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Candidate surname		Other names	
Pearson Edexcel Level 3 GCE		Centre Number	Candidate Number
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Thursday 13 June 2019			
Afternoon (Time: 1 hour 30 minutes)		Paper Reference 9FM0/3A	
Further Mathematics Advanced Paper 3A: Further Pure Mathematics 1			
You must have: Mathematical Formulae and Statistical Tables (Green), calculator			Total Marks <div style="border: 1px solid black; height: 40px; width: 80px; margin: 0 auto;"></div>

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. Use Simpson's rule with 4 intervals to estimate

$$\int_{0.4}^2 e^{x^2} dx$$

(5)

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Question 1 continued

Lined area for writing the answer to Question 1.

(Total for Question 1 is 5 marks)



2. Given that k is a real non-zero constant and that

$$y = x^3 \sin kx$$

use Leibnitz's theorem to show that

$$\frac{d^5 y}{dx^5} = (k^2 x^2 + A)k^3 x \cos kx + B(k^2 x^2 + C)k^2 \sin kx$$

where A , B and C are integers to be determined.

(4)



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Question 2 continued

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(Total for Question 2 is 4 marks)



3.

$$\frac{dy}{dx} = x - y^2 \quad (\text{I})$$

(a) Show that

$$\frac{d^5 y}{dx^5} = ay \frac{d^4 y}{dx^4} + b \frac{dy}{dx} \frac{d^3 y}{dx^3} + c \left(\frac{d^2 y}{dx^2} \right)^2$$

where a , b and c are integers to be determined.

(4)

(b) Hence find a series solution, in ascending powers of x as far as the term in x^5 , of the differential equation (I), given that $y = 1$ at $x = 0$

(5)

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Question 3 continued

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Question 3 continued

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Question 3 continued

Lined area for writing the answer to Question 3.

(Total for Question 3 is 9 marks)



4. The parabola C has equation

$$y^2 = 16x$$

The distinct points $P(p^2, 4p)$ and $Q(q^2, 4q)$ lie on C , where $p \neq 0$, $q \neq 0$

The tangent to C at P and the tangent to C at Q meet at the point $R(-28, 6)$.

Show that the area of triangle PQR is 1331

(8)



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Question 4 continued

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Question 4 continued

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5.

$$I = \int \frac{1}{4 \cos x - 3 \sin x} dx \quad 0 < x < \frac{\pi}{4}$$

Use the substitution $t = \tan\left(\frac{x}{2}\right)$ to show that

$$I = \frac{1}{5} \ln \left(\frac{2 + \tan\left(\frac{x}{2}\right)}{1 - 2 \tan\left(\frac{x}{2}\right)} \right) + k$$

where k is an arbitrary constant.

(8)



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Question 5 continued

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Question 5 continued

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Question 5 continued

Lined area for writing the answer to Question 5.

(Total for Question 5 is 8 marks)



6. The concentration of a drug in the bloodstream of a patient, t hours after the drug has been administered, where $t \leq 6$, is modelled by the differential equation

$$t^2 \frac{d^2 C}{dt^2} - 5t \frac{dC}{dt} + 8C = t^3 \quad (\text{I})$$

where C is measured in micrograms per litre.

- (a) Show that the transformation $t = e^x$ transforms equation (I) into the equation

$$\frac{d^2C}{dx^2} - 6\frac{dC}{dx} + 8C = e^{3x} \quad (\text{II})$$

- (b) Hence find the general solution for the concentration C at time t hours.

Given that when $t = 6$, $C = 0$ and $\frac{dC}{dt} = -36$

- (c) find the maximum concentration of the drug in the bloodstream of the patient.



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Question 6 continued

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Question 6 continued

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Question 6 continued

Lined area for writing the answer to Question 6.



Question 6 continued

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7. With respect to a fixed origin O , the points A , B and C have coordinates $(3, 4, 5)$, $(10, -1, 5)$ and $(4, 7, -9)$ respectively.

The plane Π has equation $4x - 8y + z = 2$

The line segment AB meets the plane Π at the point P and the line segment BC meets the plane Π at the point Q .

- (a) Show that, to 3 significant figures, the area of quadrilateral $APQC$ is 38.5 (6)

The point D has coordinates $(k, 4, -1)$, where k is a constant.

Given that the vectors \overrightarrow{AB} , \overrightarrow{AC} and \overrightarrow{AD} form three edges of a parallelepiped of volume 226

- (b) find the possible values of the constant k . (4)



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Question 7 continued

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Question 7 continued

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Question 7 continued

Lined area for writing the answer to Question 7.

(Total for Question 7 is 10 marks)



8. The hyperbola H has equation

$$\frac{x^2}{16} - \frac{y^2}{9} = 1$$

The line l_1 is the tangent to H at the point $P(4\cosh \theta, 3\sinh \theta)$.

The line l_1 meets the x -axis at the point A .

The line l_2 is the tangent to H at the point $(4, 0)$.

The lines l_1 and l_2 meet at the point B and the midpoint of AB is the point M .

- (a) Show that, as θ varies, a Cartesian equation for the locus of M is

$$y^2 = \frac{9(4-x)}{4x} \quad p < x < q$$

where p and q are values to be determined.

(11)

Let S be the focus of H that lies on the positive x -axis.

- (b) Show that the distance from M to S is greater than 1

(3)



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Question 8 continued

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Question 8 continued

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Question 8 continued

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Question 8 continued

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(Total for Question 8 is 14 marks)

TOTAL FOR PAPER IS 75 MARKS

