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, 16 July 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) The cost of manufacturing a propulsion unit is made up of material costs, labour costs and overhead costs in the ratio 5:3:2 .

   Determine the percentage rise in the manufacturing cost when the cost of materials rises by 9%, the cost of labour rises by 5% and the cost of overheads falls by 3%. (10)

   (b) Water escapes from an engine's cooling system at the rate of 3% per week.

   The system was initially filled with 44 litres of coolant.

   One litre of water is added at the end of each week.

   Calculate the volume of coolant in the system at the start of the fifth week. (6)

2. (a) A ship travels a distance of 900 nautical miles at an average speed of V knots.

   The ship would travel the same distance in 15 hours less if the average speed was increased by 3 knots.

   Calculate the actual speed V. (10)

   (b) A rectangle of area 40 cm^2 has its length 2 cm greater than its breadth.

   Determine the dimensions of the rectangle, correct to 2 decimal places. (6)

3. (a) Solve for x and y in the following system of equations:

$$\frac{1}{x}+\frac{4}{y}=\frac{9}{5}$$
$$\frac{3}{x}-\frac{1}{y}=\frac{1}{5}$$

(8)

(b) Solve the following equation for z:

$$\frac{z+3}{2}+\frac{4}{z-3}=6$$

(8)

4. (a) The potential drop, V millivolts, across an electrical component is given by:

$V = 0.84e^{-\alpha t}\sin \beta t$

where α and β are constants, and t is the time in seconds after the actuating switch is closed.

Determine the potential drop when t = 40 seconds, $\alpha = 0.3$ and $\beta = 0.2$. (6)

Note: the angle βt is in radians.

(b) Express the following in its simplest form:

$$5\sqrt[3]{27a^3b^6}+3b\sqrt{16a^2b^2}-3a\sqrt[4]{b^8}$$

(6)

(c) Given:

$$y=\frac{4\log 3}{\log 6-\log 2}$$

evaluate y without using tables or calculator. (4)

5. The power, P, required to propel a certain vessel and the speed, V, of the vessel are related by:

$P = aV^3 + b$ where a and b are constants.

Table Q5 indicates recorded values of P and V.

V	10	11.5	13	14.5	16
P	1302	1850	2648	3603	4803

Table Q5

(a) Using the values in Table Q5 draw a straight line graph to verify the relationship between P and V; (10)

Suggested scales: *horizontal axis* 2 cm = 400
vertical axis 2 cm = 400

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

6. An 18 metre tall building has dimensions as shown in the end elevation in Fig Q6.

The building has a horizontal base and the walls are vertical.

Calculate the size of EACH of the angles $x°$, $y°$ and $z°$. (16)

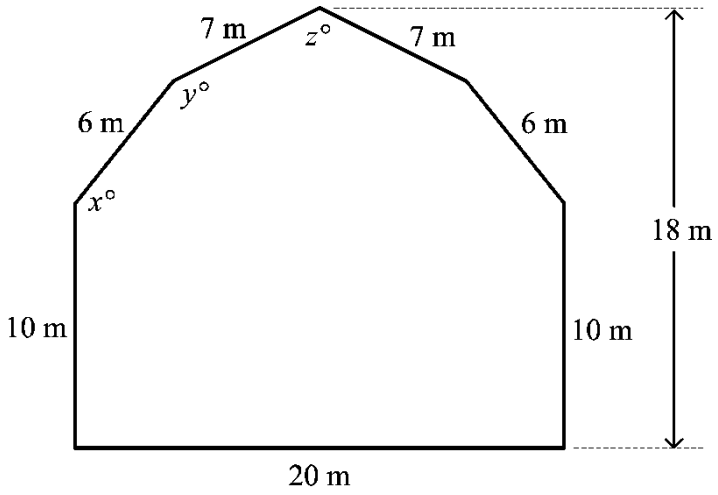

Fig Q6

7. (a) The cost per hour in operating a vessel is £$(2V^2 + 242)$, where V is the speed of the vessel in knots.

Calculate the speed of the vessel which will minimise the cost per nautical mile.
Verify that the result obtained gives minimum cost per nautical mile. (10)

(b) When a flywheel rotates through an angle of θ radians in t seconds, its angular velocity is given by $\frac{d\theta}{dt}$ rads/s, and its angular acceleration is given by $\frac{d^2\theta}{dt^2}$ rads/s^2.

For a certain flywheel $\theta = 30t - 4t^2$.

Determine EACH of the following for this flywheel:

(i) the angular velocity when $t = 3$; (3)

(ii) the angular acceleration; (1)

(iii) the time that elapses before the angular velocity is zero. (2)

8. (a) Given:

$$\frac{ds}{dt} = 6t^2 + t - 3 \quad \text{and} \quad s = 4 \quad \text{when} \quad t = 1$$

(i) Express s as a function of t. (6)

(ii) Determine s when $t = 5$. (2)

(b) Calculate the area enclosed by the function $y = 8 - 5\sin x$, the x axis and the ordinates $x = 0.5$ and $x = 2$. (*Note: angle x is in radians)* (8)

9. A 12 m long tunnel is constructed with straight vertical sides of height 4 m, a horizontal floor of width 6 m and an arched roof.

The tangents to the roof at the points where they meet the sides are inclined at 30° to the vertical as shown by the cross section of the tunnel in Fig Q9.

Calculate EACH of the following for the tunnel:

(a) the maximum vertical height; (8)

(b) the cross sectional area; (6)

(c) the volume of the air-space. (2)

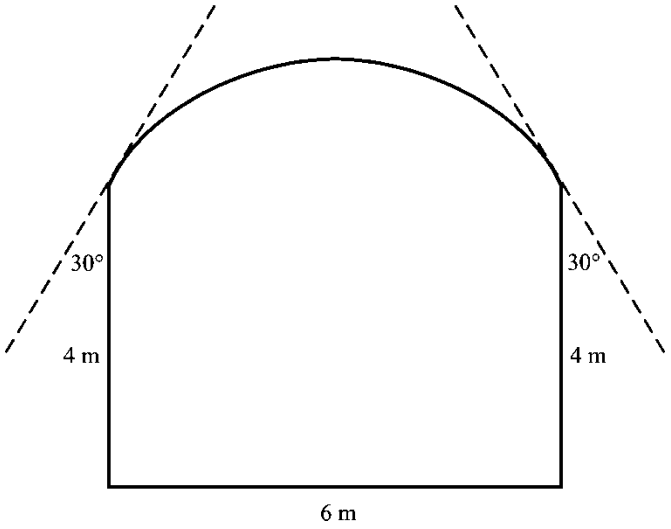

Fig Q9