

**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

058-11 - GENERAL ENGINEERING SCIENCE I

FRIDAY, 17 JUNE 2022

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.

GENERAL ENGINEERING SCIENCE I

Attempt ALL questions

Marks for each question are shown in brackets.

Section A

1. (a) Determine the value of 'x' in the following expression if $a = -4$, $b = -5$, $c = -3$:

$$a^2x + bc = cx \quad (4)$$

- (b) Simplify the following expression:

$$\left(\frac{4}{7} + 3\frac{4}{5}\right) \times 2\frac{1}{2} \quad (4)$$

2. (a) Rearrange the following expression to make 'a' the subject:

$$s = ut + \frac{1}{2} a t^2 \quad (4)$$

- (b) Simplify the following expression:

$$\frac{3X}{2} - \frac{2X}{3} + \frac{4X}{5} \quad (4)$$

3. (a) Plot the points shown in Table Q3 using an appropriate scale and draw the best fit line. (4)

- (b) State the general law of a straight line graph. (2)

- (c) Determine the equation that best represents the data from your graph. (4)

x	-2.00	0.00	2.00	4.00	6.00	8.00
y	-1.67	-1.00	-0.33	0.33	1.00	1.67

Table Q3

4. (a) State Pythagoras's Theorem, for the triangle shown in FIG Q4. (2)
- (b) Calculate EACH of the following:
- (i) the length of AC; (3)
- (ii) the angle at C. (3)



Fig Q4

5. (a) Define the term scalene triangle. (2)
- (b) For the shape shown in FIG Q5, determine the angle MBD describing your reasoning. (6)

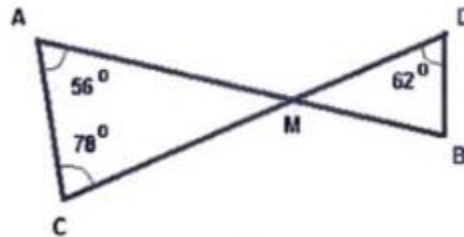


FIG Q5

6. For the diagram shown in FIG Q6, determine the area of the shaded section when r is 2 cm.

(8)

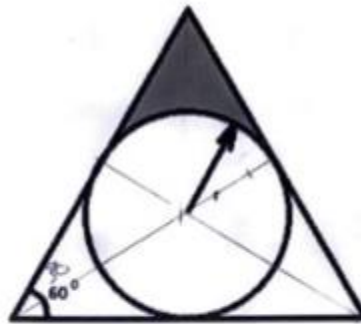


FIG Q6

Section B

7. A pump is accelerated from 200 rpm to 1000 rpm in 20 seconds.

Calculate EACH of the following:

- (a) the angular acceleration in rad/s^2 ; (4)
(b) the final instantaneous linear velocity in m/s of a point on the pump impellor perimeter with an effective diameter of 0.3 m. (4)

8. A casting of mass of 26 kg has a horizontal force of 180 N applied to it which causes acceleration in a frictionless horizontal plane.

Calculate EACH of the following, ignoring friction:

- (a) the acceleration of the body; (4)
(b) the distance the body will travel from rest in 8 seconds. (4)

9. FIG Q9 shows a loaded uniform beam with a mass 800 kg.

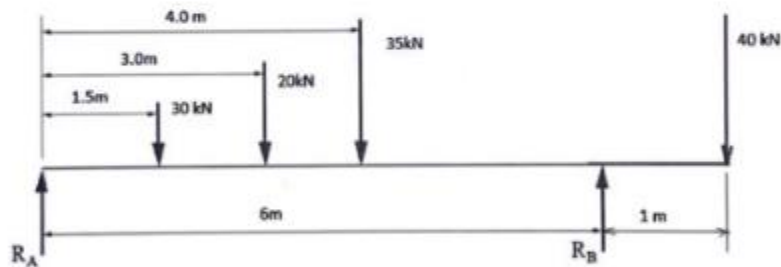


Fig Q9 (not to scale)

Calculate EACH of the reaction forces at A and B. (10)

10. (a) For a simple machine define the term Force Ratio. (2)
(b) For a simple machine define the term Velocity Ratio. (2)
(c) State the expression for mechanical efficiency of a simple machine in terms of force ratio and velocity ratio. (2)
(d) State why mechanical efficiency is always less than 100%. (2)

11. (a) Describe what is meant by shear stress. (2)
- (b) A hydraulic press is used to punch rivet holes in metal plate. The plate is 5 mm thick and the holes required should have a diameter of 10 mm. A force of 40 kN is required to punch the hole.
- Determine the shear stress at failure of the metal plate (6)
12. (a) State the difference between static and dynamic friction. (2)
- (b) A container has a mass of 400 kg and is pulled along a horizontal plane by a cable. The cable makes an angle of 10° above the horizontal and has a tension of 1.8 kN when pulling the container at a constant speed.
- Determine the coefficient of friction between the container and surface. (6)