



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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4037/22

May/June 2024

2 hours

You must answer on the question paper.

No additional materials are needed.

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You should use a calculator where appropriate.
- You must show all necessary working clearly; no marks will be given for unsupported answers from a calculator.
- Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place for angles in degrees, unless a different level of accuracy is specified in the question.

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [].

This document has **16** pages. Any blank pages are indicated.

Mathematical Formulae**1. ALGEBRA***Quadratic Equation*

For the equation $ax^2 + bx + c = 0$,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Binomial Theorem

$$(a + b)^n = a^n + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^2 + \dots + \binom{n}{r}a^{n-r}b^r + \dots + b^n$$

where n is a positive integer and $\binom{n}{r} = \frac{n!}{(n-r)!r!}$

Arithmetic series $u_n = a + (n-1)d$

$$S_n = \frac{1}{2}n(a + l) = \frac{1}{2}n\{2a + (n-1)d\}$$

Geometric series $u_n = ar^{n-1}$

$$S_n = \frac{a(1-r^n)}{1-r} \quad (r \neq 1)$$

$$S_\infty = \frac{a}{1-r} \quad (|r| < 1)$$

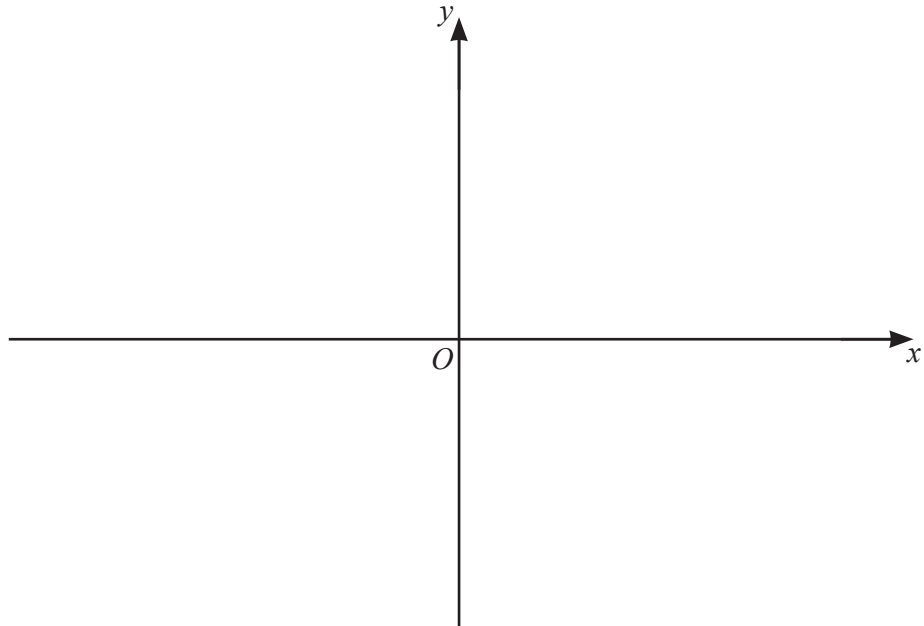
2. TRIGONOMETRY*Identities*

$$\begin{aligned}\sin^2 A + \cos^2 A &= 1 \\ \sec^2 A &= 1 + \tan^2 A \\ \operatorname{cosec}^2 A &= 1 + \cot^2 A\end{aligned}$$

Formulae for $\triangle ABC$

$$\begin{aligned}\frac{a}{\sin A} &= \frac{b}{\sin B} = \frac{c}{\sin C} \\ a^2 &= b^2 + c^2 - 2bc \cos A \\ \Delta &= \frac{1}{2}bc \sin A\end{aligned}$$

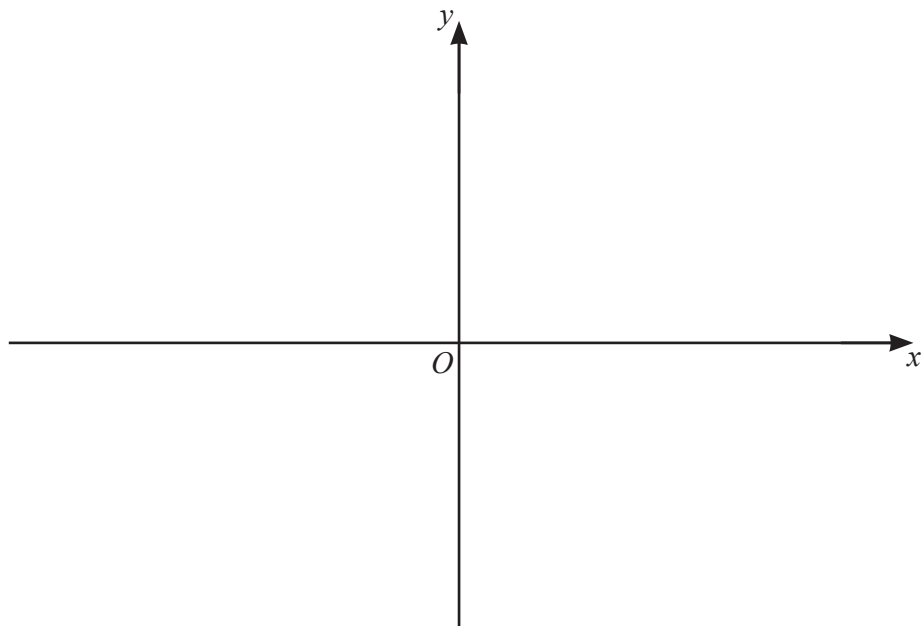
- 1 (a) On the axes, sketch the graph of $y = (2x - 5)(x + 3)(1 - x)$, stating the intercepts with the coordinate axes. [3]



(b) Hence

- (i) solve the inequality $(2x - 5)(x + 3)(1 - x) \leq 0$ [2]

- (ii) on the axes below, sketch the graph of $y = |(2x - 5)(x + 3)(1 - x)|$. [1]



2 (a) Evaluate $\int_{\frac{\pi}{3}}^{\frac{\pi}{2}} \cos \frac{x}{4} \mathrm{d}x$. You must show all your working. [4]

(b) Find $\int \left(\frac{1}{4x-3} + \frac{1}{x^3} \right) \mathrm{d}x$. [3]

- 3 (a) Determine whether the equation $\frac{(4x+1)(3x+2)}{5x-3} = x+1$ has two distinct real roots, two equal roots or no real roots. [4]

- (b) Solve the equation $\frac{12}{\sqrt[3]{x}} - \sqrt[3]{x} = 4$. [4]

4 The polynomial p is such that $p(x) = 6x^3 + x^2 - 12x + 5$.

(a) Find the remainder when $p(x)$ is divided by $x - 2$. [1]

(b) (i) Show that $2x - 1$ is a factor of $p(x)$. [1]

(ii) Hence write $p(x)$ as a product of linear factors. [3]

(iii) Hence solve the equation $6 \sin^3 \theta + \sin^2 \theta - 12 \sin \theta + 5 = 0$ for $0^\circ \leq \theta \leq 90^\circ$. [2]

- 5 A curve has equation $y = 5e^{2x-1} + e$. The tangent to the curve at the point where $x = 1$ cuts the x -axis at the point P .

Find the equation of the tangent in the form $y = mx + c$, where m and c are exact values, and hence find the x -coordinate of P . [6]

6 **(a)** Show that $\sin^3 x \left(\frac{\operatorname{cosec} x}{\cot x} \right)$ can be written as $\sin^2 x \tan x$. [3]

(b) Solve the equation $\cos^2 x \tan x - \frac{1}{2} \tan x = 0$ for $-\pi < x < \pi$. [5]

7 Find the number of different ways the 9 letters of the word POLYMATHS can be arranged when

(a) the O and A are **not** next to each other

[2]

(b) the letters MATHS are together in this order.

[2]

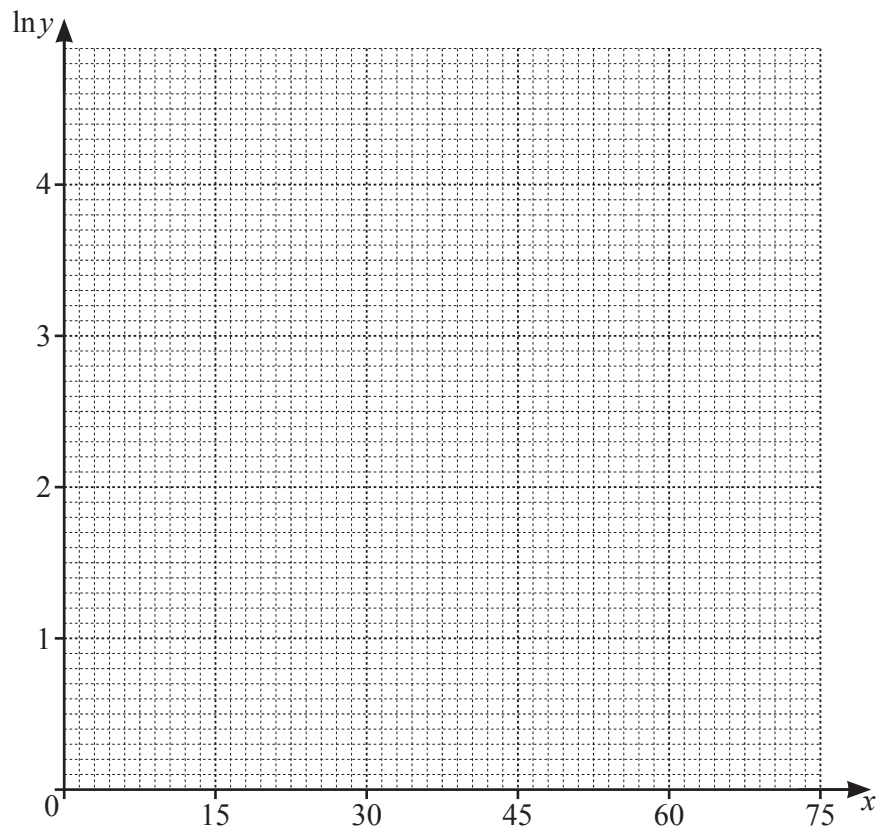
- 8 An experiment was carried out and values of y for certain values of x were recorded. The table shows the values recorded.

x	15	30	45	60	75
y	10	13	22	35	50

The relationship between y and x is modelled by $y = Ae^{kx}$, where A and k are constants.

- (a) Draw a straight line graph for $\ln y$ against x .

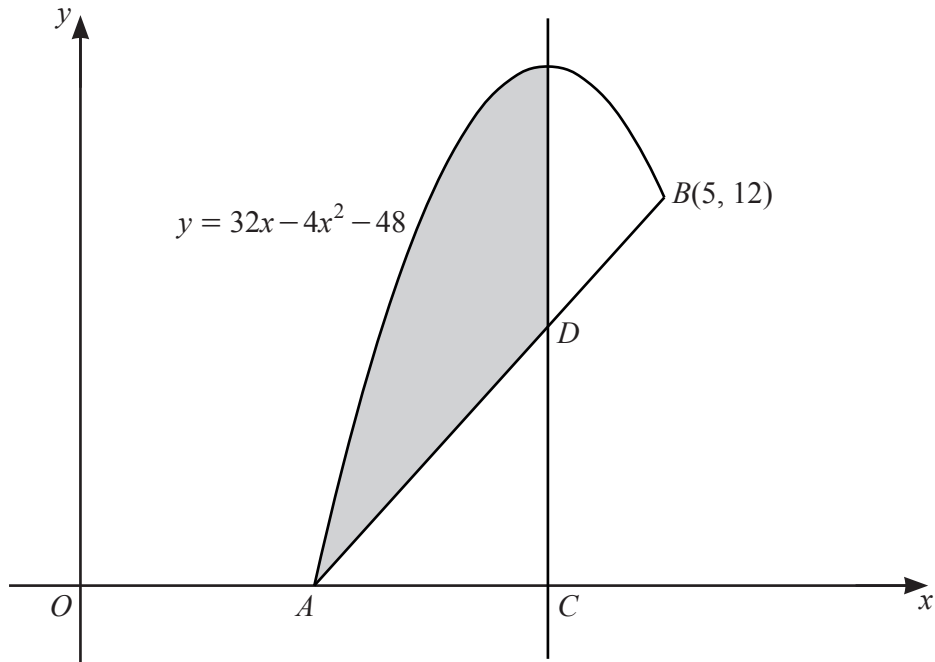
[2]



- (b) Find the equation of the line in **part (a)** and hence find the values of A and k . Give each value correct to 1 significant figure. [5]

- (c) Find the value of x for which $y = 17$. [2]

9



The diagram shows part of the curve $y = 32x - 4x^2 - 48$ and the line AB .
 The curve and the line AB meet the x -axis at A and meet again at the point $B(5, 12)$.
 The line CD extended is parallel to the y -axis and passes through the maximum point of the curve.
 Find the area of the shaded region.

[9]

Continuation of working space for Question 9.

10 The functions f and fg are defined by

$$f(x) = e^{x^2+3} \quad \text{for } x < 0$$

$$fg(x) = e^{2x} \quad \text{for } x > \frac{3}{2}.$$

(a) Explain why f^{-1} exists. [1]

(b) Find an expression for $f^{-1}(x)$ and state the domain and range of f^{-1} . [5]

(c) Hence find and simplify an expression for $g(x)$. [2]

- 11 In the binomial expansion of $\left(2 + \frac{x}{2}\right)^n$, the first three terms in increasing powers of x are $b + abx + \frac{9}{8}abx^2$. Find the values of the constants n , a and b .

[8]

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