

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, 11 DECEMBER 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. Describe the THREE modes of heat transfer and give an example of each. (9)

2. (a) State Charles' Law for a perfect gas. (2)

(b) A perfect gas has volume of 30 litres at a pressure and temperature of 0.95 bar and 24°C respectively. The temperature of the gas rises to 162°C at constant pressure.

Calculate EACH of the following:

(i) the increase in the volume of the gas in m³; (3)

(ii) the mass of gas. (3)

Note: for the gas $R = 0.29 \text{ kJ/kgK}$

3. With reference to the performance of a diesel engine.

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

(a) indicated power; (2)

(b) brake power; (2)

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

(d) power loss to exhaust. (2)

4. (a) State TWO thermodynamic and TWO general properties required of a good refrigerant. (4)

(b) For the FOUR key points in a simple refrigeration circuit state the condition of the refrigerant. (4)

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5. Butane (C_4H_{10}) is completely burned in 30% 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 nitrogen in the exhaust gases per kg of fuel. (4)

6. (a) Explain what is meant by EACH of the following terms:

(i) specific heat capacity; (3)

(ii) specific enthalpy of evaporation. (3)

(b) 6 kg of liquid at $20^\circ C$ has 1240 kJ of heat transferred to it raising its temperature to $92^\circ C$.

Determine the specific heat capacity of the liquid. (3)

Section B

7. (a) Determine the thrust load in MN 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 gauge pressure, in bar, at the lowest point on the bulkhead. (4)

8. A ship has a displacement of 35500 tonne.

Determine the distance a mass of $\Delta/500$ tonne, already on board, must be moved off the Centreline to cause the ship to list by exactly 1° . (8)

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

$KM = 6.2 \text{ m}$

$KG = 5.3 \text{ m}$.

9. (a) Explain the main differences in molecular structure which determines 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)
- (iii) its heating effect. (2)
10. (a) In a moving coil instrument state the purpose of a shunt resistor. (4)
- (b) Describe with the aid of a diagram, the operation of a moving coil instrument. (4)
11. An electric fire operated from a 230 V supply has a heating element comprising two 25Ω coils. The coils may be connected in series to give a low setting, or in parallel to give a high setting.
- Calculate EACH of the following:
- (a) the power output for the low setting; (4)
- (b) the power output for the high setting. (4)

12. A conductor of 7.5 mm diameter has an effective length of 400 mm and carries a current of 20 A. The force on the conductor is 20 N.

Calculate EACH of the following:

- (a) the flux density; (4)
- (b) the magnetic flux. (4)