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ADDITIONAL MATHEMATICS

0606/22

Paper 2

February/March 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

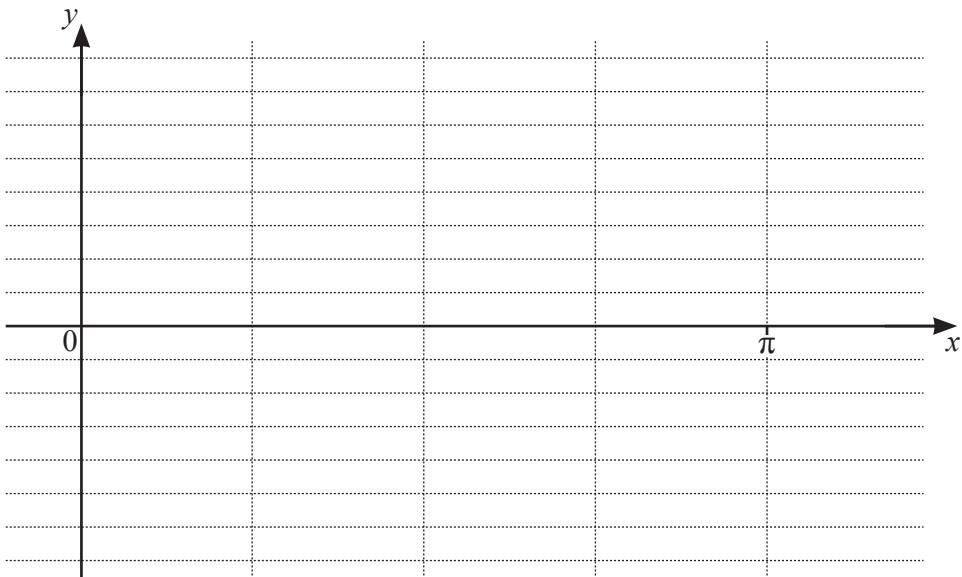
$$\begin{aligned}\sin^2 A + \cos^2 A &= 1 \\ \sec^2 A &= 1 + \tan^2 A \\ \operatorname{cosec}^2 A &= 1 + \cot^2 A\end{aligned}$$

Formulae for ΔABC

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

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

- 1 On the axes below, sketch the graph of $y = |4 \cos 2x|$ for $0 \leq x \leq \pi$, giving the coordinates of any points where the graph meets the axes. [3]



2 DO NOT USE A CALCULATOR IN THIS QUESTION.

Expand and simplify $\left(\frac{x\sqrt{11}}{2\sqrt{3}-1}\right)^2$, giving your answer with a rational denominator. [4]

3 Solve the inequality $|5x+4| \leq |2x-3|$.

[4]

4 $y = \frac{\sec^2 5x - \tan^2 5x}{\operatorname{cosec} 5x}$

Show that $y = a \sin bx$, where a and b are integers, and hence find the value of $\int_0^{\frac{\pi}{5}} y \, dx$. [4]

5 DO NOT USE A CALCULATOR IN THIS QUESTION.

(a) Show that $x - 1$ is a factor of the expression $x^3 - 2x^2 - 19x + 20$.

[1]

(b) Hence write $x^3 - 2x^2 - 19x + 20$ as a product of its linear factors.

[3]

(c) Hence find the exact solutions of the equation $e^{3y} - 2e^{2y} - 19e^y + 20 = 0$.

[2]

6 (a) A geometric progression has first term 64 and common ratio 0.5.

(i) Find the 10th term.

[2]

(ii) Find the sum of the first 10 terms.

[2]

(iii) Find the sum to infinity.

[1]

- (b) An arithmetic progression is such that $S_{20} - 400 = 2S_{10}$ and $u_1 : u_6$ is $1 : 5$.
Find the sum of the first 3 terms of this progression.

[6]

- 7 (a) Variables x and y are such that $y = \frac{1 + \cos^2 x}{\tan x}$. Use differentiation to find the approximate change in y as x increases from $\frac{\pi}{4}$ to $\frac{\pi}{4} + h$, where h is small. [5]

- (b) Given that $y = \frac{1}{(x-3)^3}$ show that $y - \frac{dy}{dx} - \frac{1}{3}\left(\frac{d^2y}{dx^2}\right)$ can be written as $\frac{(x+1)(x-4)}{(x-3)^5}$. [4]

8 The function f is defined for $x \geq 0$ by $f(x) = 5 - 2e^{-x}$.

(a) (i) Find the domain of f^{-1} .

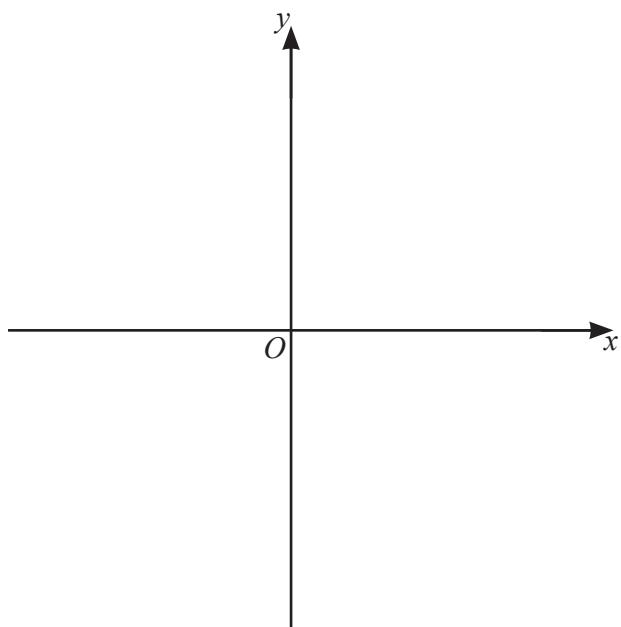
[2]

(ii) Solve $ff^{-1}(x) = \sqrt{5x-4}$.

[3]

(iii) On the axes, sketch the graph of $y = f(x)$ and hence sketch the graph of $y = f^{-1}(x)$. Show clearly the positions of any points where your graphs meet the coordinate axes and the positions of any asymptotes.

[4]



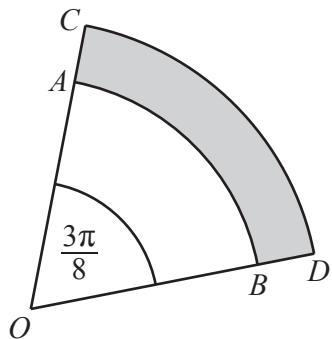
(b) The function g is defined for $0 \leq x \leq 0.2$ by $g(x) = \frac{3}{1-x}$.

Find and simplify an expression for $f^{-1}g(x)$.

[4]

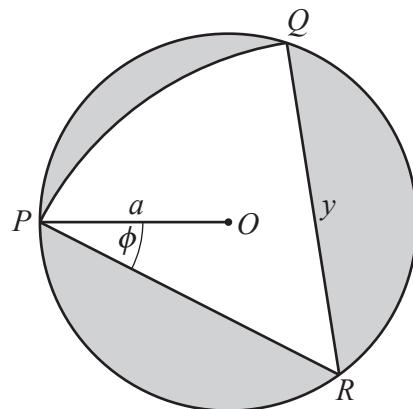
- 9 In this question, all lengths are in centimetres and all angles are in radians.

(a)



The diagram shows sectors AOB and COD of two circles with the same centre, O . Angle AOB is $\frac{3\pi}{8}$ and the length of OC is 6.5. It is given that OAC and OBD are straight lines and $OA : OC$ is $4 : 5$. Find the perimeter of the shaded region. [3]

(b)



The diagram shows a circle with centre O and radius a . Sector PQR is a sector of a different circle with centre R and radius y . Angle OPR is ϕ . Find, in terms of a and ϕ only, the total area of the three shaded regions. Simplify your answer. [4]

- 10 A particle P moves in a straight line such that, t seconds after passing a fixed point O , its acceleration, $a \text{ ms}^{-2}$, is given by

$$\begin{aligned}a &= 6t && \text{for } 0 \leq t \leq 3, \\a &= \frac{18e^3}{e^t} && \text{for } t \geq 3.\end{aligned}$$

When $t = 1$, the velocity of P is 2 ms^{-1} and its displacement from O is -4 m .

- (a) (i) Find the velocity of P when $t = 3$.

[3]

- (ii) Find the displacement of P from O when $t = 3$.

[3]

- (b) Find an expression in terms of t for the displacement of P from O when $t \geq 3$.

[4]

Question 11 is printed on the next page.

- 11 The normal to the curve $y = \sin(4x - \pi)$ at the point $A(a, 0)$, where $\frac{\pi}{2} < a < \pi$, meets the y -axis at the point B . Find the exact area of triangle OAB , where O is the origin. [9]

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