

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, 19 MARCH 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 &
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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. Explain what is meant by EACH of the following terms:
 - (a) heat energy; (2)
 - (b) higher calorific value; (2)
 - (c) convection; (2)
 - (d) enthalpy of fusion. (2)

2. (a) State the meaning of the abbreviations 'STP' and 'NTP'. (2)
(b) 420 grams of a perfect gas has a volume of 0.8 m^3 at a temperature of 88°C . The gas is compressed to a quarter of the original volume where its pressure is 200 kN/m^2 .
Determine the final temperature of the gas. (6)
Note: $R = 290 \text{ J/kgK}$

3. LPG (C_3H_8) is completely burned using 30% excess air.
Calculate EACH of the following:
 - (a) the mass of carbon dioxide in the exhaust gases per kg of fuel; (5)
 - (b) the mass of nitrogen in the exhaust gases per kg of fuel. (5)

4. A brass bearing is to be shrink fitted to a steel shaft. The bearing has an internal bore of 69.82 mm at a temperature of 20°C. The steel shaft has an external diameter of 70 mm at 20°C.

Calculate the lowest temperature to which the bearing must be heated in order to slide onto the shaft without force

(8)

Note: coefficient of linear expansion of brass = 0.000018 / °C

5. A 2 stroke diesel engine was tested over a 24 hour period and used 1.8 tonnes of fuel. The power of the engine was tested using a dynamometer which gave 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; (2)

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

(c) the brake thermal efficiency. (3)

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

6. (a) Describe the basic functions of the key components of a vapour compression refrigeration system. (6)

(b) If the refrigeration system described in 6(a) has a water cooled condenser what will be the effect of a higher cooling water inlet temperature if the flow rate remains the same. (2)

Section B

7. A wooden beam is 3 m long x 20 cm wide x 75 mm deep and floats horizontally in sea water of density 1025 kg/m^3 .

Calculate the height of wood above the water surface (freeboard) given that the wood has a density of 750 kg/m^3 . (8)

8. A ship has a displacement volume of 6430 m^3 in sea water of density 1025 kg/m^3 .

Two double bottom tanks each measuring 12.5 m long x 5.5 m wide x 2.1 m deep are positioned equally, one either side of the centre line.

These tanks are now completely filled with heavy fuel oil of density 968 kg/m^3 .

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

9. Determine the current at EACH of the points 1, 2 & 3 in the circuit shown in Fig Q9 if the cell e.m.f. is 32 V. (9)

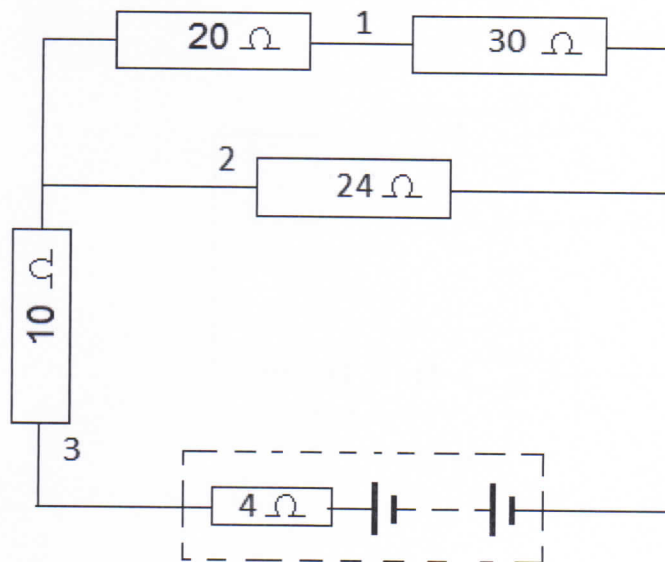


Fig Q9

10. (a) In relation to their structure explain why metals are good conductors of electricity. (2)
- (b) In relation to their structure explain why insulators are not a good conductors of electricity. (2)
- (c) State why conductors have power losses. (2)
- (d) State how power losses can be calculated in conductors. (2)
11. (a) State Lenz's Law. (2)
- (b) A conductor with an effective length of 500 mm creates a magnetic flux $280 \mu\text{Wb}$ when carrying a current of 45 A. The force on the conductor is 40 N.
- Calculate the diameter of the conductor. (6)
12. The circuit in Fig Q12 has a voltmeter as shown. When the switch is open the reading on the voltmeter is 30 V, when the switch is closed the voltage drops to 26.67 V.
- (a) Explain the reason for the change in the voltmeter readings. (4)
- (b) Determine the resistance of the cell. (5)

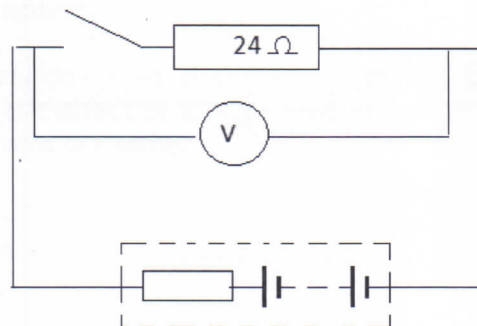


Fig Q12