

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Pearson Edexcel
Level 3 GCE

Centre Number

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Candidate Number

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Specimen Paper

(Time: 1 hour 30 minutes)

Paper Reference **9FM0/01**

Further Mathematics

Advanced

Paper 1: Core Pure Mathematics 1

You must have:

Mathematical Formulae and Statistical Tables, 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 8 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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Answer ALL questions. Write your answers in the spaces provided.

1. Solve the equation

$$6 \cosh 2x + 4 \sinh x = 7$$

giving your answers as exact logarithms.

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Question 1 continued

Lined area for writing the answer to Question 1.

(Total for Question 1 is 6 marks)



2. A company runs three theme parks, A (Aztec Adventureland), B (Babylonian Towers) and C (Carthaginian Kingdom).

It is known that park A makes a profit of £30 per visitor, park B makes a profit of £26 per visitor and park C makes a profit of £33 per visitor.

In 2017 the Aztec Adventureland park was upgraded, which took one year to carry out. During 2017

- park *A* had only 50% of the number of visitors it had in 2016
- park *B* had 25% more than the number of visitors it had in 2016
- park *C* had 15% more than the number of visitors it had in 2016

In total 1 350 000 people visited the three theme parks during 2017.

The company made a total profit from the parks of £39.15 million in 2016. The profits dropped by 1% for 2017.

Form and solve a matrix equation to find, to 2 significant figures, the number of visitors for each of the theme parks in 2016.

(8)

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Question 2 continued

Lined area for writing the answer to Question 2.

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Question 2 continued

Lined area for writing the answer to Question 2.

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Question 2 continued

Lined area for writing the answer to Question 2.

(Total for Question 2 is 8 marks)



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Question 3 continued

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Question 3 continued

Lined area for writing the answer to Question 3.

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Question 3 continued

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(Total for Question 3 is 10 marks)



4.

$$f(x) = \begin{cases} \frac{kx}{x^2 + 6} & \text{for } 0 \leq x < 3 \\ \frac{k}{x^2 - 4} & \text{for } 3 \leq x \end{cases}$$

where k is a positive constant.

The area between the curve $y = f(x)$ and the positive x -axis is $\frac{1}{4}$

Show that

$$k = \frac{1}{\ln a}$$

where a is a constant to be determined.

(8)

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Question 4 continued

Lined area for writing the answer to Question 4.

(Total for Question 4 is 8 marks)



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Question 5 continued

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Question 5 continued

Lined area for writing the answer to Question 5.

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Question 5 continued

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(Total for Question 5 is 9 marks)



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(2)

Question 6 continued

Lined area for writing the answer to Question 6.

(Total for Question 6 is 9 marks)



7. (i) Prove by induction that, for $n \in \mathbb{N}$,

$$\begin{pmatrix} 4 & -1 \\ 9 & -2 \end{pmatrix}^n = \begin{pmatrix} 3n+1 & -n \\ 9n & 1-3n \end{pmatrix}$$

(6)

(ii) Consider the statement

$$n^2 < 2^n \quad \text{for all } n \in \mathbb{Z}^+$$

A student attempts to prove this statement using induction as follows.

Student's response

For $n = 1$ we have $1^2 = 1$ and $2^1 = 2$

Since $1 < 2$ the statement is true for $n = 1$

Suppose it is true for $n = k$, so $k^2 < 2^k$

Line 4 →

$$\begin{aligned} \text{Then } (k+1)^2 &= k^2 + 2k + 1 < k^2 + k^2 && (\text{since } 2k + 1 < k^2 \text{ for } k \in \mathbb{Z}^+) \\ &= 2k^2 \\ &< 2 \times 2^k && (\text{by the assumption } k^2 < 2^k) \\ &= 2^{k+1} \end{aligned}$$

Hence the result is true for $n = k + 1$

So the result is true for $n = 1$ and if it is true for $n = k$ then it is true for $n = k + 1$, and hence it is true for all positive integers n by mathematical induction.

(a) Show by a counterexample that the statement is not true.

Given that the only mathematical error in the student's proof occurs in line 4,

(b) identify the error made in the student's proof,

(c) hence determine for which positive integers the statement is true, explaining your reasoning.

(5)



Question 7 continued

Lined area for writing the answer to Question 7 continued.

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Question 7 continued

Lined area for writing the answer to Question 7.

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Question 7 continued

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(Total for Question 7 is 11 marks)



8. A large container initially contains 3 litres of pure water.

Contaminated water starts pouring into the container at a constant rate of 250 ml per minute and you may assume the contaminant dissolves completely.

At the same time, the container is drained at a constant rate of 125 ml per minute. The water in the container is continually mixed.

The amount of contaminant in the water pouring into the container, at time t minutes after pouring began, is modelled to be $(5 - e^{-0.1t})$ mg per litre.

Let m be the amount of contaminant, in milligrams, in the container at time t minutes after the contaminated water begins pouring into the container.

- (a) (i) Write down an expression for the total volume of water in litres in the container at time t .
- (ii) Hence show that the amount of contaminant in the container can be modelled by the differential equation

$$\frac{dm}{dt} = \frac{5 - e^{-0.1t}}{4} - \frac{m}{24 + t} \quad (4)$$

- (b) By solving the differential equation, find an expression for the amount of contaminant, in milligrams, in the container t minutes after the contaminated water begins to be poured into the container.

After 30 minutes, the concentration of contaminant in the water was measured as 3.79 mg per litre.

- (c) Assess the model in light of this information, giving a reason for your answer.



Question 8 continued

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Question 8 continued

Lined area for writing the answer to Question 8.

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Question 8 continued

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Question 8 continued

Lined area for writing answers.

(Total for Question 8 is 14 marks)

TOTAL FOR PAPER IS 75 MARKS

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