



# Cambridge O Level

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**ADDITIONAL MATHEMATICS**
**4037/13**

Paper 1

**October/November 2024**
**2 hours**

You must answer on the question paper.

No additional materials are needed.

## INSTRUCTIONS

- 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.

## INFORMATION

- 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 $\triangle ABC$

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



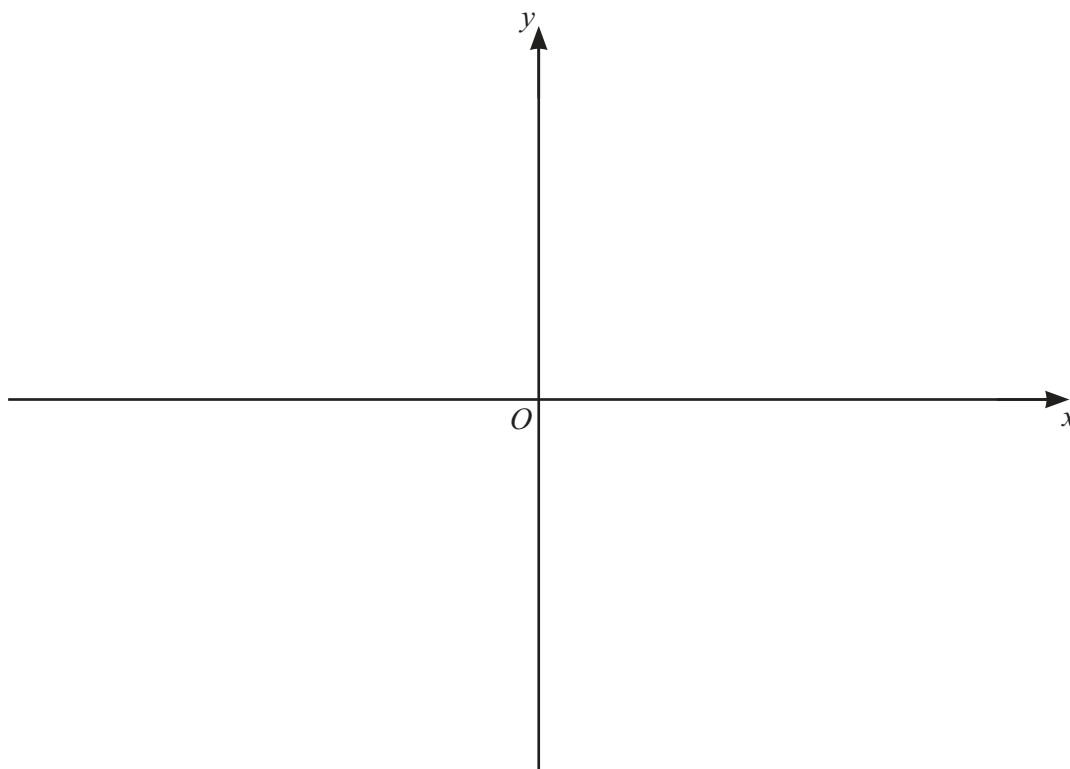


- 1 (a) Find the coordinates of the stationary point on the curve  $y = (x+3)(x-4)$ .

[3]

- (b) On the axes, sketch the graph of  $y = |(x+3)(x-4)|$ , stating the intercepts with the axes.

[2]



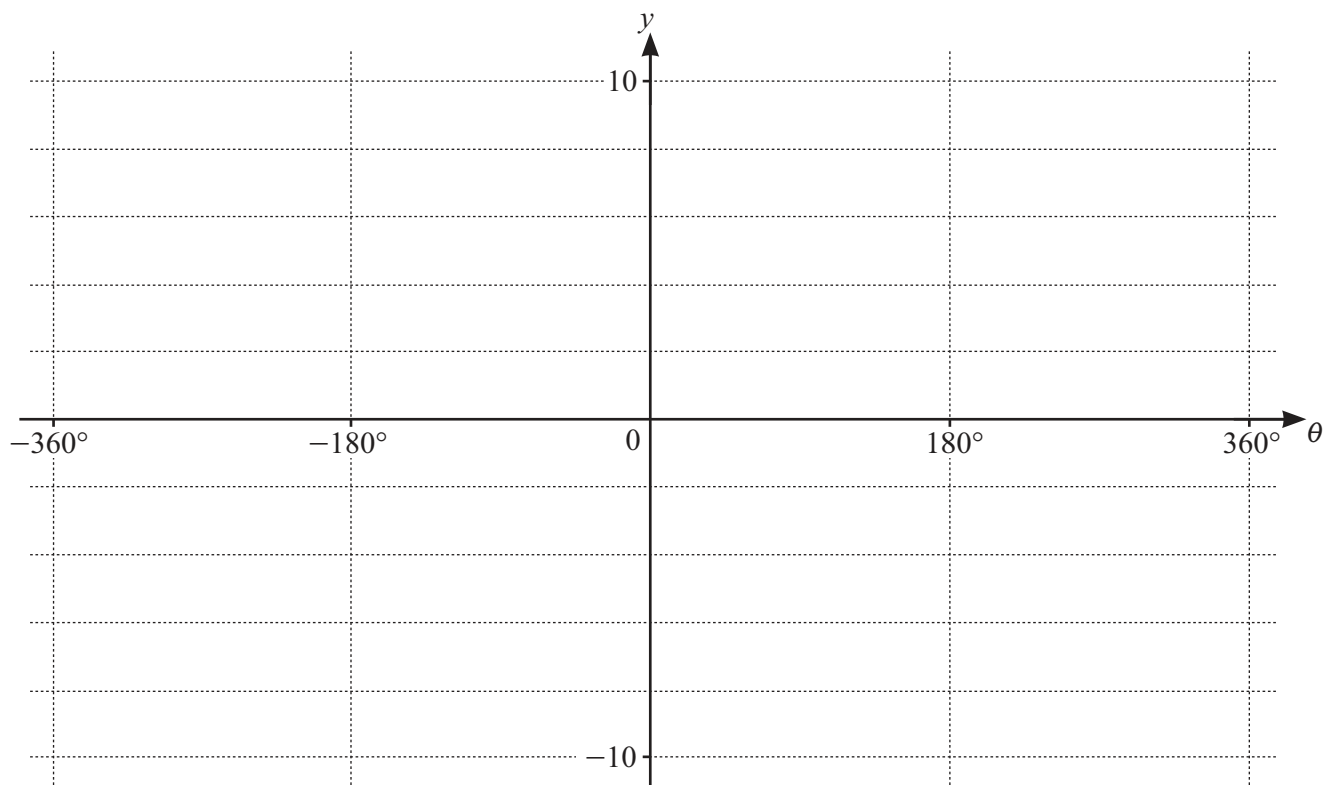
- (c) Given that  $k > 0$ , write down the values of  $k$  for which the equation  $|(x+3)(x-4)| = k$  has exactly 2 distinct real roots.

[1]





- 2 On the axes, sketch the graph of  $y = 4 + 5 \sin \frac{\theta}{2}$ , for  $-360^\circ \leq \theta \leq 360^\circ$ . State the intercept with the  $y$ -axis. [4]



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3 Find the values of  $k$  for which the equation  $4x^2 - k = 4kx - 2$  has no real roots.

[4]





4 (a) Write  $3 + 4 \log_2 a - \log_2 b$  as a single base 2 logarithm.

[3]

(b) Solve the equation  $\lg x = 4 \log_x 10$ .

[4]

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- 5 The polynomial  $p$  is such that  $p(x) = ax^3 + bx^2 - 19x + c$ , where  $a$ ,  $b$  and  $c$  are integers. It is given that  $x + 2$  is a factor of  $p(x)$ . When  $p(x)$  is divided by  $x + 1$  the remainder is 20.

(a) Show that  $7a - 3b = 39$ . [3]

It is also given that when  $p'(x)$  is divided by  $x - 1$  the remainder is 1.

(b) Find the values of  $a$ ,  $b$  and  $c$ . [3]



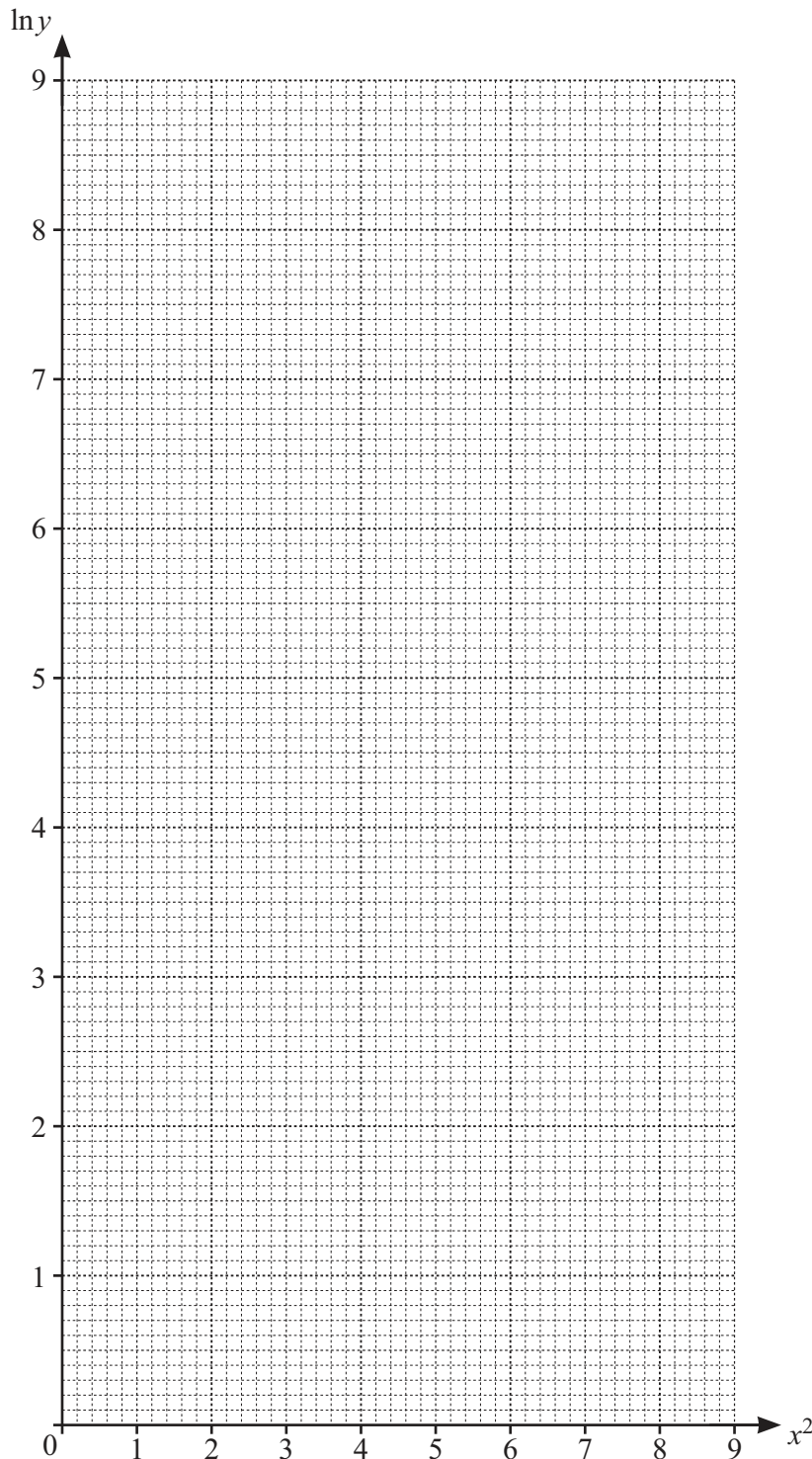


- 6 The table shows the variables  $x$  and  $y$  which are related by the equation  $y = Ab^{x^2}$ , where  $A$  and  $b$  are constants.

$x$	1	1.5	2	2.5	3
$y$	14	33.3	112	532.8	3584

- (a) Use the data to draw a straight line graph of  $\ln y$  against  $x^2$ .

[2]







- (b) Use your graph to estimate the values of  $A$  and  $b$ . Give your answers correct to 1 significant figure.  
[5]

- (c) Use your graph to estimate the value of  $x$  when  $y = 200$ . Give your answer correct to 2 significant figures.  
[2]





7 (a) Given that  $y = x^3 \ln x$ , find  $\frac{dy}{dx}$ .

[2]

(b) Hence find  $\int_1^2 3x^2 \ln x \, dx$ , giving your answer in the form  $\ln a + b$ , where  $a$  is an integer and  $b$  is a rational number.

[4]

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- 8 The straight line  $y = 2x + 1$  intersects the curve  $y + xy + 3x^2 = 15$  at the points  $A$  and  $B$ . The point  $C$  with coordinates  $\left(\frac{21}{10}, k\right)$  lies on the perpendicular bisector of  $AB$ .

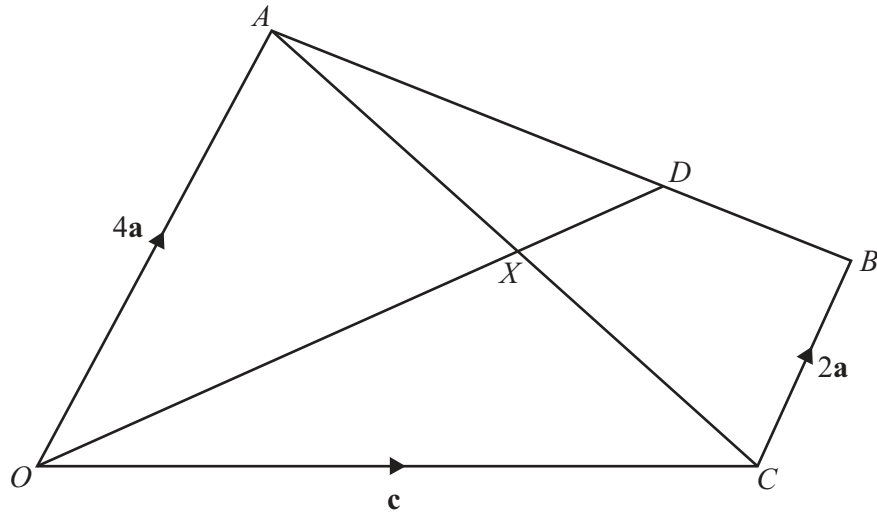
(a) Find the exact value of  $k$ .

[8]

- (b) The point  $D$  lies on the perpendicular bisector of  $AB$  such that its perpendicular distance from  $AB$  is twice that of the point  $C$  from  $AB$ . Find the possible coordinates of  $D$ .

[4]





The diagram shows the trapezium  $OABC$ , where  $\overrightarrow{OA} = 4\mathbf{a}$ ,  $\overrightarrow{OC} = \mathbf{c}$ , and  $\overrightarrow{CB} = 2\mathbf{a}$ . The point  $D$  lies on  $AB$  such that  $AD:DB = 2:1$ . The point  $X$  is the point of intersection of the lines  $OD$  and  $AC$ . It is given that  $\overrightarrow{AX} = \lambda\overrightarrow{AC}$  and  $\overrightarrow{OX} = \mu\overrightarrow{OD}$ .

Find in terms of  $\mathbf{a}$  and  $\mathbf{c}$

(a)  $\overrightarrow{AB}$  [1]

(b)  $\overrightarrow{OD}$ . [2]

(c) Find  $\overrightarrow{OX}$  in terms of  $\mathbf{a}$ ,  $\mathbf{c}$  and  $\mu$ . [1]

(d) Find  $\overrightarrow{AX}$  in terms of  $\mathbf{a}$ ,  $\mathbf{c}$  and  $\lambda$ . [2]





(e) Hence find the values of  $\lambda$  and  $\mu$ .

[4]





10 (a) Solve the equation  $7 \tan^2 \theta + 5 \tan \theta - 2 = 0$ , for  $-180^\circ \leq \theta \leq 180^\circ$ .

[4]

(b) Solve the equation  $3 \sin(3\phi - 1.5) - 2 = 0$ , for  $0 < \phi < 3$ , where  $\phi$  is in radians.

[5]

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- 11 (a) The first 3 terms of an arithmetic progression are  $\log_x 3$ ,  $\log_x 81$ ,  $\log_x 2187$ . Find the sum to  $n$  terms, giving your answer in the form  $k \log_x 3$ , where  $k$  is in terms of  $n$ . [3]

- (b) The first 3 terms of a geometric progression are  $1$ ,  $3 \tan^2 \theta$ ,  $9 \tan^4 \theta$ , for  $0 < \theta < \frac{\pi}{2}$ .

Find the values of  $\theta$  for which this geometric progression has a sum to infinity. [4]





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