Please check the examination details below before entering your candidate information

| Candidate surname | Other names |
|---|---|
| | |

**Pearson Edexcel International GCSE**

| Centre Number | Candidate Number |
|---|---|
| | |

**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.
- Good luck with your examination.

*Turn over* ▶

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P 6 6 0 2 5 A 0 1 3 6

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## 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)**

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

### 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

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

**Answer all ELEVEN questions.**

**Write your answers in the spaces provided.**

**You must write down all the stages in your working.**

**1** Find the set of values for $x$ for which

(a) $8x - 7 < 5x + 5$

**(2)**

(b) $2x^2 - 5x - 3 > 0$

**(3)**

(c) **both** $8x - 7 < 5x + 5$ **and** $2x^2 - 5x - 3 > 0$

**(1)**

**(Total for Question 1 is 6 marks)**

**2**

$$f(x) = 2 + \frac{4}{5}x - \frac{1}{25}x^2$$

Given that f($x$) can be expressed in the form $A - B(x + C)^2$ where $A$, $B$ and $C$ are constants,

(a) find the value of $A$, the value of $B$ and the value of $C$.

**(4)**

(b) Hence write down

(i) the maximum value of f($x$),

(ii) the value of $x$ for which this maximum occurs.

**(2)**

**Question 2 continued**

**(Total for Question 2 is 6 marks)**

**3**

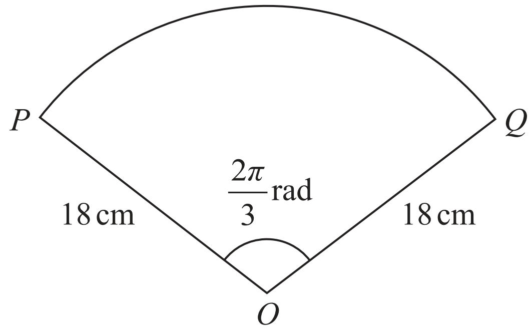


Diagram **NOT** accurately drawn

**Figure 1**

Figure 1 shows a sector *OPQ* of a circle with centre *O*.

The radius of the circle is 18 cm and the angle *POQ* is $\frac{2\pi}{3}$ radians.

(a) Find the length of the arc *PQ*, giving your answer as a multiple of $\pi$

**(2)**

Figure 2 below shows the sector *OPQ* and the kite *OPTQ*.

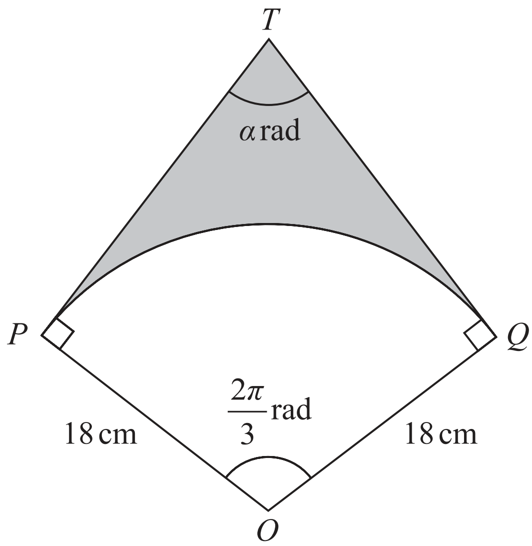


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**Figure 2**

*PT* is the tangent to the circle at *P* and *QT* is the tangent at *Q*, such that angle *PTQ* = $\alpha$ radians.

(b) (i) Find $\alpha$ in terms of $\pi$

**(1)**

(ii) Calculate, to 3 significant figures, the area of the region, shown shaded in Figure 2, which is bounded by the arc *PQ* and the tangents *PT* and *QT*.

**(6)**

**Question 3 continued**

**Question 3 continued**

**Question 3 continued**

**(Total for Question 3 is 9 marks)**

**4** The point $A$ has coordinates $(-4, -10)$ and the point $B$ has coordinates $(3, 11)$
The line $l$ passes through $A$ and $B$.

(a) Find an equation of $l$.

**(2)**

The point $P$ lies on $l$ such that $AP:PB = 3:4$

(b) Find the coordinates of $P$.

**(2)**

The point $Q$ with coordinates $(m, n)$, where $m < 0$, lies on the line through $P$ that is perpendicular to $l$.

Given that the length of $PQ$ is $\sqrt{10}$

(c) find the coordinates of $Q$.

**(6)**

The point $R$ has coordinates $(-11, -21)$

(d) Show that

(i) $AB$ and $RQ$ are equal in length,

(ii) $AB$ and $RQ$ are parallel.

**(4)**

(e) Find the area of the quadrilateral $ABQR$.

**(2)**

**Question 4 continued**

**Question 4 continued**

**Question 4 continued**

**(Total for Question 4 is 16 marks)**

**5** The $n$th term of a geometric series with common ratio $r$ is $u_n$

Given that $u_2 + u_4 = 212.5$ and that $u_3 + u_4 = 62.5$

(a) find the two possible values of $r$.

**(5)**

Given that the series is convergent with sum to infinity $S$,

(b) find the exact value of $S$.

**(2)**

**Question 5 continued**

**(Total for Question 5 is 7 marks)**

**6** $$f(x) = x^3 + (p + 1)x^2 - 10x + q$$

where $p$ and $q$ are integers.

Given that $(x - 3)$ is a factor of $f(x)$

(a) show that $9p + q + 6 = 0$

**(3)**

Given that $(x + p)$, where $p > 0$, is also a factor of $f(x)$

(b) show that $p^2 + 10p + q = 0$

**(3)**

(c) Hence find the value of $p$ and the value of $q$.

**(5)**

(d) Using your values of $p$ and $q$, factorise $f(x)$ completely.

**(2)**

**Question 6 continued**

**Question 6 continued**

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Question 6 continued

(Total for Question 6 is 13 marks)

**7** (a) Complete the table of values for $y = 3^{\frac{x}{4}} + 2$

Give your answers to 2 decimal places where appropriate.

**(2)**

| $x$ | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| $y$ | 3 | 3.32 | | | | 5.95 |

(b) On the grid opposite, draw the graph of

$$y = 3^{\frac{x}{4}} + 2 \qquad \text{for} \quad 0 \leqslant x \leqslant 5$$

**(2)**

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

$$\log_3(6 - 2x)^4 - x = 0$$

in the interval $0 \leqslant x \leqslant 5$

**(5)**

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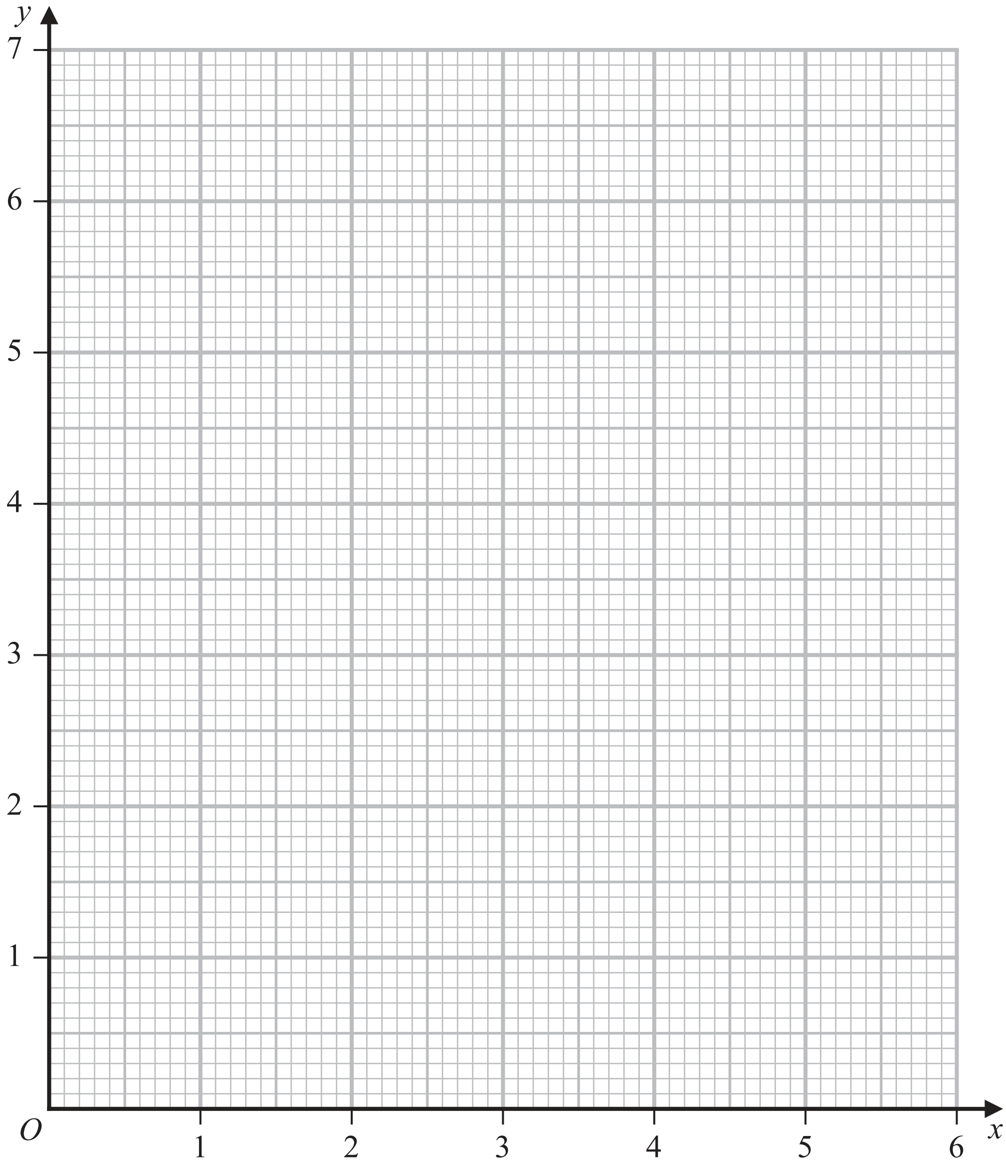
**Question 7 continued**

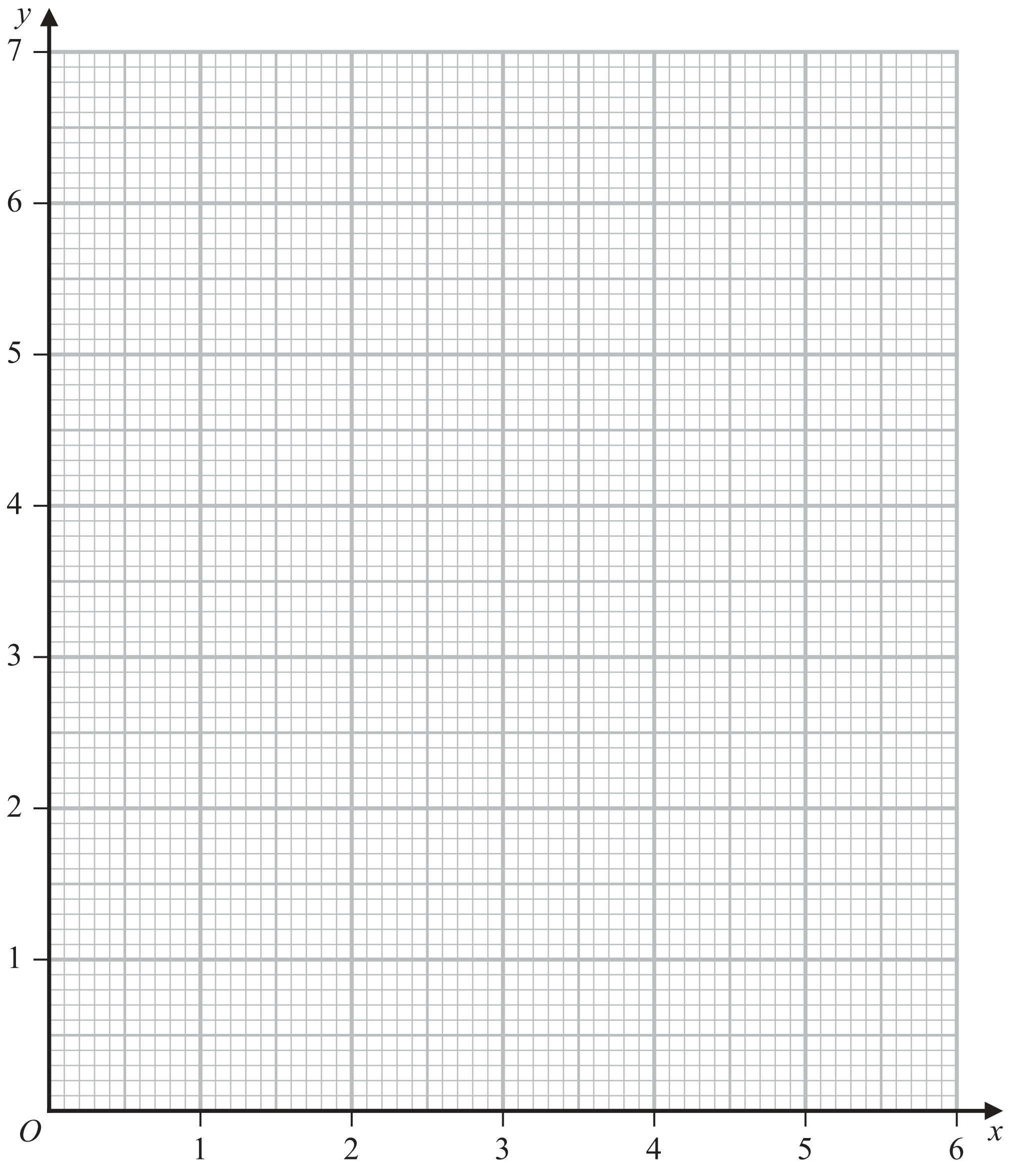



**Turn over for a spare grid if you need to redraw your graph.**

**Question 7 continued**

**Question 7 continued**

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

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**(Total for Question 7 is 9 marks)**

**8** Use an algebraic method to solve the simultaneous equations

$$\log_4 a + 3\log_8 b = \frac{5}{2}$$

$$2^a = \frac{16^4}{4^{b^2}}$$

**(8)**

**Question 8 continued**

**(Total for Question 8 is 8 marks)**

**9**

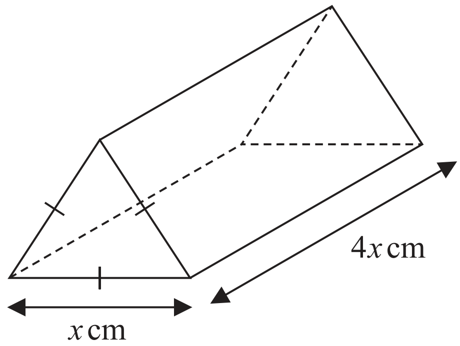


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**Figure 3**

Figure 3 shows a metal solid $S$.

The solid is a right triangular prism.

The cross section of $S$ is an equilateral triangle with sides of length $x$ cm.
The length of $S$ is $4x$ cm.

The prism is being heated so that the cross sectional area is increasing at a constant rate of 0.03 cm$^2$/s.

(a) Find, giving your answer to 3 significant figures, $\frac{dx}{dt}$ when $x = 2$

**(5)**

(b) Find the rate of increase, in cm$^3$/s, of the volume of $S$ when $x = 2$

**(3)**

Question 9 continued

**Question 9 continued**

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**Question 9 continued**

**(Total for Question 9 is 8 marks)**



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**10** (a) Solve the equation

$$\tan x° = -3 \qquad \text{for } 0 \leqslant x < 360$$

Give your solutions to the nearest whole number.

**(3)**

Given that

$$7\sin^2\theta + \sin\theta\cos\theta = 6$$

(b) show that

$$\tan^2\theta + \tan\theta - 6 = 0$$

**(3)**

(c) Hence solve the equation

$$7\sin^2 y° + \sin y° \cos y° = 6 \qquad \text{for } 0 \leqslant y < 360$$

Give your solutions to the nearest whole number.

**(4)**

Question 10 continued

**Question 10 continued**

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**Question 10 continued**

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

**11**

Diagram **NOT** accurately drawn

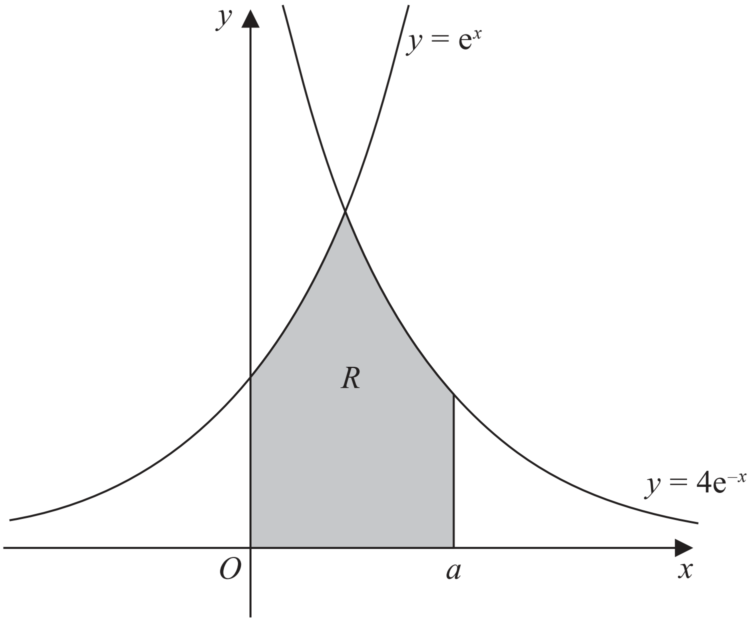


**Figure 4**

The region $R$, shown shaded in Figure 4, is bounded by the curve with equation $y = e^x$, the curve with equation $y = 4e^{-x}$, the straight line with equation $x = a$, the $x$-axis and the $y$-axis.

When the region $R$ is rotated through 360° about the $x$-axis, the volume of the solid generated is

$$k - 8\pi e^{-4}$$

where $k$ is a constant.

Using algebraic integration, find a possible value of $a$ and the exact corresponding value of $k$.

**(8)**

**Question 11 continued**

**Question 11 continued**

**(Total for Question 11 is 8 marks)**

**TOTAL FOR PAPER IS 100 MARKS**