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Other names

Pearson Edexcel
Level 3 GCE

Centre Number

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Candidate Number

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Mathematics

Advanced

Paper 2: Pure Mathematics 2

Wednesday 13 June 2018 – Morning

Time: 2 hours

Paper Reference

9MA0/02

You must have:

Mathematical Formulae and Statistical Tables, calculator

Total Marks

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Candidates may use any calculator allowed by the regulations of the Joint Council for Qualifications. 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.
- Answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 14 questions in this question paper. The total mark for this paper is 100.
- 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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Question 1 continued

Lined area for writing the answer to Question 1.

(Total for Question 1 is 6 marks)

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2. Relative to a fixed origin O ,

the point A has position vector $(2\mathbf{i} + 3\mathbf{j} - 4\mathbf{k})$,

the point B has position vector $(4\mathbf{i} - 2\mathbf{j} + 3\mathbf{k})$,

and the point C has position vector $(a\mathbf{i} + 5\mathbf{j} - 2\mathbf{k})$, where a is a constant and $a < 0$

D is the point such that $\overrightarrow{AB} = \overrightarrow{BD}$.

(a) Find the position vector of D . (2)

Given $|\overrightarrow{AC}| = 4$

(b) find the value of a . (3)

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Question 2 continued

Lined writing area for Question 2. The area is bounded by a rounded rectangle and contains approximately 30 horizontal lines for writing.

(Total for Question 2 is 5 marks)

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3. (a) “If m and n are irrational numbers, where $m \neq n$, then mn is also irrational.”

Disprove this statement by means of a counter example.

(2)

(b) (i) Sketch the graph of $y = |x| + 3$

(ii) Explain why $|x| + 3 \geq |x + 3|$ for all real values of x .

(3)

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Question 3 continued

Lined area for writing the answer to Question 3.

(Total for Question 3 is 5 marks)

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Question 4 continued

Lined writing area for Question 4 continued.

(Total for Question 4 is 7 marks)

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6.

$$f(x) = -3x^3 + 8x^2 - 9x + 10, \quad x \in \mathbb{R}$$

- (a) (i) Calculate $f(2)$
- (ii) Write $f(x)$ as a product of two algebraic factors. (3)

Using the answer to (a)(ii),

- (b) prove that there are exactly two real solutions to the equation
- $$-3y^6 + 8y^4 - 9y^2 + 10 = 0$$
- (2)

- (c) deduce the number of real solutions, for $7\pi \leq \theta < 10\pi$, to the equation
- $$3 \tan^3 \theta - 8 \tan^2 \theta + 9 \tan \theta - 10 = 0$$
- (1)

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Question 6 continued

Lined writing area for the answer to Question 6.

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Question 6 continued

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Question 6 continued

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(Total for Question 6 is 6 marks)

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7. (i) Solve, for $0 \leq x < \frac{\pi}{2}$, the equation

$$4 \sin x = \sec x \quad (4)$$

(ii) Solve, for $0 \leq \theta < 360^\circ$, the equation

$$5 \sin \theta - 5 \cos \theta = 2$$

giving your answers to one decimal place.

(Solutions based entirely on graphical or numerical methods are not acceptable.) (5)

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Question 7 continued

Lined writing area for the response to Question 7.

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Question 7 continued

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8.

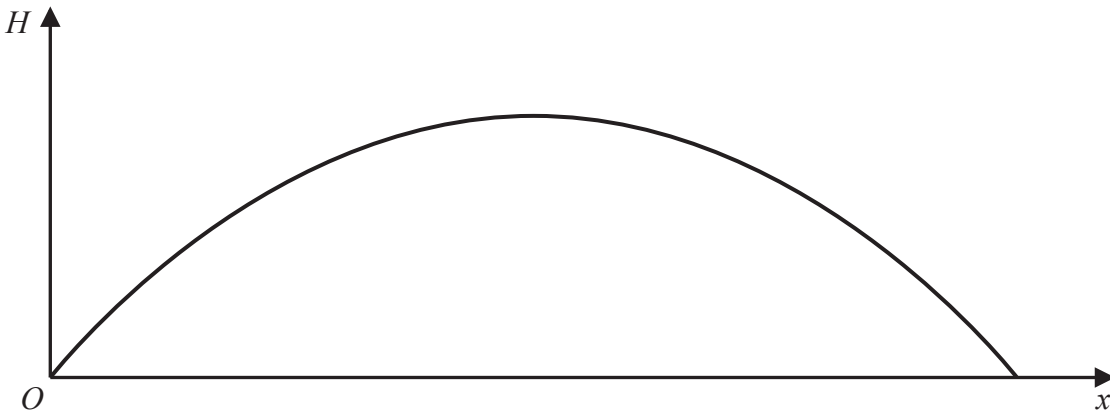


Figure 1

Figure 1 is a graph showing the trajectory of a rugby ball.

The height of the ball above the ground, H metres, has been plotted against the horizontal distance, x metres, measured from the point where the ball was kicked.

The ball travels in a vertical plane.

The ball reaches a maximum height of 12 metres and hits the ground at a point 40 metres from where it was kicked.

- (a) Find a quadratic equation linking H with x that models this situation. (3)

The ball passes over the horizontal bar of a set of rugby posts that is perpendicular to the path of the ball. The bar is 3 metres above the ground.

- (b) Use your equation to find the greatest horizontal distance of the bar from O . (3)

- (c) Give one limitation of the model. (1)

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Question 8 continued

Lined writing area for 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 7 marks)

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9. Given that θ is measured in radians, prove, from first principles, that

$$\frac{d}{d\theta}(\cos \theta) = -\sin \theta$$

You may assume the formula for $\cos(A \pm B)$ and that as $h \rightarrow 0$, $\frac{\sin h}{h} \rightarrow 1$ and $\frac{\cos h - 1}{h} \rightarrow 0$ (5)

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10. A spherical mint of radius 5 mm is placed in the mouth and sucked.
Four minutes later, the radius of the mint is 3 mm.

In a simple model, the rate of decrease of the radius of the mint is inversely proportional to the square of the radius.

Using this model and all the information given,

- (a) find an equation linking the radius of the mint and the time.
(You should define the variables that you use.) (5)
- (b) Hence find the total time taken for the mint to completely dissolve. Give your answer in minutes and seconds to the nearest second. (2)
- (c) Suggest a limitation of the model. (1)

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Question 10 continued

Lined writing area for the answer to Question 10.

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Question 10 continued

Lined writing area for the answer to Question 10.

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Question 10 continued

Lined writing area for the answer to Question 10.

(Total for Question 10 is 8 marks)

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11.

$$\frac{1 + 11x - 6x^2}{(x - 3)(1 - 2x)} \equiv A + \frac{B}{(x - 3)} + \frac{C}{(1 - 2x)}$$

(a) Find the values of the constants A , B and C .

(4)

$$f(x) = \frac{1 + 11x - 6x^2}{(x - 3)(1 - 2x)} \quad x > 3$$

(b) Prove that $f(x)$ is a decreasing function.

(3)

Ruled lines for writing the answer to part (b).

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Question 11 continued

Lined writing area for the answer to Question 11.

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(Total for Question 11 is 7 marks)



Question 12 continued

A large rectangular area with a rounded top and bottom, containing 30 horizontal lines for writing. The lines are evenly spaced and extend across the width of the page.

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Question 12 continued

Area with horizontal lines for writing.

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Question 12 continued

Lined area for writing the answer to Question 12.

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(Total for Question 12 is 9 marks)



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13.

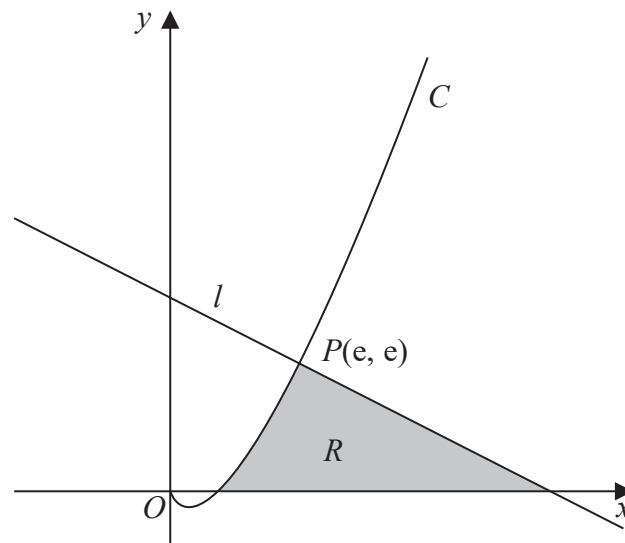


Figure 2

Figure 2 shows a sketch of part of the curve C with equation $y = x \ln x$, $x > 0$

The line l is the normal to C at the point $P(e, e)$

The region R , shown shaded in Figure 2, is bounded by the curve C , the line l and the x -axis.

Show that the exact area of R is $Ae^2 + B$ where A and B are rational numbers to be found.

(10)

Handwriting lines for the solution.

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Question 13 continued

Lined writing area for the answer to Question 13.

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Question 13 continued

Lined writing area for the question.

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(Total for Question 13 is 10 marks)



14. A scientist is studying a population of mice on an island.

The number of mice, N , in the population, t months after the start of the study, is modelled by the equation

$$N = \frac{900}{3 + 7e^{-0.25t}}, \quad t \in \mathbb{R}, \quad t \geq 0$$

(a) Find the number of mice in the population at the start of the study. (1)

(b) Show that the rate of growth $\frac{dN}{dt}$ is given by $\frac{dN}{dt} = \frac{N(300 - N)}{1200}$ (4)

The rate of growth is a maximum after T months.

(c) Find, according to the model, the value of T . (4)

According to the model, the maximum number of mice on the island is P .

(d) State the value of P . (1)

Handwriting area with horizontal lines.

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Question 14 continued

Lined writing area for the answer to Question 14.

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