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:

Notes for the guidance of candidates:

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.

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)

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

(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)

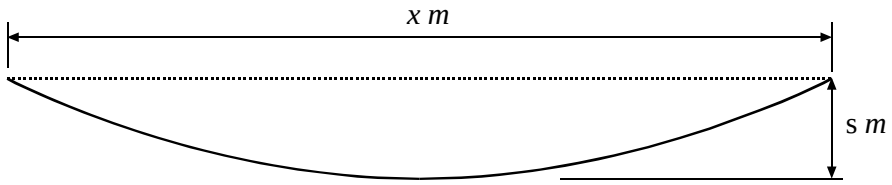

Fig Q3(a)

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

Express R as a fraction in its simplest form. (8)

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

Calculate the value of P_1 when $n = 2.5$ and $P_2 = 2.8$ (4)

(b) Calculate the value of *t* such that $\ln\left(3 - \dfrac{2}{t}\right) = -0.2$ (6)

(c) Use laws of indices to fully simplify: (6)

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

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)

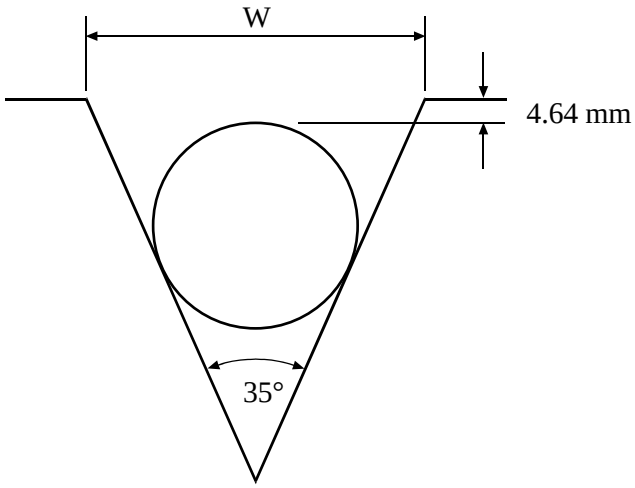

Fig Q6(a)

(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°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 $0 \le \theta \le \frac{\pi}{2}$ (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)

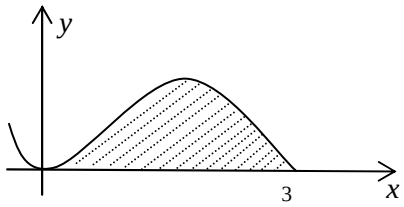

Fig Q8(b)

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)

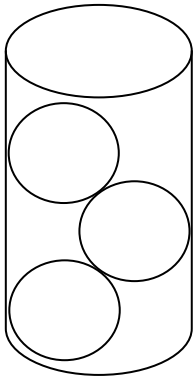

Fig Q9