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, 12 DECEMBER 2013

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) Solve the following system of equations for *x* and *y*.

$$\frac{x+3}{5} - \frac{y}{4} = 5$$
$$3x + 4y = 4$$
(8)

(b) A ballast tank can be filled by pump A in 18 minutes and by another pump, B, in 15 minutes.

When a third pump, C, is used simultaneously with pumps A and B the tank can be filled in 6 minutes.

Calculate how long it would take to fill the tank using only pump C. (8)

2. (a) The coefficient of rigidity, *n*, of a wire, is directly proportional to the length, *L* and inversely proportional to the fourth power of the diameter, *d*, of the wire.

Determine the approximate percentage error in the calculated value of *n* when *L* and *d* are both measured too small by 2% and 1% respectively. (8)

(b) $$\mathrm{S} = \frac{5x+10y}{x^2-4y^2} \times \frac{x^2+xy-6y^2}{x^2+6xy+9y^2}$$

Express *S* as a single algebraic fraction in its simplest form. (8)

3. (a) Fully simplify EACH of the following:

(i) $$\frac{\left(4a^4b^2c^6\right)^{\frac{1}{2}}}{\left(2ab^2c^3\right)^2}$$ (4)

(ii) $log_2 16 + log_3 27 - log_5 25$ (4)

(b) The value of a vessel at any age can be determined from the formula:

$$R_V = C\left(1 - \frac{r}{100}\right)^n$$

where n = the age of the vessel in years

r = the rate of depreciation

C = the value of the vessel when new

R_v = the residual value of the vessel after n years

Use the formula to determine how long it will take a vessel, which cost £17 M to build and depreciates in value by 14% each year, to fall to its scrap value of £850 000. (8)

4. (a) Make M the subject of the following formula:

$$T = 4\pi\sqrt{\frac{(M+3m)l}{3(M+2m)g}}$$ (8)

(b) Solve the following equation for x when y = 2:

$$y = \frac{3}{x-2} - \frac{2}{x+1}$$ (8)

5. The torque, T newton metres, required to rotate shafts of different diameters, D millimetres, on a machine is shown in Table Q5.

(a) Verify graphically that T and D are related according to the law:

$T = aD^n$ where a and n are constants. (10)

D	12	20	25	40	50
T	2.29	5.13	7.28	15.31	21.63

Table Q5

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

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

6. (a) An observer on a level plain measures the elevation of a captive weather balloon to be 20° and after moving 300 m towards the balloon the observer measures the elevation to be 32°.

Calculate EACH of the following:

(i) the horizontal distance of the balloon from the first observation point; (8)

(ii) the height of the balloon. (2)

(b) An alternating current, i milliamps, is given by:

$i = 10\sin(100\pi t - 0.25)$ where t is the time in seconds.

Calculate the least value of t, $t > 0$, for which the current $i = 6$ milliamps. (6)

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7. A closed right cylindrical tank, of diameter *d* metres and volume 5 cubic metres, is to be fabricated from surplus sheet steel.

The seam of the cylindrical shell is welded and then the circular ends are welded to the shell as shown in Fig Q7.

The cost, *C* pounds, of welding the seams is given by the formula:

$$C = 80\pi d + \frac{800}{\pi d^2}$$

Calculate EACH of the following for the tank:

(a) the diameter that minimises the cost of welding; (6)

(b) the minimum cost of the welding; (3)

(c) the height of the tank for minimum welding cost; (3)

(d) the cost of the welding per metre length. (4)

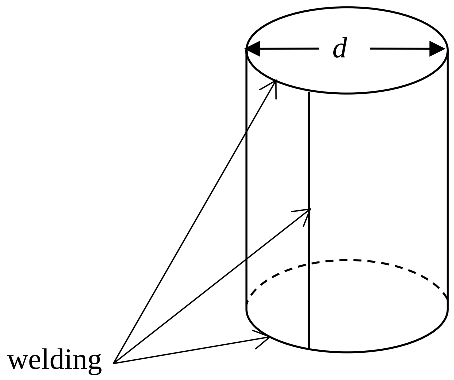

Fig Q7

8. Calculate the shaded area between the curve $y = 4 - x^2$ and the line $y = 3x$, as shown in Fig Q8. (16)

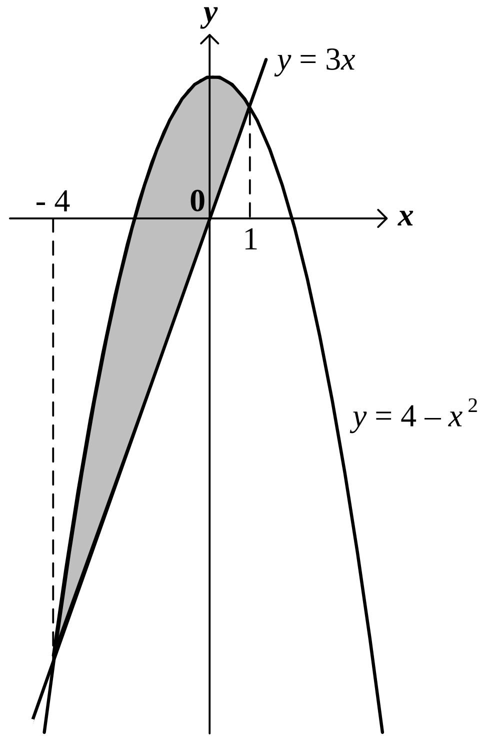

Fig Q8

9. A solid is in the form of a right pyramid standing on an octagonal base.

Each side of the octagonal base is 20 centimetres and the vertical height of the pyramid is 100 centimetres.

Calculate the surface area of the pyramid including the base. (16)