

**Paper Reference 9MA0/01**  
**Pearson Edexcel Level 3 GCE**

**Mathematics**  
**Advanced**  
**PAPER 1: Pure Mathematics 1**

**Time: 2 hours**

**YOU MUST HAVE**  
**Mathematical Formulae and Statistical Tables (Green),**  
**calculator**

**YOU WILL BE GIVEN**  
**Answer Booklet**  
**Diagram Booklet**

**Q69601A**

**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**

**In the boxes on the Answer Booklet and on the Diagram Booklet, write 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 Answer Booklet – there may be more space than you need.**

**Do NOT write on the Question Paper.**

**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 16 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.**

**You may be provided with a model for Question 15**

## **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.**

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1. The point  $P(-2, -5)$  lies on the curve with equation  $y = f(x)$ ,  $x \in \mathbb{R}$

Find the point to which  $P$  is mapped, when the curve with equation  $y = f(x)$  is transformed to the curve with equation

(a)  $y = f(x) + 2$   
(1 mark)

(b)  $y = |f(x)|$   
(1 mark)

(c)  $y = 3f(x - 2) + 2$   
(2 marks)

(Total for Question 1 is 4 marks)

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2.  $f(x) = (x - 4)(x^2 - 3x + k) - 42$  where  $k$  is a constant

Given that  $(x + 2)$  is a factor of  $f(x)$ , find the value of  $k$

(Total for Question 2 is 3 marks)

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3. A circle has equation

$$x^2 + y^2 - 10x + 16y = 80$$

(a) Find

(i) the coordinates of the centre of the circle,

(ii) the radius of the circle.

(3 marks)

Given that **P** is the point on the circle that is furthest away from the origin **O**,

(b) find the exact length **OP**

(2 marks)

(Total for Question 3 is 5 marks)

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4. (a) Express  $\lim_{\delta x \rightarrow 0} \sum_{x=2 \cdot 1}^{6 \cdot 3} \frac{2}{x} \delta x$  as an integral.  
(1 mark)

(b) Hence show that

$$\lim_{\delta x \rightarrow 0} \sum_{x=2 \cdot 1}^{6 \cdot 3} \frac{2}{x} \delta x = \ln k$$

where **k** is a constant to be found.

(2 marks)

(Total for Question 4 is 3 marks)

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Turn over

5. The height,  $h$  metres, of a tree,  $t$  years after being planted, is modelled by the equation

$$h^2 = at + b \quad 0 \leq t < 25$$

where  $a$  and  $b$  are constants.

Given that

- the height of the tree was  $2.60$  metres, exactly  $2$  years after being planted
- the height of the tree was  $5.10$  metres, exactly  $10$  years after being planted

- (a) find a complete equation for the model, giving the values of  $a$  and  $b$  to 3 significant figures.  
(4 marks)

(continued on the next page)



**5. continued.**

**Given that the height of the tree was 7 metres,  
exactly 20 years after being planted**

**(b) evaluate the model, giving reasons for your  
answer.**

**(2 marks)**

**(Total for Question 5 is 6 marks)**

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6. Refer to the diagram for Question 6 in the Diagram Booklet.

It shows a sketch of a curve **C** with equation  $y = f(x)$  where  $f(x)$  is a cubic expression in  $x$

The curve

- passes through the origin
- has a maximum turning point at  $(2, 8)$
- has a minimum turning point at  $(6, 0)$

- (a) Write down the set of values of  $x$  for which

$$f'(x) < 0$$

(1 mark)

(continued on the next page)

**6. continued.**

The line with equation  $y = k$ , where  $k$  is a constant, intersects  $C$  at only one point.

**(b) Find the set of values of  $k$ , giving your answer in set notation.**

**(2 marks)**

**(c) Find the equation of  $C$**

**You may leave your answer in factorised form.**

**(3 marks)**

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

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7. (i) Given that  $p$  and  $q$  are integers such that

$pq$  is even

use algebra to prove by contradiction that at least one of  $p$  or  $q$  is even.

(3 marks)

(ii) Given that  $x$  and  $y$  are integers such that

- $x < 0$
- $(x + y)^2 < 9x^2 + y^2$

show that  $y > 4x$

(2 marks)

(Total for Question 7 is 5 marks)

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8. Refer to the diagram for Question 8 in the Diagram Booklet.

A car stops at two sets of traffic lights.

The diagram shows a graph of the speed of the car,  $v \text{ ms}^{-1}$ , as it travels between the two sets of traffic lights.

The car takes  $T$  seconds to travel between the two sets of traffic lights.

The speed of the car is modelled by the equation

$$v = (10 - 0.4t) \ln(t + 1) \quad 0 \leq t \leq T$$

where  $t$  seconds is the time after the car leaves the first set of traffic lights.

(continued on the next page)

8. continued.

According to the model,

(a) find the value of  $T$   
(1 mark)

(b) show that the maximum speed of the car  
occurs when

$$t = \frac{26}{1 + \ln(t + 1)} - 1$$

(4 marks)

(continued on the next page)

8. continued.

Using the iteration formula

$$t_{n+1} = \frac{26}{1 + \ln(t_n + 1)} - 1$$

with  $t_1 = 7$

(c) (i) find the value of  $t_3$  to 3 decimal places,

(ii) find, by repeated iteration, the time taken  
for the car to reach maximum speed.

(3 marks)

(Total for Question 8 is 8 marks)

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9. Refer to the diagram for Question 9 in the Diagram Booklet.

It shows a sketch of a parallelogram **PQRS**

Given that

- $\overrightarrow{PQ} = 2\mathbf{i} + 3\mathbf{j} - 4\mathbf{k}$
- $\overrightarrow{QR} = 5\mathbf{j} - 2\mathbf{k}$

- (a) show that parallelogram **PQRS** is a rhombus.

(2 marks)

- (b) Find the exact area of the rhombus **PQRS**

(4 marks)

(Total for Question 9 is 6 marks)

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10. A scientist is studying the number of bees and the number of wasps on an island.

The number of bees, measured in thousands,  $N_b$ , is modelled by the equation

$$N_b = 45 + 220e^{0.05t}$$

where  $t$  is the number of years from the start of the study.

According to the model,

- (a) find the number of bees at the start of the study,  
(1 mark)
- (b) show that, exactly 10 years after the start of the study, the number of bees was increasing at a RATE of approximately 18 thousand per year.  
(3 marks)

(continued on the next page)

Turn over

10. continued.

The number of wasps, measured in thousands,  $N_w$ , is modelled by the equation

$$N_w = 10 + 800e^{-0.05t}$$

where  $t$  is the number of years from the start of the study.

When  $t = T$ , according to the models, there are an equal number of bees and wasps.

- (c) Find the value of  $T$  to 2 decimal places.  
(4 marks)

(Total for Question 10 is 8 marks)

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11. Refer to the diagram for Question 11 in the Diagram Booklet.

It shows a sketch of part of the curve  $C_1$  with equation

$$y = 2x^3 + 10 \quad x > 0$$

and part of the curve  $C_2$  with equation

$$y = 42x - 15x^2 - 7 \quad x > 0$$

- (a) Verify that the curves intersect at  $x = \frac{1}{2}$   
(2 marks)

The curves intersect again at the point P

- (b) Using algebra and showing all stages of working, find the exact  $x$  coordinate of P  
(5 marks)

(Total for Question 11 is 7 marks)

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

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

**Show that**

$$\int_1^{e^2} x^3 \ln x \, dx = ae^8 + b$$

**where  $a$  and  $b$  are rational constants to be found.**

**(Total for Question 12 is 5 marks)**

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13. (i) In an arithmetic series, the first term is  $a$  and the common difference is  $d$

Show that

$$S_n = \frac{n}{2} [2a + (n - 1)d]$$

(3 marks)

(continued on the next page)

**13. continued.**

**(ii) James saves money over a number of weeks to buy a printer that costs £64**

**He saves £10 in week 1, £9.20 in week 2, £8.40 in week 3 and so on, so that the weekly amounts he saves form an arithmetic sequence.**

**Given that James takes  $n$  weeks to save exactly £64**

**(a) show that**

$$n^2 - 26n + 160 = 0$$

**(2 marks)**

**(continued on the next page)**

**Turn over**

**13. (ii) continued.**

**(b) Solve the equation**

$$n^2 - 26n + 160 = 0$$

**(1 mark)**

**(c) Hence state the number of weeks James takes to save enough money to buy the printer, giving a brief reason for your answer.**

**(1 mark)**

**(Total for Question 13 is 7 marks)**

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

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

(a) Given that

$$2 \sin (x - 60^\circ) = \cos (x - 30^\circ)$$

show that

$$\tan x = 3\sqrt{3}$$

(4 marks)

(continued on the next page)



14. continued.

(b) Hence or otherwise solve, for  $0 \leq \theta < 180^\circ$

$$2 \sin 2\theta = \cos (2\theta + 30^\circ)$$

giving your answers to one decimal place.

(4 marks)

(Total for Question 14 is 8 marks)

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15. Refer to Diagram 1 and Diagram 2 for Question 15 in the Diagram Booklet.

You may be provided with a model.

A company makes toys for children.

Diagram 1 and the model shows the design for a solid toy that looks like a piece of cheese.

The toy is modelled so that

- face **ABC** is a sector of a circle with radius  **$r$  cm** and centre **A** as shown by Diagram 2
- angle **BAC** =  **$0.8$**  radians
- faces **ABC** and **DEF** are congruent
- edges **AD**, **CF** and **BE** are perpendicular to faces **ABC** and **DEF**
- edges **AD**, **CF** and **BE** have length  **$h$  cm**

(continued on the next page)

15. continued.

Given that the volume of the toy is  $240 \text{ cm}^3$

- (a) show that the surface area of the toy,  $S \text{ cm}^2$ , is given by

$$S = 0.8r^2 + \frac{1680}{r}$$

making your method clear.

(4 marks)

Using algebraic differentiation,

- (b) find the value of  $r$  for which  $S$  has a stationary point.

(4 marks)

- (c) Prove, by further differentiation, that this value of  $r$  gives the minimum surface area of the toy.

(2 marks)

(Total for Question 15 is 10 marks)

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Turn over

16. Refer to the diagram for Question 16 in the Diagram Booklet.

It shows a sketch of the curve **C** with parametric equations

$$x = 8 \sin^2 t \quad y = 2 \sin 2t + 3 \sin t \quad 0 \leq t \leq \frac{\pi}{2}$$

The region **R**, shown shaded in the diagram, is bounded by **C**, the **x**-axis and the line with equation  $x = 4$

(a) Show that the area of **R** is given by

$$\int_0^a (8 - 8 \cos 4t + 48 \sin^2 t \cos t) dt$$

where **a** is a constant to be found.

(5 marks)

(continued on the next page)

**16. continued.**

- (b) Hence, using algebraic integration, find the exact area of  $R$**   
**(4 marks)**

**(Total for Question 16 is 9 marks)**

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**TOTAL FOR PAPER IS 100 MARKS**

**END OF PAPER**

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