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 24 JULY 2014

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) Tank A contains a fuel mixture of petrol and oil in the ratio 12:1 and tank B contains a fuel mixture of petrol and oil in the ratio 11:2.

   Determine the ratio in which fuel should be drawn from A and B to give a petrol and oil mixture in the ratio 10:1. (8)

   (b) The crippling load, P, for a steel rod is directly proportional to the fourth power of its diameter, D, and is inversely proportional to the square of its length, L.

   Determine the approximate percentage change in P if D is increased by 1% and L is decreased by 1%. (8)

2. (a) $Y = \dfrac{7x+17}{2x^2-7x-4} + \dfrac{2x}{2x+1} - \dfrac{5}{x-4}$

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

   (b) Solve for x in the following equation:

   $(2x + 1)(4x - 1) = 5$ (8)

3. (a) A propulsion problem causes a reduction in a ship's speed of 3 knots throughout a passage of 520 nautical miles, resulting in the ship arriving at its destination 3 hours behind schedule.

   Calculate EACH of the following for the ship:

   (i) the normal service speed; (7)

   (ii) the passage time. (3)

   (b) Solve for x in the following equation:

   $7^{3x-1} = 0.5$ (6)

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4. A keyway, of width 14 mm, is cut into a steel shaft, of radius 25 mm, along its entire length, as shown in Fig. Q4.

Calculate EACH of the following for the shaft:

(a) the maximum depth of the keyway; (8)

(b) the percentage of steel removed. (8)

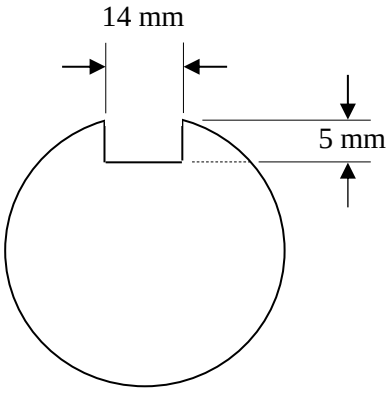

Fig Q4

5. The fuel consumption, F tonnes per day, at a speed, V knots, for a certain vessel are related by:

$F = aV^2 + b$ where a and b are constants.

Table Q5 indicates recorded values of F and V.

(a) Using the values in Table Q5 draw a graph to verify the relationship between F and V: (10)

F	1.1	2.9	6.5	11.2	17.5
V	2	4	6	8	10

Table Q5

Suggested scales: horizontal axis 2 cm = 10
vertical axis 2 cm = 2

(b) Use the drawn graph to determine approximate values of a and b. (6)

6. (a) A quadrilateral shaped metal plate has dimensions as shown in Fig Q6(a).

The angle ABC is 48°

Calculate EACH of the following for the plate:

(i) the distance from A to C; (4)

(ii) the size of angle DAB. (8)

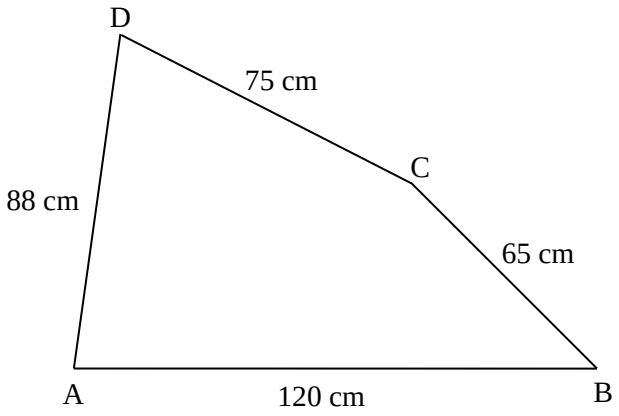

Fig Q6(a)

(b) Solve for Θ in the following equation in the range $90° < \Theta < 180°$

$\sin 2\Theta = -0.95$ (4)

7 (a) Determine the first and second differential coefficients of the expression:

$$y = 9x^{\frac{4}{3}} + 2\ln x - 4\sin x$$ (6)

(b) The displacement, s metres, of a body from a fixed point is given by the equation:

$s = 45t + 3t^2 - t^3$ where t is the time in seconds.

Determine EACH of the following for the body:

(i) the time when its velocity is zero; (6)

(ii) its acceleration after 3 seconds. (4)

8. The uniform cross-section of a 60 metres long cargo space, in a small bulk carrier, can be represented by the area enclosed by the curve $y=\frac{1}{4}x^2$ and the lines y = 1 and y = 9, as shown by the shaded part in Fig Q8.

Calculate EACH of the following for the cargo space:

(a) the area of its cross-section; (13)

(b) its capacity in cubic metres. (3)

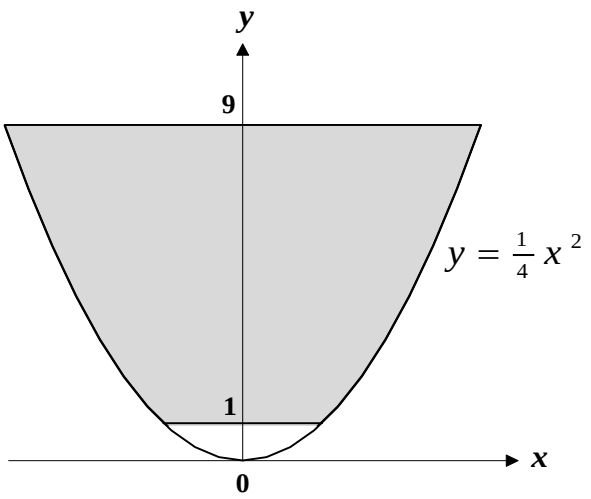

Fig Q8

9. A rectangular swimming pool is 25 metres long and 12 metres wide.

When full, the water is 1 metre deep at the shallow end and the bottom slopes uniformly along its length to the opposite end, where it is 4 metres deep.

The pool was filled by water flowing through a pipe, of internal diameter 100 millimetres, flowing at the rate of 4 metres per second, the pipe always being full.

Calculate EACH of the following for the pool:

(a) the volume of water when full; (6)

(b) the filling rate in cubic metres per hour; (7)

(c) the total filling time. (3)