Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International GCSE

Friday 15th November 2024

Morning (Time: 2 hours)

Paper reference **4PM1/02**

Further Pure Mathematics
PAPER 2

Calculators may be used.

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Without sufficient working, correct answers may be awarded no marks.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- You must **NOT** write anything on the formulae page.
  Anything you write on the formulae page will gain NO credit.

Information

- 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.
- Check your answers if you have time at the end.

Turn over ▶

P73587A

P 7 3 5 8 7 A 0 1 3 2

Pearson

International GCSE in Further Pure Mathematics Formulae sheet

Mensuration

Surface area of sphere = $4\pi r^2$

Curved surface area of cone = $\pi r \times$ slant height

Volume of sphere = $\frac{4}{3}\pi r^3$

Series

Arithmetic series

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

Geometric series

Sum to n terms, $S_n = \frac{a(1-r^n)}{(1-r)}$

Sum to infinity, $S_\infty = \frac{a}{1-r} \quad |r| < 1$

Binomial series

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \ldots + \frac{n(n-1)\ldots(n-r+1)}{r!}x^r + \ldots \quad \text{for} \quad |x| < 1, n \in \mathbb{Q}$$

Calculus

Quotient rule (differentiation)

$$\frac{\mathrm{d}}{\mathrm{d}x}\left(\frac{\mathrm{f}(x)}{\mathrm{g}(x)}\right) = \frac{\mathrm{f}'(x)\mathrm{g}(x) - \mathrm{f}(x)\mathrm{g}'(x)}{[\mathrm{g}(x)]^2}$$

Trigonometry

Cosine rule

In triangle ABC: $a^2 = b^2 + c^2 - 2bc\cos A$

$$\tan\theta = \frac{\sin\theta}{\cos\theta}$$

$\sin(A+B) = \sin A\cos B + \cos A\sin B$ $\quad$ $\sin(A-B) = \sin A\cos B - \cos A\sin B$

$\cos(A+B) = \cos A\cos B - \sin A\sin B$ $\quad$ $\cos(A-B) = \cos A\cos B + \sin A\sin B$

$$\tan(A+B) = \frac{\tan A + \tan B}{1 - \tan A\tan B} \qquad \tan(A-B) = \frac{\tan A - \tan B}{1 + \tan A\tan B}$$

Logarithms

$$\log_a x = \frac{\log_b x}{\log_b a}$$

Answer all TEN questions.

Write your answers in the spaces provided.

You must write down all the stages in your working.

1

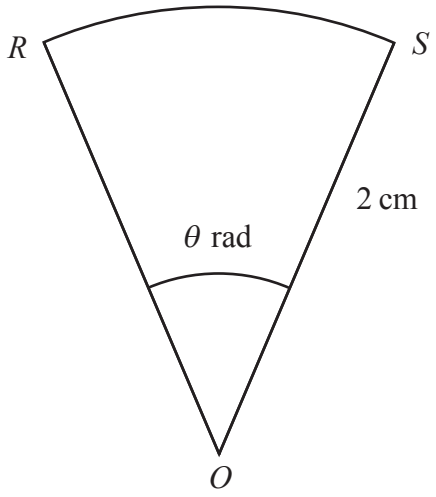


Diagram **NOT** accurately drawn

Figure 1

Figure 1 shows sector ROS of a circle with centre O and radius 2 cm
The size of angle ROS is θ radians.

The area of sector ROS is $\frac{\pi}{2}$ cm^2

(a) Find the exact value of θ

(2)

The perimeter of sector ROS is P cm

(b) Find the exact value of P

(3)

(Total for Question 1 is 5 marks)

2 The length of rectangle R is 2 cm greater than its width.

The area of R is greater than $8\,cm^2$ and the perimeter of R is less than 30 cm.

Given that the width of R is w cm,

find the set of possible values of w
Give your answer in the form $a < w < b$ where a and b are rational numbers.

(6)

Question 2 continued

(Total for Question 2 is 6 marks)

3 The curve C has equation $y = e^{3x}(2x-1)^4$

Using calculus, find the exact value of the gradient of the tangent to C when $x = 1$

(5)

Question 3 continued

(Total for Question 3 is 5 marks)

4 (a) Complete the table of values for $y = \log_{10}(6x-1) - x$ giving your answers to 2 decimal places.

x	0.25	0.5	1	1.5	2	2.5	3
y		–0.20	–0.30	–0.60			

(2)

(b) On the grid opposite, draw the graph of $y = \log_{10}(6x-1) - x$ for $0.25 \leqslant x \leqslant 3$

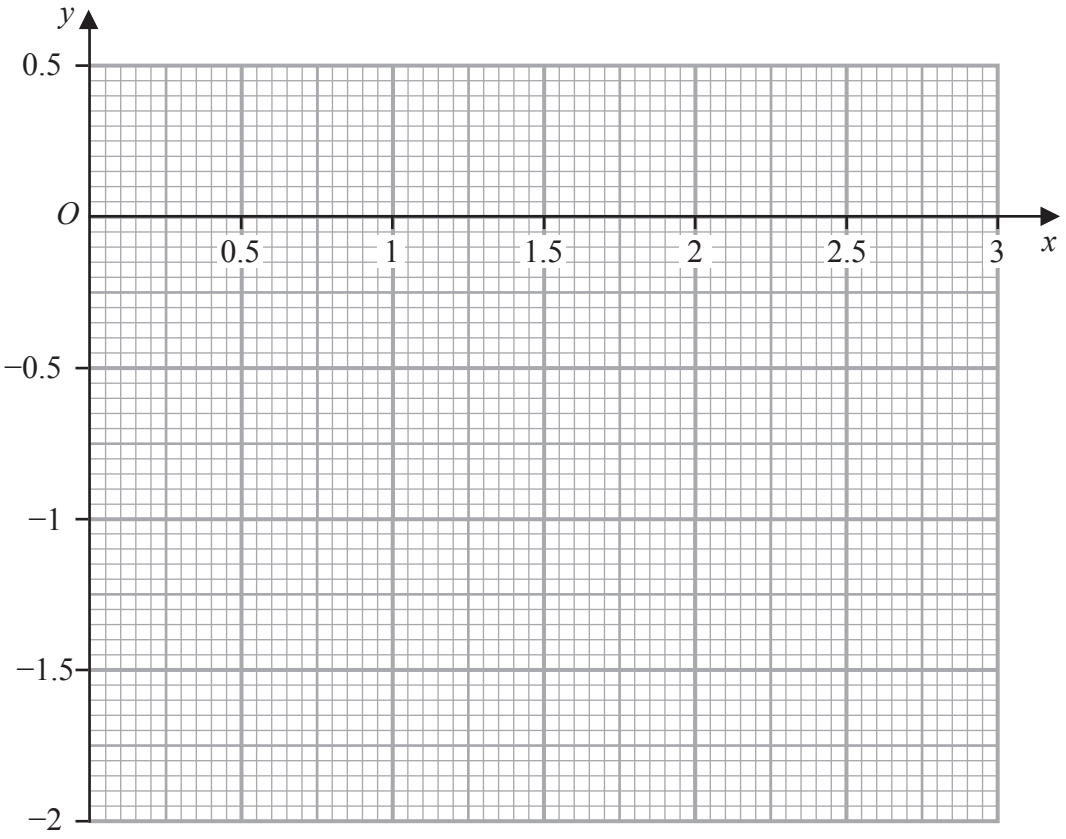
(2)

(c) By drawing a suitable straight line on the grid, obtain an estimate, to one decimal place, of the root of the equation

$$10^{\frac{3x-4}{2}} = 6x - 1 \quad \text{in the interval } 0.25 \leqslant x \leqslant 3$$

(4)

Question 4 continued

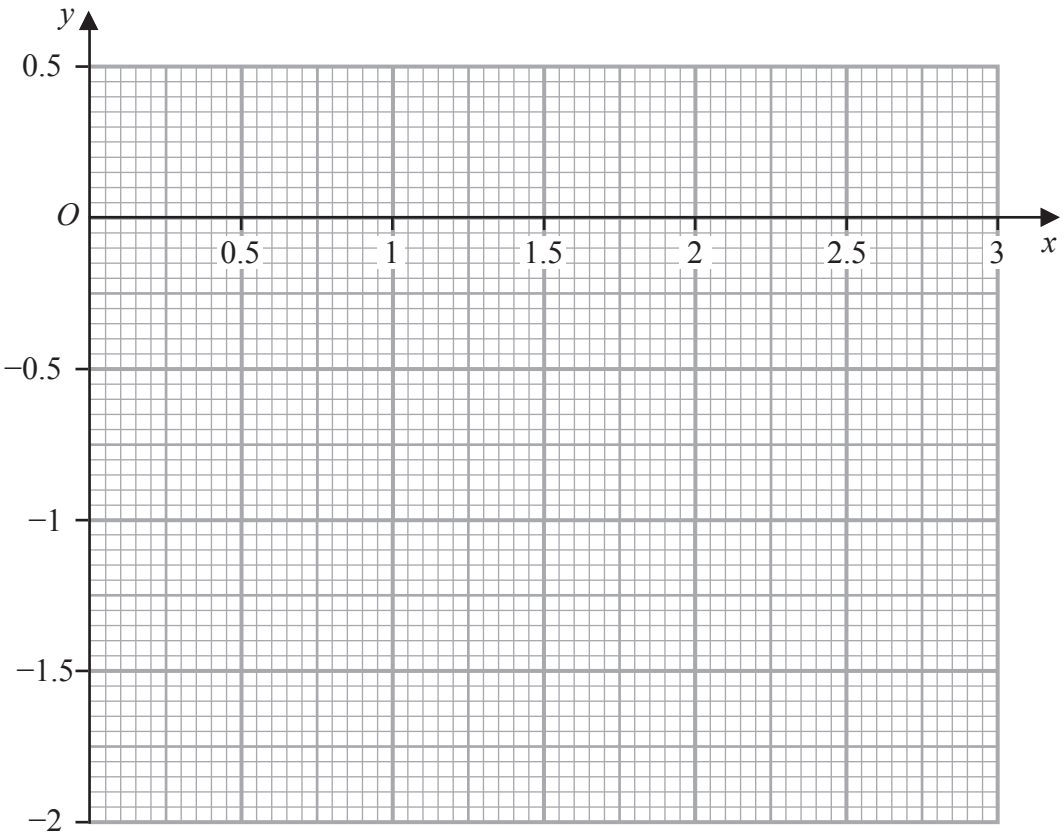


Turn over for a spare grid if you need to redraw your graph.

Question 4 continued

Question 4 continued

Only use this grid if you need to redraw your graph.



(Total for Question 4 is 8 marks)

5 The height of liquid in a vessel P is h
The volume, V, of the liquid in P is given by $V = 6h^3$
Liquid is leaking from P at a constant rate of $36\,\text{cm}^3/\text{s}$

Find the exact rate of change, in cm/s, of h when $V = 384\ \text{cm}^3$

(5)

Question 5 continued

(Total for Question 5 is 5 marks)

6 (i) Solve the equation $5\left(\log_b 9 + \log_b 3\right) = 3$

(4)

(ii) Solve the equation $3\log_3 x + 3\log_x 27 = 8\log_4 128$
Give your answers in exact form.

(7)

Question 6 continued

(Total for Question 6 is 11 marks)

7 (a) Use the factor theorem to show that $(4x-1)$ is a factor of

$$f(x) = 64x^3 - 64x^2 + 3$$

(2)

(b) Hence, or otherwise, find the exact roots of the equation

$$f(x) = 0$$

(4)

A geometric series G has first term a and common ratio r
The third term of G is 9 and the sum to infinity of G is 192

(c) Show that $64r^3 - 64r^2 + 3 = 0$

(3)

Given that r is a rational number

(d) write down the value of r

(1)

(e) show that $a = 144$

(2)

The sum to n terms of G is S_n

(f) Using logarithms, find the least value of n such that $S_n > 191.9$

(4)

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Question 7 continued

Question 7 continued

Question 7 continued

(Total for Question 7 is 16 marks)

8

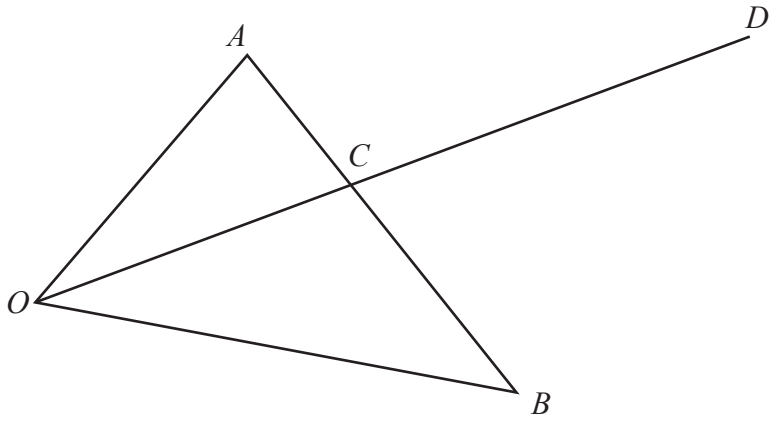

Diagram **NOT** accurately drawn

Figure 2

Figure 2 shows triangle AOB

$\overrightarrow{OA} = 4\mathbf{a} + 5\mathbf{b}$ $\overrightarrow{OB} = 8\mathbf{a} - \mathbf{b}$ $\overrightarrow{OD} = 15\mathbf{a} + 10\mathbf{b}$ where $|\mathbf{a}| = |\mathbf{b}| = 1$

(a) (i) Find $\overrightarrow{AB}$ in terms of **a** and **b**

(ii) Find, in its simplest form, the exact value of $|\overrightarrow{AB}|$

(3)

(b) Find the area of triangle AOB

(4)

The point C lies on AB and OD such that O, C and D are collinear.

(c) Use a vector method to find vector $\overrightarrow{OC}$ as a simplified expression in terms of **a** and **b**

(5)

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Question 8 continued

Question 8 continued

Question 8 continued

(Total for Question 8 is 12 marks)

9 (a) Using a formula given on page 2, show that

$$\cos 2\theta = 2\cos^2\theta - 1$$

(2)

(b) Hence show that

$$\int_{\frac{\pi}{3}}^{\frac{3\pi}{4}} \left(2\cos^2\theta - 1\right) \mathrm{d}\theta = -\frac{a+\sqrt{b}}{c}$$

where *a, b* and *c* are integers to be found.

(4)

Diagram **NOT** accurately drawn

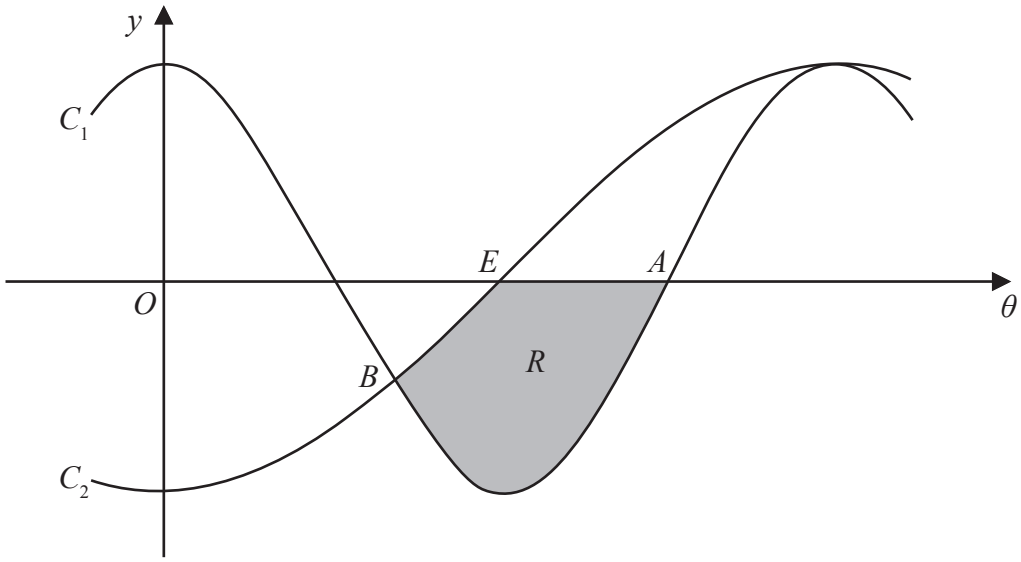


Figure 3

Figure 3 shows part of the curve C_1 with equation $y = 2\cos^2\theta - 1$ and part of the curve C_2 with equation $y = -\cos\theta$

Point B is the intersection of C_1 and C_2 as shown in Figure 3

Point $A\left(\frac{3\pi}{4}, 0\right)$ is the intersection of C_1 with the θ-axis as shown in Figure 3

Point $E\left(\frac{\pi}{2}, 0\right)$ is the intersection of C_2 with the θ-axis as shown in Figure 3

The finite region R, shown shaded in Figure 3, is bounded by the θ-axis, C_1 and C_2

(c) Use calculus to find, in its simplest form, the exact area of R

(8)

Question 9 continued

Question 9 continued

Question 9 continued

(Total for Question 9 is 14 marks)

10 A curve C has equation

$$y = \frac{5x-2}{3x+2} \qquad x \neq -\frac{2}{3}$$

(a) Find the coordinates of the point where C intersects the

(i) x-axis
(ii) y-axis

(2)

(b) Write down an equation of the asymptote to C that is

(i) parallel to the x-axis
(ii) parallel to the y-axis

(2)

(c) Sketch C on the opposite page.
Show and label the asymptotes and the coordinates of the points where C crosses the coordinate axes.

(3)

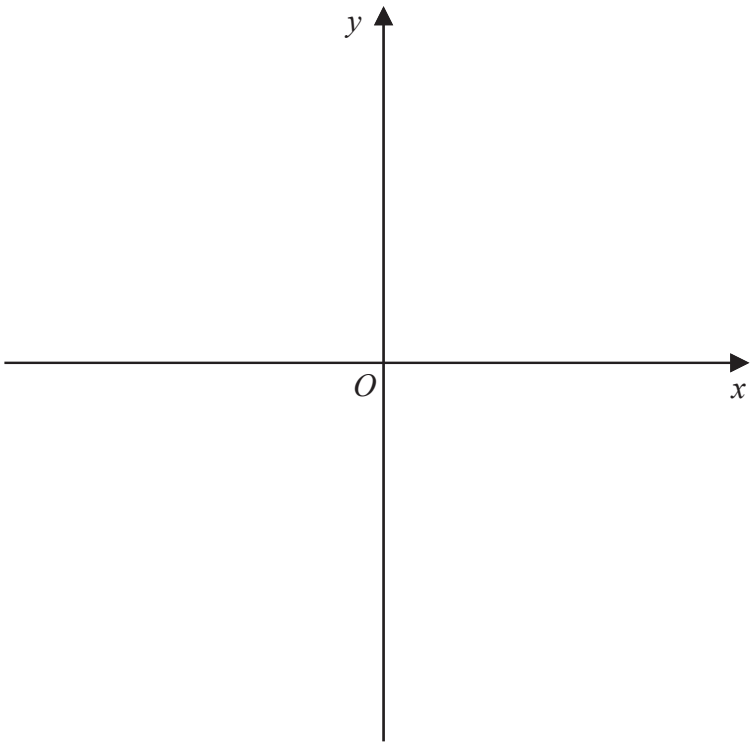
Point A lies on C such that the gradient of C at A is parallel to the line with equation $4y - x = 7$

The normal to C at A intersects the x-axis at point D and the y-axis at point E
Given that the x coordinate of A is positive,

(d) find, in its simplified form, the exact length of line DE

(11)

Question 10 continued



Question 10 continued

Question 10 continued

Question 10 continued

(Total for Question 10 is 18 marks)

TOTAL FOR PAPER IS 100 MARKS