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, 21 JULY 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) List prices of items A and B are £17.50 and £12.00 respectively. Item A is sold at a discount of 15% and item B at a discount of 22%.

   Determine the overall percentage discount in the purchase of 5 of item A and 8 of item B. (8)

   (b) The average tonnage of three vessels, A, B and C, is 42000 tonnes. The tonnage of vessel B exceeds that of vessel A by 4000 tonnes. The tonnage of vessel C is 2000 tonnes greater than twice that of vessel B.

   Determine the tonnage of EACH of the three vessels. (8)

2. (a) Determine the value of y that satisfies the following equation: (8)

$$\frac{2-y}{15}+\frac{y}{3}=\frac{4y+5}{7}+\frac{5+y}{6}$$

   (b) The shear stress τ in a shaft of diameter D under a torque T is given by:

$$\tau=\frac{kT}{\pi D^3}$$

   Determine the approximate percentage error in calculating τ if T is measured 2% too small and D is measured 1.75% too large. (8)

3. (a) Given $a=\frac{c}{s}\left(\frac{h^2}{d-h}\right)$

   Calculate the value of $h\ \left(for\ h\rangle 0\right)$ when c = 15, a = 1.2, s = 16 and d = 18. (8)

   (b) Given: $y=\frac{3}{2x+1}+\frac{1}{x+1}-\frac{x}{2x^2+3x+1}$

   Express y as a single fraction in its simplest form. (8)

4. (a) Calculate the value of n that satisfies the following equation: (6)

$$2^{\frac{n-1}{n}} = 3^{\frac{1}{n}}$$

(b) Solve the following system of equations for x and y, giving x and y correct to 3 decimal places: (6)

$$2\ln x + 3\ln y = 8.1$$
$$5\ln x - 12\ln y = -6.5$$

(c) Determine the value of x which satisfies the following equation: (4)

$$\frac{4}{6+e^x} = 0.2$$

5. (a) Draw the graph of $y = 2\sin\theta - \cos\theta$ in the range $0 \le \theta \le 4$ radians in intervals of 0.5 radians. (10)

(b) Determine EACH of the following using the graph drawn in Q5(a):

(i) the maximum value of y; (2)

(ii) the values of θ such that $y = 0$. (4)

Suggested scales: *horizontal axis 2 cm = 0.4*
vertical axis 2 cm = 0.4

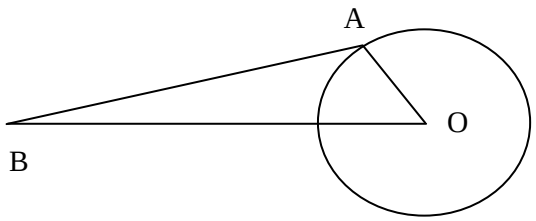
6. A crank mechanism of an engine is shown in Fig Q6. Arm OA is 100 mm long and rotates clockwise about centre O. The connecting rod AB is 300 mm long and is constrained to move horizontally.

Determine EACH of the following:

(a) the angle between the connecting rod AB and the horizontal; (5)

(b) the length of OB; (4)

(c) the distance B moves when angle AOB changes from 50° to 120°. (7)



Angle AOB = 50°

Fig Q6

7. (a) The cost, C million pounds, of pumping water at a particular hydro-electric station is related to the diameter, d, of the pipe carrying the water by the formula:

$$C = \frac{d}{2} + \frac{18}{d} + 6$$

Calculate EACH of the following:

(i) the diameter that minimises the cost; (8)

(ii) the minimum cost. (2)

(b) Given: $H = 3xy - 2y\dfrac{dy}{dx}$ and $y = x^2 - \sqrt{x}$

Calculate the value of H when $x = 4$. (6)

8. (a) Fig Q8(a) shows a sketch of the curve $y = x^2 + \frac{1}{x^2}$ in the range $\frac{1}{2} \le x \le 2$

Calculate the shaded area . (10)

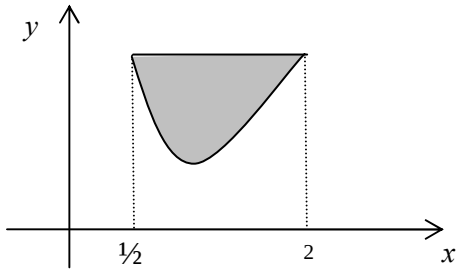


Fig Q(8a)

(b) Given: $PV^{1.12} = 72$

Evaluate $\int_1^2 P\, dV$ (6)

9. (a) Fig Q9(a) shows the cross section of a tunnel 120 metres long. The section is a segment of a circle of diameter 12 metres. The width of the base of the tunnel AB is 7.5 metres.

Determine the approximate volume of material removed to make the tunnel. (10)

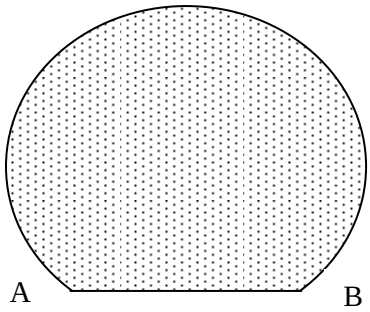


Fig Q9(a)

(b) A solid cylindrical metal bar is 400 mm long and has a diameter 160 mm. It is melted down to make small solid cylinders of diameter 15 mm and length 40 mm.

Calculate how many of these small cylinders can be made, given that 10 % is lost in the process. (6)