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, 18 MARCH 2022

1400 - 1600 hrs

Materials to be supplied by examination centres

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| Candidate's examination workbook<br>Graph paper |

Examination Paper Inserts

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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 brass shaft has a diameter of 48 mm at a temperature of 20°C.

   Calculate the temperature at which a brass sleeve with a hole diameter of 47.75 mm will just slide onto the shaft to provide a shrink fitting. (8)

   *Note: co-efficient of linear expansion of brass = 0.000018/°C.*

2. (a) Describe how changes of state occur without change in temperature. (4)

   (b) A metal component with a mass of 1.15 kg at 600°C is quenched by immersion in 5 kg of water at 20°C. The combined final temperature of the water and metal is 36°C.

   Determine the Specific Heat Capacity of the metal. (4)

   *Note: the Specific Heat Capacity of water is 4.18 kJ/kgK.*

3. (a) Outline what is meant by the enthalpy of fusion. (2)

   (b) 100 grammes of ice at -5°C is heated with 50 kJ of energy. State the final state and temperature. (6)

   *Note: Specific heat capacity of ice = 2.11 kJ/kgK,*
   *Specific heat capacity of water = 4.18 kJ/kgK,*
   *Enthalpy of fusion of water = 335 kJ/kg*

[OVER

4. Nitrogen has a volume of 0.3 $m^3$ at 3.5 bar and a temperature of 35°C. The Nitrogen is now heated in its vessel until the pressure reaches 1.05 $MN/m^2$ the volume is unchanged.

Determine EACH of the following:

(a) the mass of Nitrogen; (4)

(b) the final temperature of the Nitrogen. (4)

*Note: The characteristic gas constant for Nitrogen has a value of 297 J/kgK.*

5. The following parameters may be determined during the analysis of a diesel engine.

Define EACH of the following terms and state the formula for calculating the values for:

(a) indicated power; (2)

(b) brake power; (2)

(c) power loss to lubricating oil; (2)

(d) power loss to exhaust. (2)

6. (a) Describe the condition of the refrigerant fluid as it flows around the basic vapour compression plant. (4)

(b) List the energy changes that occur across EACH item of plant in the basic system of Q6(a). (4)

(c) State the effect that higher ambient temperatures would have on the plant operation. (2)

Section B

7. (a) Copper is the best known conductor of electricity. State why is it a good conductor of electricity in relation to its structure. (2)

(b) Cables with copper conductors often have PVC insulation. State why is it NOT a good conductor of electricity in relation to its structure. (2)

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

(d) Explain how power losses can be determined in conductors. (2)

8. The power dissipated in the circuit in Fig Q8 is 7.5 kW.

Calculate EACH of the following:

(a) the supply current ($I_s$); (2)

(b) the current ($I_1$) flowing in the resistor $R_1$; (2)

(c) the value of $R_2$; (2)

(d) the energy consumed in the 20 Ω resistor in 5 minutes. (2)

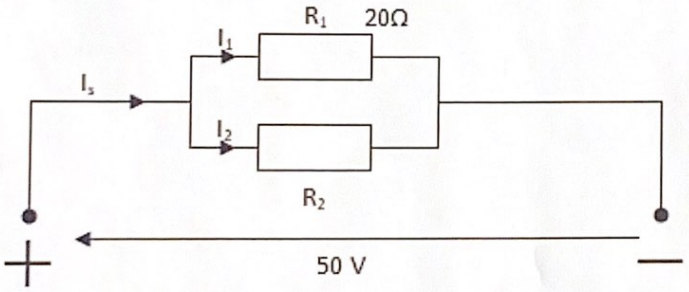


Fig Q8

9. (a) Describe what happens to the electrical resistance of metals as the temperature rises. (2)

(b) Outline what happens to the flow of electrons in metals to cause the effect stated in Q9(a). (2)

(c) Describe what is meant by the temperature coefficient of resistance. (2)

(d) Outline what resistivity is. (2)

[OVER

10. (a) Outline the difference between a primary and a secondary cell. (2)

(b) Describe, with the aid of a sketch, the electro-chemical action of a lead/acid cell. (8)

11. (a) Determine the thrust on a cofferdam (bulkhead) 25 m wide by 26 m deep when flooded with seawater of density 1025 kg/m$^3$ on one side only. (4)

(b) Determine the pressure, in bar, at the lowest point on the bulkhead. (4)

12. A vessel has a displacement volume of 12730 m$^3$ in sea water of density 1025 kg/m$^3$.

A double bottom tank measuring 16 m long x 9.5 m wide x 1.8 m deep is positioned symmetrically, either side of the ships centre line and is initially empty.

The tank is now completely filled with fresh water of density 1000 kg/m$^3$.

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