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 26th MARCH 2015

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) A cruise line contracts to purchase two identical ships at a cost of £364 M each.

During construction of the first ship the costs of labour and materials are in the ratio of 3:4 and the ship builders make a profit of 4%.

Determine EACH of the following:

(i) the cost of the materials for the first ship; (5)

(ii) the percentage profit made on the second ship if the labour costs have increased by 2% and the material costs have decreased by 5%. (5)

(b) The ratio of the volumes of two solid cubes is 729:64.

Determine the side length of the larger cube if the surface area of the smaller cube is 384 cm^2. (6)

2. (a) Solve the following system of equations for x and y:

$3x^2 + 2y^2 + y = 13$
$3x + 2y - 7 = 0$

(10)

(b) Fully factorise EACH of the following:

(i) $30ab^2 + 39ab - 126a$; (3)

(ii) $(2x - 5y)^2 - 9y^2$. (3)

3. (a) Make L the subject of the following formula:

$$S = \frac{1}{t}\log_e\left(\frac{L}{L - V^2}\right) \qquad (7)$$

(b) Solve for x in EACH of the following equations:

(i) $4^{5x-1} = 8^{2x+1}$; (6)

(ii) $2^x = 10$. (3)

4. (a) The force, F, produced on a ship's rudder is proportional to the area, A, of the rudder, the square of the ship's speed, V, in knots and the sine ratio of the rudder angle, α.

For a ship travelling at 10 knots, with a rudder area of 24 m^2 operating at an angle of 23°, the rudder force is 144 kN.

Calculate the force on a similar rudder of area 29 m^2 operating at an angle of 15° when the ship's speed is 14 knots. (8)

(b) $$Y = \frac{3 + \dfrac{9}{x-2}}{x - \dfrac{3}{x-2}}$$

Express Y as a single algebraic fraction in its simplest form. (8)

5. The power, P watts, dissipated by a resistor, was measured for various currents, I amps, as shown in Table Q5.

P	105	214	359	692	955
I	2.09	2.95	3.94	5.37	6.31

Table Q5

(a) Verify, by drawing a straight line graph, that P and I are related according to the law:

$P = RI^n$ where R and n are constants. (10)

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

(b) Use the graph in Q5(a) to determine the values of R and n. (6)

6. A tower 45 m high stands on the top of a hill which has a 15º incline.

The angle of depression from the top of the tower to a point A on the hill is 60º. Further down the hill at an angle of depression of 35º from the top of the tower is point B.

Calculate the distance between the points A and B. (16)

7 (a) The blade efficiency E of a particular turbine is given by:

$$E = \frac{2u(\mathrm{V} - u)}{\mathrm{V}^2}$$ Where u = the speed of the blade
V = the constant velocity of the jet.

Determine EACH of the following:

(i) the value of u for maximum efficiency; (6)

(ii) the maximum percentage efficiency. (2)

(b) Differentiate EACH of the following functions:

(i) $\frac{3}{x^3} - \frac{4}{x^2} + \frac{2}{\sqrt{x}} - \sqrt{x}$ (4)

(ii) $2\sin t - \cos t - t + \ln t$. (4)

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8.

(a) Evaluate $\int_{\frac{\pi}{6}}^{\frac{5\pi}{6}} (2\sin\theta - \cos\theta)\,d\theta$ (6)

(b) Determine the volume of solid of revolution when the shaded area shown in Fig Q8(b) is rotated about the *x*-axis through one complete revolution. (10)

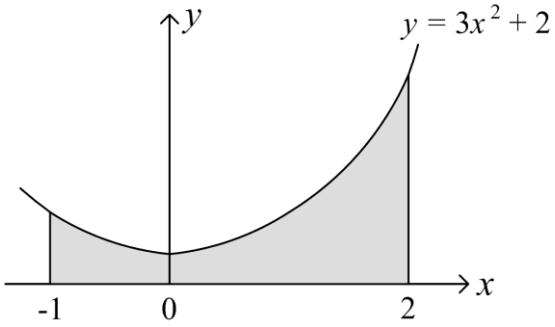

Fig Q8(b)

9. A solid metal cylinder has diameter 12 cm and length 25 cm.

Nine holes of diameter 2 cm are drilled through the cylinder, parallel to its axis, as shown in Fig Q9.

Calculate EACH of the following:

(a) the percentage decrease in the volume of the cylinder; (6)

(b) the total surface area of the original cylinder; (4)

(c) the percentage increase in the total surface area after the nine holes have been drilled. (6)

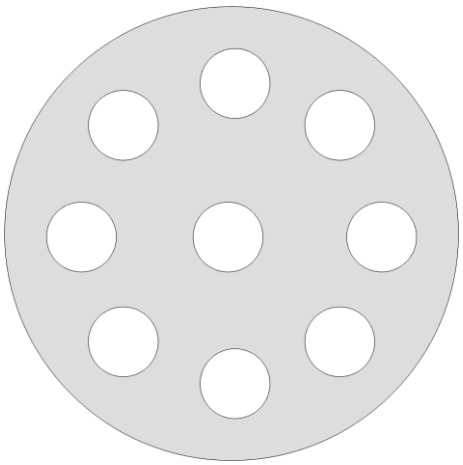

Fig Q9