# 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, 04 DECEMBER 2020

## 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 &
Coastguard
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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 and rearrange to make x the subject of the expression:

   (a) $y = \dfrac{bx^3}{x^2} \times \dfrac{x^4}{4b}$  (4)

   (b) $y = \dfrac{x^2 \times z^3}{z^2} \div \dfrac{2x^5 \times z}{x^2}$  (4)

2. A lifeboat davit has a straight arm pivoting about P, at deck level as shown in Fig Q2. When launching the lifeboat, the davit arm, PD, makes an angle of 10° to the deck.

   Determine the required length of the davit arm so that there is a clearance of 0.8 m between the ships side and the lifeboat at launching.  (6)
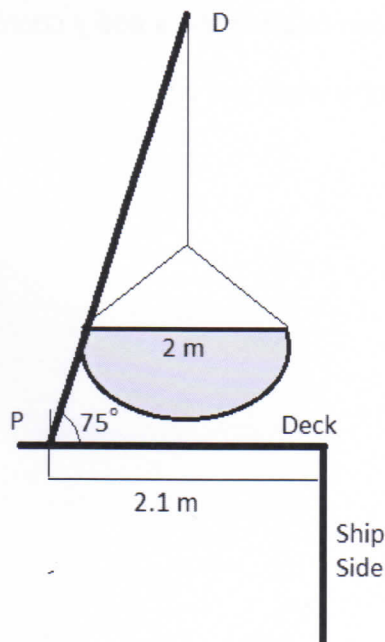


Fig Q2 (not to scale)

3. Determine the area of the shaded sector shown in Fig Q3 for the angles given. (9)

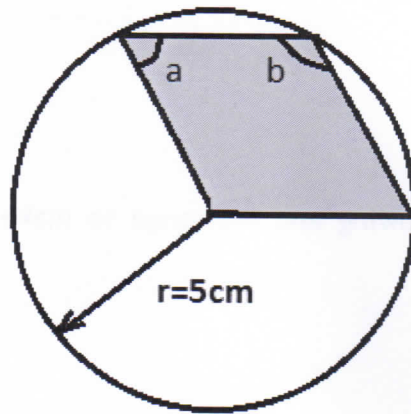$$Angle\ a\ =\ \frac{\pi}{3}\ rads$$

$$Angle\ b\ =\ \frac{2\,\pi}{3}\ rads$$



Fig Q3

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

| x | -2 | -1 | 0 | 1 | 2 | 3 |
|---|-----|-----|---|-----|-----|------|
| y | 5.8 | 4.4 | 3 | 1.6 | 0.2 | -1.2 |

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

(c) Determine the value of y when x = 1.5. (2)
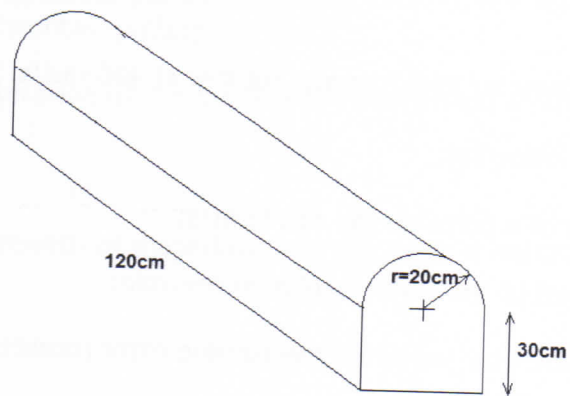
5. A concrete beam is shown in Fig Q5.



Fig Q5 (not to scale)

Determine EACH of the following:

(a) the volume of the beam; (4)

(b) the total surface area of the beam. (5)

6. Evaluate EACH of the following:

(a) $2\frac{6}{7} \div \left(3\frac{2}{3} + 2\frac{4}{5}\right)$ (4)

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

## Section B

7.  A turbine rotor has a diameter of 0.6 m and rotates at 400 rad/s.

    Calculate EACH of the following:

    (a)  the linear velocity of a point on the rim in m/s; (3)

    (b)  the rotational speed of the turbine rotor in rev/min; (3)

    (c)  the number of radians turned when the turbine rotor rotates through 325°. (2)


8.  A pump on the water main discharges through a pipe of 100 mm diameter against a head of 32 m at a constant velocity of 3.5 m/s.  You can ignore the effects of friction in the pump and pipe-work.

    Calculate EACH of the following:

    (a)  the power of the pump; (5)

    (b)  the motor power to drive the pump if the combined electrical and mechanical efficiency is 88%. (3)

    *Note: Density of seawater 1025 kg/m³*


9.  A uniform beam with a mass of 800 kg is loaded as shown in Fig Q9.

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

**Beam mass = 800 kg**

```
        250 kg                          500 kg          1000 kg
   3 m                    7 m                              2 m
|<----->|+|<--------------------------->|+|          |<--|+|-->|
         |                                |              |
         ↓                                ↓              ↓
 ┌───────────────────────────────────────────────────────────────┐
 └───────────────────────────────────────────────────────────────┘
         ▲                                         ▲
   2 m   |          10 m                           |      4 m
|<----->|+|<------------------------------------->|+|<------->|
         A                                         B
```
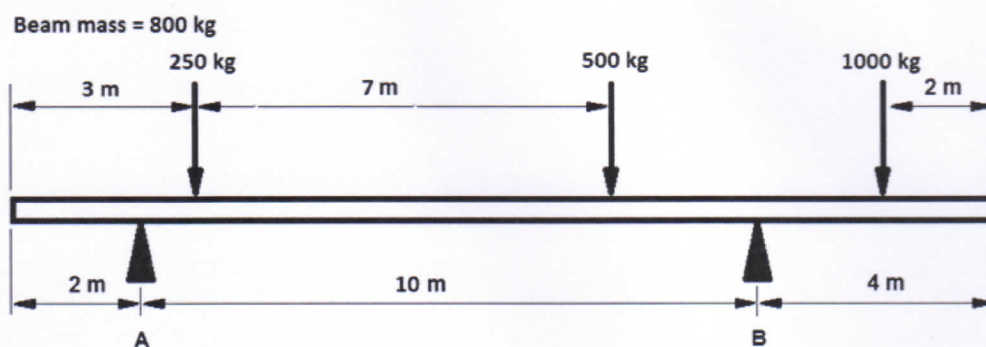
Fig Q9

10. A stationary block with a mass of 150 kg has a force applied to it which causes acceleration in an horizontal plane.  The force of 1770 N is applied at an angle of 10° below the horizontal, pulling the block.

    Determine the acceleration of the block if the coefficient of friction is 0.2.    (8)


11. In relation to the strength of materials, explain what is meant by EACH of the following terms:

    (a) Hooke's Law;    (2)

    (b) Young's Modulus;    (2)

    (c) stress;    (2)

    (d) strain.    (2)


12. A hoist has a pulley and axle with the following dimensions:

    Pulley diameter = 200 mm    Axle diameter = 50 mm

    (a) Produce a simple dimensioned sketch of the lifting machine.    (3)

    (b) Determine EACH of the following:

        (i) the movement ratio of the machine;    (3)

        (ii) the efficiency of the machine if it requires an effort of 400 N to just lift a mass of 90 kg.    (2)