CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY
MARINE ENGINEER OFFICER

STCW 78 as amended SMALL VESSEL CHIEF ENGINEER <3000 GT, <9000 kW UNLIMITED

058-12 - GENERAL ENGINEERING SCIENCE II

FRIDAY, 08 DECEMBER 2023

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.

Section A

1. (a) Explain where the units for specific heat capacity, J/kgK, are derived from. (4)

(b) A 15 kg cast iron cylinder block is cooled from a temperature of 400°C to 24°C. During cooling it dissipates 2.7 MJ of energy.

Determine the specific heat capacity of cast iron. (4)

2. (a) State the meaning of the abbreviations 'STP' and 'NTP'. (2)

(b) 760 grams of a perfect gas occupies a volume of 0.9 m^3 and has a temperature of 28°C. The gas is compressed to a tenth of its original volume where its pressure is 15.4 bar.

Determine the final temperature. (6)

Note: R = 290 J/kgK

3. 0.75 kg of Methane (CH_4) is completely burned in 20% excess air.

Determine 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. (4)

[OVER

4. A cast steel crank web is joined to a bearing journal by thermal interference fitting. The crank web is bored with an internal diameter of 149.55 mm at a temperature of 20°C. The journal has an external diameter of 150 mm at 20°C.

Determine the highest temperature to which the journal must be cooled in order to slide into the crank web without force. (7)

Note: co-efficient of linear expansion of steel = 0.000016 /°C

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

6. (a) Describe the basic operation of a vapour compression refrigeration system. (8)

(b) If the refrigeration system described in Q6(a) has a water cooled condenser, explain what will be the effect of a higher cooling water inlet temperature. (2)

Section B

7. (a) Explain the main differences in molecular structures which determine whether the material is a conductor or an insulator. (4)

(b) State examples of an electric current being used for EACH of the following:

(i) its magnetic effect; (2)

(ii) its chemical effect. (2)

8. Fig Q8 shows two lamps, each of 4 Ω resistance connected in parallel across a 20 V supply.

To avoid exceeding the current rating for the lamps a resistor of 2 Ω is connected in series with the supply.

Calculate EACH of the following:

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

(b) the power dissipated by the 2 Ω resistor; (3)

(c) the total energy used by the circuit in 60 minutes. (3)

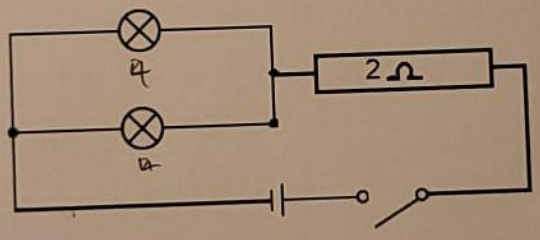

Fig Q8

9. (a) State the meaning of the term *magnetic flux*, stating the units. . . . . (2)

(b) A conductor of 7.5 mm diameter has an effective length of 400 mm when carrying a current of 12 A at right angles to a magnetic field. The magnetic flux is measured to be 18 microwebers.

Determine the force on the conductor. (6)

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10. A battery has an e.m.f. of 38 volts and an internal resistance of 4 ohms. It feeds a circuit consisting of three resistors connected in parallel.

The resistors have values of 10 ohm, 20 ohm and 30 ohm.

Determine EACH of the following:

(a) the battery terminal voltage; (4)

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

11. (a) Determine the thrust load in MN on a bulkhead 8 m wide by 9 m deep when flooded with seawater of density 1025 kg/m^3 on one side only. (6)

(b) Determine the gauge pressure, in bar, at the lowest point on the bulkhead. (2)

12. A ship has a displacement of 33250 tonnes. KM= 5.9 m and KG= 4.7 m.

(a) Explain what is meant by the terms KM and KG. (2)

(b) Determine the distance a mass of 220 tonne, already on board ship, must be moved across the deck to correct a heel of 1.8°. (6)

Note: $m \times d = \Delta GM \tan \theta$