## Cambridge IGCSE ${ }^{\text {TM }}$

CANDIDATE NAME

CENTRE


## ADDITIONAL MATHEMATICS

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 [ ].


## Mathematical Formulae

## 1. ALGEBRA

## Quadratic Equation

For the equation $a x^{2}+b x+c=0$,

$$
x=\frac{-b \pm \sqrt{b^{2}-4 a c}}{2 a}
$$

Binomial Theorem

$$
(a+b)^{n}=a^{n}+\binom{n}{1} a^{n-1} b+\binom{n}{2} a^{n-2} b^{2}+\ldots+\binom{n}{r} a^{n-r} b^{r}+\ldots+b^{n}
$$

where $n$ is a positive integer and $\binom{n}{r}=\frac{n!}{(n-r)!r!}$

Arithmetic series

$$
\begin{aligned}
& u_{n}=a+(n-1) d \\
& S_{n}=\frac{1}{2} n(a+l)=\frac{1}{2} n\{2 a+(n-1) d\}
\end{aligned}
$$

Geometric series

$$
\begin{aligned}
& u_{n}=a r^{n-1} \\
& S_{n}=\frac{a\left(1-r^{n}\right)}{1-r}(r \neq 1) \\
& S_{\infty}=\frac{a}{1-r}(|r|<1)
\end{aligned}
$$

## 2. TRIGONOMETRY

Identities

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

Formulae for $\triangle A B C$

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

1 (a) Solve the equation $\frac{|4 x-5|}{7}=1$.
[2]
(b)


The diagram shows the graph of $y=|3 x+9|$.
By drawing a suitable graph on the same diagram, solve the inequality $|3 x+9| \leqslant|x-5|$.

## 2 DO NOT USE A CALCULATOR IN THIS QUESTION.

Write the expression $\frac{\sqrt{98 x^{12}}}{3+\sqrt{2}}$ in the form $(a \sqrt{b}+c) x^{d}$ where $a, b, c$ and $d$ are integers.

3 (a) Differentiate $\ln \left(x^{3}+3 x^{2}\right)$ with respect to $x$, simplifying your answer.
(b) Hence find $\int \frac{x+2}{x(x+3)} \mathrm{d} x$.

4 The polynomial p is such that $\mathrm{p}(x)=2 x^{3}+11 x^{2}+22 x+40$.
(a) Show that $x=-4$ is a root of the equation $\mathrm{p}(x)=0$.
(b) Factorise $\mathrm{p}(x)$ and hence show that $\mathrm{p}(x)=0$ has no other real roots.

5 (a) (i) A gardening group has 20 members. A committee of 6 members is to be selected. Anwar and Bo belong to the gardening group and at most one of them can be on the committee. How many different committees are possible?
(ii) The gate for the garden has a lock with a 6 -character passcode. The passcode is to be made from

| Letters | G | A | R | D | E | N |  |  |  |  |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Numbers | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9. |

No character may be used more than once in any passcode.
Find the number of possible passcodes that have 4 letters followed by 2 numbers.
(b) (i) Given that $n \geqslant 4$, show that $(n-3) \times{ }^{n} C_{3}=4 \times{ }^{n} C_{4}$.
(ii) Given that ${ }^{n} C_{3}=5 n$, where $n \geqslant 3$, show that $n$ satisfies the equation $n^{2}-3 n-28=0$. Hence find the value of $n$.


The diagram shows the curve $y=5 \mathrm{e}^{2 x}-3$. The curve meets the $y$-axis at the point $A$. The tangent to the curve at $A$ meets the $x$-axis at the point $B$. Find the length of $A B$.

7 Variables $x$ and $y$ are such that $y=\frac{4 x^{3}+2 \sin 8 x}{1-x}$. Use differentiation to find the approximate change in $y$ as $x$ increases from 0.1 to $0.1+h$, where $h$ is small.

8 (a) The functions $f$ and $g$ are defined by

$$
\begin{array}{ll}
\mathrm{f}(x)=\sec x & \text { for } \frac{\pi}{2}<x<\frac{3 \pi}{2} \\
\mathrm{~g}(x)=3\left(x^{2}-1\right) & \text { for all real } x .
\end{array}
$$

(i) Find the range of f .
(ii) Solve the equation $\mathrm{f}^{-1}(x)=\frac{2 \pi}{3}$.
(iii) Given that gf exists, state the domain of gf.
(iv) Solve the equation $\operatorname{gf}(x)=1$.
(b) The function h is defined by $\mathrm{h}(x)=\ln (4-x)$ for $x<4$. Sketch the graph of $y=\mathrm{h}(x)$ and hence sketch the graph of $y=\mathrm{h}^{-1}(x)$. Show the position of any asymptotes and any points of intersection with the coordinate axes.


9 (a) Show that $\int_{1}^{8} \frac{x+4}{\sqrt[3]{x}} \mathrm{~d} x=36.6$.
(b)


The diagram shows part of the line $10 y=7-3 x$ and part of the curve $y=\frac{1}{3 x+4}$.
The line and curve intersect at the point $A$. Verify that the $y$-coordinate of $A$ is 0.1 and calculate the area of the shaded region.

Continuation of working space for Question 9(b).

10 An arithmetic progression, $A$, has first term $a$ and common difference $d$.
The 2nd, 14th and 17th terms of $A$ form the first three terms of a convergent geometric progression, $G$, with common ratio $r$.
(a) (i) Given that $d \neq 0$, find two expressions for $r$ in terms of $a$ and $d$ and hence show that $a=-17 d$.
(ii) Find the value of $r$.
(b) The first term of the geometric progression, $G$, is $q$ and the sum to infinity is $\frac{256}{3}$.

Find the sum of the first 20 terms of the arithmetic progression, $A$.

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