

CANDIDATE
NAME

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MATHEMATICS

9709/31

Paper 3 Pure Mathematics 3 **(P3)**

May/June 2017

1 hour 45 minutes

Candidates answer on the Question Paper.

Additional Materials: List of Formulae (MF9)

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO NOT WRITE IN ANY BARCODES.

Answer **all** the questions.

Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

The use of an electronic calculator is expected, where appropriate.

You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is 75.

This document consists of **19** printed pages and **1** blank page.



1 Solve the inequality $|2x + 1| < 3|x - 2|$.

[4]

This image shows a full page of a document template designed for handwriting practice or as a general writing guide. It consists of approximately 20 evenly spaced, horizontal dotted lines running across the width of the page. The background is plain white, and there are no margins, text, or other markings present.

- 2 Expand $\frac{1}{\sqrt[3]{1+6x}}$ in ascending powers of x , up to and including the term in x^3 , simplifying the coefficients. [4]

[illegible]

3 It is given that $x = \ln(1 - y) - \ln y$, where $0 < y < 1$.

(i) Show that $y = \frac{e^{-x}}{1 + e^{-x}}$. [2]

[illegible]

(ii) Hence show that $\int_0^1 y \, dx = \ln\left(\frac{2e}{e+1}\right)$. [4]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

4 The parametric equations of a curve are

$$x = \ln \cos \theta, \quad y = 3\theta - \tan \theta,$$

where $0 \leq \theta < \frac{1}{2}\pi$.

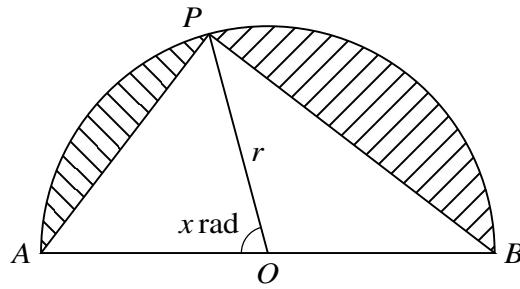
(i) Express $\frac{dy}{dx}$ in terms of $\tan \theta$.

[5]

[illegible]

- (ii) Find the exact y-coordinate of the point on the curve at which the gradient of the normal is equal to 1. [3]

This image shows a full page of white paper with horizontal dotted lines, typical of primary school writing paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.



The diagram shows a semicircle with centre O , radius r and diameter AB . The point P on its circumference is such that the area of the minor segment on AP is equal to half the area of the minor segment on BP . The angle AOP is x radians.

- (ii) Show that x satisfies the equation $x = \frac{1}{3}(\pi + \sin x)$. [3]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

- (ii) Verify by calculation that x lies between 1 and 1.5.

[2]

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- (iii) Use an iterative formula based on the equation in part (i) to determine x correct to 3 decimal places. Give the result of each iteration to 5 decimal places.

[3]

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- 6** The plane with equation $2x + 2y - z = 5$ is denoted by m . Relative to the origin O , the points A and B have coordinates $(3, 4, 0)$ and $(-1, 0, 2)$ respectively.

(i) Show that the plane m bisects AB at right angles.

[5]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

(ii) Find the equation of p , giving your answer in the form $ax + by + cz = d$. [3]

[illegible]

7 Throughout this question the use of a calculator is not permitted.

The complex numbers u and w are defined by $u = -1 + 7i$ and $w = 3 + 4i$.

- (i) Showing all your working, find in the form $x + iy$, where x and y are real, the complex numbers $u - 2w$ and $\frac{u}{w}$. [4]

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In an Argand diagram with origin O , the points A , B and C represent the complex numbers u , w and $u - 2w$ respectively.

- (ii) Prove that angle $AOB = \frac{1}{4}\pi$. [2]

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(iii) State fully the geometrical relation between the line segments OB and CA . [2]

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- 8** (i) By first expanding $2 \sin(x - 30^\circ)$, express $2 \sin(x - 30^\circ) - \cos x$ in the form $R \sin(x - \alpha)$, where $R > 0$ and $0^\circ < \alpha < 90^\circ$. Give the exact value of R and the value of α correct to 2 decimal places. [5]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

(ii) Hence solve the equation

$$2 \sin(x - 30^\circ) - \cos x = 1,$$

for $0^\circ < x < 180^\circ$.

[3]

This image shows a full page of white paper with horizontal dotted lines. The lines are evenly spaced and run across the width of the page, providing a guide for handwriting practice. There are no margins, text, or other markings on the page.

- 9 (i) Express $\frac{1}{x(2x+3)}$ in partial fractions. [2]

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- (ii) The variables x and y satisfy the differential equation

$$x(2x+3)\frac{dy}{dx} = y,$$

and it is given that $y = 1$ when $x = 1$. Solve the differential equation and calculate the value of y when $x = 9$, giving your answer correct to 3 significant figures. [7]

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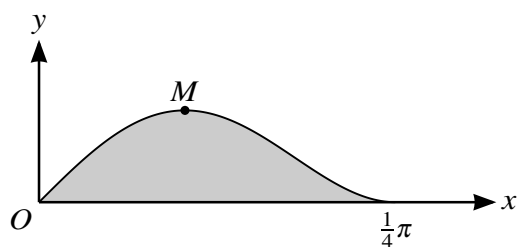
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(i) Using the substitution $u = \cos x$, find by integration the exact area of the shaded region bounded by the curve and the x -axis. [6]

This image shows a full page of a handwriting practice worksheet. It consists of multiple sets of three horizontal dashed lines spaced evenly down the page, providing a guide for letter height and placement. The background is plain white, and there are no other markings or text present.

[illegible]

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