

Please check the examination details below before entering your candidate information

Candidate surname					Other names				
Centre Number					Candidate Number				

**Pearson Edexcel International Advanced Level**

**Tuesday 4 June 2024**

Morning (Time: 1 hour 30 minutes)      Paper reference **WFM02/01**

**Mathematics**

**International Advanced Subsidiary/ Advanced Level**

**Further Pure Mathematics F2**

**You must have:**  
Mathematical Formulae and Statistics Tables (Yellow), calculator

Total Marks

**Candidates may use any calculator permitted 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.
- There are 10 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.
- If you change your mind about an answer, cross it out and put your new answer and any working underneath.

Turn over ►

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1. The complex number  $z = x + iy$  satisfies the equation

$$|z - 3 - 4i| = |z + 1 + i|$$

- (a) Determine an equation for the locus of  $z$  giving your answer in the form  $ax + by + c = 0$  where  $a$ ,  $b$  and  $c$  are integers.

(3)

- (b) Shade, on an Argand diagram, the region defined by

$$|z - 3 - 4i| \leq |z + 1 + i|$$

You do **not** need to determine the coordinates of any intercepts on the coordinate axes.

(1)



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Question 1 continued

Lined area for writing answers.

(Total for Question 1 is 4 marks)



2.

$$x \frac{dy}{dx} - y^3 = 4$$

(a) Show that

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

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

(4)

Given that  $y = 1$  at  $x = 2$ (b) determine the Taylor series expansion for  $y$  in ascending powers of  $(x - 2)$ , up to and including the term in  $(x - 2)^3$ , giving each coefficient in simplest form.

(3)



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Question 2 continued

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(Total for Question 2 is 7 marks)



3. (a) Express

$$\frac{1}{(n+3)(n+5)}$$

in partial fractions.

(2)

(b) Hence, using the method of differences, show that for all positive integer values of  $n$ ,

$$\sum_{r=1}^n \frac{1}{(r+3)(r+5)} = \frac{n(pn+q)}{40(n+4)(n+5)}$$

where  $p$  and  $q$  are integers to be determined.

(4)

(c) Use the answer to part (b) to determine, as a simplified fraction, the value of

$$\frac{1}{9 \times 11} + \frac{1}{10 \times 12} + \dots + \frac{1}{24 \times 26}$$

(2)



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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 8 marks)





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Question 4 continued

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(Total for Question 4 is 9 marks)



5.

**In this question you must show all stages of your working.****Solutions relying entirely on calculator technology are not acceptable.**Use algebra to determine the values of  $x$  for which

$$\frac{x+1}{(x-3)(x+2)} \leq 1 - \frac{2}{x-3}$$

(6)



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Question 5 continued

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Question 5 continued

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Question 5 continued

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(Total for Question 5 is 6 marks)



6. The transformation  $T$  from the  $z$ -plane to the  $w$ -plane is given by

$$w = \frac{z-i}{z+1} \quad z \neq -1$$

Given that  $T$  maps the imaginary axis in the  $z$ -plane to the circle  $C$  in the  $w$ -plane, determine

- (i) the coordinates of the centre of  $C$   
(ii) the radius of  $C$

(7)





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Question 6 continued

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Question 6 continued

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Question 6 continued

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(Total for Question 6 is 7 marks)





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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 answers.

(Total for Question 7 is 7 marks)



$$\frac{d^2 y}{dx^2} = e^{-2t} \left( \frac{d^2 y}{dt^2} - \frac{dy}{dt} \right) \quad (3)$$

$$x^2 \frac{d^2 y}{dx^2} - 2y = 1 + 4 \ln x - 2(\ln x)^2 \quad (\text{I})$$

$$\frac{d^2y}{dt^2} - \frac{dy}{dt} - 2y = 1 + 4t - 2t^2 \quad (1)$$

(c) Solve differential equation (II) to determine  $y$  in terms of  $t$ . (5)

(d) Hence determine the general solution of differential equation (I). (1)



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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 10 marks)



9.

**In this question you must show all stages of your working.**

**Solutions relying entirely on calculator technology are not acceptable.**

(a) Use De Moivre's theorem to show that

$$\cos 6\theta \equiv 32\cos^6\theta - 48\cos^4\theta + 18\cos^2\theta - 1 \quad (4)$$

(b) Hence determine the smallest positive root of the equation

$$48x^6 - 72x^4 + 27x^2 - 1 = 0$$

giving your answer to 3 decimal places. (4)

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Question 9 continued

Lined area for writing the answer to Question 9.



Question 9 continued

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Question 9 continued

Handwriting practice area with horizontal lines.

(Total for Question 9 is 8 marks)



10.

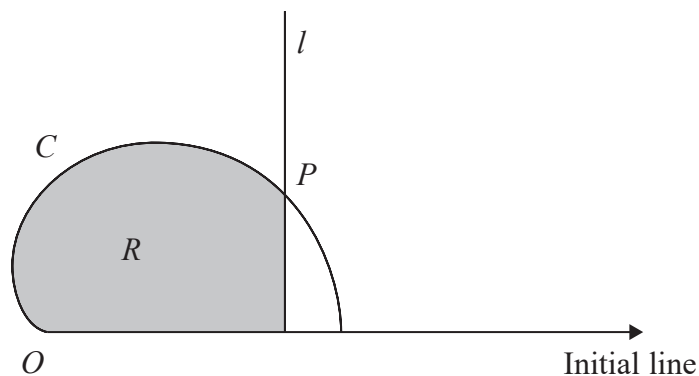


Figure 1

Figure 1 shows a sketch of the curve  $C$  with polar equation

$$r = 1 + \cos \theta \quad 0 \leq \theta \leq \pi$$

and the line  $l$  with polar equation

$$r = k \sec \theta \quad 0 \leq \theta < \frac{\pi}{2}$$

where  $k$  is a positive constant.

Given that

- $C$  and  $l$  intersect at the point  $P$
- $OP = 1 + \frac{\sqrt{3}}{2}$

(a) determine the exact value of  $k$ .

(2)

The finite region  $R$ , shown shaded in Figure 1, is bounded by  $C$ , the initial line and  $l$ .

(b) Use algebraic integration to show that the area of  $R$  is

$$p\pi + q\sqrt{3} + r$$

where  $p$ ,  $q$  and  $r$  are simplified rational numbers to be determined.

(7)





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Question 10 continued

Lined area for writing the answer to Question 10.



Question 10 continued

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Question 10 continued

Lined area for writing the answer to Question 10.



**Question 10 continued**

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**(Total for Question 10 is 9 marks)**

**TOTAL FOR PAPER IS 75 MARKS**

