

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 ►

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Q1/1/1/1/



Pearson

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

(Total for Question 1 is 4 marks)



P 6 9 6 0 1 A 0 3 4 8

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 .

(3)

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Question 2 continued

(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)

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

(b) find the exact length OP

(2)

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Question 3 continued

(Total for Question 3 is 5 marks)



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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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Question 4 continued

(Total for Question 4 is 3 marks)



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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)



Question 5 continued

(Total for Question 5 is 6 marks)



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6.

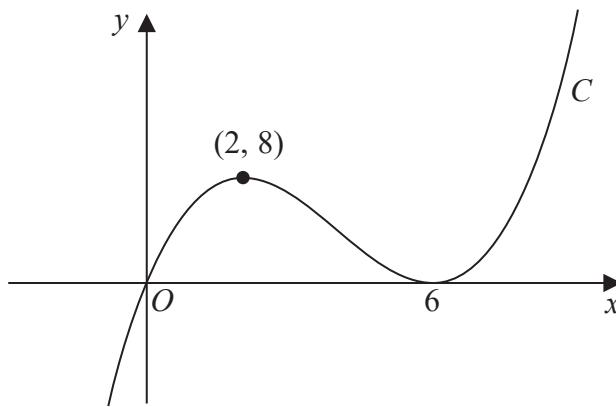


Figure 1

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

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

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

(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)



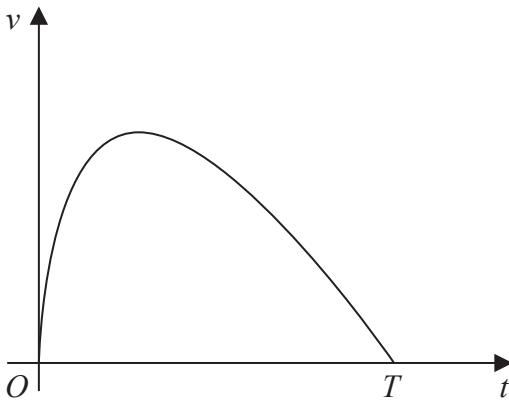
Question 7 continued

(Total for Question 7 is 5 marks)



P 6 9 6 0 1 A 0 1 5 4 8

8.

**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



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Question 8 continued

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Question 8 continued

(Total for Question 8 is 8 marks)



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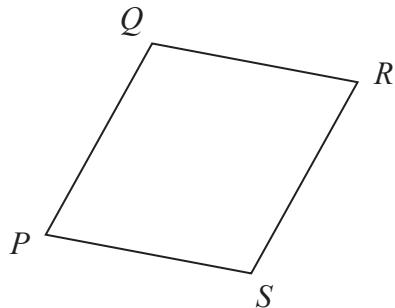
**Figure 3**

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

Given that

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

(a) show that parallelogram $PQRS$ is a rhombus.

(2)

(b) Find the exact area of the rhombus $PQRS$.

(4)



Question 9 continued



P 6 9 6 0 1 A 0 2 1 4 8

Question 9 continued

(Total for Question 9 is 6 marks)



P 6 9 6 0 1 A 0 2 3 4 8

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

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

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

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

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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Question 10 continued



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Question 10 continued

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Question 10 continued

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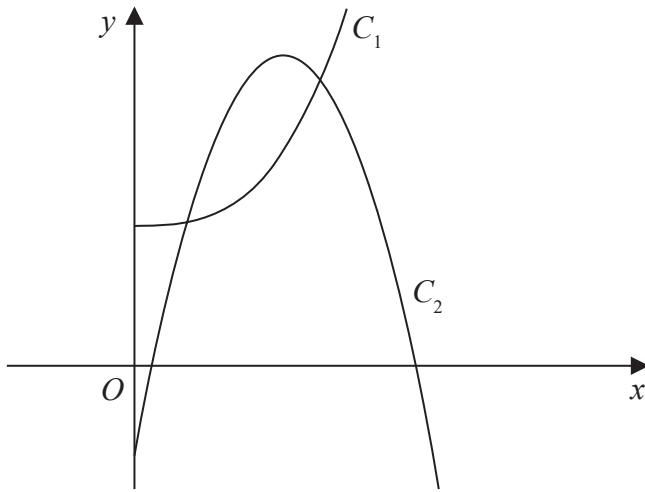
**Figure 4**

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



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Question 11 continued

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Question 11 continued

(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.

(5)

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Question 12 continued

(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 13 continued

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Question 13 continued

(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)

(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)



Question 14 continued



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Question 14 continued

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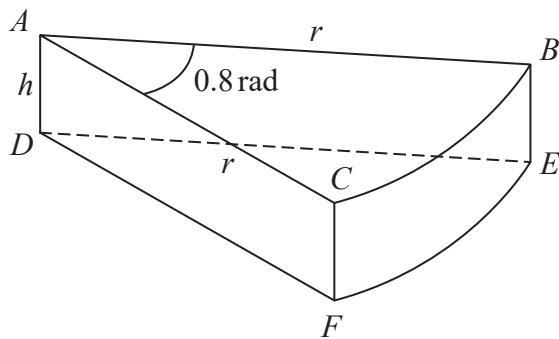
Question 14 continued

(Total for Question 14 is 8 marks)



P 6 9 6 0 1 A 0 4 1 4 8

15.

**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 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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Question 15 continued



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Question 15 continued

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Question 15 continued

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16.

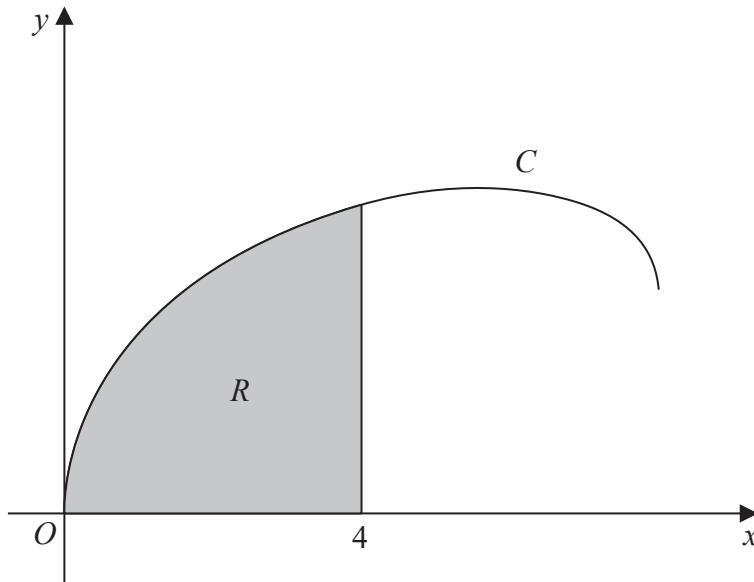
**Figure 6**

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)



Question 16 continued



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Question 16 continued

(Total for Question 16 is 9 marks)

TOTAL FOR PAPER IS 100 MARKS

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