marine Department ...	Master; 1st Mate; Only Mate; 2nd Mate; 1st Class Engineer; 2nd Class Engineer.	9 August 1872	1 May 1872
New South Wales ...	‡ Department of Navigation	Master; 1st Mate; 2nd Mate; 1st Class Engineer; 2nd Class Engineer.	30 August 1873	18 June 1872
Malta	The Head of the Government ...	Master; 1st Mate; 2nd Mate; 1st Class Engineer; 2nd Class Engineer.	12 May 1874	12 May 1874
South Australia	Marine Board	Master; 1st Mate; Only Mate; 2nd Mate; 1st Class Engineer; 2nd Class Engineer.	12 May 1874	12 May 1874
Tasmania .	The Governor	Master; 1st Mate; Only Mate; 2nd Mate; 1st Class Engineer; 2nd Class Engineer.	12 Feb. 1876	1 April 1876
Bengal.....	Lieutenant-Governor...	Master; 1st Mate; Only Mate; 2nd Mate; 1st Class Engineer; 2nd Class Engineer.	27 June 1876	27 June 1876
§ Newfoundland	Governor ...	Master; 1st Mate; Only Mate; 2nd Mate.	14 May 1877	14 May 1877
Bombay ...	Governor ...	Master; 1st Mate; Only Mate; 2nd Mate; 1st Class Engineer; 2nd Class Engineer.	11 July 1877	11 July 1877
Queensland	Marine Board...	Master; 1st Mate; 2nd Mate; 1st Class Engineer; 2nd Class Engineer.	26 March 1878	1 October 1877
Hongkong .	Governor ...	Master; 1st Mate; Only Mate; 2nd Mate; 1st Class Engineer; 2nd Class Engineer; 2nd Class Engineer, Oil Engines.	31 Dec. 1883	1 January 1884
Straits Settlements.	Governor ...	Master; 1st Mate; 2nd Mate. 1st Class Engineer; 2nd Class Engineer.	1 May 1890 ...	1 June 1890 1 August 1888
‖ Mauritius	Governor ...	Master; 1st Mate; 2nd Mate.	22 Nov. 1890	1 January 1891

* The Steam Navigation Board was superseded by the Marine Board on the 21st December, 1888. *See* Order in Council of 23rd November, 1893.

† Equivalent to 1st Mate.

‡ The Marine Board was superseded by the Department of Navigation on the 17th March, 1900.

§ Newfoundland does not issue Engineer Certificates under the Order in Council.

‖ Mauritius does not issue Engineer Certificates under the Order in Council.