

Please check the examination details below before entering your candidate information

Candidate surname

Other names

Centre Number

Candidate Number

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## Pearson Edexcel Level 3 GCE

Time 2 hours

Paper  
reference

**9MA0/01**

### Mathematics

Advanced

**PAPER 1: Pure Mathematics 1**

**You must have:**

Mathematical Formulae and Statistical Tables (Green), 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 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.*

### 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 ►

P69601A

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Q:1/1/1/1/



  
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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)

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

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

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**Question 1 continued**

Lined writing area for the answer to Question 1.

**(Total for Question 1 is 4 marks)**



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2.

$$f(x) = (x - 4)(x^2 - 3x + k) - 42 \text{ where } k \text{ is a constant}$$

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

(3)

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4. (a) Express  $\lim_{\delta x \rightarrow 0} \sum_{x=2.1}^{6.3} \frac{2}{x} \delta x$  as an integral.

(1)

(b) Hence show that

$$\lim_{\delta x \rightarrow 0} \sum_{x=2.1}^{6.3} \frac{2}{x} \delta x = \ln k$$

where  $k$  is a constant to be found.

(2)

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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 m, exactly 2 years after being planted
- the height of the tree was 5.10 m, 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)

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

(b) evaluate the model, giving reasons for your answer. (2)

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**Question 5 continued**

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



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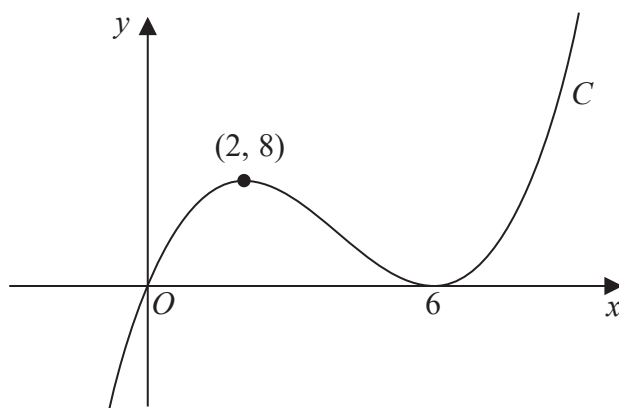


Figure 1

Figure 1 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

$$f'(x) < 0 \qquad (1)$$

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)

(c) Find the equation of  $C$ . You may leave your answer in factorised form. (3)

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**Question 6 continued**

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Lined writing area with 30 horizontal lines.

**(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)

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

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

show that  $y > 4x$

(2)

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**Question 7 continued**

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**(Total for Question 7 is 5 marks)**



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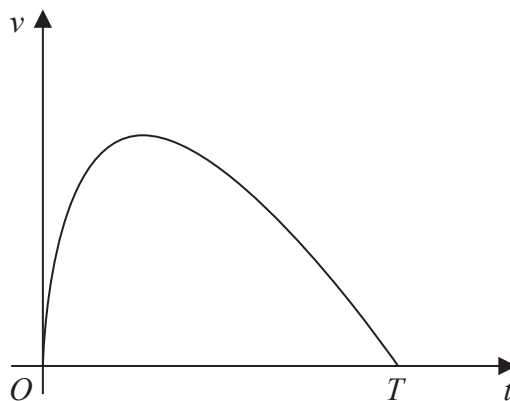


Figure 2

A car stops at two sets of traffic lights.

Figure 2 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.

According to the model,

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

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

$$t = \frac{26}{1 + \ln(t + 1)} - 1 \quad (4)$$

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)

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**Question 8 continued**

Lined area for writing the answer to Question 8.

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**Question 8 continued**

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**Question 8 continued**

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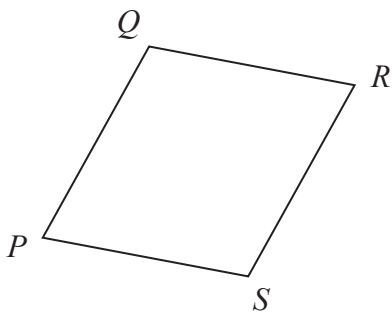
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**(Total for Question 8 is 8 marks)**



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9.



**Figure 3**

Figure 3 shows a sketch of a parallelogram  $PQRS$ .

Given that

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

- (a) show that parallelogram  $PQRS$  is a rhombus. (2)
- (b) Find the exact area of the rhombus  $PQRS$ . (4)

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**Question 9 continued**

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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)

(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)

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)

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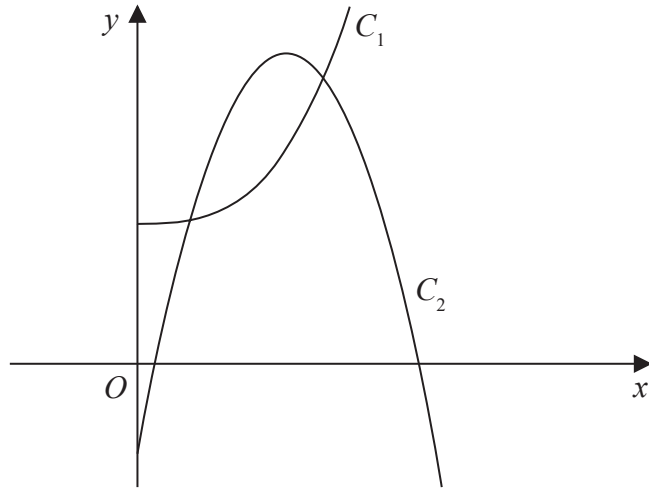


Figure 4

Figure 4 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)

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)

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Question 11 continued

Lined writing area for the answer.

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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.

(5)

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**Question 12 continued**

Lined area for writing the answer to Question 12.

**(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

$$S_n = \frac{n}{2} [2a + (n - 1)d] \quad (3)$$

(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

$$n^2 - 26n + 160 = 0 \quad (2)$$

(b) Solve the equation

$$n^2 - 26n + 160 = 0 \quad (1)$$

(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)

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**Question 13 continued**

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Question 14 continued

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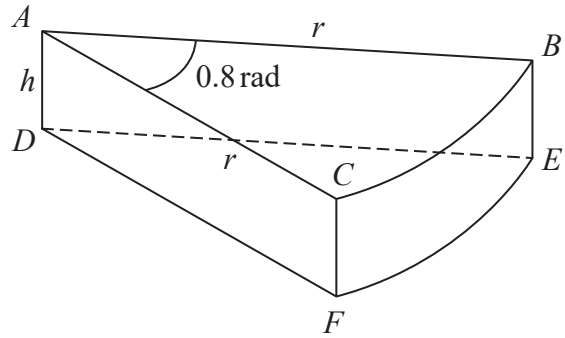


Figure 5

A company makes toys for children.

Figure 5 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  $A$
- 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

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)

Using algebraic differentiation,

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

(4)

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

(2)

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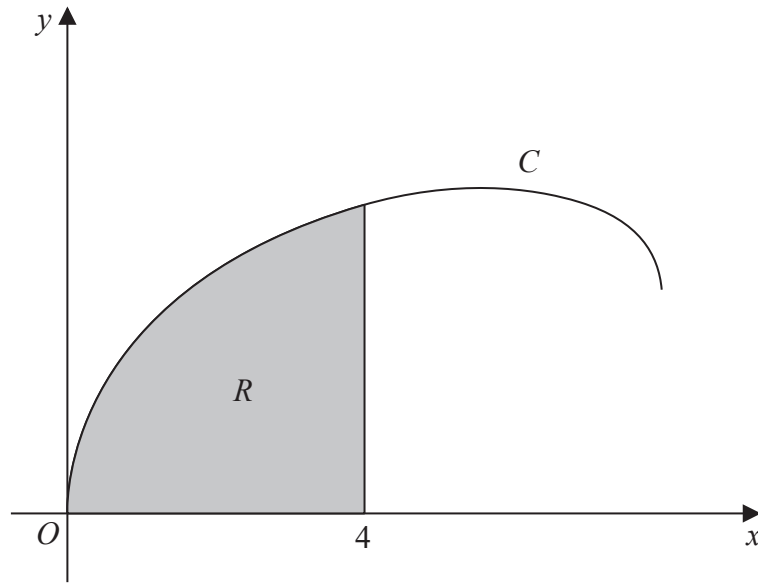


Figure 6

Figure 6 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 Figure 6, 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)

(b) Hence, using algebraic integration, find the exact area of  $R$ .

(4)

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Question 16 continued

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Lined writing area for the answer to Question 16.



