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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*

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

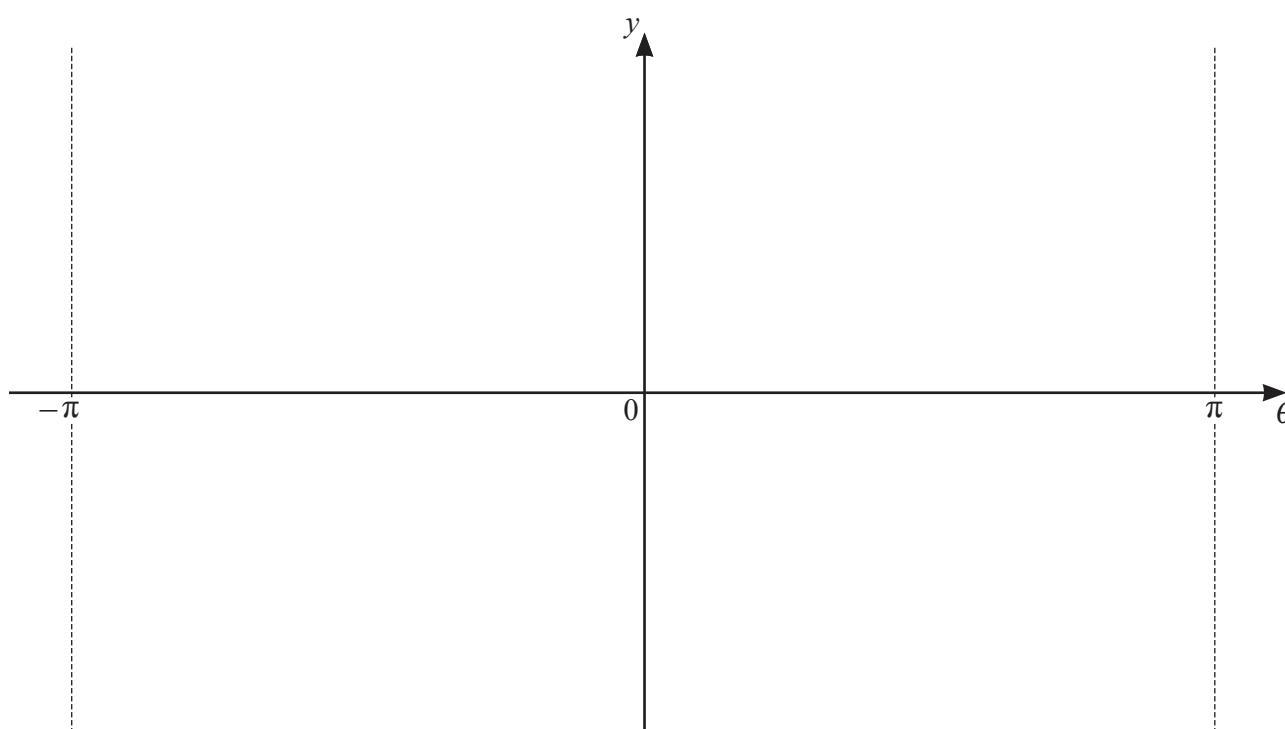
Formulae for $\triangle ABC$

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

3

- 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]



4

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]

5

- 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]

6

- 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]

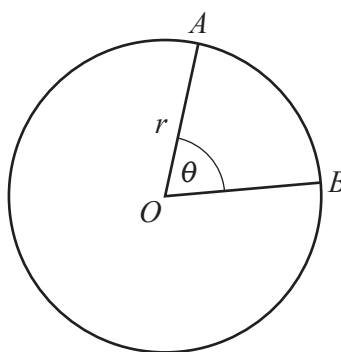
7

- 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]

8

- 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 cm^2 . The angle AOB is θ .

- (a) Find an expression for the perimeter, P , of the minor sector AOB , in terms of r . [3]

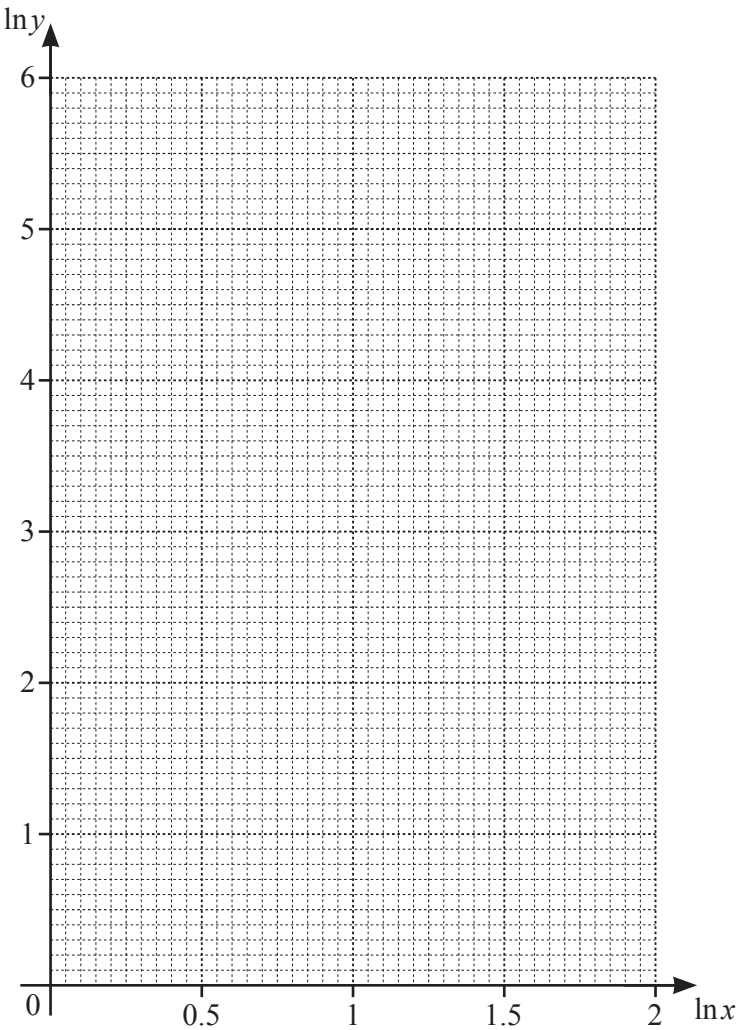
9

- (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]



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

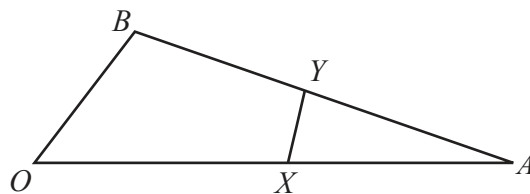
[5]

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

[2]

12

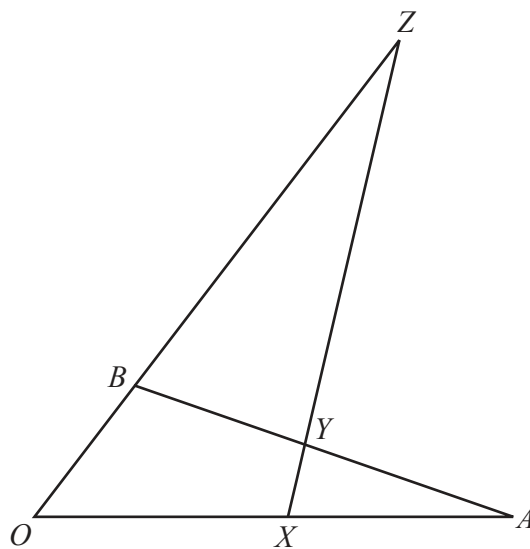
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The diagram shows the triangle OAB with $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$. The point X lies on the line OA such that $\overrightarrow{OX} = \frac{3}{5}\mathbf{a}$. The point Y is the mid-point of the line AB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

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

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

(e) Hence find the values of λ and μ . [3]

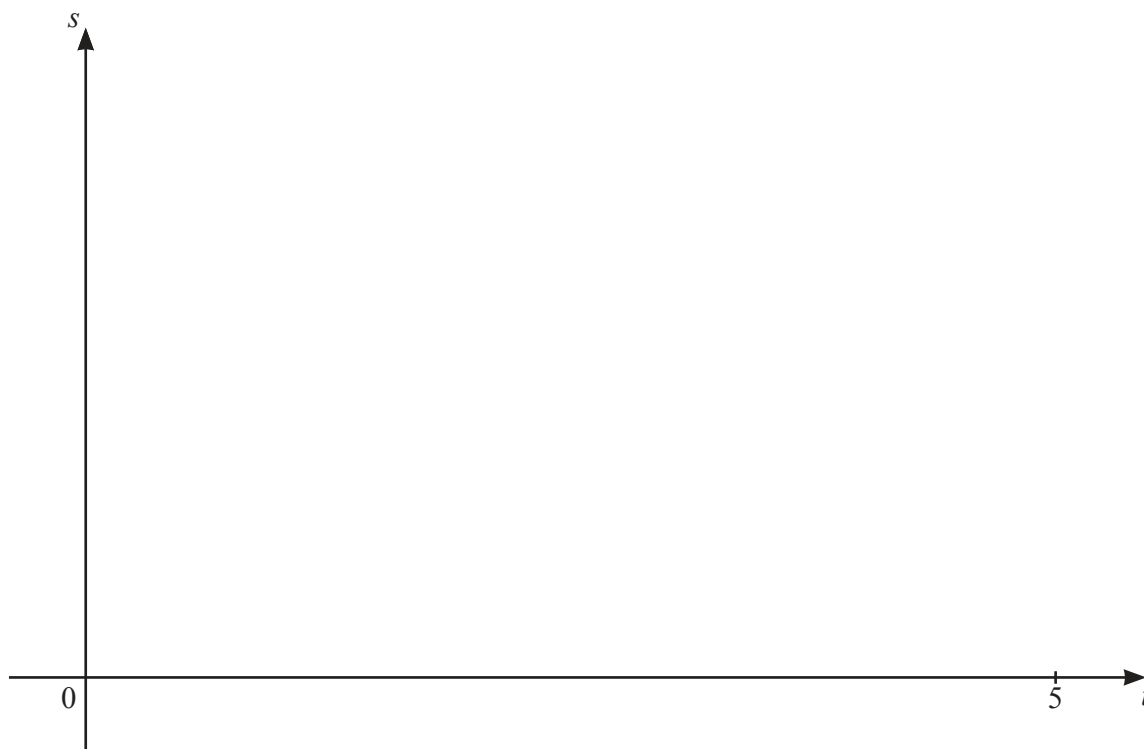
14

- 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]



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- (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 π . [5]

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