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 15 OCTOBER 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) In a three cylinder engine the power developed in the No. 1 cylinder is 5% less than in the No. 2 cylinder.

The power developed in the No. 3 cylinder is 20% more than in the No.1 cylinder.

Express the power developed by EACH of the cylinders as a percentage of the total power of the engine. (8)

(b) The mass of a square bar varies as its length and the square of its side.

The length of bar A is $\frac{3}{4}$ of the length of bar B and the side of bar A is $\frac{2}{3}$ of that of bar B.

The mass of bar A is 14 kg and both bars are composed of the same material.

Calculate the mass of bar B. (8)

2. (a) Solve for x, $x > 0$, in the following equation:

$$\frac{x-2}{x+3} - \frac{x-3}{2x-1} = \frac{5}{2}$$ (8)

(b) For a particular ship, at deadweight displacement, the power of the main engine is given by:

$P = v\,(av^2 + b)$ where v is the speed of the ship in knots, and a and b are positive constants.

The powers are 3456 kW and 7632 kW when the speeds are 9 and 12 knots respectively.

Calculate the power when the speed of the ship is 14 knots. (8)

3. (a) A formula associated with the magnetic field strength of a solenoid is given by:

$$B = \frac{\mu_0 N r^2 I}{2\left(r^2 + x^2\right)^{\frac{3}{2}}}$$

Calculate the value of x when $B = 0.01$, $\mu_0 = 4\pi \times 10^{-7}$, $N = 1000$, $r = 0.1$ and $I = 10$. (8)

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

$3\sin A + 4\cos B = 1.77$
$2\sin A - \cos B = 0.52$ (8)

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

(a) $7^{2x-1} = 4^{x+1}$ (6)

(b) $\log\left(\frac{5-x}{3-x}\right) = 0.5$ (6)

(c) $\sqrt{x^5} = 7$ (4)

5. (a) Plot the graph of $y = 2x^3 - x^2 - 7x + 4$, at intervals of 0.5 from $x = -2$ to $x = 2$. (13)

Suggested scales: horizontal axis 2 cm = 0.5
vertical axis 2 cm = 1

(b) Using the graph drawn in Q5(a), estimate the solutions, to 1 decimal place, of the equation:

$2x^3 - x^2 - 7x + 4 = 0$ (3)

6. A parallelogram has sides of 25 cm and 15 cm.

The two acute angles between the sides are 30°.

Calculate EACH of the following for the parallelogram:

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(a) the lengths of the diagonals; (12)

(b) the area. (4)

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

$s = \frac{10}{3} t^3 - \frac{33}{2} t^2 + 20\,t + 6$ where t is the time in seconds.

Determine EACH of the following for this body:

(i) its initial velocity; (3)

(ii) the times when it is at rest; (4)

(iii) the time when its acceleration is 7 ms^{-2}. (3)

(b) Given $h = 4 - 3\sin t + 5\cos t$, where t is the time in seconds, evaluate.

$h - \frac{dh}{dt}$ when $t = 1$ second (6)

8. A solid of revolution is formed when the area bounded by the curve $y = 2x^2 + 3$ and the lines $y = 1$, $x = -1$ and $x = 2$, as shown by the shaded area in Fig Q8, is rotated about the x-axis through one complete revolution.

The dimensions are in centimetres.

Calculate EACH of the following for this solid of revolution:

(a) its volume; (12)

(b) its mass, if its density is 2720 kg m^{-3}. (4)

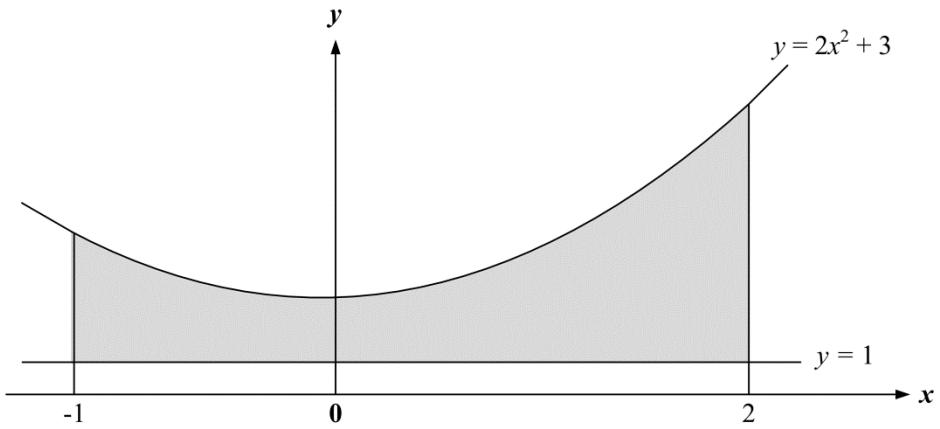

Fig Q8

9. A solid right pyramid stands on an equilateral triangular base BCD, as shown in Fig Q9.

The vertical height of the pyramid is 30 cm and each side of the base is 16 cm.

Calculate EACH of the following for the pyramid:

(a) the volume; (6)

(b) the total surface area. (10)

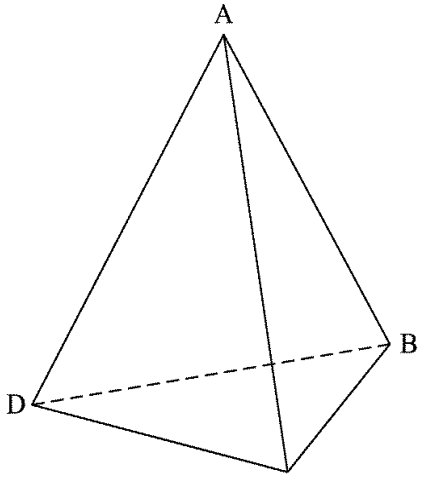

Fig Q9