

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 International GCSE

Friday 7 June 2024

Morning (Time: 2 hours)	Paper reference	4PM1/02
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Further Pure Mathematics

PAPER 2



Calculators may be used.	Total Marks
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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 ►

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Pearson

International GCSE in Further Pure Mathematics Formulae sheet

Mensuration

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

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

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

Series**Arithmetic series**

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

Geometric series

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

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

Binomial series

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

Calculus**Quotient rule (differentiation)**

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

Trigonometry**Cosine rule**

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

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

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

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

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

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

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

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

Logarithms

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

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2 The quadratic equation $3x^2 - 5x + 1 = 0$ has roots α and β

Without solving the equation,

form a quadratic equation with integer coefficients, that has roots $\frac{\alpha}{2\beta}$ and $\frac{\beta}{2\alpha}$ (8)

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Question 2 continued

Area with horizontal dotted lines for writing.

(Total for Question 2 is 8 marks)



3

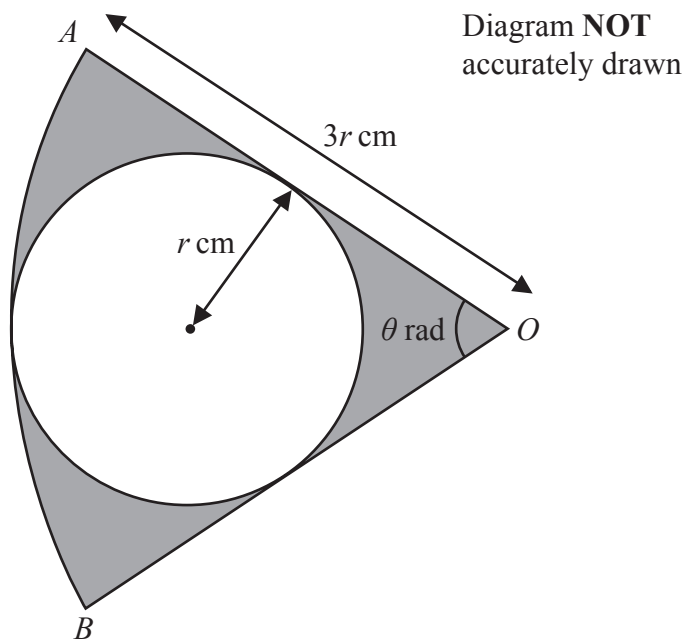


Figure 1

Figure 1 shows the sector AOB of a circle with centre O and radius $3r$ cm

A circle with radius r cm touches OA and OB and the arc AB

Angle AOB is θ radians, where $0 < \theta < \frac{\pi}{2}$

(a) Find the exact value of θ (2)

The area of the region shown shaded in Figure 1 is 8π cm²

(b) Find the value of r (4)

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Question 3 continued

Area with horizontal dotted lines for writing answers.

(Total for Question 3 is 6 marks)



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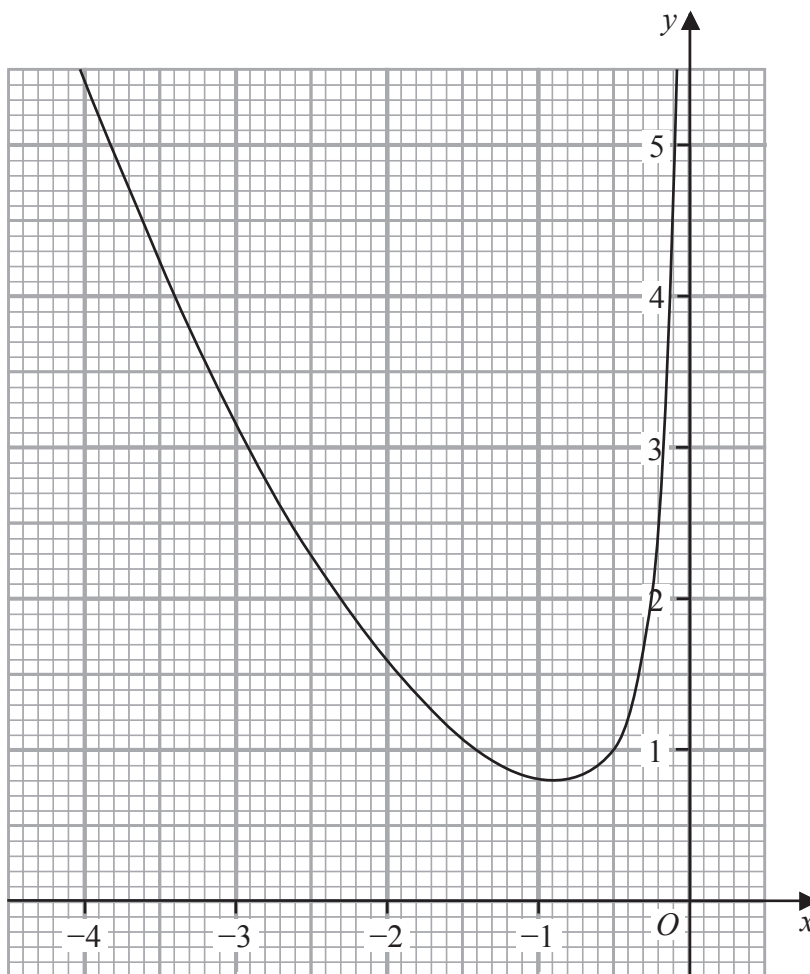


Figure 2

Figure 2 shows part of the curve with equation $y = \frac{x^2}{3} - \frac{1}{2x}$ for $-4 < x < 0$

By drawing a suitable straight line on the grid, obtain estimates, to one decimal place,

of the roots of the equation $4x^3 + 3x^2 - 36x - 6 = 0$ in the interval $-4 < x < 0$

(4)

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Question 4 continued

Area with horizontal dotted lines for writing answers.

(Total for Question 4 is 4 marks)



5

$$y = e^{2x}(x^2 - 5x)$$

Show that $2e^{2x} = \frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y$

(7)

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Question 5 continued

Area with horizontal dotted lines for writing answers.

(Total for Question 5 is 7 marks)



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Question 6 continued

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(Total for Question 6 is 10 marks)



- 7 (a) Expand $(1 + 2x^2)^{-\frac{3}{4}}$ in ascending powers of x up to and including the term in x^6

Express each coefficient as an exact fraction in its lowest terms.

(3)

$$f(x) = \frac{(2 + kx)^{\frac{3}{4}}}{(1 + 2x^2)^{\frac{3}{4}}} \quad \text{where } k \neq 0$$

- (b) Obtain a series expansion for $f(x)$ in ascending powers of x up to and including the term in x^5

Give each coefficient in terms of k where appropriate.

(2)

The coefficient of the term in x^5 is fourteen times the coefficient of the term in x^2

- (c) Find the value of k

(2)

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Question 7 continued

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Question 7 continued

Area with horizontal dotted lines for writing answers.

(Total for Question 7 is 7 marks)



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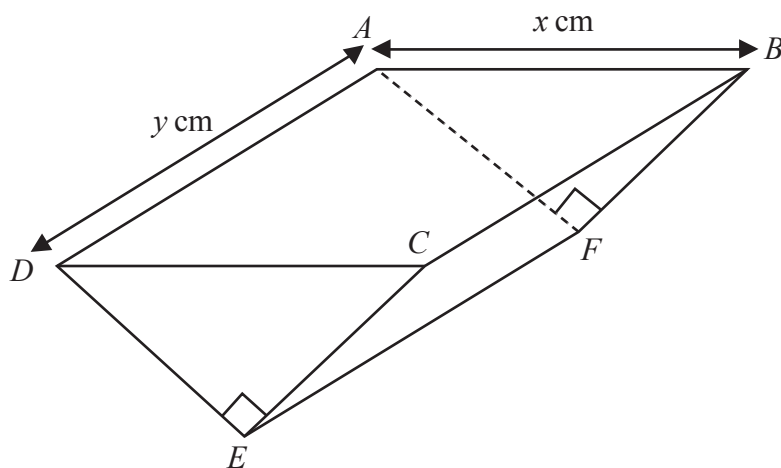


Diagram NOT accurately drawn

Figure 4

Figure 4 shows a solid right triangular prism $ABCDEF$

The cross section of the prism is an isosceles triangle.

- $\angle DEC = \angle AFB = 90^\circ$
- $AB = DC = x \text{ cm}$
- $AD = BC = FE = y \text{ cm}$
- $AF = BF = DE = CE$

The triangular faces of the prism are vertical and the edges AD , BC and FE are horizontal.

The volume of the prism is 3.6 cm^3

The total external surface area of the prism is $S \text{ cm}^2$

(a) Show that S satisfies the equation

$$S = \frac{x^2}{2} + \frac{72(\sqrt{2} + 1)}{5x} \tag{4}$$

Given that x can vary,

(b) use calculus, to find to 3 significant figures, the value of x for which S is a minimum.

Justify that this value of x gives a minimum value of S

(4)

(c) Hence find, to 2 significant figures, the minimum value of S

(2)

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Question 8 continued

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Question 8 continued

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(Total for Question 8 is 10 marks)



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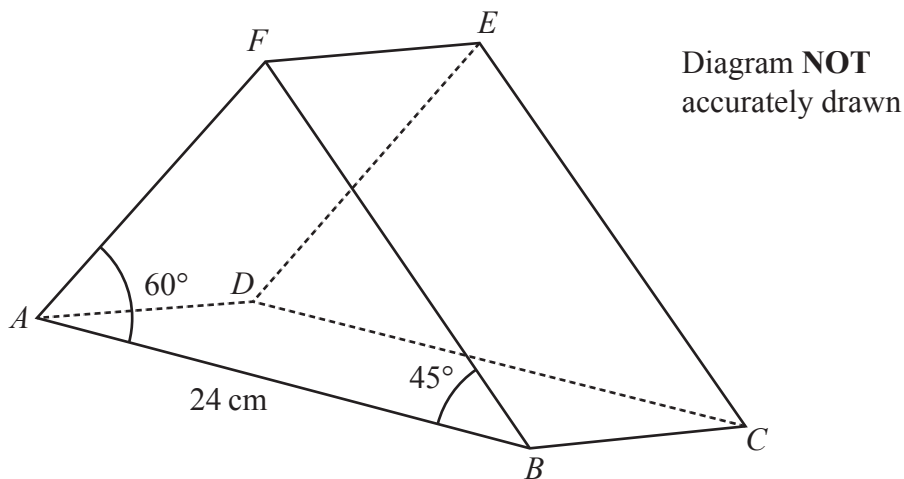


Figure 5

Figure 5 shows a right triangular prism $ABCDEF$ where $ABCD$ is a rectangle.

$$AF = DE \quad BF = CE \quad AD = FE = BC \quad AB = DC = 24 \text{ cm}$$

$$\angle ABF = \angle DCE = 45^\circ \quad \angle BAF = \angle CDE = 60^\circ$$

Using a formula from page 2,

(a) show that $\sin AFB = \frac{\sqrt{2} + \sqrt{6}}{4}$ (3)

Without using a calculator,

(b) show that $BF = 12(3\sqrt{2} - \sqrt{6})$ cm (5)

The angle between the plane AEB and the plane $ABCD$ is 65°

(c) Find, in cm to 2 significant figures, the length of EF (3)

(d) Find, in degrees to one decimal place, the size of the angle between the line CF and the plane $ABCD$ (4)

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Question 9 continued

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Question 9 continued

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(Total for Question 9 is 15 marks)



10 The points A, B, C and D are the vertices of a quadrilateral such that

$$\vec{AB} = 3\mathbf{a} + 4\mathbf{b} \quad \vec{AC} = 7\mathbf{a} + 9\mathbf{b} \quad \vec{AD} = 4\mathbf{a} + 5\mathbf{b}$$

(a) Show that $ABCD$ is a parallelogram.

(3)

BC is extended to the point E such that BCE is a straight line.

Point F lies on CD such that $CF : FD = 1 : 2$

Given that A, F and E are collinear,

(b) find the vector \vec{AE} in the form $X\mathbf{a} + Y\mathbf{b}$ where X and Y are rational numbers to be found.

(8)

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Question 10 continued

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11 Using formulae from page 2, show that

(a) (i) $\cos 2A = 2\cos^2 A - 1$ (3)

(ii) $\sin 2A = 2\sin A \cos A$ (1)

(b) Show that $\cos^3 A = \frac{\cos 3A + 3\cos A}{4}$ (4)

Hence, or otherwise,

(c) solve, giving exact values in terms of π

$$8\cos^3\left(\frac{\theta}{2}\right) - 6\cos\left(\frac{\theta}{2}\right) - 1 = 0 \quad \text{for } 0 \leq \theta \leq 2\pi \quad (4)$$

(d) use algebraic integration to find the exact value of

$$\int_0^{\frac{\pi}{6}} (4\cos^3 \theta - \sin 2\theta) \, d\theta \quad (4)$$

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Question 11 continued

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Handwriting practice area consisting of multiple horizontal dotted lines for writing.



