



# **Cambridge IGCSE™**

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## **ADDITIONAL MATHEMATICS**

**0606/13**

Paper 1

**May/June 2023**

**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.

## **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*

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

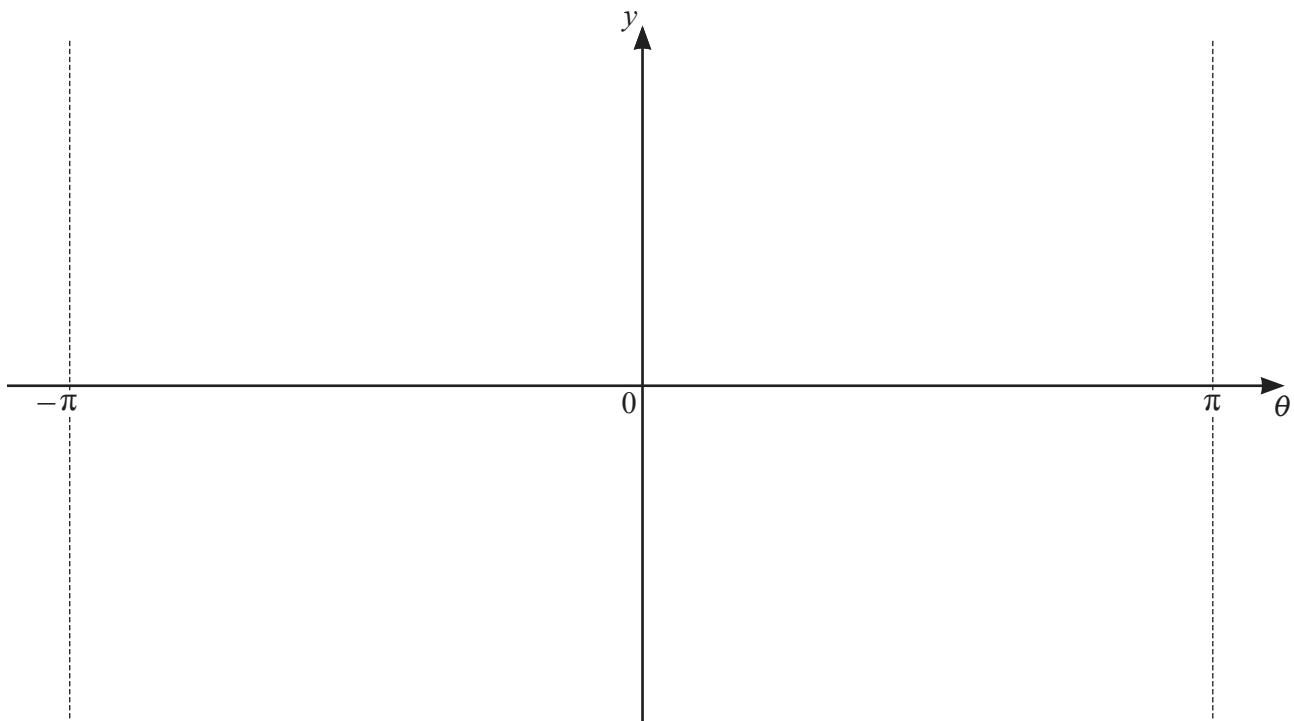
#### *Formulae for $\Delta ABC$*

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

$$\Delta = \frac{1}{2}bc \sin A$$

1 (a) Write down the period, in radians, of  $3 \tan \frac{\theta}{2} - 3$ . [1]

(b) On the axes, sketch the graph of  $y = 3 \tan \frac{\theta}{2} - 3$  for  $-\pi \leq \theta \leq \pi$ , stating the coordinates of the points where the graph meets the axes. [3]



2 (a) Write  $2x^2 + 5x + 3$  in the form  $2(x+a)^2 + b$ , where  $a$  and  $b$  are rational numbers. [2]

(b) Hence write down the coordinates of the stationary point on the curve  $y = 2x^2 + 5x + 3$ . [2]

(c) Solve the inequality  $2x^2 + 5x + 3 < \frac{15}{8}$ . [3]

3 (a) Write  $3 + 2 \lg a - \frac{1}{2} \lg(4b^2)$ , where  $a$  and  $b$  are both positive, as a single logarithm to base 10. Give your answer in its simplest form. [3]

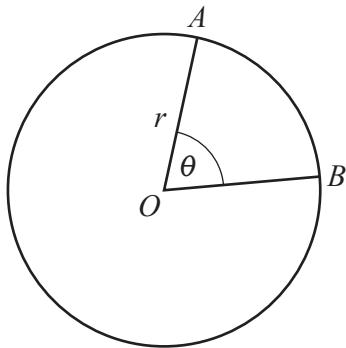
(b) Given that  $2 \log_c 3 = 7 + 4 \log_3 c$ , find the possible values of the positive constant  $c$ , giving your answers in exact form. [5]

4 The straight line  $y = 3x - 11$  and the curve  $xy = 4 - 3x - 2x^2$  intersect at the points  $A$  and  $B$ . The point  $C$ , with coordinates  $(a, -8)$  where  $a$  is a constant, lies on the perpendicular bisector of the line  $AB$ . Find the value of  $a$ . [8]

5 (a) Find the first three terms in the expansion of  $\left(x^2 - \frac{4}{x^2}\right)^{10}$  in descending powers of  $x$ . Give each term in its simplest form. [3]

(b) Hence find the coefficient of  $x^{16}$  in the expansion of  $\left(x^2 - \frac{4}{x^2}\right)^{10} \left(x^2 + \frac{2}{x^2}\right)^2$ . [3]

6 In this question lengths are in centimetres and angles are in radians.



The diagram shows a circle with centre  $O$  and radius  $r$ . The points  $A$  and  $B$  lie on the circumference of the circle. The area of the minor sector  $OAB$  is  $25 \text{ cm}^2$ . The angle  $AOB$  is  $\theta$ .

(a) Find an expression for the perimeter,  $P$ , of the minor sector  $AOB$ , in terms of  $r$ .

[3]

**(b)** Given that  $r$  can vary, show that  $P$  has a minimum value and find this minimum value.

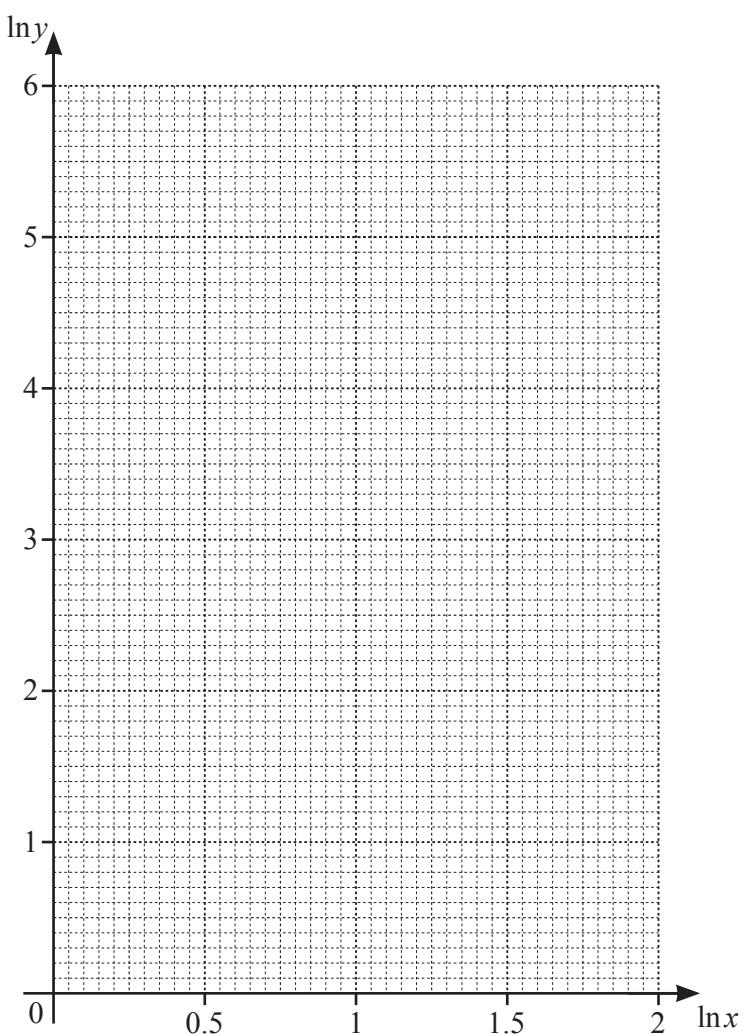
[4]

7 The table shows values of the variables  $x$  and  $y$  which are related by an equation of the form  $y = Ax^b$ , where  $A$  and  $b$  are constants.

$x$	1.5	2	2.5	3	4
$y$	13.8	27.5	46.9	72.6	145

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

[3]

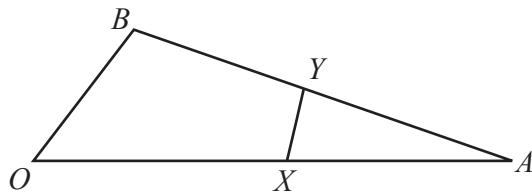


**(b)** Use your graph to estimate the values of  $A$  and  $b$ .

[5]

**(c)** Estimate the value of  $x$  when  $y = 100$ .

[2]



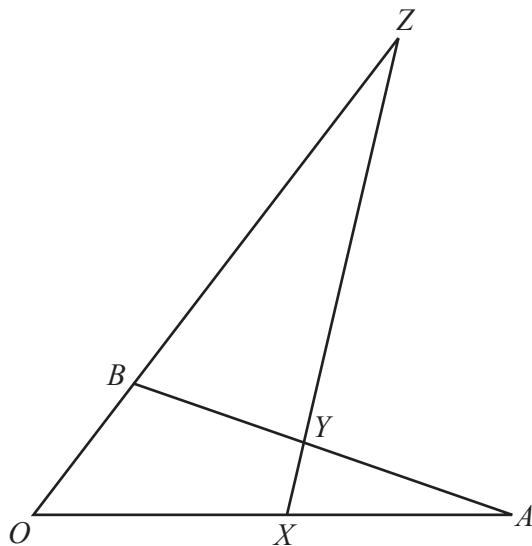
The diagram shows the triangle  $OAB$  with  $\overrightarrow{OA} = \mathbf{a}$  and  $\overrightarrow{OB} = \mathbf{b}$ . The point  $X$  lies on the line  $OA$  such that  $\overrightarrow{OX} = \frac{3}{5}\mathbf{a}$ . The point  $Y$  is the mid-point of the line  $AB$ . Find, in terms of  $\mathbf{a}$  and  $\mathbf{b}$ ,

(a)  $\overrightarrow{AB}$

[1]

(b)  $\overrightarrow{XY}$ .

[2]



The lines  $OB$  and  $XY$  are extended to meet at the point  $Z$ . It is given that  $\overrightarrow{YZ} = \lambda \overrightarrow{XY}$  and  $\overrightarrow{BZ} = \mu \mathbf{b}$ .

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

(d) Find  $\overrightarrow{XZ}$  in terms of  $\mu$ ,  $\mathbf{a}$  and  $\mathbf{b}$ . [2]

(e) Hence find the values of  $\lambda$  and  $\mu$ . [3]

9 In this question lengths are in centimetres and time is in seconds.

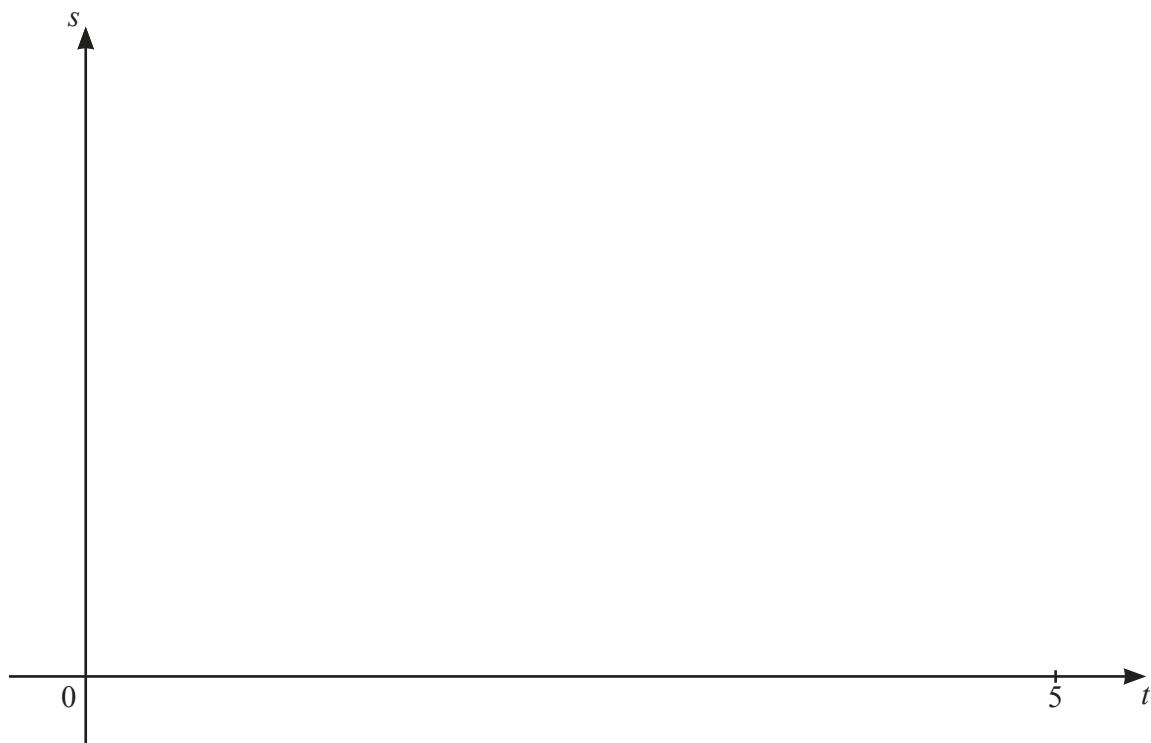
A particle  $P$  moves in a straight line such that its displacement  $s$ , from a fixed point at a time  $t$ , is given by  $s = 3(t+2)(t-4)^2$  for  $0 \leq t \leq 5$ .

(a) Find the values of  $t$  for which the velocity,  $v$ , of  $P$  is zero.

[4]

(b) On the axes below, sketch the displacement–time graph of  $P$ , stating the intercepts with the axes.

[3]



(c) On the axes below, sketch the velocity–time graph of  $P$ , stating the intercepts with the axes. [2]



(d) (i) Find an expression for the acceleration of  $P$  at time  $t$ . [1]

(ii) Hence, on the axes below, sketch the acceleration–time graph of  $P$ , stating the intercepts with the axes. [2]



**Question 10 is printed on the next page.**

10 (a) Show that  $\cos^4 \theta - \sin^4 \theta + 1 = 2 \cos^2 \theta$ .

[3]

(b) Solve the equation  $\cos^4 \frac{\phi}{3} - \sin^4 \frac{\phi}{3} + 1 = \frac{1}{2}$ , for  $-3\pi < \phi < 3\pi$ , giving your answers in terms of  $\pi$ . [5]

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