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, 31 MARCH 2011

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 supplier buys 80 items, all at the same price.   He sells 50 of them at a profit of 30% on each.   He sells the remainder at a profit of 15 % on each.

    Calculate the overall profit he made on the sale of the 80 items. (8)

   (b) A car is driven for 5 hours without stopping from town A to town B.   The return journey on the same route took only three hours.   The return average speed was 26 mph faster than the first journey.

    Determine the average speed of the journeys in each direction. (8)

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

    (i) $100 - 100t - 64t^2 + 64t^3$ (5)

    (ii) $2\sin^2 A + 5\sin A \cos A - 12\cos^2 A$ (3)

   (b) Given: $Z = \sqrt{R^2 + \left(\omega L - \dfrac{1}{\omega C}\right)^2}$

    Make C the subject of the formula. (8)

3. (a) Given: $E = 0.36\, V \left[\dfrac{D - 0.7}{D}\right]^3$

    Calculate the value of D when E = 0.64 and V =12. (6)

   (b) Solve the following system of equations for a, b and c: (10)

    $$2a + 3b + 4c = 32$$
    $$3a - 2b + 3c = 23$$
    $$7a + 5b - 8c = 13$$

4. (a) Evaluate without using tables or calculator: (5)

$$\frac{5\log 25 - \log 125 + \frac{1}{2}\log 625}{3\log 5}$$

(b) Solve for t in the following equation: (5)

$$\log 2t^3 - \log t = \log 16 + \log t$$

(c) The value £C of a piece of machinery after t years is given by:

$$C = 28000\,e^{-0.115\,t}$$

Calculate the number of complete years before its value is less than £10000. (6)

5. Table Q5 indicates the various temperatures T°C, of a cooling liquid after t minutes as recorded in an experiment.

The relationship between T and t is given by the formula:

$$T = T_0 e^{at}$$ where a and T_0 are constants.

(a) Draw a graph to verify this relationship. (8)

(b) Use the graph drawn in Q5(a) to determine EACH of the following:

   (i) approximate values of a and T_0; (4)

   (ii) the temperature after 23 minutes; (2)

   (iii) the time it takes for the temperature to fall to 25°C. (2)

$T°C$	92.5	55.5	34.1	20.8	12.8
t minutes	10	20	30	40	50

Table Q5

Suggested scale: horizontal axis 2 cm = 5
vertical axis   2 cm = 0.2

6. (a) Calculate the size of $\theta°$ using the dimensions in Fig Q6(a). (8)

6 m

30 m

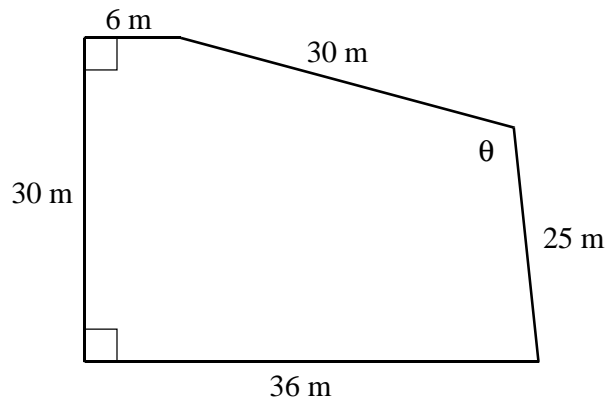θ

30 m

25 m

36 m

Fig Q6(a)

Note: *the figure is <u>not</u> drawn to scale*

(b) Determine the values of ϕ in the range $0 \le \phi \le 2\pi$ which satisfy the following equation: (8)

$$8\sin^2 \phi - 10\sin \phi - 3 = 0$$

7. (a) Given $V = (2t-1)^2(3t-2)$

(i) express V as a polynomial in descending powers of t ; (3)

(ii) determine $\dfrac{d\,V}{dt}$ (3)

(b) Determine the coordinates of the turning points on the function: (10)

$$y = x^2 + \frac{16}{x^2}$$

8. (a) Fig Q8(a) shows the graphs of the functions $y = x^2 + 1$ and $y = 7 - x$.

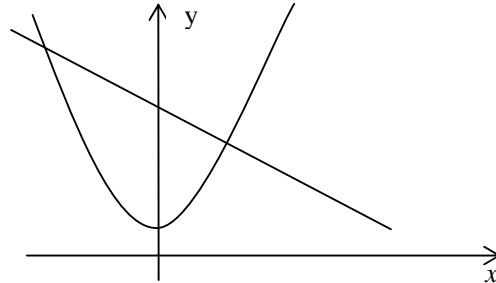Calculate the area enclosed by the two functions.   (8)

Fig Q8(a)

(b) Given $\dfrac{d^2 y}{dx^2} = 2 - 3\sin x + 5\cos x$ and when $x = 0$, $\dfrac{dy}{dx} = 4$ and $y = 5$.

Express y as a function of x.   (8)

9. (a) Fig Q9(a) shows the cross section of a regular hexagonal nut which is 8 mm thick.

Determine the number of these nuts which can be cast from a block of metal having dimensions of 5 cm × 4 cm × 12 cm, allowing for 9.2% wastage.   (10)
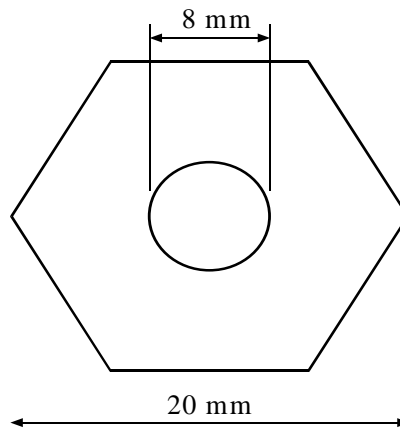

8 mm

20 mm

Fig Q9(a)

(b) A solid conic frustum made of aluminium has end diameters 120 mm and 180 mm and a vertical height of 120 mm.

The density of the aluminium is $2.7 \times 10^3 \, \text{kg/m}^3$.

Determine the mass of the frustum.   (6)