

**CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY –
MARINE ENGINEER OFFICER**

EXAMINATIONS ADMINISTERED BY THE
SCOTTISH QUALIFICATIONS AUTHORITY
ON BEHALF OF THE
MARITIME AND COASTGUARD AGENCY

STCW 95 SECOND ENGINEER REG. III/2 (UNLIMITED)

042-23 – MATHEMATICS

THURSDAY, 16 DECEMBER 2010

1315 - 1615 hrs

Examination paper inserts:

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Notes for the guidance of candidates:

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| <ol style="list-style-type: none">1. Non-programmable calculators may be used.2. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer. |
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Materials to be supplied by examination centres:

Candidate's examination workbook Graph Paper

MATHEMATICS

Attempt SIX questions only

All questions carry equal marks

Marks for each part question are shown in brackets

1. (a) By applying Kirchoff's Laws in a circuit the following equations were obtained:

$$24(I_1 - I_2) + 48I_1 = 4.2$$

$$16I_2 - 4(I_1 - I_2) = 0.7$$

Calculate the values of the currents I_1 and I_2 . (8)

- (b) Pump A can fill an empty tank in 1 hour 40 minutes. A second more powerful pump, B, can fill the same tank in 40 minutes.

Calculate the overall time to fill the empty tank if pump A runs alone for 30 minutes and then pump B is used to assist pump A. (8)

2. (a) Solve for x in the following equation: (6)

$$\frac{2x + 3}{4} = \frac{x - 3}{5} + 2$$

- (b) Make D the subject of the following formula: (6)

$$T = \frac{12.5 D}{D + 4d}$$

- (c) The volumes of two solid spheres are in the ratio 2197 : 512.

Determine the ratio of their surface areas. (4)

3. (a) The sag, s metres, in a wire of length L metres stretched between two supports x metres apart, as illustrated in Fig Q3(a), is given by the formula:

$$L = x + \frac{8s^2}{3x}$$

Calculate the distance x when L is 200 m and s is 8 m.

(8)

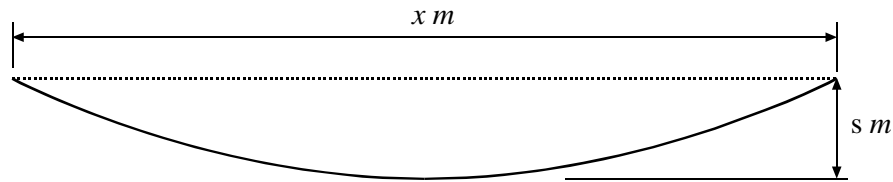


Fig Q3(a)

(b) Given:
$$R = \frac{(27y - 18x)(4x^2 + 12xy + 9y^2)}{(4x^2 - 9y^2)(10x + 15y)}$$

Express R as a fraction in its simplest form.

(8)

4. (a) Given:
$$n = 10 \log_{10} \left(\frac{P_2}{P_1} \right)$$

Calculate the value of P_1 when $n = 2.5$ and $P_2 = 2.8$

(4)

(b) Calculate the value of t such that
$$\ln \left(3 - \frac{2}{t} \right) = -0.2$$

(6)

(c) Use laws of indices to fully simplify:

(6)

$$\sqrt[3]{\frac{125h^{\frac{5}{2}} \times n^{\frac{13}{5}}}{27n^{\frac{7}{4}} \times h}}$$

5. Table Q5 indicates the deflection, d mm, of a beam under loads, L Newtons. The deflection is related to the load by the formula: $L = kd^n$ where k and n are constants.

(a) Draw a graph to verify this relationship. (10)

(b) Determine approximate values of k and n . (6)

d mm	7.58	10.8	14.5	18.6	23.0	27.7
L Newtons	20	25	30	35	40	45

Table Q5

Suggested scales: horizontal axis 2 cm = 0.1
vertical axis 2 cm = 0.04

6. (a) A roller of diameter 25 mm is placed in a V block as shown in Fig Q6(a). The distance from the top of the roller to the top of the V block is 4.64 mm.

Calculate the width W of the block. (10)

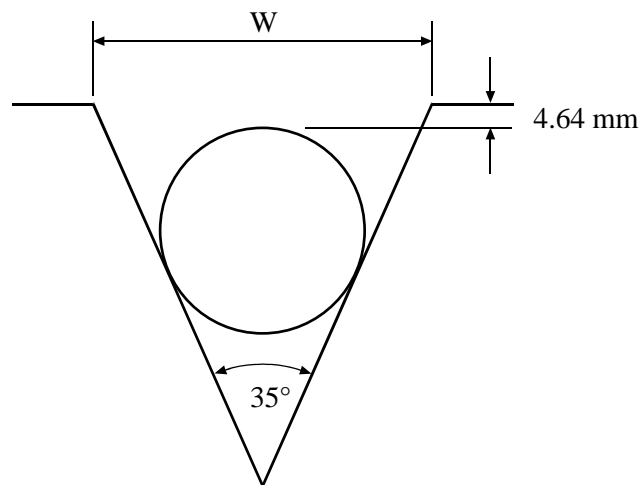


Fig Q6(a)

(b) Given: $H(t) = 6 - 5 \sin \left[\left(\frac{\pi}{6} \right) t + \frac{\pi}{2} \right]$

(i) State the maximum value of $H(t)$; (1)

(ii) Calculate the first positive value of t when this occurs. (5)

7. (a) The temperature $T^{\circ}\text{C}$ at a certain location t hours after 9 a.m. is given by the function:

$$T = \frac{t^3}{3} - 3t^2 + 8t + 10$$

Calculate the time when the temperature starts to fall.

(8)

- (b) Given: $S = 5 + 2\sin\theta + 3\cos\theta$

- (i) Determine the value of $\frac{dS}{d\theta}$ when $\theta = \frac{2\pi}{3}$ radians

(4)

- (ii) Solve $\frac{dS}{d\theta} = 0$ for θ in the range $0 \leq \theta \leq \frac{\pi}{2}$

(4)

8. (a) The average value, \bar{y} , of a function $y = f(x)$ in the range $x = a$ to $x = b$ is given by:

$$\bar{y} = \frac{1}{b-a} \int_a^b f(x) dx.$$

Determine the average value of the function $y = 5x^4 - 4x$ in the range $x = 0$ to $x = 2$.

(6)

- (b) Fig Q8(b) shows a sketch of the function $y = 3x^2 - x^3$

Calculate the volume of the solid of revolution obtained when the shaded area is rotated once about the x axis.

(10)

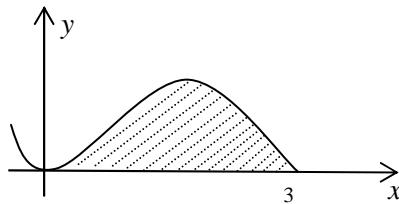


Fig Q8(b)

9. Fig Q9 shows three heavy spheres lying inside a hollow cylinder. The diameter of the cylinder is 250 mm. The diameters of EACH of the three spheres is 150 mm.

Calculate the volume of water, in cm^3 , to just cover the top sphere.

(16)

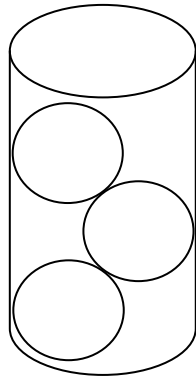


Fig Q9