

**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, 13 MARCH 2026

1400 - 1600 hrs

Materials to be supplied by examination centres

Candidate's examination workbook Graph paper

Examination Paper Inserts

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Notes for the guidance of candidates:

1. Examinations administered by Qualifications Scotland 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.

GENERAL ENGINEERING SCIENCE II

Attempt ALL questions.

Marks for each question are shown in brackets.

Section A

1. A stainless steel water vessel has a mass of 3 kg and contains 12 kg of water at a temperature of 22°C. A further 15 kg of water at 70°C is added to the vessel.

Determine the final equilibrium temperature of the vessel and water. (8)

Note: Assume there are no heat losses.

the specific heat of stainless steel = 0.5 kJ/kgK

the specific heat of water = 4.18 kJ/kg

$$Q = MC \Delta T$$

2. A gas is contained at high pressure in a cylinder. When it is vented to atmosphere through a nozzle, explain what happens to the temperature of the gas released.

- (a) A perfect gas at an initial pressure, temperature and volume of 3.75 bar, 145°C and 280 litres respectively is cooled at constant pressure until its temperature is 10°C. (2)

- (b) Determine EACH of the following:

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

(ii) the final volume in m³. (3)

Note: $R = 0.29 \text{ kJ/kgK}$ $C = 1.005 \text{ kJ/kgK}$

$$\frac{PV}{T} = mR$$

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

- (b) 250 grams of ice at -20°C is heated with 120 kJ of energy. Determine what is the final state and temperature of the resultant. (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

$$Q = mc \Delta T$$

4. An 8 cylinder, 4 stroke diesel engine has a bore of 350 mm and a stroke of 400 mm.

Indicator cards were taken and each had a mean effective height of 22 mm.

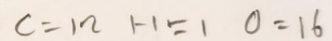
The power of the engine was also tested using a dynamometer which gives a steady state torque reading of 36 kNm at 800 rpm.

Determine EACH of the following:

- (a) the brake power; $BP = 2\pi T n$ (3)
- (b) the indicated power; $IP = \frac{P_m L A N K}{2}$ (3)
- (c) the mechanical efficiency. $\frac{BP}{IP}$ (2)

Note: Indicator spring constant was 80 kN/m²/mm

5. 1.5 kg of Heptane (C₇ H₁₆) is completely burned in air.



Determine EACH of the following:

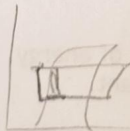
- (a) the stoichiometric mass of air required; (4)
- (b) the mass of carbon dioxide in the exhaust gases. (4)

Note: assume air is 23% oxygen by mass

6. Describe the working principles of a vapour compression refrigeration system.

Include a basic layout diagram and a corresponding pressure vs enthalpy diagram to reference your answer.

(10)



Section B

7. The power dissipated in the circuit in FIG Q7 is 7.5 kW.

Determine EACH of the following:

- (a) the supply current, I_s ; (3)
- (b) the current (I_1) flowing in the resistor R_1 ; (3)
- (c) the value of R_2 ; (2)
- (d) the energy consumed in the $20\ \Omega$ resistor in 5 minutes. (2)

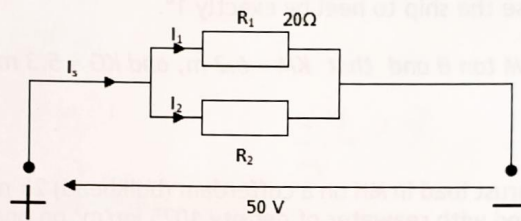


FIG Q7

Handwritten notes:

$$\frac{V}{I \times R}$$

$$\frac{P}{V \times I}$$

$$R_b = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$$

- 8. (a) Define the resistivity of a material. (2)
- (b) The resistance of 1.9 km of copper wire with a diameter of 0.5 mm is 170 ohms.

Determine the resistance of 1 km of iron wire of 1 mm diameter. (6)

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

Handwritten formula:

$$R = \frac{\text{Constant} \times L}{A}$$

9. An electric fire operated from a 230 V supply has a heating element comprising of two $25\ \Omega$ 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)

Handwritten formula:

$$\text{Power} = V \times I \text{ in kW}$$

10. A conductor of 7.5 mm diameter has an effective length of 400 mm when carrying a current of 20 A at right angles to a magnetic field. The force on the conductor is 20 N.

Determine EACH of the following:

(a) the flux density;

$$B = \frac{F}{A \times L}$$

$$F = B \times I \times L$$

(4)

(b) the magnetic flux.

$$\Phi = \frac{B}{A}$$

$$\Phi = A \times B$$

(4)

11. A ship has a displacement of 35500 tonne.

Determine the distance a mass of 71 tonnes, already on board, must be moved off the centreline to cause the ship to heel by exactly 1°.

Given $m \times d = \Delta GM \tan \theta$ and that $KM = 6.2 \text{ m}$, and $KG = 5.3 \text{ m}$.

(8)

$$P = \frac{F}{A}$$

$$F = \frac{\rho L}{A}$$

$$\Delta = B \times L \times d = \alpha$$

12. (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/m³ on one side only.

(4)

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

(4)

item mass distance power

$$\frac{\Sigma \text{ moment}}{\text{mass}}$$