CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY - MARINE ENGINEER OFFICER

STCW 78 as amended CHIEF ENGINEER REG. III/2 – "YACHT 2"
STCW 78 as amended SMALL VESSEL CHIEF ENGINEER <3000 GT, <9000 kW UNLIMITED

058-12 – GENERAL ENGINEERING SCIENCE II

FRIDAY, 09 OCTOBER 2020

1400 - 1600 hrs

Materials to be supplied by examination centres

Candidate's examination workbook
Graph paper

Examination Paper Inserts

Notes for the guidance of candidates:

1. Examinations administered by SQA on behalf of the Maritime & Coastguard Agency.

2. Candidates are required to obtain 50% of the total marks allocated to this paper to gain a pass **AND** also obtain a minimum 40% in Sections A and B of the paper.

3. Non-programmable calculators may be used.

4. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

Maritime &
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GENERAL ENGINEERING SCIENCE II

Attempt ALL questions

Marks for each question are shown in brackets.

All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

Section A

1. A steel forging has a mass 6 kg and is cooled from a temperature of 400°C by being completely immersed in a tank containing 8 kg of oil at a temperature of 20°C.

    Calculate the final equilibrium temperature of the oil and the steel forging, assuming there are no heat losses from the tank. The effect of the tank can be ignored. (8)

    Note: s.h.c. of steel = 0.48 kJ/kgK
           s.h.c. of oil = 1.8 kJ/kgK

2. Nitrogen gas has a volume of 0.3 m³ at 3.5 bar and a temperature of 35°C. The nitrogen is now heated in its vessel until the pressure reaches 1.05 MN/m², at constant volume.

    Determine EACH of the following:

    (a) the mass of nitrogen; (3)

    (b) the final temperature of the nitrogen. (5)

    Note: The characteristic gas constant
           R, for nitrogen has a value of 297 J/kgK.

3. (a) Describe, with the aid of a P-h diagram, the condition of the refrigerant fluid as it flows around the basic vapour compression plant. (6)

    (b) List the energy changes that occur in the refrigerant across EACH item of plant in the basic refrigeration system of Q3(a). (4)

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4. A 4 cylinder 2 stroke diesel engine under test has a bore of 120 mm and a stroke of 150 mm and runs at 800 revs per minute. The mean effective pressure was found to be 600 kN/m². During the test a torsion meter on the shaft gave a reading of 579 Nm.

Calculate EACH of the following:

(a) the brake power;   (3)

(b) the indicated power;   (3)

(c) the mechanical efficiency.   (2)

5. Methane (CH_4) is completely burned in 25% excess air by mass.

Calculate EACH of the following:

(a) the mass of carbon dioxide in the exhaust gases per kg of fuel;   (4)

(b) the mass of oxygen in the exhaust gases per kg of fuel.   (4)

6. (a) A straight steel steam pipe is 20 m long at 20°C. In use the temperature rises to 450°C.

    Determine the length of the steam pipe when in use.   (4)

    (b) State the practical considerations that need to be considered before fastening the pipe to the bulkhead.   (4)

Note: coefficient of linear thermal expansion for steel = 12 x 10⁻⁶ m/mK

7. A solid block of wood is 2 m long x 90 cm wide x 50 cm deep and floats in sea water of density 1025 kg/m³.

    Calculate the height of block above the water surface (freeboard) given that the wood has a density of 750 kg/m³ and that it floats horizontally. (8)

8. A box barge has a displacement volume of 18500 m³ in sea water of density 1025 kg/m³.

    A ballast tank measuring 6 m long x 12 m wide x 1.6 m deep is positioned equally either side of the centre line above the keel.

    The tank is now completely filled with sea water.

    Calculate the change in position of G, in both magnitude and direction, given that the initial KG=3.8 m. (8)

9. A battery with an e.m.f. of 40 volts is found to have an internal resistance of 3 ohms. It feeds a circuit consisting of three resistors connected in parallel.

    The resistors have values of 120 ohm, 180 ohm and 250 ohm.

    Calculate EACH of the following:

    (a) the battery terminal voltage; (4)

    (b) the current in EACH resistor. (4)

10. (a) Define the resistivity of a material. (3)

    (b) The resistance of 1.9 km of copper wire of 0.5 mm diameter is 170 ohms.

         Calculate the resistance of 1 km of iron wire of 1 mm diameter. (7)

         Note: the resistivity of iron = 5.9 x resistivity of copper

11 (a) In a moving coil instrument what is the purpose of a *multiplier* resistor. (2)

    (b) Describe, with the aid of a diagram, the operation of a moving iron instrument. (6)

12. (a) Copper is a familiar conductor of electricity. In relation to its structure explain why it is a good conductor of electricity. (2)

     (b) Explain why PVC is not a good conductor of electricity, in relation to its structure. (2)

     (c) Explain why conductors have power losses. (2)

     (d) State how power losses can be calculated in conductors. (2)