

**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, 16 JUNE 2023**

**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) Engine A has a cubic capacity of 1.6 litres, Engine B has cubic capacity of 2.2 litres. Express as a percentage how much larger Engine B is compared to Engine A. (3)

- (b) Simplify the following giving your answer in a mixed number format.

$$x = \left(9\frac{5}{8} \div 1\frac{3}{4}\right) - 2\frac{2}{3} \quad (5)$$

2. (a) Simplify the following expression to a single fraction:

$$12 \frac{ab^3}{6bc} + \frac{2ab^2}{c^2} \quad (4)$$

- (b) Solve the following expression for x:

$$3(x - 2) + 2(2x + 2) = 0 \quad (4)$$

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3. Consider the graph shown in FIG Q3.

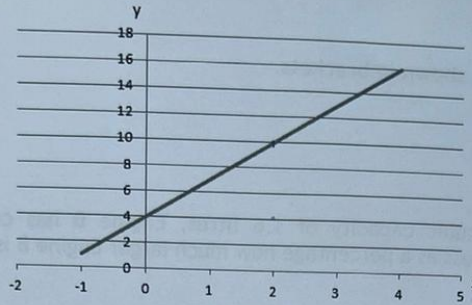


FIG Q3

- (a) State the general equation that describes graphs of the type shown in FIG Q3, define the terms used in the equation. (2)
  - (b) Determine the variables defined in Q3(a) as they apply to FIG Q3. (3)
  - (c) State the specific equation that describes the graph shown in FIG Q3. (3)
  - (d) Determine the 'y' value when  $x = 2.5$ . (2)
4. The triangle shown in FIG Q4a is a copy of the 4 triangles joined as shown in FIG Q4b arranged to enclose the square ABCD.
- Show that the area of ABCD is equal to  $x^2 + y^2$  (8)

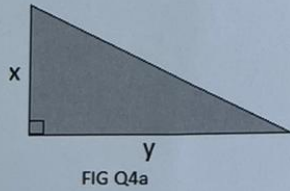


FIG Q4a

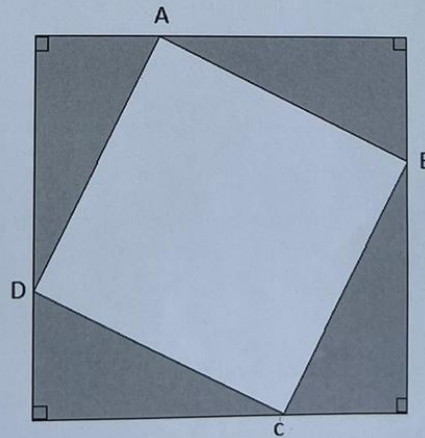


FIG Q4b



5. Describe EACH of the following with the aid of a diagram:
- (a) an equilateral triangle; (2)
  - (b) a scalene triangle; (2)
  - (c) an isosceles triangle; (2)
  - (d) a tangent to a circle. (2)
6. A sphere has a diameter of 0.8 m which is compared to a solid cone with a height of 1.2 m and a base diameter of 1 m.
- Show which object has the greater total surface area. (8)

**Section B**

7. A uniform beam 3.5 m long has a mass of 85 kg and is pivoted on a single point 1.2 m from the left end point. There is a point load with a mass of 50 kg acting at the left end of the beam. A mass is to be added acting at a point 3 m from the left end point to balance the beam in a level condition.
- (a) Sketch the beam showing relevant forces. (3)
  - (b) Determine the mass which needs to be added to give a balanced equilibrium condition about the fulcrum. (5)
8. A vehicle wheel, with a diameter of 360 mm, has an angular velocity of 300 rev/min and is accelerated uniformly to 600 rev/min over a 15 second period.
- Determine EACH of the following:
- (a) the initial and final angular velocities of the wheel in rads/s; (2)
  - (b) the angular acceleration of the wheel; (3)
  - (c) the linear acceleration of a point on the wheel rim. (3)
9. A mass of 1250 kg is raised by a winch through a distance of 9.5 m in 32 seconds. The motor power input to the system is 4.2 kW.
- Determine EACH of the following:
- (a) the work done raising the load; (3)
  - (b) the power required to raise the load; (3)
  - (c) the system efficiency. (2)
10. (a) Sketch a complete load/extension diagram for a typical low carbon steel specimen. (2)
- (b) Indicate EACH of the following on your diagram:
- (i) limit of proportionality; (2)
  - (ii) yield point; (2)
  - (iii) maximum load. (2)

11. A screw jack is used to raise a load of 600 kg. The jack has a single start square thread with a 6mm pitch. The effort applied acts on an effective radius of 30 cm.

If the applied effort is 180 Newtons, determine EACH of the following:

- (a) the force ratio; (3)
- (b) the movement ratio; (3)
- (c) the efficiency of the screw jack. (2)

12. A stationary body with a mass of 50 kg has a force applied to it which causes acceleration on a horizontal plane. The force of 120 N is applied at an angle of  $10^\circ$  below the horizontal pulling the block. There is a coefficient of friction is 0.2 between the block and the surface.

Determine EACH of the following:

- (a) the effective normal force on the surface caused by the block; (4)
- (b) the frictional force; (3)
- (c) the acceleration of the block. (3)