

**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, 03 DECEMBER 2021

1400 - 1600 hrs

Materials to be supplied by examination centre

Candidate's examination workbook
Graph paper

Examination Paper Inserts

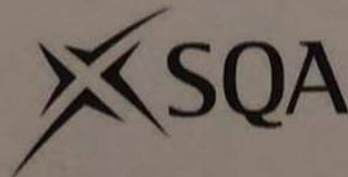
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Notes for the guidance of candidates:

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 &
Coastguard
Agency



GENERAL ENGINEERING SCIENCE I

Attempt ALL questions

Marks for each question are shown in brackets

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Section A

1. Simplify EACH of the following showing all working:

(a) $\left(\frac{2}{3} + 3\frac{4}{5}\right) \times 2\frac{1}{2}$ $4\frac{5}{6}$ (4)

(b) $\left(3\frac{4}{5} \div 1\frac{1}{9}\right) \times 2\frac{1}{2}$ $8\frac{11}{20}$ (4)

2. Simplify EACH of the following and rearrange to make x the subject of the expression:

(a) $4(2x - 2) - 3(2x + 2) = 0$ $x = 7$ (4)

(b) $4x(2x - 3) \div 8x = 0$ $x = 0$ (4)

3. (a) Plot the graph of the equation $y = 2x^3 + 3$ between the limits of $x = -1$ and $x = 3$ indicating in the answer how the plotting points are obtained. (8)

(b) Indicate on the graph plotted in Q3(a) the value of y when $x = 1.5$. (2)

x	-1	0	1	2	3
y	-2	0	2	16	24

4. For the shape given in FIG Q4 angle OBA is $\pi/4$ rads and angle OAC is $\pi/3$ rads.

Determine the angle ABC:

30°

(8)

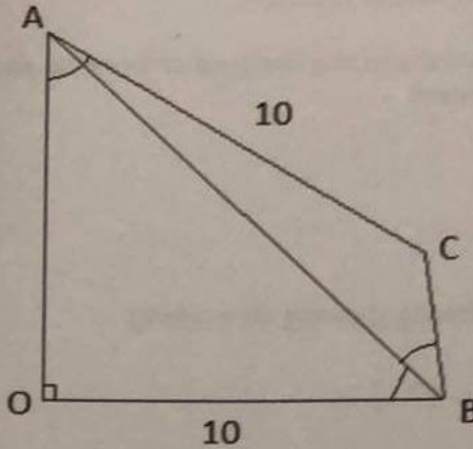


FIG Q4 (not to scale)

5. Show that the shaded area in Fig Q5 is given by:

(8)

$$\text{Area} = \frac{L^2}{12} \left(\sqrt{3} - \frac{\pi}{3} \right)$$

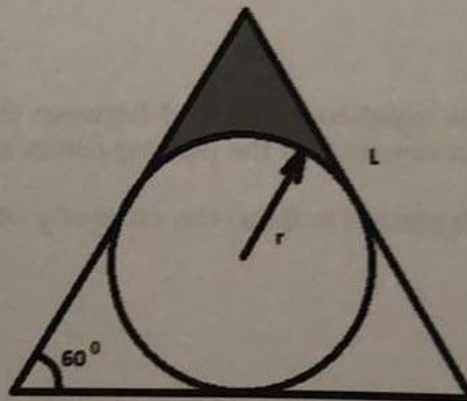


FIG Q5

6. A right cone has a height of 1.2 m and a base diameter of 1 m which is compared to a sphere with a diameter of 0.8 m. Show which object has the greater volume.

(8)

0.314 m^3

0.268 m^3

Section B

7. (a) Define the relative density of a liquid. (2)
(b) 425 litres of fluid has a relative density of 0.88.

Determine EACH of the following:

- (i) the volume of the fluid in standard SI derived units; 0.425 m^3 (4)
(ii) the mass of the fluid in SI fundamental units. 374 kg (4)

8. An engine flywheel is accelerated from 1000 rpm to 2420 rpm in 16 seconds.

Determine EACH of the following:

- (a) the angular acceleration in rad/s^2 ; 9.294 rad/s^2 (4)
(b) the final equivalent linear velocity of a point on the flywheel rim in m/s if the flywheel radius is 0.2 m. 50.684 m/s (4)

9. An oil transfer pump delivers heavy fuel oil through a 150 mm diameter pipe to a tank inlet at a height of 9.5 m at a constant velocity of 0.3 m/s .

Calculate EACH of the following:

- (a) the power of the pump; 0.49 kW (4)
(b) the overall power to drive the pump if the combined electrical and mechanical efficiency of the drive system is 80%. (4)

Note: the density of fuel oil is 990 kg/m^3 . 0.61 kW

10. Define EACH of the following terms with examples:

- (a) Stable, Neutral and Unstable equilibrium; (2)
(b) Scalar and Vector Quantities; (2)
(c) Moments; (2)
(d) Centroid. (2)

11. A box with a mass of 20 kg rests on a horizontal surface. The box has a force of 75 N applied to it parallel to the horizontal surface.

Determine EACH of the following:

(a) the acceleration of the body with no friction; 2.616 m/s^2 (4)

(b) the acceleration of the body when a friction coefficient of 0.35 exists between the box and the surface. (4)

$$0.915 \text{ m/s}^2$$

12. (a) Sketch a complete load/extension diagram for a typical low carbon steel specimen. (2)

(b) Indicate EACH of the following on the diagram sketched in Q12(a):

(i) limit of proportionality; (2)

(ii) yield point; (2)

(iii) maximum load. (2)

