

Please check the examination details below before entering your candidate information

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| Candidate surname    |                      | Other names          |                      |
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**Pearson Edexcel International Advanced Level**

**Time** 1 hour 30 minutes

**Paper reference** **WFM01/01**

**Mathematics**

**International Advanced Subsidiary/ Advanced Level**

**Further Pure Mathematics F1**

**You must have:**  
Mathematical Formulae and Statistics Tables (Yellow), 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.
- 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.
- 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. Given that

$$\mathbf{A} = \begin{pmatrix} 2 & -1 & 3 \\ -2 & 3 & 0 \end{pmatrix} \text{ and } \mathbf{B} = \begin{pmatrix} 1 & k \\ 0 & -3 \\ 2k & 2 \end{pmatrix}$$

where  $k$  is a non-zero constant,

(a) determine the matrix  $\mathbf{AB}$  (2)

(b) determine the value of  $k$  for which  $\det(\mathbf{AB}) = 0$  (3)



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Question 1 continued

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(Total for Question 1 is 5 marks)



2.

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

Solutions relying entirely on calculator technology are not acceptable.

Use the standard results for  $\sum_{r=1}^n r$  and  $\sum_{r=1}^n r^2$  to show that for all positive integers  $n$

$$\sum_{r=1}^n (7r - 5)^2 = \frac{n}{6}(7n + 1)(An + B)$$

where  $A$  and  $B$  are integers to be determined.

(6)



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Question 2 continued

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(Total for Question 2 is 6 marks)



3.

**In this question you must show all stages of your working.****Solutions relying entirely on calculator technology are not acceptable.**

$$f(z) = 4z^3 + pz^2 - 24z + 108$$

where  $p$  is a constant.

Given that  $-3$  is a root of the equation  $f(z) = 0$

(a) determine the value of  $p$  (2)

(b) using algebra, solve  $f(z) = 0$  completely, giving the roots in simplest form, (4)

(c) determine the modulus of the complex roots of  $f(z) = 0$  (2)

(d) show the roots of  $f(z) = 0$  on a single Argand diagram. (2)



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Question 3 continued

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Question 3 continued

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Question 3 continued

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(Total for Question 3 is 10 marks)





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Question 4 continued

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Question 4 continued

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Question 4 continued

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(Total for Question 4 is 8 marks)



## 5. The quadratic equation

$$4x^2 + 3x + k = 0$$

where  $k$  is an integer, has roots  $\alpha$  and  $\beta$

(a) Write down, in terms of  $k$  where appropriate, the value of  $\alpha + \beta$  and the value of  $\alpha\beta$  (2)

(b) Determine, in simplest form in terms of  $k$ , the value of  $\frac{\alpha}{\beta^2} + \frac{\beta}{\alpha^2}$  (4)

(c) Determine a quadratic equation which has roots

$$\frac{\alpha}{\beta^2} \text{ and } \frac{\beta}{\alpha^2}$$

giving your answer in the form  $px^2 + qx + r = 0$  where  $p$ ,  $q$  and  $r$  are integer values in terms of  $k$

(3)



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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 9 marks)



**6.**

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

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

The rectangular hyperbola  $H$  has equation  $xy = 20$

The point  $P\left(2t\sqrt{a}, \frac{2\sqrt{a}}{t}\right)$ ,  $t \neq 0$ , where  $a$  is a constant, is a general point on  $H$

- (a) State the value of  $a$  **(1)**
- (b) Show that the normal to  $H$  at the point  $P$  has equation

$$ty - t^3x - 2\sqrt{5}(1 - t^4) = 0 \quad (4)$$

The points  $A$  and  $B$  lie on  $H$

The point  $A$  has parameter  $t = c$  and the point  $B$  has parameter  $t = -\frac{1}{2c}$ , where  $c$  is a constant.

The normal to  $H$  at  $A$  meets  $H$  again at  $B$

- (c) Determine the possible values of  $c$  (4)

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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 9 marks)



**7. (i)**

$$\mathbf{P} = \begin{pmatrix} 0 & -1 \\ -1 & 0 \end{pmatrix}$$

The matrix  $\mathbf{P}$  represents a geometrical transformation  $U$

- (a) Describe  $U$  fully as a single geometrical transformation. (2)

The transformation  $V$ , represented by the  $2 \times 2$  matrix  $\mathbf{Q}$ , is a rotation through  $240^\circ$  anticlockwise about the origin followed by an enlargement about  $(0, 0)$  with scale factor 6

- (b) Determine the matrix  $\mathbf{Q}$ , giving each entry in exact numerical form. (2)

Given that  $U$  followed by  $V$  is the transformation  $T$ , which is represented by the matrix  $\mathbf{R}$

- (c) determine the matrix  $\mathbf{R}$  (2)

- (ii) The transformation  $W$  is represented by the matrix

$$\begin{pmatrix} -2 & 2\sqrt{3} \\ 2\sqrt{3} & 2 \end{pmatrix}$$

Show that there is a real number  $\lambda$  for which  $W$  maps the point  $(\lambda, 1)$  onto the point  $(4\lambda, 4)$ , giving the exact value of  $\lambda$

(5)



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Question 7 continued

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Question 7 continued

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Question 7 continued

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(Total for Question 7 is 11 marks)



8. A parabola  $C$  has equation  $y^2 = 4ax$  where  $a$  is a positive constant.

The point  $S$  is the focus of  $C$

The line  $l_1$  with equation  $y = k$  where  $k$  is a positive constant, intersects  $C$  at the point  $P$

(a) Show that

$$PS = \frac{k^2 + 4a^2}{4a} \quad (3)$$

The line  $l_2$  passes through  $P$  and intersects the directrix of  $C$  on the  $x$ -axis.

The line  $l_2$  intersects the  $y$ -axis at the point  $A$

(b) Show that the  $y$  coordinate of  $A$  is  $\frac{4a^2k}{k^2 + 4a^2}$  **(3)**

The line  $l_1$  intersects the directrix of  $C$  at the point  $B$

Given that the areas of triangles  $BPA$  and  $OSP$ , where  $O$  is the origin, satisfy the ratio

$$\text{area } BPA : \text{area } OSP = 4k^2 : 1$$

(c) determine the exact value of  $a$  (5)



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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 11 marks)



9. Prove by induction that for all positive integers  $n$

$$\sum_{r=1}^n \log(2r-1) = \log\left(\frac{(2n)!}{2^n n!}\right) \quad (6)$$



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Question 9 continued

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**Question 9 continued**

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**(Total for Question 9 is 6 marks)**

**TOTAL FOR PAPER IS 75 MARKS**

