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, 29 MARCH 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) In a four cylinder engine the power developed in the No.1 cylinder is 15% more than in the No.3 cylinder. The No.2 cylinder develops 5% less power than in the No.3 cylinder. The No.3 and No.4 cylinders develop the same power.

   Express the power of EACH cylinder as a percentage of the total power of the engine. (8)

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

   (i) ——— ——— = ——— 1 (4)

   (ii) ——— = ——— (4)

2. (a) A sheet of metal is to be cut in the shape of a rectangle with a semi-circle at one end as shown in Fig Q2(a).

   It has to have an area of 30 cm^2 and an overall length of 10 cm.

   Calculate the radius of the semi-circle. (8)

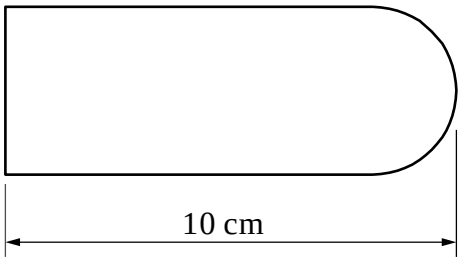

Fig Q2(a)

   (b) The angle, θ radians, that a rotating shaft turns through after *t* seconds is given by:

   where ω and are constants.

   When $t = 1.2$ then = 4.032 and when $t = 2.5$ then = 9.375

   Determine the values of and α. (8)

3. (a) A length of wire is tightly wound into circular coils each of radius r cm.

When a current of I amps is passed through it the magnetic field, H gauss, at a distance of x cm from the centre is given by the following formula:

Calculate the value of x when $H = 1.8$ gauss, $r = 5$ cm, $n = 100$ and $I = 4.5$ amps. (8)

(b) Make A_2 the subject of the following formula:

$$1$$

(8)

4. (a) Given

When $t = 36$, $P = 12$ and when $t = 11$ then $P = 30$.

Determine the values of the constants k and . (8)

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

(i) (4)

(ii) (4)

5. In an experiment the resistance of wire, R ohms, is measured for wires of different diameters, d mm.

The results are shown in Table Q5.

(a) Verify graphically that R and d are related by the law: where a and b are constants. (10)

(b) Use the graph drawn in Q5(a) to determine the approximate values of a and b. (6)

R ohms	1.63	1.15	0.88	0.76	0.63
d mm	1.10	1.41	1.75	2.05	2.55

Table Q5

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

6. (a) A ship on a bearing 197° from a lighthouse measures the angle of elevation of the top of the lighthouse as 13°. After sailing 144 metres the ship is on a bearing 178° from the lighthouse and the angle of elevation to the top of the lighthouse is then 9°.

Calculate the height of the lighthouse. (10)

(b) Fig Q6(b) shows the major segment of a circle of radius 75 mm.

Chord AB is 120 mm.

Determine the perimeter of the segment. (6)

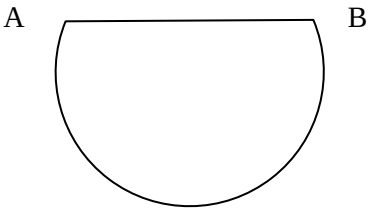

Fig Q6(b)

7. (a) Fig Q7(a) shows a rectangular sheet of metal with four identical holes drilled in it.

The length of the rectangle is 400 mm and its width is 30x mm.

Each hole has a diameter of 20x mm.

(i) Show that the remaining area, A, is given by . (3)

(ii) Calculate the value of x such that the remaining area, A, is a maximum. (7)

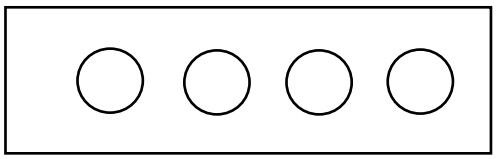

Fig Q7(a)

(b) Given : —

Determine the value of — when $B = 4\pi$ (6)

8. Fig Q8 represents the graph of the function ¯ in the range $x = 0$ to $x = 16$.

(a) Determine the area shaded in Fig Q8. (6)

(b) Calculate the volume of the solid of revolution when this shaded area is rotated through 360° about the x axis. (10)

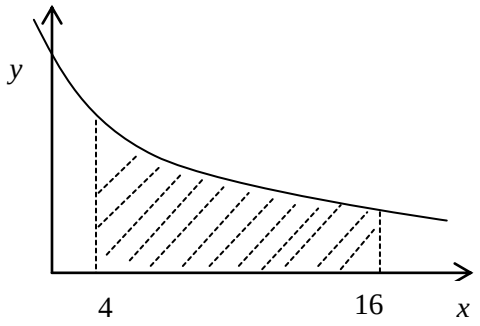

Fig Q8

9. (a) A solid conic frustum is placed within a hollow open-topped cylinder as illustrated in Fig Q9(a). The frustum and the cylinder have the same axis of symmetry and the same height (30cm). The end diameters of the frustum are 10 cm and 15 cm. The diameter of the cylinder is 20 cm.

Calculate the volume of the space within the cylinder. (12)

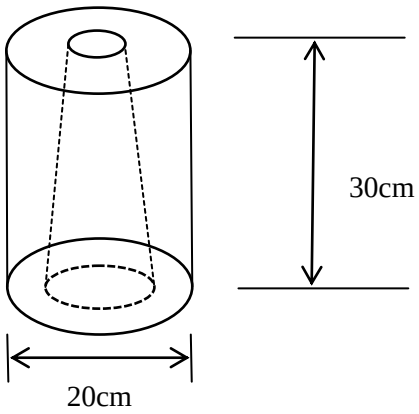

Fig Q9(a)

(b) Determine the mass of 400 steel ball bearings of diameter 10 mm. (4)

Note: The density of the steel is 7900 kg/m^3.