Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Mock Paper Set 2

(Time: 1 hour 30 minutes) | Paper Reference **9FM0/02**

Further Mathematics

Advanced

Paper 2: Core Pure Mathematics 2

You must have:
Mathematical Formulae and Statistical Tables (Green), calculator

Total Marks

Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for algebraic manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 9 questions in this question paper. The total mark for this paper is 75.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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1. With respect to a fixed origin O, the lines l_1 and l_2 are given by the equations

$$l_1 : \mathbf{r} = (10\mathbf{i} - 9\mathbf{k}) + \lambda(-\mathbf{i} + \mathbf{j} + 2\mathbf{k})$$

$$l_2 : \mathbf{r} = (17\mathbf{i} + \mathbf{j} + 3\mathbf{k}) + \mu(5\mathbf{i} - \mathbf{j} + 3\mathbf{k})$$

where λ and μ are scalar parameters.

Show that l_1 and l_2 meet and find the position vector of their point of intersection.

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Question 1 continued

(Total for Question 1 is 6 marks)

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2. $$f(x) = \ln(1 + x) \qquad -1 < x \leqslant 1$$

(a) Use differentiation to show that the first four non-zero terms of the Maclaurin series of f(x) are

$$x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4}$$

(5)

(b) Use the result in part (a) to find the first four non-zero terms of the series expansion of

$$\ln\left(\frac{1 + 2x}{(1 - 2x)^2}\right)$$

(3)

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Question 2 continued

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Question 2 continued

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3.

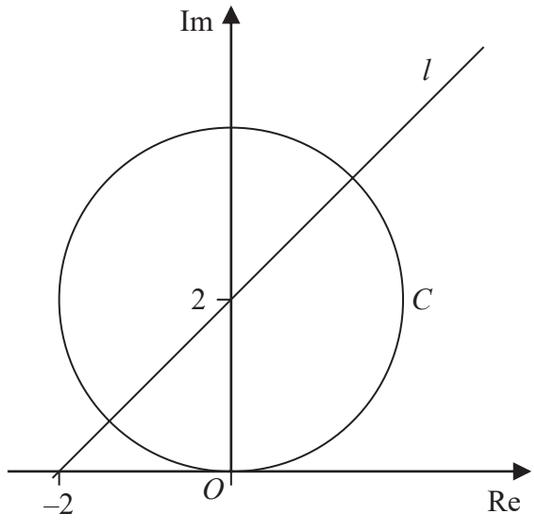

Figure 1

The Argand diagram, shown in Figure 1, shows a circle C and a half-line l.

(a) Write down the equation of the locus of points represented in the complex plane by

(i) the circle C,

(ii) the half-line l.

(2)

(b) Use set notation to describe the set of points that lie on both C and l.

(1)

(c) Find the complex numbers that lie on both C and l, giving your answers in the form $a + \mathrm{i}b$, where $a, b \in \mathbb{R}$.

(3)

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Question 3 continued

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4. The value V, in thousands of pounds, of a new car, t years after it is first sold, is modelled by the differential equation

$$5\frac{\mathrm{d}V}{\mathrm{d}t} + 2V = 5\mathrm{e}^{-0.4t}\cos\left(\frac{t}{2}\right) \qquad t \geqslant 0$$

Given that the value of the car when it is first sold is £10 000

(a) find, according to the model, the value of the car 8 years after it was first sold.

(5)

(b) Give a limitation of the model.

(1)

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Question 4 continued

(Total for Question 4 is 6 marks)

5. (a) Use the standard results for $\sum_{r=1}^{n} r^2$ and $\sum_{r=1}^{n} r$ to show that

$$\sum_{r=1}^{n} r(r+1) = \frac{n}{3}(n+a)(n+b)$$

where a and b are integers to be determined.

(4)

(b) Hence show that

$$\log 9 + 2\log 27 + 3\log 81 + \ldots + 11\log(531\,441)$$

can be written in the form $p\log q$, where p and q are integers to be determined.

(4)

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Question 5 continued

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6.

Figure 2

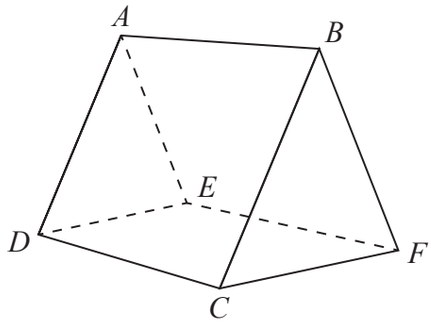

Figure 3

A tent is shown in Figure 2.
The tent is modelled as a triangular prism *ABCDEF* shown in Figure 3.

The side *ABCD* is modelled by part of the plane with Cartesian equation

$$2x + 3y - 4z = 1$$

The side *ABFE* is modelled by part of the plane with Cartesian equation

$$8x + 12y + 15z = 252$$

(a) Find, according to the model, the acute angle between these two sides of the tent. Give your answer to the nearest degree.

(3)

These two sides of the tent meet along the straight line *AB*.

(b) Show, according to the model, that the point P (6, 7, 8) lies on this straight line.

(2)

One end of a rope is attached to the top of the tent at the point *P*. The other end is pegged into the ground at the point *Q*. The rope is modelled as a straight line and, according to the model, *Q* has coordinates (–4, –3, 0)

(c) Find, according to the model, the acute angle between the rope *PQ* and the side *ABCD* of the tent. Give your answer to the nearest degree.

(5)

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Question 6 continued

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Question 6 continued

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7. (a) By writing $\tanh x$ in terms of exponentials, show that

$$\tanh^{-1} x = \frac{1}{2}\ln\left(\frac{1+x}{1-x}\right)$$

(3)

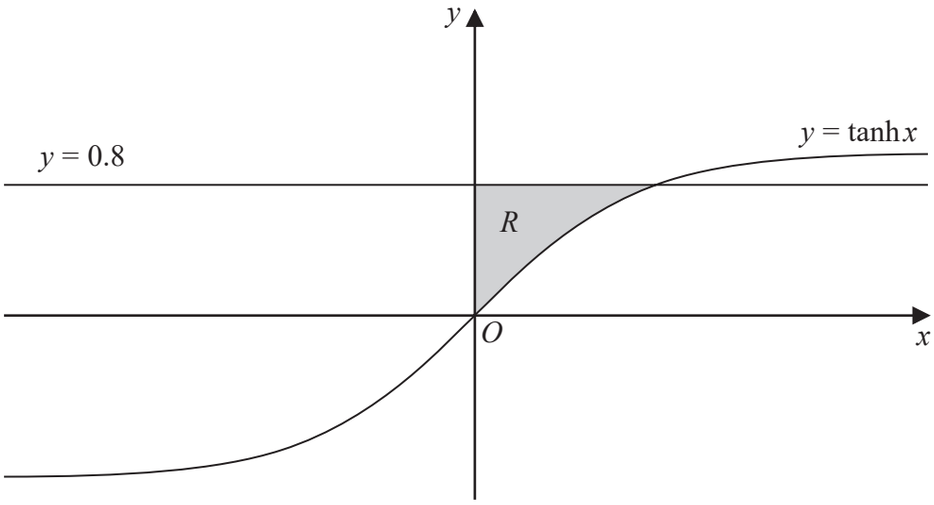

Figure 4

Figure 4 shows a sketch of part of the curve with equation $y = \tanh x$ and the line with equation $y = 0.8$

The finite region R, shown shaded in Figure 4, is bounded by the curve, the line with equation $y = 0.8$ and the y-axis.

The region R is rotated through 2π radians about the x-axis to form a solid of revolution.

(b) Determine the exact value of the volume of this solid of revolution, giving your answer in the form $\pi(a - b\ln 3)$, where a and b are simplified constants to be found.

(7)

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Question 7 continued

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Question 7 continued

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8.

$$\mathbf{M} = \begin{pmatrix} 1 & 4 & -1 \\ 3 & 0 & p \\ q & r & s \end{pmatrix}$$

where p, q, r and s are constants and $q > 0$

Given that $\mathbf{M}\mathbf{M}^{\mathrm{T}} = k\mathbf{I}$ for some constant k,

(a) show that $p = 3$

(2)

(b) write down the value of k.

(1)

(c) Hence write down $\mathbf{M}^{-1}$ in terms of q, r and s.

(1)

(d) Determine the exact value of q, the exact value of r and the exact value of s.

(6)

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Question 8 continued

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Question 8 continued

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9. (a) Show that $e^{2i\theta} + e^{-2i\theta} = 2\cos 2\theta$

(2)

The convergent infinite series C and S are defined as

$$C = 1 + \frac{1}{4}\cos 2\theta + \frac{1}{16}\cos 4\theta + \frac{1}{64}\cos 6\theta + \ldots$$

$$S = \frac{1}{4}\sin 2\theta + \frac{1}{16}\sin 4\theta + \frac{1}{64}\sin 6\theta + \ldots$$

(b) Show that

$$C + iS = \frac{k}{k - e^{2i\theta}}$$

where k is an integer to be determined.

(3)

(c) Show that

$$C = \frac{16 - 4\cos 2\theta}{17 - 8\cos 2\theta}$$

(3)

(d) Hence determine the values of θ, in the range $0 \leqslant \theta \leqslant \pi$, for which $C + iS$ is real.

(3)

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Question 9 continued

Question 9 continued

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TOTAL FOR PAPER IS 75 MARKS

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