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 OCTOBER 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) A cruise ship has cabin accommodation for passengers on four separate decks A, B, C and D. Deck B has 25 cabins more than deck A. Deck C has 20% more cabins than deck B. Deck C has three quarters of the number of cabins on deck D. `

   The total number of cabins on the four decks is 671.

   Determine the number of cabins on EACH of the four decks. (8)

   (b) Calculate the number of litres of 80% antifreeze solution that are required to be mixed with 45 litres of 15% antifreeze solution to obtain a mixture that is 50% antifreeze. (8)

2. (a) Make v the subject of the following formula:

$$T = \frac{T_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$ (8)

   (b) Solve the following system of equations for A and B in the ranges $0 \leq \mathrm{A} \leq \frac{\pi}{2}$ and $0 \leq \mathrm{B} \leq \frac{\pi}{2}$ radians:

   4sin A – 5cos B = 0.42
   3sin A + cos B = 1.25 (8)

3. (a) Solve the following equation for x, ($x \geq 0$):

$$\frac{x-1}{x+2} - \frac{x-3}{x-2} = \frac{2}{x}$$ (10)

   (b) Factorise fully EACH of the following:

   (i) 4ab + 5ac -8bd – 10cd (3)

   (ii) $9x^3y + 15x^2y^2 - 6xy^3$ (3)

4. (a) In a drive belt pulley system, the tension T newtons in the taut side is given by $T = T_0e^{\mu\theta}$ where T_0 is the tension in newtons in the slack side, μ is the coefficient of friction between the belt and pulley and θ is the angle of lap, in radians, of the belt on the pulley.

Determine EACH of the following for this system when $\mu = 0.25$:

(i) the tension T when $T_0 = 20.5$ newtons and $\theta = 1.15$ radians. (3)

(ii) the value of θ when T = 24 newtons and $T_0 = 19$ newtons. (5)

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

(i) $ln\,(1 + 3x) = -0.63$; (4)

(ii) $log\, 5x^3 - log\, x^2 = log\,(3x + 1)$. (4)

5. (a) Plot the graph of $y = 3x^3 - 3x^2 - 12x + 7$ at unit intervals from $x = -3$ to $x = 3$. (13)

Suggested scales: *horizontal axis* 2 cm = 1
vertical axis 2 cm = 10

(b) Using the graph drawn in Q5(a) determine the solutions of the equation:

$3x^3 - 3x^2 - 12x + 7 = 0$ (3)

6. Two spheres of diameters 30 mm and 60 mm fit into an oil funnel spout as shown in Fig Q6.

Calculate EACH of the following:

(a) the internal taper angle of the spout; (8)

(b) the dimension D. (8)

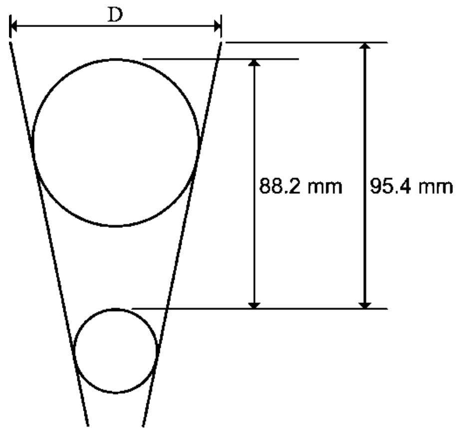

Fig Q6

7. (a) The rate at which a particular vessel consumes fuel is given by:

rate = $10 + 0.000625V^3$ tonnes per hour (where V is the speed of the vessel in knots).

Calculate EACH of the following:

(i) the speed of the vessel which minimises the amount of fuel consumed on a passage of 1 000 nautical miles; (10)

(ii) the amount of fuel consumed during the passage when the vessel sails at its most economical speed. (2)

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

$P = \sin\theta + \cos\theta$ (4)

8. (a) Calculate the shaded area enclosed by the functions $y_1 = 20 - 3x^2$, $y_2 = 50 - x^3$ and the ordinates $x = -1$ and $x = 2$ as shown in Fig Q8(a). (10)

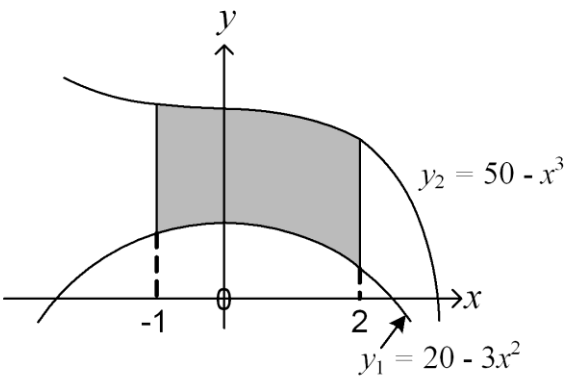

Fig Q8(a)

(b) Evaluate $\int_1^3 \left(\frac{7}{p^{2.4}}\right) dp$ (6)

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9. A hexagonal steel bar of side 8 cm and length 45 cm is machined, without reducing its overall length, into a composite solid as shown in Fig Q9.

The top third is conical with maximum possible base diameter.
The middle third is cylindrical with the same diameter as the base of the cone.
The lower third remains intact.

Calculate EACH of the following:

(a) the total volume of steel removed; (14)

(b) the percentage volume of steel removed. (2)

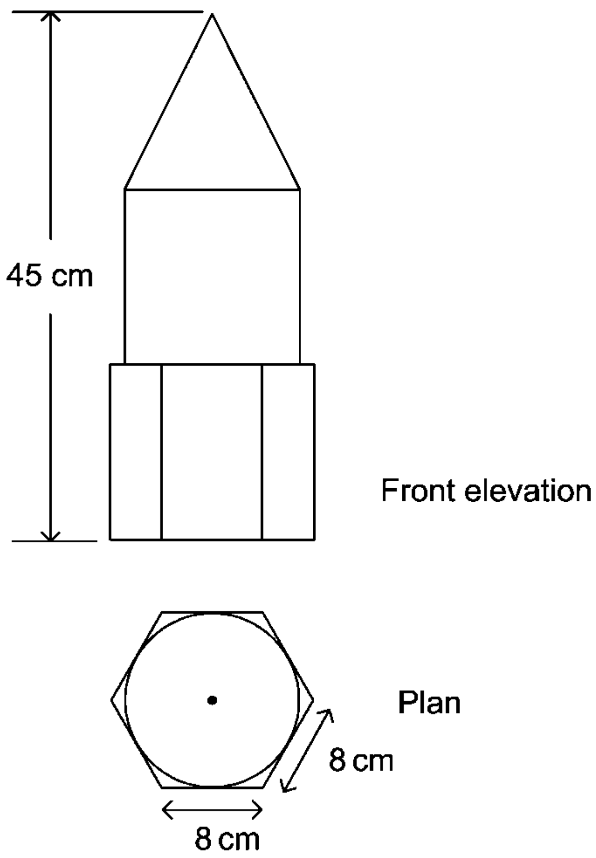

Fig Q9