

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

**9MA0/02**

### Mathematics

Advanced

**PAPER 2: Pure Mathematics 2**

**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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Q:1/1/1/1/



Pearson

1. In this question you must show all stages of your working.  
Solutions relying entirely on calculator technology are not acceptable.

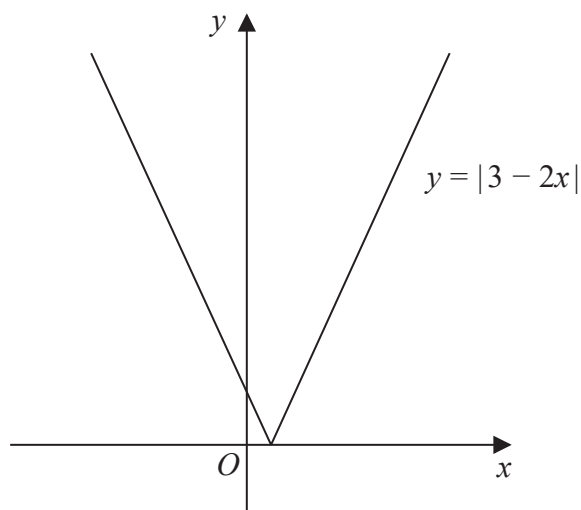


Figure 1

Figure 1 shows a sketch of the graph with equation  $y = |3 - 2x|$

Solve

$$|3 - 2x| = 7 + x \quad (4)$$





2. (a) Sketch the curve with equation

$$y = 4^x$$

stating any points of intersection with the coordinate axes.

(2)

(b) Solve

$$4^x = 100$$

giving your answer to 2 decimal places.

(2)

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**Question 2 continued**

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**(Total for Question 2 is 4 marks)**



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3. A sequence of terms  $a_1, a_2, a_3, \dots$  is defined by

$$a_1 = 3$$
$$a_{n+1} = 8 - a_n$$

(a) (i) Show that this sequence is periodic.

(ii) State the order of this periodic sequence.

(2)

(b) Find the value of

$$\sum_{n=1}^{85} a_n$$

(2)



Question 3 continued

Horizontal lines for writing.

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(Total for Question 3 is 4 marks)



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4. Given that

$$y = 2x^2$$

use differentiation from first principles to show that

$$\frac{dy}{dx} = 4x$$

(3)

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Question 4 continued

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(Total for Question 4 is 3 marks)



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5. The table below shows corresponding values of  $x$  and  $y$  for  $y = \log_3 2x$

The values of  $y$  are given to 2 decimal places as appropriate.

$x$	3	4.5	6	7.5	9
$y$	1.63	2	2.26	2.46	2.63

(a) Using the trapezium rule with all the values of  $y$  in the table, find an estimate for

$$\int_3^9 \log_3 2x \, dx$$

(3)

Using your answer to part (a) and making your method clear, estimate

(b) (i)  $\int_3^9 \log_3 (2x)^{10} \, dx$

(ii)  $\int_3^9 \log_3 18x \, dx$

(3)



**Question 5 continued**

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Handwriting practice area consisting of 30 horizontal lines.

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



6.

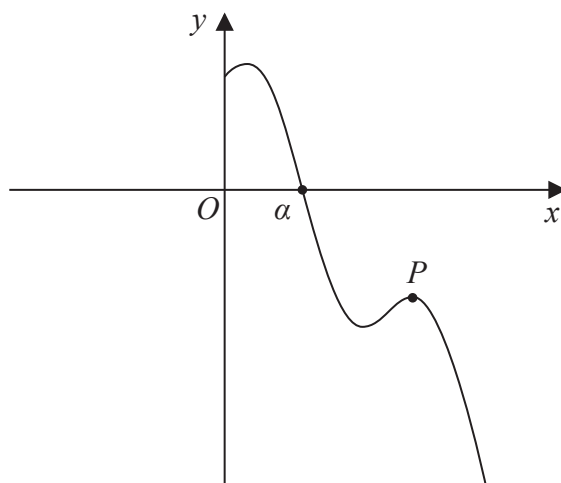


Figure 2

Figure 2 shows a sketch of part of the curve with equation  $y = f(x)$  where

$$f(x) = 8 \sin\left(\frac{1}{2}x\right) - 3x + 9 \quad x > 0$$

and  $x$  is measured in radians.

The point  $P$ , shown in Figure 2, is a local maximum point on the curve.

Using calculus and the sketch in Figure 2,

- (a) find the  $x$  coordinate of  $P$ , giving your answer to 3 significant figures. (4)

The curve crosses the  $x$ -axis at  $x = \alpha$ , as shown in Figure 2.

Given that, to 3 decimal places,  $f(4) = 4.274$  and  $f(5) = -1.212$

- (b) explain why  $\alpha$  must lie in the interval  $[4, 5]$  (1)

- (c) Taking  $x_0 = 5$  as a first approximation to  $\alpha$ , apply the Newton-Raphson method once to  $f(x)$  to obtain a second approximation to  $\alpha$ .

Show your method and give your answer to 3 significant figures. (2)

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**Question 6 continued**

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# Question 6 continued

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(Total for Question 6 is 7 marks)



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7. (a) Find the first four terms, in ascending powers of  $x$ , of the binomial expansion of

$$\sqrt{4 - 9x}$$

writing each term in simplest form.

(4)

A student uses this expansion with  $x = \frac{1}{9}$  to find an approximation for  $\sqrt{3}$

Using the answer to part (a) and without doing any calculations,

(b) state whether this approximation will be an overestimate or an underestimate of  $\sqrt{3}$  giving a brief reason for your answer.

(1)

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8.

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

Solutions relying on calculator technology are not acceptable.

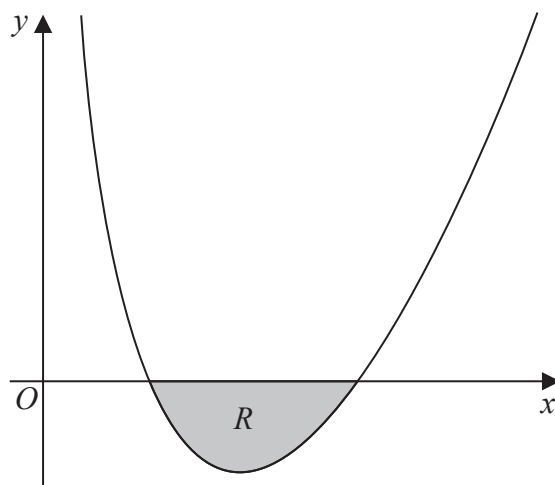


Figure 3

Figure 3 shows a sketch of part of a curve with equation

$$y = \frac{(x - 2)(x - 4)}{4\sqrt{x}} \quad x > 0$$

The region  $R$ , shown shaded in Figure 3, is bounded by the curve and the  $x$ -axis.

Find the exact area of  $R$ , writing your answer in the form  $a\sqrt{2} + b$ , where  $a$  and  $b$  are constants to be found.

(6)

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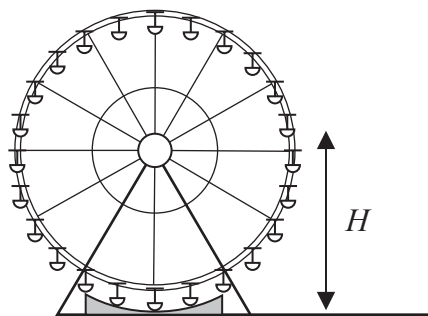


Figure 4

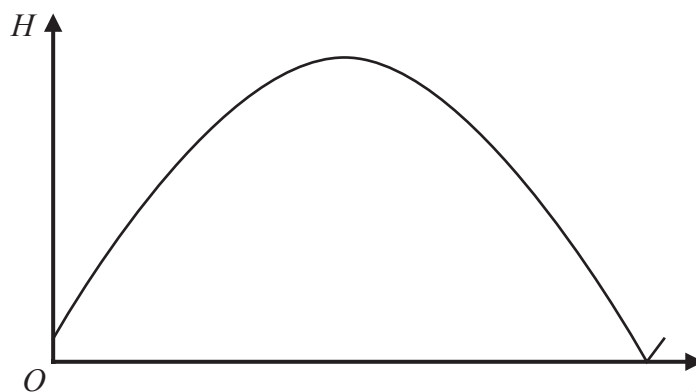


Figure 5

Figure 4 shows a sketch of a Ferris wheel.

The height above the ground,  $H$  m, of a passenger on the Ferris wheel,  $t$  seconds after the wheel starts turning, is modelled by the equation

$$H = |A \sin(bt + \alpha)^\circ|$$

where  $A$ ,  $b$  and  $\alpha$  are constants.

Figure 5 shows a sketch of the graph of  $H$  against  $t$ , for one revolution of the wheel.

Given that

- the maximum height of the passenger above the ground is 50 m
- the passenger is 1 m above the ground when the wheel starts turning
- the wheel takes 720 seconds to complete one revolution

(a) find a complete equation for the model, giving the exact value of  $A$ , the exact value of  $b$  and the value of  $\alpha$  to 3 significant figures.

(4)

(b) Explain why an equation of the form

$$H = |A \sin(bt + \alpha)^\circ| + d$$

where  $d$  is a positive constant, would be a more appropriate model.

(1)

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10. The function  $f$  is defined by

$$f(x) = \frac{8x + 5}{2x + 3} \quad x > -\frac{3}{2}$$

(a) Find  $f^{-1}\left(\frac{3}{2}\right)$

(2)

(b) Show that

$$f(x) = A + \frac{B}{2x + 3}$$

where  $A$  and  $B$  are constants to be found.

(2)

The function  $g$  is defined by

$$g(x) = 16 - x^2 \quad 0 \leq x \leq 4$$

(c) State the range of  $g^{-1}$

(1)

(d) Find the range of  $f \circ g^{-1}$

(3)





Question 10 continued

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11. Prove, using algebra, that

$$n(n^2 + 5)$$

is even for all  $n \in \mathbb{N}$ .

(4)

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**Question 11 continued**

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**(Total for Question 11 is 4 marks)**



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**Question 12 continued**

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Lined area for student response.

**(Total for Question 12 is 6 marks)**



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**13.** Relative to a fixed origin  $O$

- the point  $A$  has position vector  $4\mathbf{i} - 3\mathbf{j} + 5\mathbf{k}$
- the point  $B$  has position vector  $4\mathbf{j} + 6\mathbf{k}$
- the point  $C$  has position vector  $-16\mathbf{i} + p\mathbf{j} + 10\mathbf{k}$

where  $p$  is a constant.

Given that  $A$ ,  $B$  and  $C$  lie on a straight line,

(a) find the value of  $p$ . (3)

The line segment  $OB$  is extended to a point  $D$  so that  $\vec{CD}$  is parallel to  $\vec{OA}$

(b) Find  $|\vec{OD}|$ , writing your answer as a fully simplified surd. (3)

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Question 13 continued

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**Question 13 continued**

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**(Total for Question 13 is 6 marks)**



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14. (a) Express  $\frac{3}{(2x-1)(x+1)}$  in partial fractions. (3)

When chemical *A* and chemical *B* are mixed, oxygen is produced.

A scientist mixed these two chemicals and measured the total volume of oxygen produced over a period of time.

The total volume of oxygen produced,  $V \text{ m}^3$ ,  $t$  hours after the chemicals were mixed, is modelled by the differential equation

$$\frac{dV}{dt} = \frac{3V}{(2t-1)(t+1)} \quad V \geq 0 \quad t \geq k$$

where  $k$  is a constant.

Given that exactly 2 hours after the chemicals were mixed, a total volume of  $3 \text{ m}^3$  of oxygen had been produced,

- (b) solve the differential equation to show that

$$V = \frac{3(2t-1)}{(t+1)} \quad (5)$$

The scientist noticed that

- there was a **time delay** between the chemicals being mixed and oxygen being produced
- there was a **limit** to the total volume of oxygen produced

Deduce from the model

- (c) (i) the **time delay** giving your answer in minutes,  
 (ii) the **limit** giving your answer in  $\text{m}^3$  (2)

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**Question 14 continued**

Lined writing area for the answer to Question 14.

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**(Total for Question 14 is 10 marks)**



15.

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

Solutions relying on calculator technology are not acceptable.

Given that the first three terms of a geometric series are

$$12 \cos \theta \quad 5 + 2 \sin \theta \quad \text{and} \quad 6 \tan \theta$$

(a) show that

$$4 \sin^2 \theta - 52 \sin \theta + 25 = 0 \tag{3}$$

Given that  $\theta$  is an obtuse angle measured in radians,

(b) solve the equation in part (a) to find the exact value of  $\theta$  (2)

(c) show that the sum to infinity of the series can be expressed in the form

$$k(1 - \sqrt{3})$$

where  $k$  is a constant to be found. (5)

Lined area for student work.







Question 15 continued

Lined writing area for the answer to Question 15. The area contains 24 horizontal lines for writing.

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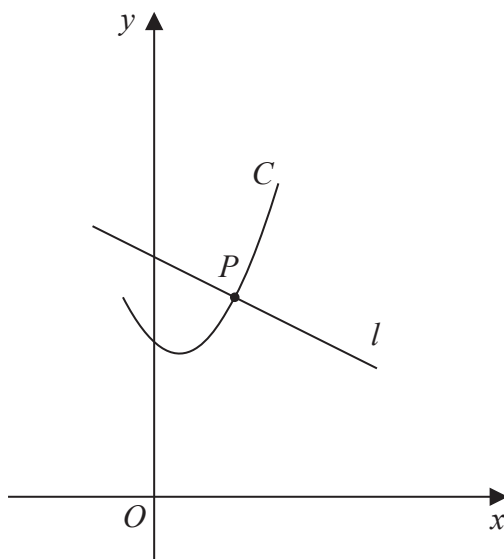


Figure 6

Figure 6 shows a sketch of the curve  $C$  with parametric equations

$$x = 2 \tan t + 1 \quad y = 2 \sec^2 t + 3 \quad -\frac{\pi}{4} \leq t \leq \frac{\pi}{3}$$

The line  $l$  is the normal to  $C$  at the point  $P$  where  $t = \frac{\pi}{4}$

(a) Using parametric differentiation, show that an equation for  $l$  is

$$y = -\frac{1}{2}x + \frac{17}{2} \quad (5)$$

(b) Show that all points on  $C$  satisfy the equation

$$y = \frac{1}{2}(x-1)^2 + 5 \quad (2)$$

The straight line with equation

$$y = -\frac{1}{2}x + k \quad \text{where } k \text{ is a constant}$$

intersects  $C$  at two distinct points.

(c) Find the range of possible values for  $k$ . (5)

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**Question 16 continued**

Lined area for writing the answer to Question 16.

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Question 16 continued

Lined writing area for the answer to Question 16.

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Question 16 continued

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Lined writing area for the response to Question 16.



