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, 13 DECEMBER 2012

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)   List prices of items A, B and C are £18, £12 and £4 respectively. Item A is available at a discount of 20%, item B at a discount of 15% and item C at a discount of 30%.

        Determine EACH of the following:

        (i)   the purchase price of EACH item;   (3)

        (ii) the overall percentage discount obtained by buying 5 of item A, 8 of item B and 20 of item C.   (5)

   (b)   The masses of two similarly shaped objects are 24 kg and 81 kg. The surface area of the larger object is 540 cm^2.

        Calculate the surface area of the smaller object.   (8)

2.   (a)   Factorise fully EACH of the following:

        (i) $6y^4 - 11y^3 - 35y^2$ (4)

        (ii) $9ab^3 - 4ay^3 - 4aby^2 + 9ab^2y$ (6)

   (b)   Transpose the terms in the following equation to make *n* the subject: (6)

$$T = \frac{an}{b+n} - h$$

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3. (a) Fig Q3(a) represents a rectangular sheet of metal with 4 equal quadrants, of radius r, removed from the corners. The area of the resultant shape is 1200 cm². (8)
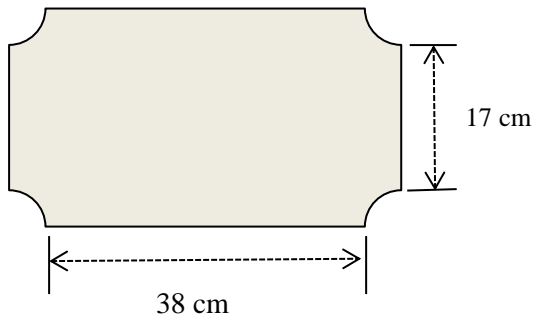
Calculate the radius of the quadrants.

17 cm

38 cm

Fig Q3(a)

(b) Determine the value of x, for $x > 0$, which satisfies the following equation: (8)

$$6x + 1 \quad x - 2 \quad x + 3 \quad - \quad 2x - 1 \quad 3x + 2 \quad x - 3 \quad = 6x - 12$$

4. (a) The voltage drop across an electrical device can be calculated using the following equation:

$$V = 0.75\, e^{-0.25t} \sin 0.1t$$

where V is the voltage drop in millivolts and t is the time in seconds after the closure of the actuating switch.

Determine the voltage drop one minute after the closure of the actuating switch. (6)

(b) Determine the values of x and y which satisfy the following simultaneous equations: (10)

$$128x^2 y^3 = 64$$

$$48x^3 y^2 = 3$$

5. (a) Draw the graph of $y_1 = x^3$ in the range $x = -2$ to $x = 2$ in intervals of 0.5. (8)

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

(b) Using the same graph paper and the same axes as in Q5(a), draw the graph of $y_2 = 5 - 2x$ in the range $x = -2$ to $x = 2$ in intervals of 0.5. (4)

(c) Using the graphs drawn in Q5(a) and Q5(b), determine the solution to the following equation: (4)

$$x^3 + 2x - 5 = 0$$

6. (a) From a ship at sea the angles of elevation of the top and base of a lighthouse standing at the top of a vertical cliff are 35° and 28° respectively.

The lighthouse is 32.4 m high.

Calculate EACH of the following:

(i) the height of the cliff; (8)

(ii) the distance of the ship from the base of the cliff. (2)

(b) An alternating voltage, v, is given by:

$v = 45 \sin(100\pi t - 0.4)$ where t is the time in seconds.

Calculate the least value of t when $v = 36.5$ volts. (6)

7. (a) In Fig Q7(a) A is a maximum turning point on the curve $y = x^3 \, x - 2 \,^2$ which touches the x axis at the origin and at B.
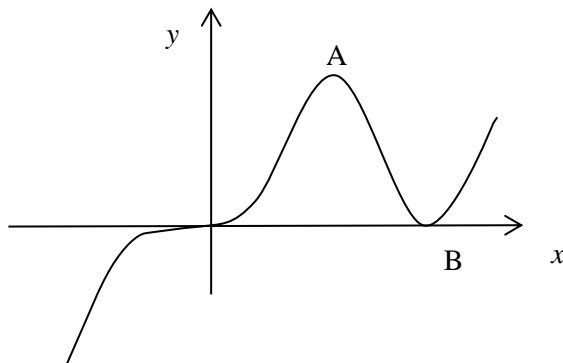
Determine the coordinates of the point A. (12)

Fig Q7(a)

(b) The length, L metres, of a certain metal rod at $t°C$ is given by:

$L = 1 + 10^{-5}t + 4 \times 10^{-7}t^2$

Determine the rate of change of L in mm/$°C$ when $t = 250°$. (4)

8. (a) The shaded area shown in Fig Q8(a) represents the area included between the two functions $y_1 = 24 + 10x - x^2$ and $y_2 = 24 - 2x$

Determine EACH of the following:

(i) the coordinates of B; (2)
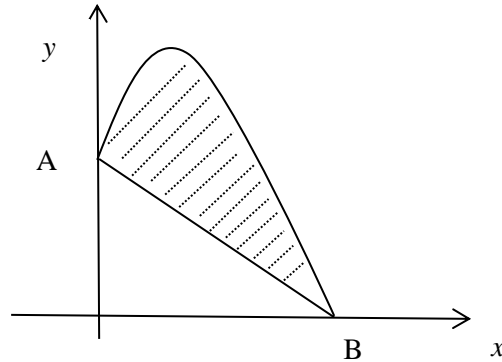
(ii) the shaded area. (10)

Fig Q8(a)

(b) Evaluate $\int_2^5 p \, dv$ where $p = \dfrac{120}{v}$ (4)

9. (a) Fig Q9(a) represents the end view of 5 solid metal cylinders, each of which has a diameter of 500 mm, bound together by a tight belt.
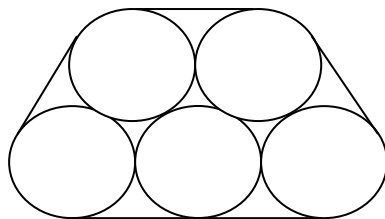
Determine the total length of the belt. (10)

Fig Q9(a)

(b) Twenty identical hollow stainless steel spheres have a total mass of 4.79 kg. Each sphere has an outside diameter of 50 mm.

Determine the thickness of each sphere. (6)

Note: the density of the stainless steel is 7500 kg/m³