

Please check the examination details below before entering your candidate information

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Centre Number	Candidate Number
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Pearson Edexcel International GCSE

Friday 17 November 2023

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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International GCSE in Further Pure Mathematics Formulae sheet

MensurationSurface area of sphere = $4\pi r^2$ Curved surface area of cone = $\pi r \times$ slant heightVolume 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, $S_\infty = \frac{a}{1-r}$ $|r| < 1$ **Binomial series** $(1+x)^n = 1 + nx + \frac{n(n-1)}{2!}x^2 + \dots + \frac{n(n-1)\dots(n-r+1)}{r!}x^r + \dots$ 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**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 In triangle ABC , $AB = 3x$ cm, $BC = 5x$ cm and $\angle ABC = 110^\circ$

(a) Find, in degrees to one decimal place, the size of $\angle BCA$

(4)

The area of triangle ABC is 24 cm^2

(b) Find, to 3 significant figures, the value of x

(3)

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Question 2 continued

Area with horizontal dotted lines for writing answers.

(Total for Question 2 is 7 marks)



3 A particle P moves along the x -axis.

At time t seconds ($t \geq 0$) the acceleration, a m/s², of P is given by $a = 6t - 16$

When $t = 0$, P is at the origin and is moving with velocity 12 m/s.

(a) Find an expression in terms of t for

(i) the velocity of P at time t seconds

(ii) the displacement of P at time t seconds.

(4)

(b) Hence find the time at which P first returns to the origin.

(3)

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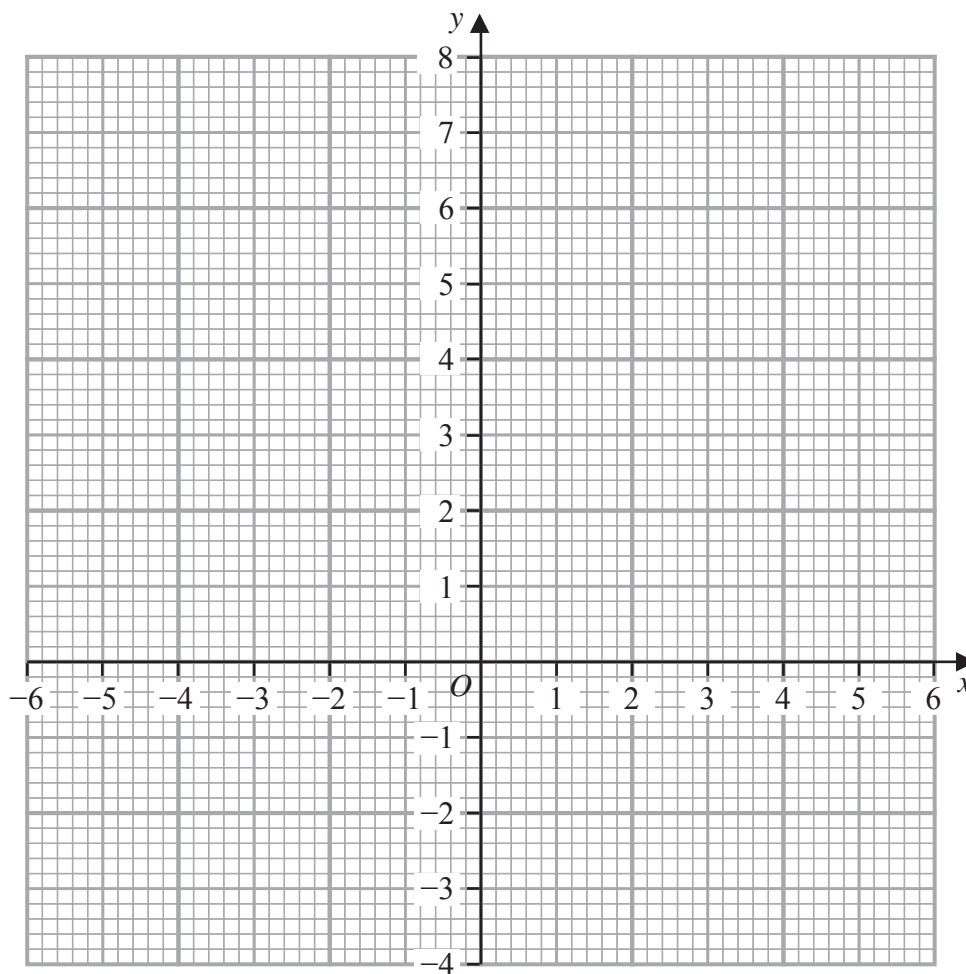
Question 3 continued

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(Total for Question 3 is 7 marks)



Question 4 continued



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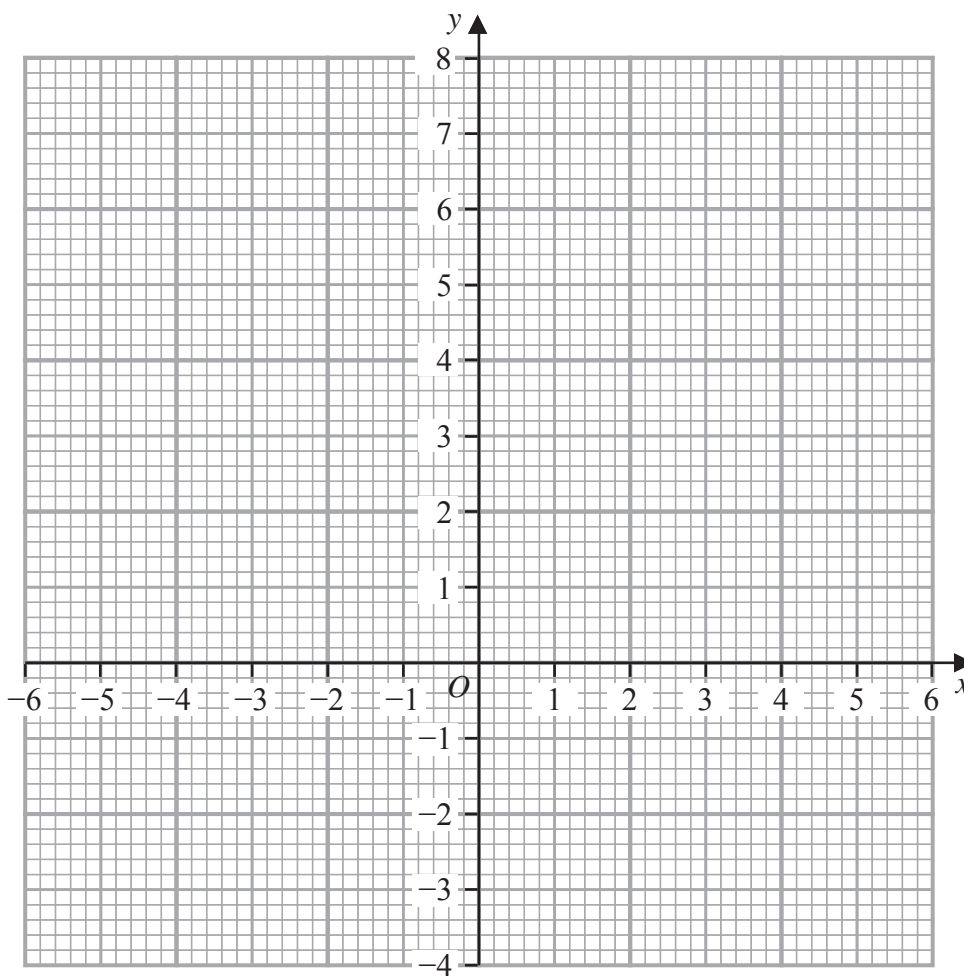
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Turn over for a spare grid if you need to redraw your graph.



Question 4 continued

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(Total for Question 4 is 8 marks)



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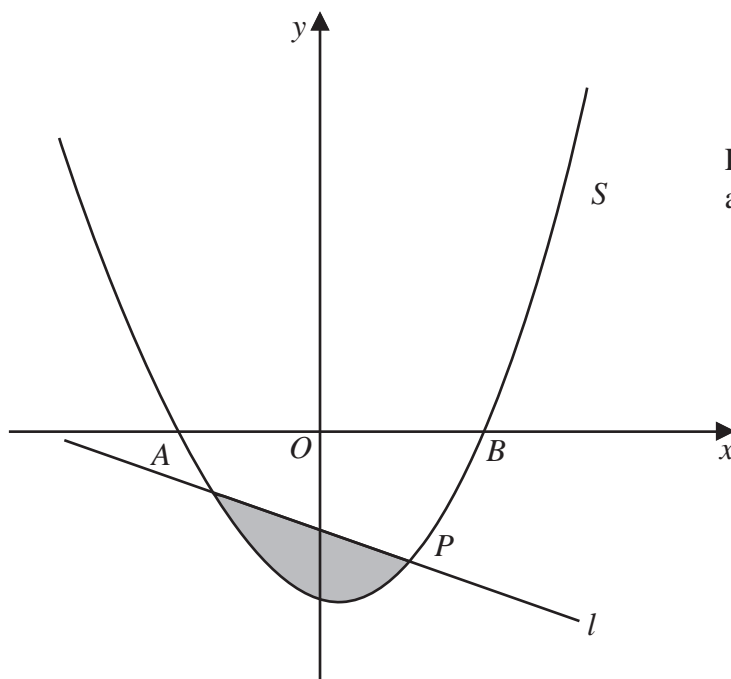


Diagram **NOT** accurately drawn

Figure 1

Figure 1 shows part of the curve S with equation $y = px^2 + qx + r$ where p, q and r are constants.

The points A, B and P with coordinates $(-2, 0), (6, 0)$ and $(4, -6)$ respectively lie on S

(a) Show that an equation of S is $y = \frac{x^2}{2} - 2x - 6$ (3)

The line l is the normal to S at the point P

(b) Show that an equation of l is $2y + x + 8 = 0$ (5)

The finite region shown shaded in Figure 1 is bounded by S and l

(c) Use algebraic integration to find the exact area of the shaded region. (7)

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Question 5 continued

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Question 5 continued

Handwriting practice area consisting of 25 horizontal dotted lines for writing answers.

(Total for Question 5 is 15 marks)



- 6 The volume of oil in a container is $V \text{ cm}^3$ when the height of the oil is $h \text{ cm}$.
Oil is pouring into the container at a constant rate of $12 \text{ cm}^3/\text{s}$.
Given that $V = 3h^3$

find the exact rate, in cm/s , at which the height of the oil is increasing
when $V = 1536 \text{ cm}^3$

(7)

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Question 6 continued

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(Total for Question 6 is 7 marks)



7 Two numbers x and y are such that $3x - y = 4$

$$S = 5x^3 + y^2$$

(a) Show that $S = 5x^3 + 9x^2 - 24x + 16$

(2)

Given that x can vary,

(b) use calculus to find the value of x for which S is a minimum, justifying that this value of x gives a minimum value of S

(5)

(c) Find the minimum value of S

(2)

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Question 7 continued

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(Total for Question 7 is 9 marks)



8 The sum to n terms of an arithmetic series A is S_n

The sum of the first four terms of A is 42 and the fifth term of A is 23

(a) Show that $S_n = \sum_{r=1}^n (Pr - Q)$ where P and Q are prime numbers. (6)

$S_{2n} - 3U_n = 1062$ where U_n is the n th term of A

(b) Find the value of n (4)

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Question 8 continued

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(Total for Question 8 is 10 marks)



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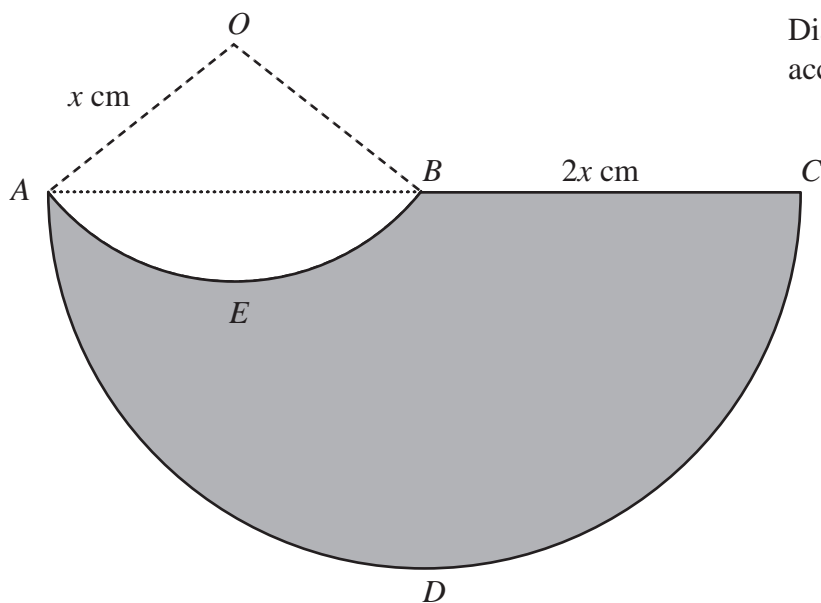


Figure 2

A logo, $AEBCD$, is shown shaded in Figure 2.

The straight line ABC is the diameter of the semicircle ADC

AEB is an arc of a circle with centre O

All angles are measured in radians.

- $BC = 2x$ cm
- $OA = OB = x$ cm
- length of arc $AEB = 1.8x$ cm

The perimeter of the logo is P

(a) Show that $P = ax(\pi + \pi \sin 0.9 + b)$ where a and b are constants to be found. (7)

Given that $x = 10$ cm,

(b) find, in cm^2 to 3 significant figures, the area of the logo. (6)

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Question 9 continued

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Question 9 continued

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(Total for Question 9 is 13 marks)



10 The roots of a quadratic equation are α and β where

$$\alpha + \beta = -\frac{5}{2} \text{ and } \alpha^3 + \beta^3 = \frac{115}{8}$$

(a) Show that $\alpha\beta = 4$

(3)

(b) Form a quadratic equation with integer coefficients, that has roots

$$\frac{\alpha^2 + 1}{\beta} \text{ and } \frac{\beta^2 + 1}{\alpha}$$

(7)

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Question 10 continued

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Question 10 continued

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(Total for Question 10 is 10 marks)



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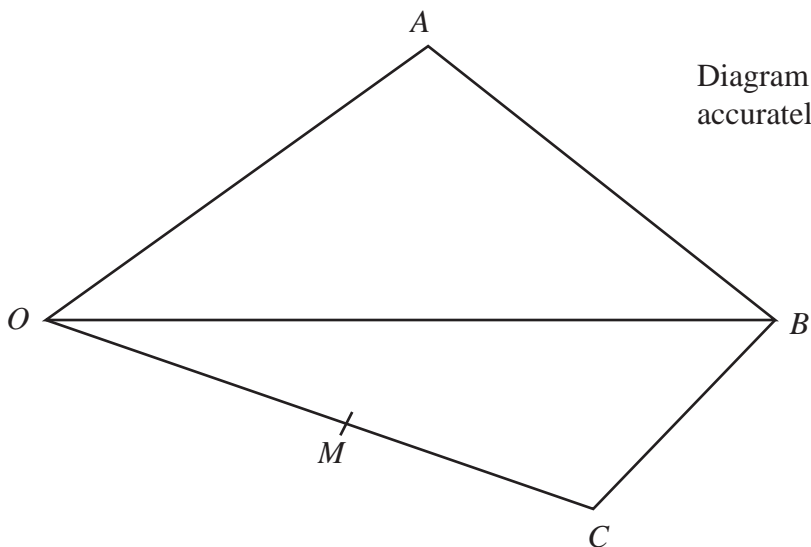


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Figure 3

Figure 3 shows quadrilateral $OABC$ where

$$\vec{OA} = 4\mathbf{p} + 5\mathbf{q} \quad \vec{OB} = 3\mathbf{p} + \mathbf{q} \quad \vec{OC} = 2\mathbf{p} - 4\mathbf{q}$$

The point M is the midpoint of OC

- (a) Find \vec{MA} as a simplified expression in terms of \mathbf{p} and \mathbf{q} (3)

The point N lies on OB such that M, N and A are collinear.

- (b) Find the ratio $MN : NA$ (6)

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Question 11 continued

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