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ADDITIONAL MATHEMATICS

0606/12

Paper 1

May/June 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.



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

$$\sin^2 A + \cos^2 A = 1$$

$$\sec^2 A = 1 + \tan^2 A$$

$$\operatorname{cosec}^2 A = 1 + \cot^2 A$$

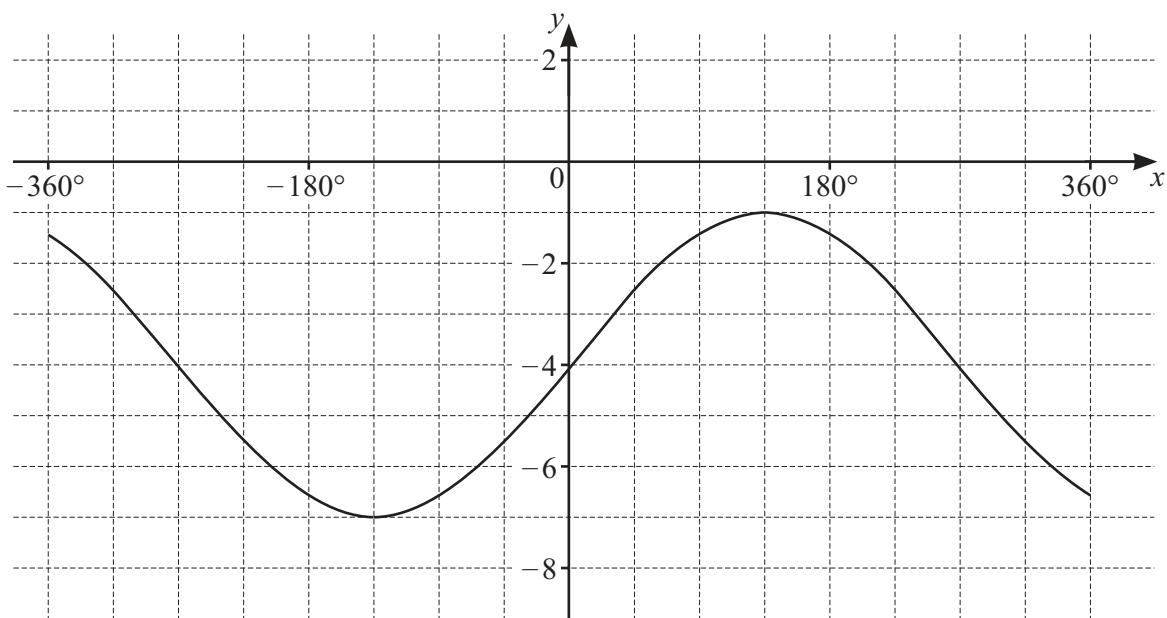
Formulae for ΔABC

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc \cos A$$

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





The diagram shows the graph of $y = a \sin bx + c$ for $-360^\circ \leq x \leq 360^\circ$, where a , b and c are constants. Find the values of a , b and c . [3]

2 Given that $\log_3 r + 2 \log_9 s = 8$, find the value of rs . [3]





3 Given that $y = \tan \frac{x}{2}$, find the exact value of $\frac{dy}{dx}$ when $x = \frac{\pi}{3}$.

[4]

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4 A team of 8 people is to be formed from 6 teachers, 5 doctors and 4 police officers.

(a) Find the number of teams that can be formed.

[1]

(b) Find the number of teams that can be formed without any teachers.

[1]

(c) Find the number of teams that can be formed with the same number of doctors as teachers.

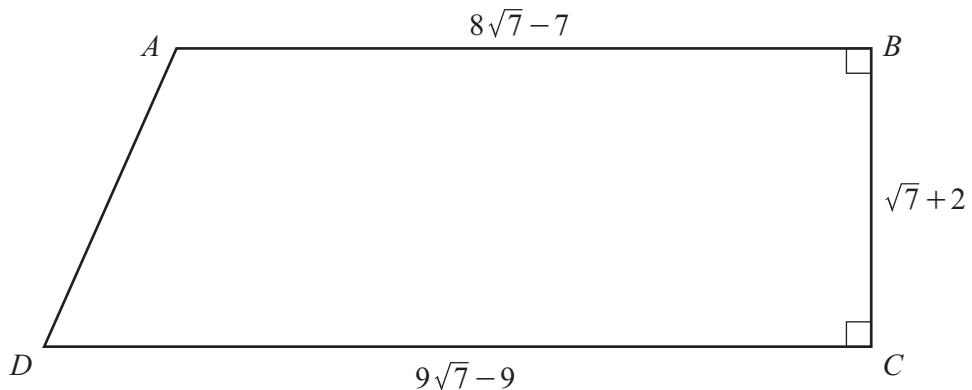
[4]





5 DO NOT USE A CALCULATOR IN THIS QUESTION.

In this question, all lengths are in centimetres.



The diagram shows the trapezium $ABCD$. The lengths of AB , BC and CD are $8\sqrt{7} - 7$, $\sqrt{7} + 2$ and $9\sqrt{7} - 9$ respectively. The line BC is perpendicular to the lines AB and CD .

(a) Find the perimeter of the trapezium, giving your answer in its simplest form. [3]

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(b) Find the area of the trapezium, giving your answer in the form $p\sqrt{7} + q$, where p and q are rational numbers. [3]



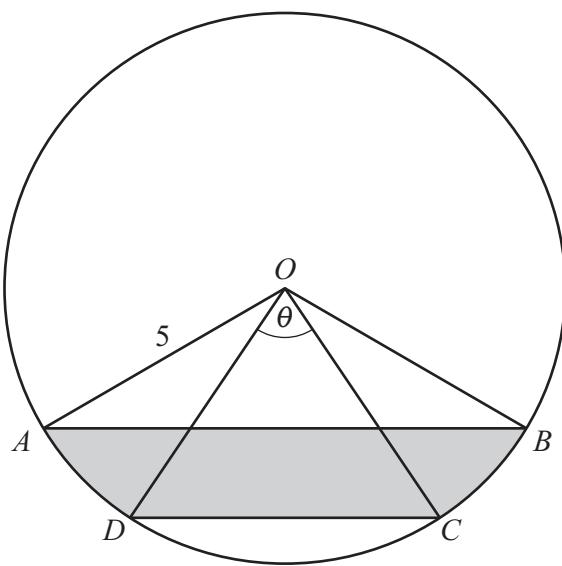


(c) Find $\cot DBC$, giving your answer in the form $r\sqrt{7} + s$, where r and s are simplified rational numbers. [3]





6 In this question, all lengths are in metres and all angles are in radians.



The diagram shows a circle with centre O and radius 5. The points A , B , C and D lie on the circumference of the circle. Angle $DOC = \theta$. Angle AOD = angle $COB = 0.5$. The length of the minor arc DC is 3.75.

(a) Show that $\theta = 0.75$. [1]

(b) Find the perimeter of the shaded region. [5]





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(c) Find the area of the shaded region.

[3]





7 (a) The line $y = 3x - 2$ intersects the curve $2x^2 - xy + y^2 = 2$ at the points A and B . The point C with coordinates $\left(k, \frac{7}{8}\right)$ lies on the perpendicular bisector of the line AB . Find the exact value of k .

[9]





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(b) The point D lies on the perpendicular bisector of AB such that D is a reflection of C in the line AB .
Find the coordinates of D . [2]





8 A curve has equation $y = \frac{(3x^2 - 5)^{\frac{1}{3}}}{x + 4}$.

(a) Show that $\frac{dy}{dx}$ can be written in the form $\frac{Ax^2 + Bx + C}{(3x^2 - 5)^{\frac{2}{3}}(x + 4)^2}$, where A , B and C are integers. [5]

(b) Hence find the x -coordinates of the stationary points on the curve. Give your answers in their simplest exact form. [3]





9 In this question, all distances are in metres and time, t , is in seconds.

A particle P moves with a speed of 14.5 parallel to the vector $\begin{pmatrix} -20 \\ 21 \end{pmatrix}$.

(a) Find the velocity vector of P .

[2]

Initially, P has position vector $\begin{pmatrix} 3 \\ 5 \end{pmatrix}$.

(b) Write down the position vector of P at time t .

[2]

A second particle Q has position vector $\begin{pmatrix} -1 \\ 3 \end{pmatrix} + \begin{pmatrix} -5 \\ 7.5 \end{pmatrix}t$ at time t .

(c) Find, in terms of t , the distance between P and Q at time t . Simplify your answer.

[4]

(d) Hence show that P and Q never collide.

[2]





10 (a) The first 3 terms of an arithmetic progression are $3 \sin 2x$, $5 \sin 2x$, $7 \sin 2x$.

(i) Show that the sum to n terms of this arithmetic progression can be written in the form $n(n+a)\sin 2x$, where a is a constant. [3]

(ii) Given that $x = \frac{2\pi}{3}$, find the exact sum of the first 20 terms. [2]





(b) The first 3 terms of a geometric progression are $\ln 2y$, $\ln 4y^2$, $\ln 16y^4$.

(i) Find the n th term of this geometric progression.

[2]

(ii) Find the sum to n terms of this geometric progression, giving your answer in its simplest form.

[2]

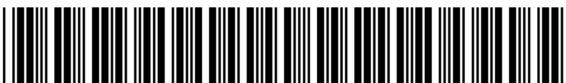
(c) The first 3 terms of a different geometric progression are $\left(2w - \frac{1}{4}\right)$, $\left(2w - \frac{1}{4}\right)^2$, $\left(2w - \frac{1}{4}\right)^3$.

Find the values of w for which this geometric progression has a sum to infinity.

[3]

Question 11 is printed on the next page.





11 (a) Given that $y = x^2 \ln x$, find $\frac{dy}{dx}$.

[2]

(b) Hence find $\int x \ln x \, dx$.

[3]

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