

**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:

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Notes for the guidance of candidates:

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| <ol style="list-style-type: none">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. |
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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)

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

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 cm^2 .

Calculate the radius of the quadrants.

(8)

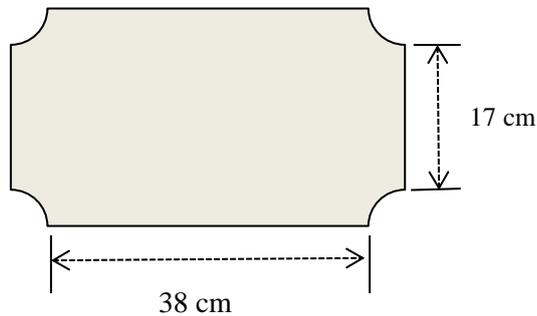


Fig Q3(a)

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

(8)

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

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)

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

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

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:

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

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 $y = x^3 - x - 2x^2$ which touches the x axis at the origin and at B.

Determine the coordinates of the point A. (12)

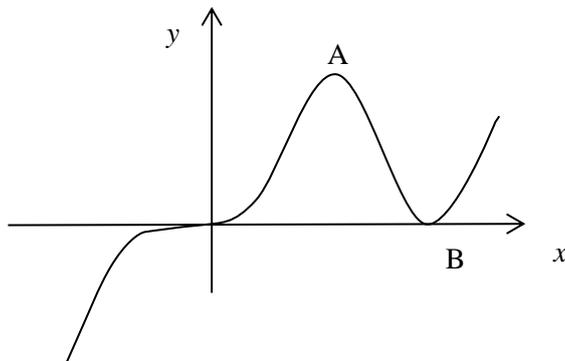


Fig Q7(a)

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

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

Determine the rate of change of L in $\text{mm}/^\circ C$ when $t = 250^\circ$. (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)

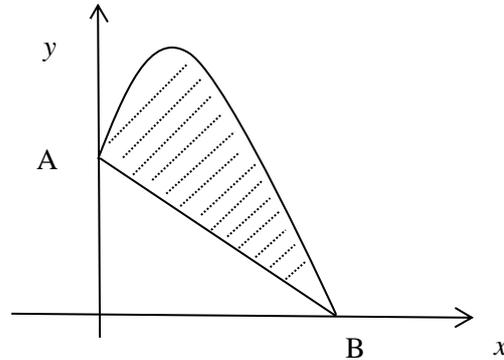


Fig Q8(a)

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

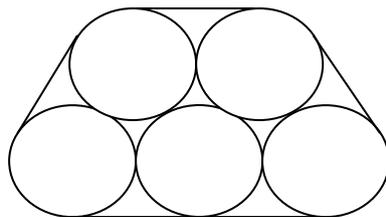


Fig Q9(a)

- (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