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 28 MARCH 2013

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) An alloy is made by combining metal A with metal B such that the ratio of their volumes is 7:5 respectively. The relative density of A is 8.9 and that of B is 7.1.

Determine the percentage mass of EACH of the metals. (8)

(b) A rod 5.2 metres long is cut into 4 lengths A, B, C and D.
A is 10% longer than B. B is 1.6 m longer than C. D is 50 % longer than C.

Calculate the lengths of A, B, C and D. (8)

2. (a) Determine the values of *x*, for $x \geq 0$, which satisfy the following equation:

$$10\sqrt{x} - 2 = 5x$$ (8)

(b) Factorise completely:

$$(4x - 3)^3 - 4(4x - 3)(2x + 1)^2$$ (8)

3. (a) Solve for *a* and *b* in the following system of equations:

$$\frac{4b - 1}{2} + \frac{2a + 1}{5} = \frac{5}{2}$$

$$\frac{2b - 3}{5} - \frac{3a - 1}{7} = -\frac{32}{35}$$ (8)

(b) Transpose the terms in the following equation to make *A* the subject:

$$T = \sqrt{\frac{2ghDA^2}{d(S^2 - A^2)}}$$ (8)

4. (a) Given $\frac{T_1}{T_2} = \left[\frac{p_1}{p_2}\right]^{\frac{n-1}{n}}$

Calculate the value of n when $T_1 = 645$, $T_2 = 300$, $p_1 = 19.2$ and $p_2 = 1.2$ (8)

(b) Determine the values of t, for $t > 0$, which satisfy the following equation:

$$log(3t - 5)^2 - log(2t) = log\left(\frac{8}{t}\right)$$ (8)

5. The intensity of radiation, R, from certain radioactive materials at a particular time, t, is considered to follow the law:

$R = kt^n$ where k and n are constants.

A test produced the values shown in Table Q5.

(a) Using the values in Table Q5, draw a graph to verify the law. (10)

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

(b) Use the graph drawn in Q5(a) to determine approximate values for k and n. (6)

R	58	43.5	26.5	14.5	10
t	1.5	2	3	5	7

Table Q5

6. (a) A ship travels 25 km on a bearing 130°.
It then travels 40 km on a bearing 200°.

Calculate EACH of the following:

(i) the distance of the ship from its starting position; (5)

(ii) the bearing the ship must take in order to return in a straight line to its starting position. (5)

(b) Determine the values of β in the range $0° \leq \beta \leq 180°$ which satisfy the equation:

$$sin^2 \frac{3\beta}{2} = 0.5$$ (6)

7. (a) The efficiency, η, of a steam turbine is given by:

$\eta = 4(n\rho cos\alpha - n^2\rho^2)$ where n and α are constants.

Determine EACH of the following:

(i) the value of ρ such that η is a maximum; (8)

(ii) the maximum value of η. (2)

(b) Determine the first and second derivatives of the following function:

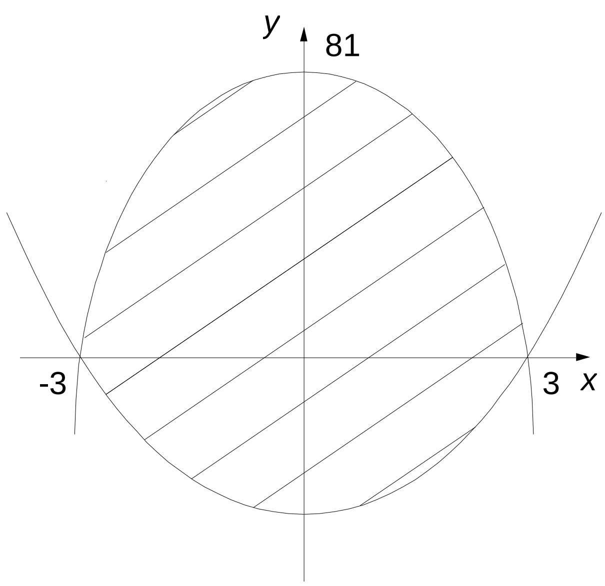
$y = 5\sin x + 6x^3 - 2x\sqrt{x}$ (6)

8. (a) Fig Q8(a) shows the graphs of the function $y_1 = 81 - x^4$ and $y_2 = x^2 - 9$

Determine the shaded area enclosed by the two functions. (10)

Fig Q8(a)

(b) Evaluate $\int_{\frac{\pi}{2}}^{\pi}(10 + 8\sin\propto - 3\cos\propto)\,d\alpha$ (6)



[OVER

9. Fig Q9 shows the area of an aluminium plate which is 5 mm thick.
It has the form of a trapezium with the major segment of a circle removed.

AB = CD = 300 mm, BC = EF = 800 mm
Angle AEF = Angle EFD = 110° and the maximum depth of the major segment is 700 mm.

Calculate EACH of the following:

(a) the area of the plate ; (14)

(b) the mass of the plate. (2)

Note: density of the aluminium is 2700 kg/m^3

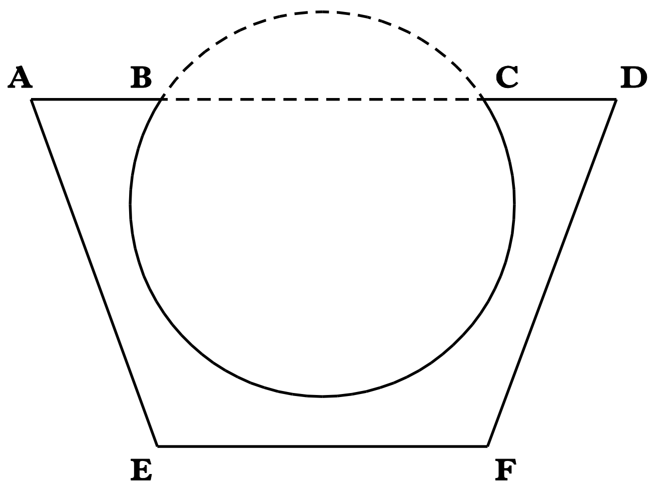


Fig Q9