OXFORD AQA

INTERNATIONAL QUALIFICATIONS

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

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I declare this is my own work.

INTERNATIONAL AS
FURTHER MATHEMATICS

(9665/FM02) Unit FPSM1 Pure Mathematics, Statistics and Mechanics

Wednesday 21 May 2025 07:00 GMT Time allowed: 1 hour 30 minutes

Materials
- For this paper you must have the OxfordAQA Booklet of Formulae and Statistical Tables (enclosed).
- You may use a graphical calculator.

Instructions
- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- There are three sections to this paper.
- The maximum mark for this paper is 80. There are 40 marks for **Section A**, 20 marks for **Section B** and 20 marks for **Section C**.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
TOTAL	

Advice
- Unless stated otherwise, you may quote formulae, without proof, from the booklet.
- Show all necessary working; otherwise marks may be lost.

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Section A

Pure Mathematics

Answer **all** questions in the spaces provided.

1 The matrix **A** is defined by $\mathbf{A} = \begin{bmatrix} 1.2 & 0.4 - p \\ 0.4 + p & 1.8 \end{bmatrix}$ where p is a constant.

1 (a) Find in terms of p the determinant of **A**

[2 marks]

Answer _____

1 (b) The matrix **B** is defined by $\mathbf{B} = \begin{bmatrix} 1 & 0 \\ k & 1 \end{bmatrix}$ where k is a constant.

1 (b) (i) Describe the transformation represented by the matrix **B**

[1 mark]

1 (b) (ii) The point (3, 2) is mapped to the point (3, –4) by the transformation represented by **B**

Find the value of k

[2 marks]

Answer _____

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1 (c) The matrix **C** represents the following sequence of transformations:

- the transformation represented by **B**

followed by

- the transformation represented by **A**

Find in terms of p the matrix **C**

[3 marks]

Answer _____

8

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2 A curve passes through the point (2, 5) and satisfies the differential equation

$$\frac{dy}{dx} = \frac{1}{2^x - \sqrt{y}}$$

Use Euler's step-by-step method with a step length of 0.05 to estimate the value of y when $x = 2.1$

Give your answer to three decimal places.

[5 marks]

Answer _____

5

Turn over for the next question

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3 The variables x and y are related by the equation

$$y = Ax^2 + Bx$$

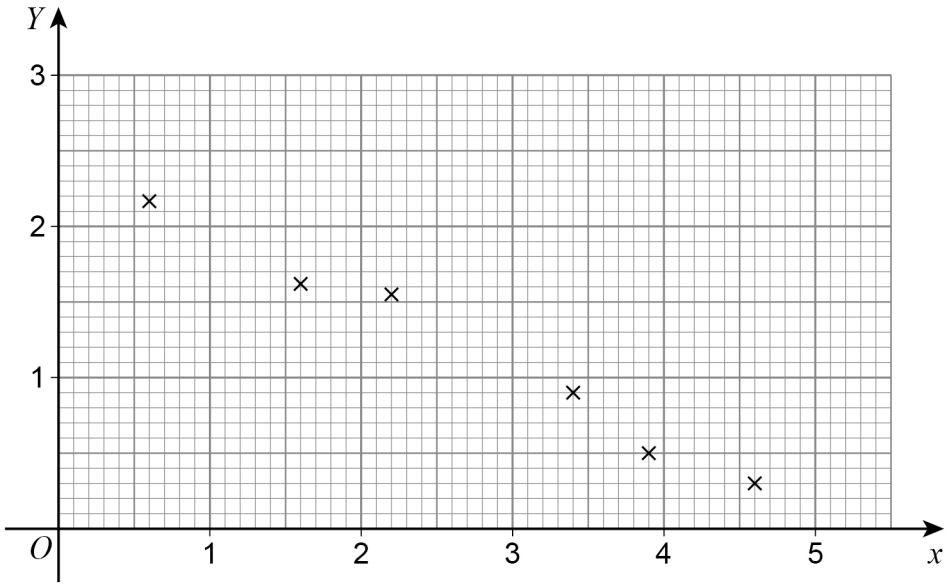
where A and B are constants.

3 (a) Show that there is a linear relationship between x and Y where $Y = \frac{y}{x}$

[2 marks]

3 (b) Six pairs of x and y values are obtained in an experiment.

The values of x and Y are plotted on the grid below.



3 (b) (i) Draw a line of best fit on the grid above.

[1 mark]

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3 (b) (ii) Use your line of best fit to estimate the value of A and the value of B

[2 marks]

$A =$ _____ $B =$ _____

3 (c) Use your answer to **part (b)(ii)** to estimate the values of x for which $y = 1$

Give your values to two significant figures.

[3 marks]

Answer _____

8

Turn over for the next question

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4 The equation $2x^3 - 4x^2 - 12x + 21 = 0$ has a real root α in the interval $2 < \alpha < 3$

4 (a) (i) Interval bisection is used once with the interval $2 < \alpha < 3$ to find an improved interval for α

Linear interpolation is also used once with the interval $2 < \alpha < 3$ to find an improved interval for α

Explain why using interval bisection and linear interpolation with the interval $2 < \alpha < 3$ result in the **same** improved interval for α

[2 marks]

4 (a) (ii) Show that the improved interval for α is $\frac{5}{2} < \alpha < 3$

[2 marks]

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4 (b) Starting with the interval $\frac{5}{2} < \alpha < 3$ use linear interpolation once to show that $\frac{63}{23} < \alpha < 3$

[5 marks]

9

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5 The matrix **M** is defined by $\mathbf{M} = \frac{1}{5}\begin{bmatrix} 2k-3 & 4-k \\ 4k+4 & 3-2k \end{bmatrix}$ where k is a constant.

5 (a) Find $\mathbf{M}^2$

[3 marks]

Answer _____

5 (b) Show that, for all values of k, the line $y = 2x$ is a line of invariant points of the transformation represented by **M**

[3 marks]

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5 (c) It is given that $k = 0$

5 (c) (i) Describe the single transformation represented by **M**

[3 marks]

5 (c) (ii) The line with equation $y = ax + 7$ is an invariant line of the transformation represented by **M**

State the value of a

[1 mark]

Answer _____

10

Turn over for the next section

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Section B

Statistics

Answer **all** questions in the spaces provided.

6 A spinner has 11 sections, numbered 1, 2, 3, …, 11

After the spinner is spun there is an equal probability of it landing on any one section.

The spinner is spun once.

The random variable X represents the number that the spinner lands on.

6 (a) State the name of the distribution of X

[1 mark]

Answer _____

6 (b) Find $\mathrm{P}(X > 6)$

[1 mark]

Answer _____

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6 (c) It is given that

$$\mathrm{E}(aX+b) = 13 \quad \text{and} \quad \mathrm{Var}(aX+b) = 90$$

where a and b are constants and $a > 0$

Find the value of a and the value of b

[5 marks]

$a =$ _____ $b =$ _____

7

Turn over for the next question

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7 The probability generating function $G_Y(t)$ of the random variable Y is given by

$$G_Y(t) = 0.318 + 0.512t + at^b$$

where a and b are constants.

7 (a) Show that the value of a is 0.17

[1 mark]

7 (b) The mean of Y is 1.872

Use differentiation to find the value of b

[3 marks]

Answer _____

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7 (c) Use differentiation to find the variance of Y

[3 marks]

Answer _____

7

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8 Akeel takes part in a contest that has two rounds.

In the first round, he makes repeated attempts to throw a ball into a hole until he is successful.

For each attempt, the probability that Akeel throws the ball into the hole is 0.4

If Akeel throws the ball into the hole within the first three attempts, he then plays a game in the second round of the contest where the probability of winning is 0.88

Otherwise, he plays a different game where the probability of winning is 0.19

8 (a) Draw a tree diagram to represent all the information for the contest.

[3 marks]

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8 (b) Akeel wins the contest if he wins the game in the second round.

Find the probability that Akeel throws the ball into the hole within three attempts given that he wins the contest.

Give your answer to three decimal places.

[3 marks]

Answer _____

6

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Section C

Mechanics

Answer **all** questions in the spaces provided.

9 (a) State the dimensions of force.

[1 mark]

Answer _____

9 (b) State the dimensions of momentum.

[1 mark]

Answer _____

9 (c) A student claims that:

the resultant force exerted on a body is equal to the rate of change of its momentum.

Determine if this claim is dimensionally consistent.

[2 marks]

4

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10 Two particles A and B are moving towards each other in a straight line on a smooth horizontal surface.

The particles then collide directly.

Particle A has mass 3 kg and particle B has mass 7 kg

Particle A is moving with a speed of 5 $m\,s^{-1}$ before the collision.

Particle B is moving with a speed of 2 $m\,s^{-1}$ before the collision.

The coefficient of restitution between the two particles is 0.1

10 (a) Find the speed of A after the collision.

[5 marks]

Answer _____

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10 (b) Find the magnitude of the impulse exerted on A by B during the collision.

Give your answer to three significant figures.

[2 marks]

Answer _____

10 (c) The particles are in contact for 0.05 seconds during the collision.

Assume that the magnitude of the force that each particle exerts on the other during the collision is constant.

Find the magnitude of the force exerted on A by B during the collision.

Give your answer to three significant figures.

[2 marks]

Answer _____

9

Turn over for the next question

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11 Two boats P and Q are moving on a lake.

Initially Q is 1200 metres north of P

Boat Q moves on a bearing of 100° at a constant speed of 3 m s^{-1} relative to the water.

Boat P moves on a bearing of θ° at a constant speed of V m s^{-1} relative to the water.

The boats collide 6 minutes later.

Model the boats as particles.

11 (a) Find the velocity of P relative to Q

Give your answer in terms of V and θ

[2 marks]

Answer _____

11 (b) Hence find the value of V and the value of θ

[5 marks]

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$V =$ _____ $\theta =$ _____

7

END OF QUESTIONS

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