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, 17 DECEMBER 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) A dealer buys 45 portable welding machines at £260 each.

One third of the machines were sold at a profit of 40% and the remainder were sold at a profit of 20%.

Calculate the overall percentage profit. (6)

(b) The fuel consumption per unit of time, C, of a ship, is directly proportional to the cube of its speed *v*.

On a particular day the ship's speed is increased by 8% above normal for 5 hours, decreased by 12% for 10 hours and is normal for the remaining 9 hours.

Calculate the percentage decrease in the fuel consumption below normal for that day. (10)

2. (a) A communications mast stands vertically on a horizontal base area.

An anchor point on the base area is 20 m from the foot of the mast.

The distance from the anchor point to the top of the mast is 5 m more than the height of the mast.

Calculate the height of the mast. (6)

(b) Solve the following equation for *x*:

$$\frac{(3x+1)(2x-1)}{3x(x-1)} - 2 = 0$$

(6)

(c) Fully factorise:

$a^2b - 3a^2 - 4b + 12$ (4)

3. The general equation of a circle is $x^2 + y^2 + 2gx + 2fy + c = 0$, where g, f and c are constants.

The points (1, 8), (-2, -1) and (2, 1) lie on the same circle.

Determine EACH of the following for this circle:

(a) the values of g, f and c; (13)

(b) the radius, *r*, given that $r = \sqrt{g^2 + f^2 - c}$ (3)

4. (a) The pressure, P units, in a defective tyre, t hours after being inflated to a pressure of 50 units, is given by:

$P = 50e^{-0.01kt}$ where k is a constant.

After 24 hours the tyre pressure falls to 40 units.

Calculate EACH of the following:

(i) the value of k, correct to 3 decimal places; (4)

(ii) the tyre pressure after 48 hours; (2)

(iii) the tyre pressure after 1 week. (2)

(b) Solve for *x*, $x > 0$, in the following equation:

$$3^{x^2} = 27^{x+1}$$ (8)

5. The current, I milliamps, and the voltage, V volts, recorded during an experiment are shown in Table Q5.

(a) Using the values in Table Q5, draw a straight line graph to show that I and V are related by a law of the form $I = aV + bV^2$ where a and b are constants. (10)

V	10	30	50	70	90
I	0.6	5.0	13.0	24.9	41.4

Table Q5

Suggested scales: *horizontal axis* 2 cm = 10
vertical axis 5 cm = 0.1

(b) Using the graph drawn in Q5(a), determine approximate values for a and b. (6)

6. A ship leaves port A and sails for $2\frac{1}{2}$ hours on a course 210°.

It then sails for 4 hours on a course 105° to reach port B.

The ship sails at a constant speed of 16 knots throughout the passage.

Calculate EACH of the following:

(a) the total distance covered; (4)

(b) the distance of port A from B; (6)

(c) the bearing of port A from B. (6)

7. (a) The drag, *D*, acting on an aircraft operating under certain conditions, is given by:

$$D = aV^2 + \frac{b}{V^2}$$

where V is the airspeed of the aircraft and a and b are positive constants.

Determine the value of V, in terms of a and b, for minimum drag. (8)

(b) Differentiate EACH of the following functions:

(i) $y = x^2 + 2x - \frac{1}{x} + \frac{4}{\sqrt{x}}$; (4)

(ii) $v = 10 - t + 5\sin t - 3\cos t$. (4)

8. The end wall of a building is in the shape of a parabolic arch.

Relative to axes, as shown in Fig Q8, the wall can be represented by the graph of

$$y = 9 - \frac{1}{4}x^2.$$

A rectangular area of the wall is to be painted white and the remainder is to be painted grey, as shown in Fig Q8.

Calculate the area to be painted grey, given that the dimensions are in metres. (16)

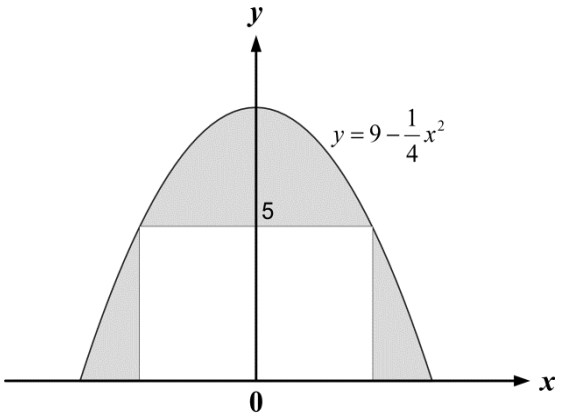

Fig Q8

9. (a) The debris from excavating a tunnel is estimated to be 174720 m^3.

This debris is to be stacked in the form of a frustum of a cone such that the vertical height is 18 m and the area of the base is four times the area of the top.

Calculate the base area of the stack. (10)

(b) Metal washers have an outside diameter of 30 mm, an inside diameter of 10 mm and a thickness of 2.5 mm.

The density of the metal is 7500 $kg\,m^{-3}$.

Calculate, to the nearest kilogram, the mass of a batch of 20000 such washers. (6)