MARINE DEPARTMENT.—NEW ZEALAND

EXAMINATION OF ENGINEERS IN THE MERCANTILE MARINE

Specimen Set of Examination Papers for a Second-class Certificate

Exn. 1c

These Examination Papers relate to Examinations held under the Regulations published in 1939 (Exn. 1A (1939))

WELLINGTON, N.Z.
By Authority: R. E. OWEN, Government Printer.
1949

NOTE—*Data to be used in working the problems will be found on the first sheet of the answer-book*

GENERAL ENGINEERING SCIENCE

Six questions ONLY *to be attempted*

Time allowed : Three hours

1. A steamer travels 30 miles with a current and then puts back to port travelling against the current. The total distance is covered in eight hours. If the vessel travels 10 nautical miles with the current in the same time as she travels 6 miles against it, calculate the speed of the current and the speed of the vessel.

2. A lever safety-valve is 3 in. diameter and weighs 3 lb. The distance from fulcrum to valve is 3·25 in. The lever weighs 9 lb. and is 30 in. long. If the valve begins to blow at a pressure of 5 lb. per square inch when the weight is removed, find the centre of gravity of the lever.

3. A body is projected vertically upwards from a point 20 ft. from the ground with a velocity of 120 ft. per second. Calculate the distance from the ground the body will be (*a*) when rising with a velocity of 40 ft. per second, (*b*) when falling with a velocity of 100 ft. per second, and (*c*) the velocity on reaching the ground.

4. A weight of 810 lb. is raised by a Weston's differential pulley block at the rate of 4 ft. per minute by a force of 90 lb. If the efficiency of the block is 40 per cent. and the larger part of the compound pulley is 10 in. diameter, what is (1) the diameter of the small part of the compound pulley, and (2) the velocity in feet per minute of the hauling chain.

5. A 12-in.-diameter crankshaft weighs 10 tons, and it is pressed against the bearing by a force of 20 tons horizontally. Find (1) the horse-power lost in friction when revolving at 90 revolutions per minute, and (2) the heat generated at the bearings.

   NOTE.—Co-efficient of friction = 0·06.

6. A cantilever 10 ft. long carries two loads W_1 tons at the free end and W_2 4 ft. from the free end. The bending moments at the wall and at 6 ft. from the wall are 27 ft. tons and 6 ft. tons respectively. Calculate the value of the two loads and draw bending moment and shearing force diagrams to the following scales : 1 in. = 2 ft. length of beam ; 1 in. = 1 ton shearing force ; and 1 in. = 5 tons of bending moment.

7. On a treble riveted double butt strap joint the pitch of the rivets are 6·23 in. and the plate thickness is $1\frac{1}{16}$ in. If the tensile strength of the plate is 28 tons per square inch and the shear strength of the rivets 23 tons per square inch, and the allowance for the rivets in double shear being $1\frac{7}{8}$, find the diameter of the rivets, assuming that the plate and rivet efficiencies are equal.

8. The stress in a shaft 14 in. diameter is 5,000 lb. per square inch. It has eight bolts on a 20-in.-diameter pitch circle. Find (1) the diameter of the bolts, assuming shaft and bolt material to be the same, and (2) the horse-power transmitted when the shaft is revolving at 80 revolutions per minute.
9. A starting air receiver is 5 ft. 9 in. diameter and 11 ft. long; the working pressure is 352 lb. per square inch. If the efficiency of the longitudinal riveted seam is 80 per cent., calculate (1) the thickness of the plate for a safe working stress in the material of 5·5 tons per square inch; (2) the longitudinal stress about the middle section of a plate away from the joint; (3) the circumferential stress about the middle section of the plate away from the joint.

HEAT AND HEAT ENGINES

Six questions ONLY *to be answered*

Time allowed: Three hours

1. A piece of cast iron weighing 250 grammes is suspended in the uptake of a boiler until it attains the same temperature as the funnel gases. It is then placed in 0·13 litre of water, and the final temperature of the iron and water is twice the initial temperature of the water. Calculate the maximum temperature of the gases in the uptake, assuming that no water is evaporated.
2. Into a tank containing 1,650 kilograms of water at 80° Fahrenheit 30 lb. of steam at 145 lb. per square inch and having a temperature of 363° Fahrenheit are blown. Assuming that there is no losses, what is the resulting temperature?
3. When the scavenging air ports of a two-stroke-cycle Diesel engine are just covered by the piston on the compression stroke, the piston is 680 millimetres from the top of the stroke. The pressure and temperature of the air in the cylinder at that instant is 4 lb. per square inch by gauge and 110 degrees Fahrenheit respectively. The diameter of the cylinder is 680 millimetres and the clearance volume is equal to 60 millimetres of piston travel. If the scavenging efficiency is 95 per cent., calculate the weight of air taken in per cycle.

   NOTE.—The weight of air at atmospheric pressure equals 0·0807 lb. per cubic foot.
4. Define the "mean gramme calorie."

   The temperature of 20 litres of lubricating-oil is raised 60° centigrade in 20 minutes. The specific gravity of the oil is 0·89. If the specific heat of the oil is 0·48, calculate (1) the equivalent work done per minute in feet/pounds, (2) the B.Th.U. absorbed by the oil per second, and (3) the gramme calories absorbed by the oil per second.
5. The accompanying diagram in answer-book was taken from a triple-expansion engine. The diameter of the cylinders are 26 in., 40 in., and 72 in. respectively, the stroke 50 in. The revolutions are 70 per minute and each cylinder develops the same power. If the coal consumption is 1·5 lb. per i.h.p. hour, calculate the amount of coal burnt per day.

6. The piston of a single-stage air-compressor is 8 in. diameter and the stroke 12 in., with a clearance volume of 25·13 cubic inches. The pressure at the commencement of the compression stroke is 14 lb. per square inch absolute and the discharge pressure 60 lb. per square inch absolute. Find the length of stroke in inches during which the discharge valve is open, assuming the law of compression is P.V. $1{\cdot}2$ = a constant.
7. A compound engine develops 1,000 h.p. The power developed in the low-pressure cylinder is twice that developed in the high-pressure cylinder. The diameter of the low-pressure cylinder is three times that of the high-pressure cylinder. If the mean effective pressure of the low-pressure cylinder is 16 lb. per square inch, what is the mean effective pressure in the high-pressure cylinder ?
8. Wet saturated steam is generated at a temperature of 400 degrees Fahrenheit from feed at 210 degrees Fahrenheit. The fuel consumption is increased 9 per cent. in order to generate dry saturated steam. Calculate the dryness fraction of the wet saturated steam.
9. The over-all efficiency of a steamship installation is 8 per cent. How much coal will be used per s.h.p. per hour if the boiler efficiency is 73 per cent., the propeller efficiency 62 per cent., and the calorific value of the coal 13,500 B.Th.U. per pound.

ENGINEERING DRAWING

General Instructions

1. Draw the object clearly in pencil, but insert the dimension arrow-heads and figures in ink.
2. Working drawings to scale are required, and not pictorial representations.
3. Insert all the dimensions necessary for the construction of the object in the workshops, including those given in the question and those purposely omitted.
4. Dimensions may be given in feet and inches, or in metrical units, but not a combination of both.
5. Do not draw more parts than are specified below.
6. Any diagram to which the question refers will be handed to you by the examiner.
7. Credit will be given for correct projection.
8. The materials of which different parts are to be made should be indicated on the drawing.

Strainer for Turbine Main Steam

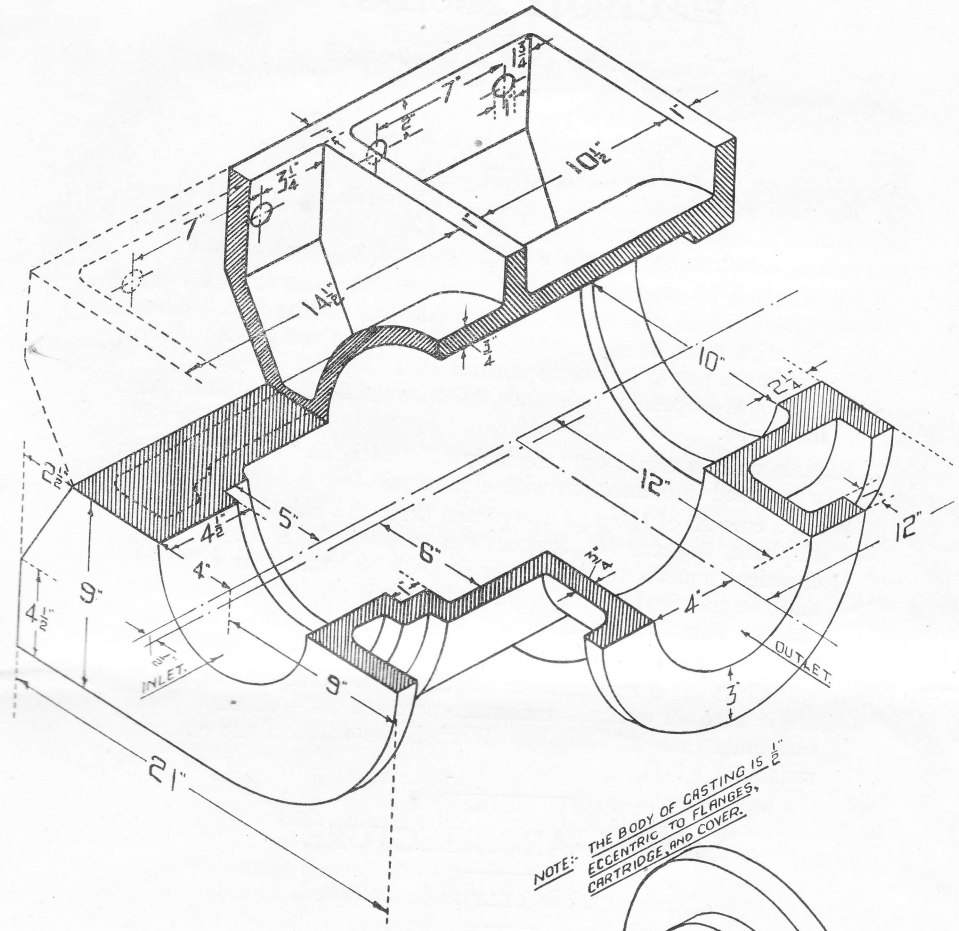
Draw the following views of the strainer with the cartridge in place :—

(*a*) A sectional view through the branches and cover ;
(*b*) A sectional view, projected from (*a*) through the side branch ;
(*c*) An elevation looking on the side branch ; and
(*d*) An end view, projected from (*c*) looking on the cover.

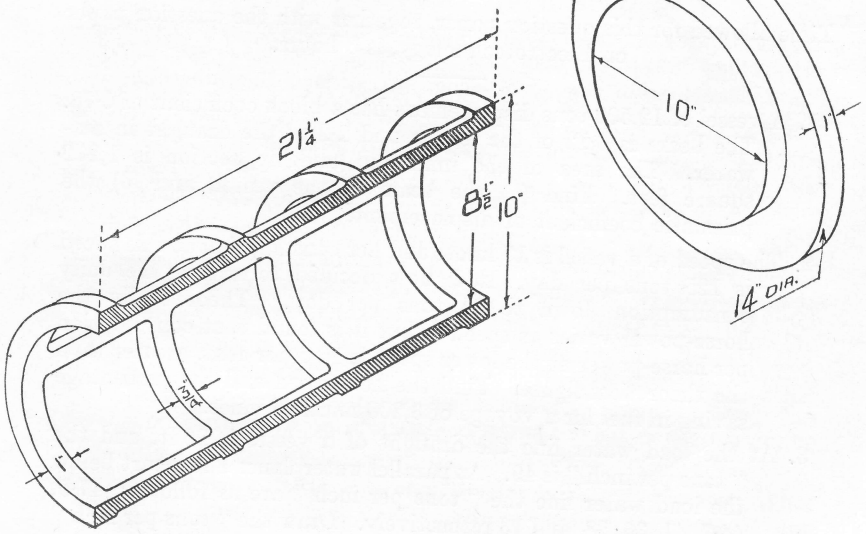
Note that the chest is half an inch eccentric relative to the cartridge, cover, and lagging flanges.

Time allowed : Six hours.

5



NOTE:- THE BODY OF CASTING IS ½" ECCENTRIC TO FLANGES, CARTRIDGE AND COVER.



ELECTROTECHNOLOGY

Three questions ONLY *to be attempted*

Time allowed for this question paper, together with the question paper on Naval Architecture, is 3 hours.

1. The field winding of a shunt motor has a resistance of 86·45 ohms at 0° Centigrade and 121 ohms at 100° Centigrade. At what temperatures Centigrade will the resistance be 92 ohms ?
2. An ammeter to read 25 amperes requires 250 ampere turns for the full indication, the mean length of the turn being 6 in. What size wire must be employed in the winding of the bobbin if the maximum power lost must not exceed 1·75 watts ?
   NOTE.—Specific resistance of wire is 0·66 microhms per inch cube.
3. Explain what is meant by " electrolyte," " cathode," and " anode " when used in connection with electrolysis.
   When a current of 12 amps was passed through a solution of copper sulphate, 9 grams of copper were deposited. If the electro-chemical equivalent of copper is 0·00033 grams per coulomb and the chemical equivalent of copper is 31·8, find how long the current was flowing and how much hydrogen was liberated from the solution.
4. A voltmeter has a resistance of 26,500 ohms. When connected in series with an external resistance across a 240-volt supply the instrument reads 180 volts. What is the value of the external resistance ?

NAVAL ARCHITECTURE

Three questions ONLY *to be attempted*

Time allowed for this question paper, together with the question paper on Electrotechnology, is 3 hours.

1. A vessel of 12,500 tons displacement has a block coefficient of 0·78. The beam is 0·12 of the length and 2·2 of the draught in sea-water. The area of the immersed midship section is 1,272 square feet. Find (*a*) the beam of the vessel, and (*b*) the prismatic coefficient of displacement.
2. The speed of a vessel is 17 knots and her consumption at this speed is 125 tons per day. It is now decided to reduce the daily consumption down to 94 tons per day. Theoretically the horse-power varies as speed ^{3}, but it is found that consumption per horse-power at the lower speed is 10·5 per cent. greater than the theoretical figure. Find the new speed and the percentage saving in fuel for a voyage of 3,200 nautical miles.
3. At the load water line the draught of a vessel is 26 ft. and the " tons per inch " is 49. At parallel waterplanes 4 ft. apart below the load water line the " tons per inch " are as follows : 47·5, 44·7, 41, 36, 28, and 13 respectively. Draw the " tons per inch "

curve using the following scales : 1 in. = 10 " tons per inch " and 1 in. = 4 ft. draught. If the vessel is resting on an even keel at a draught of 21 ft., estimate the new draught when 546 tons of cargo are discharged, the trim of the vessel remaining unaltered.

4. A box-shaped barge 140 ft. in length and 24 ft. in breadth rests on an even keel at a draught of 5 ft. 6 in. in sea-water. At the forward end there are two adjacent full-width compartments 10 ft. in length. Fresh water is pumped into all compartments as follows : the forward one to a depth of 5 ft., the next one 3 ft., and the main compartment just sufficient to maintain the trim as before. Calculate (*a*) the new draught and (*b*) the vertical movement of the C. of G. of the vessel from its original position of 3 ft. above keel. Through what horizontal distance, if any, will C. of G. of vessel have moved ?

ENGINEERING KNOWLEDGE

MORNING PAPER. ALL CANDIDATES

Six questions only to be answered

Time allowed : Three hours

1. Give a description of a bilge suction-pipe arrangement for a double-bottom ship. Make a diagrammatic sketch showing the position of the suction valves and the precautions taken to prevent sea-water flowing into the bilges.
2. Sketch and describe a distiller. How is it operated ? What are the necessary precautions when using it ?
3. Describe the emergency steering arrangement of your last ship. In the event of the steering-gear breaking down, explain the procedure of putting the emergency gear into operation.
4. State how the quantity of oil contained in oil bunkers is ascertained and describe different means provided for its measurement. What provision is made for filling oil bunkers, and what precautions are taken to prevent overflow of oil when filling ?
5. Describe the construction of a propeller with detachable blades. How are the blades secured and prevented from coming loose ? Illustrate how slight alteration of the pitch is provided for.
6. When a dynamo is running on load it is observed to become warm, although in perfect order. What is the cause of this ? What provision is made in the construction of a dynamo to keep this temperature within reasonable limits ? What is the maximum safe temperature ?
7. Explain briefly the process of producing zinc from the ore. What is the chief use for zinc in marine engineering practice, and state a common alloy that zinc forms part of the composition.

8. Describe the thrust arrangement in a large vessel showing, by means of sketches of the seating and adjacent portions of the hull, the manner in which the propeller thrust is transmitted to the ship. How is the block prevented from moving in a fore and aft direction ?

9. State the probable causes of fire or explosions in a ship using oil as fuel. Describe the precautions which should be adopted to minimize the risk of these occurrences.

ENGINEERING KNOWLEDGE

AFTERNOON PAPER. STEAM CANDIDATES

Six questions ONLY *to be attempted*

Time allowed : Three hours

1. Make a line sketch of a steam-pipe expansion joint of the stuffing-box type, and explain its action, indicating the direction in which the parts move relative to one another when being heated. What attention should be given to maintain the joint in a satisfactory working condition ?

2. Sketch the combustion-chamber girder and stays as found in a single-ended multitubular boiler of the marine type. In what way can the girder be considered as a beam ? What particulars govern its dimensions ?

3. Describe fully the operation of bringing a steam-engine fitted with Stevenson's link motion from "full ahead" to "full astern" positions, and explain the effect upon the running of the engine.

4. A ship has four boilers, and while in port three of them are opened up for examination and cleaning, steam being maintained on the fourth for auxiliary purposes. Describe fully any precautions you would take under such conditions to obviate the danger of steam entering any of the boilers in which men might be working.

5. On a vessel with oil-fired boilers, trace the pipes and fittings through which the oil fuel passes from the time it leaves the settling-tanks until it arrives at the burners in the furnace, also state the pressures and temperatures in the system you describe.

6. Describe an independent circulating-pump and explain its action. Compare the advantages and disadvantages of such a pump with one of the ordinary type driven from the main engine.

7. Describe in detail how you would proceed to take a set of indicator cards from a triple-expansion engine. What adjustments would you make before taking the cards and what data would you note for the accurate calculation of power ? Assume the vessel to be oil fired.

8. If one of the bottom ends in a triple-expansion reciprocating steam-engine fitted with independent valve gear was to run badly, explain how you could temporarily reduce the load on it without reducing the speed of the ship.

9. State the procedure of warming up and preparing a turbine for sea. Show by diagrammatic sketch where the drains are placed. Describe how they are operated and for what purpose.

ENGINEERING KNOWLEDGE

AFTERNOON PAPER. MOTOR CANDIDATE

Six questions ONLY *to be attempted*

Time allowed: Three hours

1. Give a description of the process of electric welding and state for what parts of a ship's machinery it is sometimes employed.

2. Describe a blast-air injection system and explain how the pressure is governed to suit various conditions of running. To which part of the system are non-return valves fitted, and why?

3. Describe a vertical steam boiler suitable for use in a motor-ship, and illustrate your description by means of a diagrammatic sketch.

4. What attention is necessary to maintain the starting-air reservoirs and blast-air bottles in a good and safe condition? what safety devices are fitted to them?

5. Sketch and describe the construction of a connecting-rod for a large internal-combustion engine. Show how the brasses are attached and the manner in which the various parts are secured to prevent working loose.

6. Write a letter addressed to the Superintendent Engineer describing defects in the main engine cylinder heads which have come under your notice or about which you have been informed. The cause of failure and method of repair should be discussed and preventive measures suggested.

7. Referring to lubrication, what is meant by forced or pressure lubrication of a Diesel engine? Explain fully what attention the pressure system requires and, if bearing oil is used to cool the pistons, the particular attention the bearings require.

8. Without referring to any particular type, describe the method and the most important points to be observed in preparing a compression-ignition engine for running.

9. Why is the compression of air employed on board motor-vessels generally effected in stages? Sketch an intercooler for the second stage of a three-stage air-compressor, and state the pressures and temperatures that you would expect to obtain at the inlet and outlet of the cooler under normal working conditions.

[1,000/9/49—8776