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ADDITIONAL MATHEMATICS

0606/12

Paper 1

February/March 2022

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 Find the values of k such that the line $y = 9kx + 1$ does not meet the curve $y = kx^2 + 3x(2k + 1) + 4$.
[5]

2 DO NOT USE A CALCULATOR IN THIS QUESTION.

Solve the equation $(3 - 5\sqrt{3})x^2 + (2\sqrt{3} + 5)x - 1 = 0$, giving your solutions in the form $a + b\sqrt{3}$, where a and b are rational numbers. [6]

- 3 The curve with equation $y = a \sin bx + c$, where a , b and c are constants, passes through the points $(4\pi, 11)$ and $(-\frac{4\pi}{3}, 5)$. It is given that $a \sin bx + c$ has period 16π .

(a) Find the exact values of a , b and c . [4]

(b) Using your answer to **part (a)**, find the coordinates of the minimum point on the curve for $0 \leq x \leq 16\pi$. [4]

4 (a) Show that $\frac{1}{2x-1} + \frac{4}{(2x-1)^2}$ can be written as $\frac{2x+3}{(2x-1)^2}$. [1]

(b) Find $\int_2^5 \frac{2x+3}{(2x-1)^2} dx$, giving your answer in the form $a + \ln b$, where a and b are constants. [5]

5 Variables x and y are such that $y = \frac{\ln(2x^2 - 3)}{3x}$.

(a) Find $\frac{dy}{dx}$. [3]

(b) Hence find the approximate change in y when x increases from 2 to $2 + h$, where h is small. [2]

(c) At the instant when $x = 2$, y is increasing at the rate of 4 units per second. Find the corresponding rate of increase in x . [2]

- 6 The normal to the curve $y = 1 + \tan 3x$ at the point P with x -coordinate $\frac{\pi}{12}$, meets the x -axis at the point Q .

The line $x = \frac{\pi}{12}$ meets the x -axis at the point R . Find the area of the triangle PQR . [8]

- 7 A curve $y = f(x)$ is such that $\frac{d^2y}{dx^2} = (2 - 3x)^{-\frac{1}{3}}$. The curve passes through the point $(-2, 10.2)$. The gradient of the tangent to the curve at $(-2, 10.2)$ is -6 . Find $f(x)$. [8]

8 In this question, all lengths are in metres and all times are in seconds.

A particle A is moving in the direction $\begin{pmatrix} -20 \\ 21 \end{pmatrix}$ with a speed of 58.

(a) Find the velocity vector of A .

[1]

(b) Given that A is initially at the point with position vector $\begin{pmatrix} 5 \\ -3 \end{pmatrix}$, write down the position vector of A at time t .

[1]

A particle B starts to move such that its position vector at time t is $\begin{pmatrix} -35t+4 \\ 44t-2 \end{pmatrix}$.

(c) Find the displacement vector \overrightarrow{AB} at time t .

[2]

(d) Hence find the distance AB , at time t , in the form $\sqrt{pt^2 + qt + r}$, where p , q and r are constants. [2]

(e) Find the value of t when the distance AB is $\sqrt{6}$, giving your answer correct to 2 decimal places. [2]

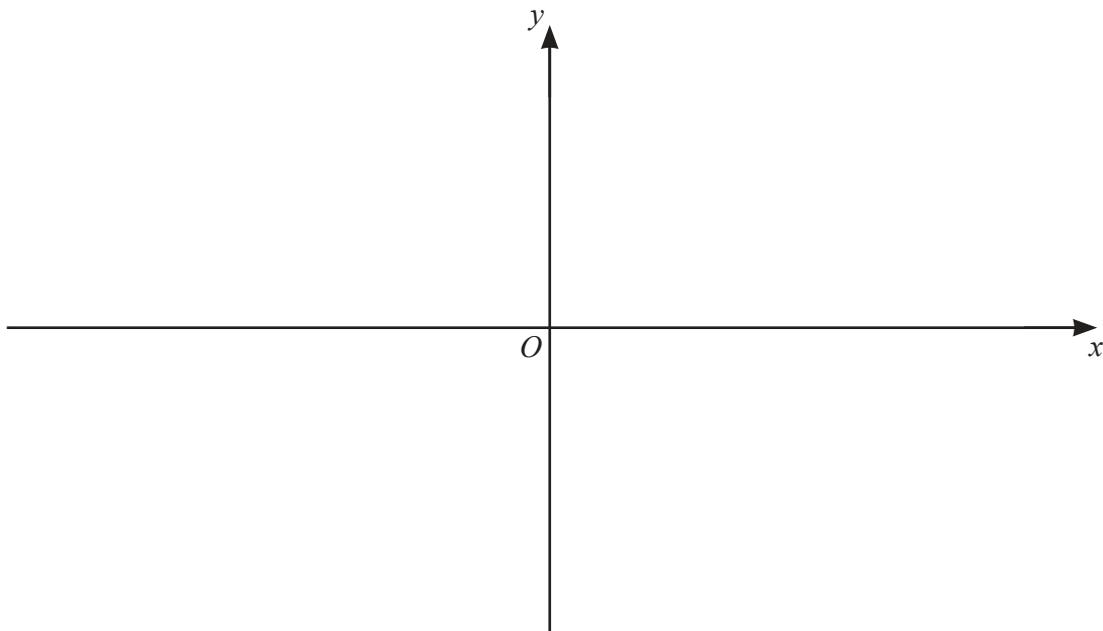
9 (a) The function f is such that $f(x) = \ln(5x+2)$, for $x > a$, where a is as small as possible.

(i) Write down the value of a . [1]

(ii) Hence find the range of f . [1]

(iii) Find $f^{-1}(x)$, stating its domain. [3]

(iv) On the axes, sketch the graphs of $y = f(x)$ and $y = f^{-1}(x)$, stating the exact values of the intercepts of the curves with the coordinate axes. [4]



(b) The function g is such that $g : x \mapsto x^{\frac{1}{2}} - 4$, for $x > 0$. Solve the equation $g^2(x) = -2$. [3]

- 10 (a) The first three terms of an arithmetic progression are $\sin 3x$, $5 \sin 3x$, $9 \sin 3x$. Find the exact values of x , where $0 \leq x \leq \frac{\pi}{2}$, for which the sum to twenty terms is equal to 390. [6]

(b) The first three terms of a geometric progression are $20 \cos y$, $10 \cos^2 y$, $5 \cos^3 y$.

(i) Explain why this progression has a sum to infinity. [2]

(ii) Find the value of y , where y is in radians and $0 < y < 2$, for which the sum to infinity is 9. Give your answer correct to 2 decimal places. [4]

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