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, 12 MARCH 2021

1400 - 1600 hrs

<u>Materials to be supplied by examination centres</u>

Candidate's examination workbook
Graph paper

<u>Examination Paper Inserts</u>

<u>Notes for the guidance of candidates:</u>

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 I

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. Simplify EACH of the following:

   (a) $\dfrac{6\frac{3}{4}}{3\frac{5}{6}}$

   (4)

   (b) $\dfrac{3X}{2} \times \left(\dfrac{2X}{3} + \dfrac{4X}{5}\right)$

   (4)

2. 0.05 m³ of iron is recast into two solid shapes, a sphere and a right cone.

   Determine EACH of the following:

   (a) the diameter of the sphere if the volume of the sphere is to be 40% of the total volume of the original mass of iron;

   (4)

   (b) the base diameter of the cone if its height is to be 0.45 m.

   (4)

3. For the shape shown in Fig Q3, determine the lengths OA and AB.
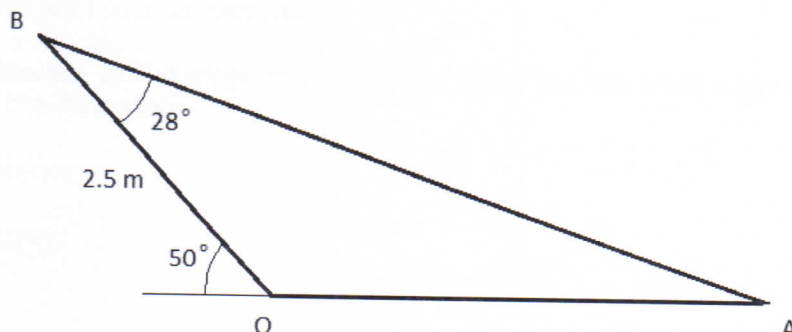
   (8)

Fig Q3 (not to scale)

4. (a) Plot the following (x,y) data on a graph: (4)

x	-2	-1	0	1	2	3
y	-4.4	-1.6	1.2	4	6.8	9.6

(b) Determine an expression relating the x and y coordinates. (4)

(c) Determine the value of y when x = 1.5. (2)

5. Show that the shaded area in Fig Q5 below is given by: (8)
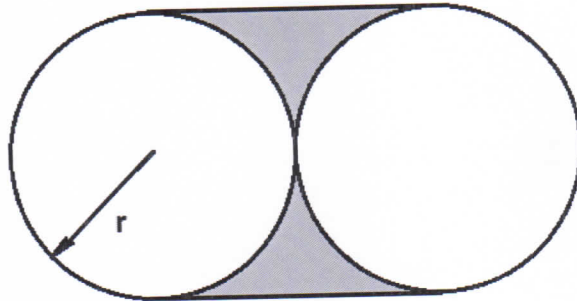
$$Area = (4 - \pi)r^2$$

Fig Q5

6. Determine the value of 'n' in the following expression:

$$P_1V_1^n = P_2V_2^n$$

when $P_2 = 2 \times P_1$ and $V_1 = 3 \times V_2$ (8)

7. The rod in a hydraulic ram is 1.1 m long and has a diameter of 45 mm. When subjected to an axial pull of 210 kN the rod extends by 0.385 mm.

    Determine EACH of the following:

    (a) the direct stress in the rod;   (3)

    (b) the direct strain in the rod;   (3)

    (c) the Modulus of Elasticity (E) for the steel.   (2)

8. A uniform beam is loaded as shown in Fig Q8. The beam has a mass of 400 kg.

    Determine the reaction forces at the supports A and B.   (10)
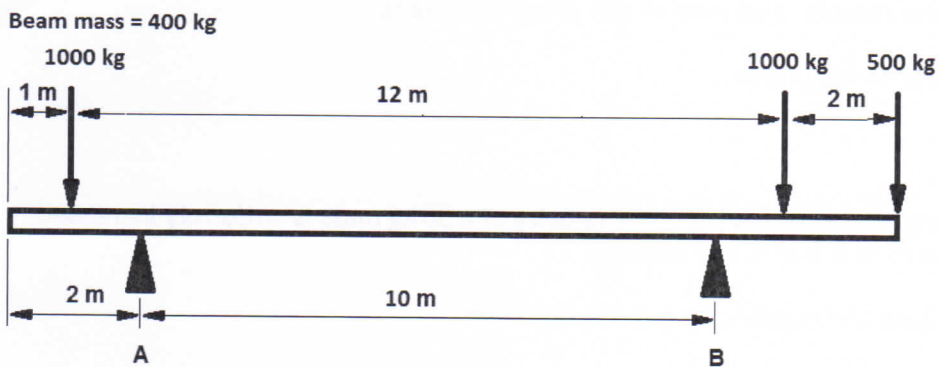

Fig Q8

9. (a) Sketch a load extension diagram for a typical low carbon steel undergoing a tensile test. On the same diagram sketch the load extension response for a brittle material such as cast iron.   (4)

    (b) With reference to the diagram sketched in Q9(a) explain what is meant by EACH of the following:

         (i) Brittleness;   (2)

         (ii) Ductility.   (2)

10. (a) Explain the difference between *speed* and *velocity*. (2)

    (b) A lift accelerates from rest at 1.2 m/s² until it reaches 3 m/s. It continues to move at 3 m/s for 6 seconds before decelerating at 1 m/s² until it stops.

        (i) Draw a velocity time graph showing the motions. (3)

        (ii) Determine the average velocity for this lift movement. (3)

11. (a) Explain what is meant by *torque*. (2)

    (b) A winch has a drum diameter of 800 mm and is required to raise a load of 400 kg through a height of 22 m in 12 seconds at a uniform speed.

    Determine EACH of the following:

        (i) the torque required; (2)

        (ii) the rotation required of the drum in radians; (2)

        (iii) the winch power. (2)

12. Ignoring any effects of friction, the velocity of a 50 kg mass is uniformly increased from 1.5 m/s to 2.0 m/s in 5 seconds.

    (a) Calculate the accelerating force required. (2)

    (b) The mass is now uniformly retarded at 0.4 m/s² from 2.0 m/s until the mass just comes to rest.

        Calculate, for the retardation period, EACH of the following:

        (i) the time taken to come to rest; (3)

        (ii) the distance travelled. (3)