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, 25 JUNE 2021

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 & Coastguard Agency

SQA

GENERAL ENGINEERING SCIENCE II

Attempt ALL questions

Marks for each question are shown in brackets

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Section A

1. (a) Explain the units for specific heat capacity J/kgK. (2)

   (b) An iron casting has a mass of 15 kg and a temperature of 200°C.

   Determine the temperature after losing 1100 kJ of heat energy. (6)

   Note: Specific Heat Capacity of Cast Iron = 477J/kgK

2. (a) Define Boyles Law (2)

   (b) A perfect gas at an initial pressure, temperature and volume of 2.75 bar, 185°C and 90 litres respectively is cooled at constant pressure until its temperature is 15°C.

   Calculate EACH of the following:

   (i) the initial mass of the gas; (3)

   (ii) the final volume in m^3. (3)

   Note: R = 0.29 kJ/kgK C = 1.005 kJ/kgK

3. Benzene (C_6H_6) is completely burned in 20% excess air.

   Calculate EACH of the following:

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

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

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4. (a) State TWO desirable properties of refrigerants. (2)

(b) In a vapour compression refrigeration plant, state the primary function of EACH of the following:

(i) the condenser; (2)

(ii) the expansion valve; (2)

(iii) the evaporator. (2)

5. State and describe the THREE modes of heat transfer, giving an example of each. (9)

6. A 2 stroke diesel engine is tested over a 24 hour period and uses 1.8 tonnes of fuel. The power of the engine is tested using a dynamometer which gives a steady state torque reading of 4.5 kNm at 800 rpm. The mechanical efficiency was later found to be 89%.

Calculate EACH of the following:

(a) the brake power; (3)

(b) the indicated specific fuel consumption; (3)

(c) the brake thermal efficiency. (3)

Note: the calorific value of the fuel = 44 MJ/kg

Section B

7. (a) Briefly describe the structure of an atom. (2)

   (b) State the feature of the atomic structure of some materials which makes them good conductors. (2)

   (c) Describe what is meant by electrical current (flow). (2)

   (d) Outline what else is required to make current flow happen. (2)

8. (a) List FOUR means by which electricity may be produced. (2)

   (b) State the THREE main effects of an electric current. (3)

   (c) State TWO practical examples of EACH effect in Q8(b). (3)

9. The navigation lights on a vessel are fed from a d.c supply. THREE lights are connected in parallel and EACH draws a current of 5 A. The lamps have a resistance of 3 Ω each.

   Calculate EACH of the following:

   (a) the power dissipated by each lamp; (4)

   (b) the total power consumed by the circuit if the total resistance of the cables was 0.6 Ω; (4)

   (c) the supply voltage. (2)

10. A conductor with an effective length of 300 mm and a diameter of 9.5 mm when carrying a current of 25 A at right angles to a magnetic field. The force on the conductor is 18 N.

    Calculate EACH of the following:

    (a) the flux density; (4)

    (b) the magnetic flux. (4)

11. A plank of wood is 4.88 m long x 25.8 cm wide x 175 mm deep and floats horizontally in calm water. Take the water density as 1010 kg/m^3 and the density of wood as 710 kg/m^3

Calculate the maximum mass that could be supported on this plank without it sinking. (8)

12. Determine the distance a mass of 30 tonne, already on board ship, must be moved across the deck of a vessel of 3250 tonne displacement to correct a heel of 1.8°. (8)

Note: KM = 6.1 m, KG = 5 m, and $m * d = \Delta GM \tan \theta$