Please check the examination details below before entering your candidate information

| Candidate surname | Other names |
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**Pearson Edexcel Level 3 GCE**

Centre Number | Candidate Number

**Paper reference** **8FM0/21**

# Further Mathematics

## Advanced Subsidiary
## Further Mathematics options
## 21: Further Pure Mathematics 1
## (Part of options A, B, C and D)

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

Total Marks

**Candidates may use any calculator allowed by Pearson regulations. Calculators must not have the facility for symbolic algebra 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.
- Inexact answers should be given to three significant figures unless otherwise stated.

## Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- The total mark for this part of the examination is 40. There are 5 questions.
- 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.
- Good luck with your examination.

*Turn over*


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**1.** Use algebra to determine the values of $x$ for which

$$x(x-1) > \frac{x-1}{x}$$

giving your answer in set notation.

**(6)**

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**Question 1 continued**

**(Total for Question 1 is 6 marks)**

**2.** The variables $x$ and $y$ satisfy the differential equation

$$\frac{d^2y}{dx^2} + 15\frac{dy}{dx} - 3y^2 = 2x$$

where $y = 1$ at $x = 0$ and where $y = 2$ at $x = 0.1$

Use the approximations

$$\left(\frac{d^2y}{dx^2}\right)_n \approx \frac{\left(y_{n+1} - 2y_n + y_{n-1}\right)}{h^2} \text{ and } \left(\frac{dy}{dx}\right)_n \approx \frac{\left(y_{n+1} - y_{n-1}\right)}{2h}$$

with $h = 0.1$ to find an estimate for the value of $y$ when $x = 0.3$

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**Question 2 continued**

**Question 2 continued**

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**Question 2 continued**

**(Total for Question 2 is 6 marks)**

**3.** On a particular day, the depth of water in a river estuary at a specific location is modelled by the equation

$$D = 2\sin\left(\frac{x}{3}\right) + 3\cos\left(\frac{x}{3}\right) + 6 \qquad 0 \leqslant x \leqslant 7\pi \qquad \text{(I)}$$

where the depth of water is $D$ metres at time $x$ hours after midnight on that day.

(a) Write down the depth of water at midnight, according to the model.

**(1)**

Using the substitution $t = \tan\left(\frac{x}{6}\right)$

(b) show that equation (I) can be re-written as

$$D = \frac{3t^2 + 4t + 9}{1 + t^2}$$

**(3)**

(c) Hence determine, according to the model, the time after midnight when the depth of water is 5 metres for the first time. Give your answer to the nearest minute.

**(5)**

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**Question 3 continued**

**Question 3 continued**

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**Question 3 continued**

**(Total for Question 3 is 9 marks)**

**4.** With respect to a fixed origin $O$, the points $A$, $B$ and $C$ have position vectors given by

$$\overrightarrow{OA} = 18\mathbf{i} - 14\mathbf{j} - 2\mathbf{k} \quad \overrightarrow{OB} = -7\mathbf{i} - 5\mathbf{j} + 3\mathbf{k} \quad \overrightarrow{OC} = -2\mathbf{i} - 9\mathbf{j} - 6\mathbf{k}$$

The points $O$, $A$, $B$ and $C$ form the vertices of a tetrahedron.

(a) Show that the area of the triangular face $ABC$ of the tetrahedron is 108 to 3 significant figures.

**(3)**

(b) Find the volume of the tetrahedron.

**(4)**

An oak wood block is made in the shape of the tetrahedron, with centimetres taken for the units.

The density of oak is $0.85\,\text{g}\,\text{cm}^{-3}$

(c) Determine the mass of the block, giving your answer in kg.

**(2)**

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**Question 4 continued**

**Question 4 continued**

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**Question 4 continued**

**(Total for Question 4 is 9 marks)**

**5.** The point $P\ (ap^2, 2ap)$, where $a$ is a positive constant, lies on the parabola with equation

$$y^2 = 4ax$$

The normal to the parabola at $P$ meets the parabola again at the point $Q\ (aq^2, 2aq)$

(a) Show that

$$q = \frac{-p^2 - 2}{p}$$

**(5)**

(b) Hence show that

$$PQ^2 = \frac{ka^2}{p^4}\left(p^2 + 1\right)^n$$

where $k$ and $n$ are integers to be determined.

**(5)**

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**Question 5 continued**

**Question 5 continued**

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**Question 5 continued**

**Question 5 continued**

**(Total for Question 5 is 10 marks)**

**TOTAL FOR FURTHER PURE MATHEMATICS 1 IS 40 MARKS**

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