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, 17 OCTOBER 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) A dealer buys 480 electrical fittings for £9 600.

He sells 360 of them at a profit of 30% on each.

Determine each of the following:

(i) the selling price of EACH of the remaining fittings in order that he would make an overall profit of 25%. (4)

(ii) the actual overall percentage profit if he only manages to sell the remaining fittings at £20.99 each. (4)

(b) A hydrofoil on a ferry run takes 15 minutes to overtake a vessel on a parallel course 4 nautical miles ahead.

On the return journey the hydrofoil takes 4 minutes to pass the same vessel which is still on the same course and speed, again from a distance of 4 nautical miles.

Calculate the speed of the hydrofoil and the vessel. (8)

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

$$\frac{7x+1}{x-2} - \frac{4x-1}{x+2} = 7 \qquad (10)$$

(b) Make s the subject of the following formula:

$$T = \frac{R}{\pi}\left(\frac{1}{h} - \frac{1}{s}\right) \qquad (6)$$

3. (a) Solve the following system of equations for x, y and z:

$$\begin{aligned} 2x - y + z &= 9 \\ 3x + 2y - 3z &= 16 \\ 5x - y + 2z &= 25 \end{aligned}$$

(9)

(b) A rectangular steel plate, of area 12 m^2, has its length 1.4 m greater than its breadth.

Calculate the dimensions of the plate, correct to two decimal places. (7)

4. Solve for x in EACH of the following equations:

(a) $5^{x-2} = 3^{2x+1}$ (8)

(b) $ln\left(\frac{3-x}{2-x}\right) = 0.8$ (8)

5. The tension, T newtons, of a rope wrapped round a drum with angle of lap, θ radians, varies as indicated in Table Q5.

(a) Verify graphically that T and θ are related according to the law:

$T = T_0 e^{\mu\theta}$ where μ and T_0 are constants. (10)

T newtons	22.20	29.97	43.82	57.97	83.10
θ radians	5.0	8.5	12.5	15.5	19.5

Table Q5

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

(b) Using the graph drawn in Q5(a), determine approximate values for μ and T_0. (6)

6. A diesel engine unit has a vertical stroke of 300 mm and a connecting rod AB of length 550 mm as shown in Fig Q6.

Angle CAB is the angle between the vertical and the position of the connecting rod.

Twice during each down stroke of the piston the angle CAB equals 5 degrees.
Determine by calculation the piston travel between these two positions. (16)

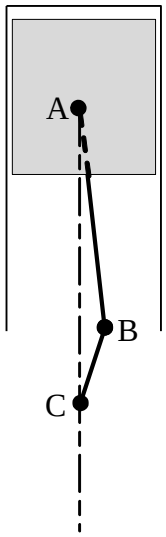

Fig Q6

7. (a) The daily profit, P pounds, of a small oil refinery is given by:

$P = 80x - 0.2x^2$, where x is the number of barrels of oil refined.

Calculate EACH of the following:

(i) the number of barrels to be refined to maximise the profit; (6)

(ii) the maximum profit. (2)

(b) Given: $T = 3 + 4\sin\theta - 2\cos\theta$

(i) Determine the value of $\frac{dT}{d\theta}$ when $\theta = \frac{5\pi}{6}$ radians ; (4)

(ii) Solve $\frac{dT}{d\theta} = 0$ for θ in the range $\frac{\pi}{2} \le \theta \le \pi$. (4)

8. A small ship has a forepeak bulkhead as shown in Fig Q8.

The equations of the deck and hull with respect to an origin 0 are:

Deck : $y = 0.36 - 0.04x^2$

Hull : $y = 0.4x^2 - 3.6$

Determine the area of the bulkhead. (16)

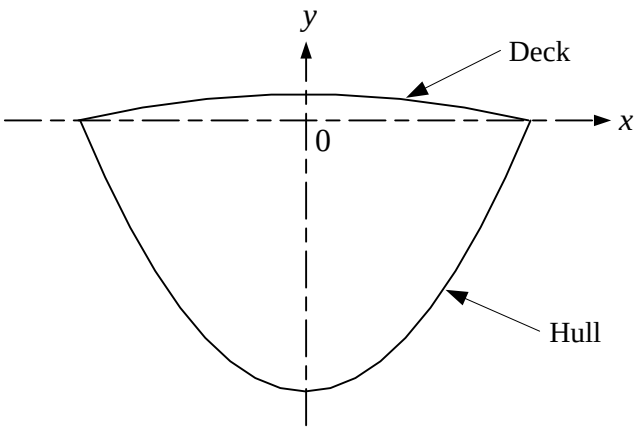

Fig Q8

9. The vertical cross section of an empty steel fuel tank in a vessel is in the shape of a trapezium as shown in Fig Q9.

The tank is 2.5 metres long and lies with its base parallel to the waterline.

5 000 litres of fuel are now pumped into the tank.

Calculate the depth of fuel in the tank. (16)

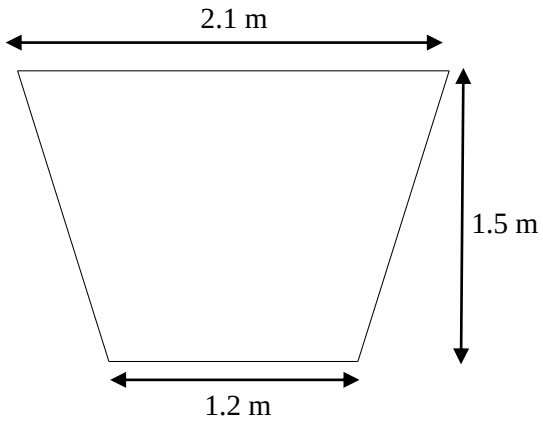

Fig Q9