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ADDITIONAL MATHEMATICS

0606/23

Paper 2

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. 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 $\triangle ABC$

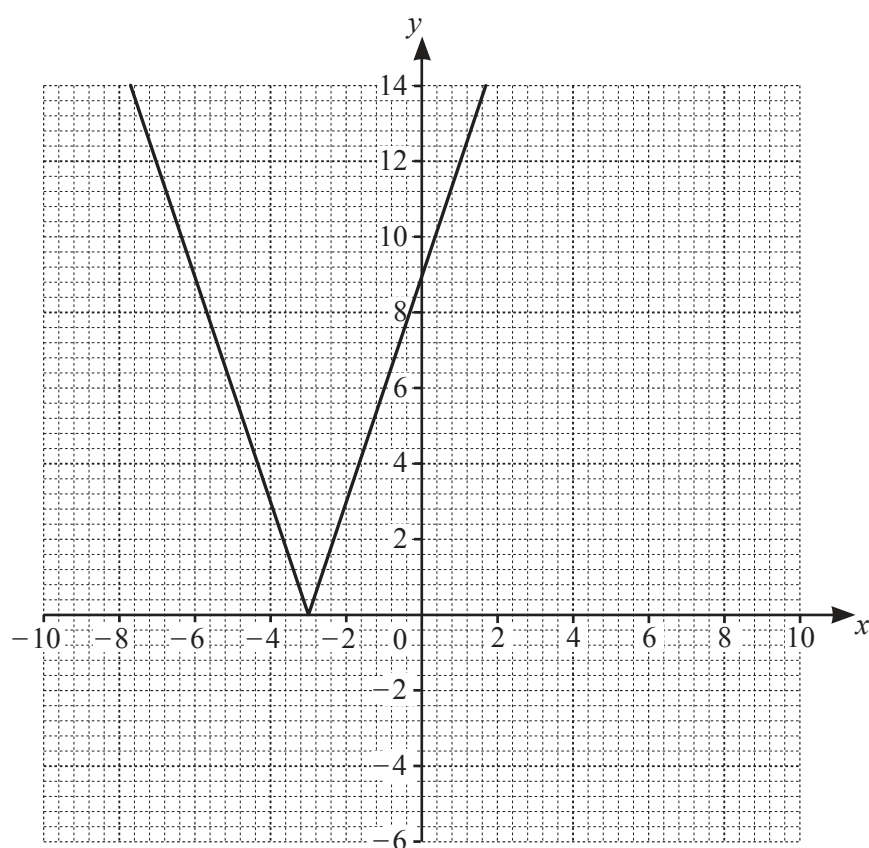
$$\begin{aligned}\frac{a}{\sin A} &= \frac{b}{\sin B} = \frac{c}{\sin C} \\ a^2 &= b^2 + c^2 - 2bc \cos A \\ \Delta &= \frac{1}{2}bc \sin A\end{aligned}$$

3

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

[2]

(b)



The diagram shows the graph of $y = |3x + 9|$.

By drawing a suitable graph on the same diagram, solve the inequality $|3x + 9| \leq |x - 5|$. [3]

4

2 DO NOT USE A CALCULATOR IN THIS QUESTION.

Write the expression $\frac{\sqrt{98x^{12}}}{3+\sqrt{2}}$ in the form $(a\sqrt{b}+c)x^d$ where a , b , c and d are integers. [4]

3 (a) Differentiate $\ln(x^3 + 3x^2)$ with respect to x , simplifying your answer. [2]

(b) Hence find $\int \frac{x+2}{x(x+3)} dx$. [2]

5

4 The polynomial p is such that $p(x) = 2x^3 + 11x^2 + 22x + 40$.

(a) Show that $x = -4$ is a root of the equation $p(x) = 0$. [1]

(b) Factorise $p(x)$ and hence show that $p(x) = 0$ has no other real roots. [4]

6

- 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? [2]

- (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. [2]

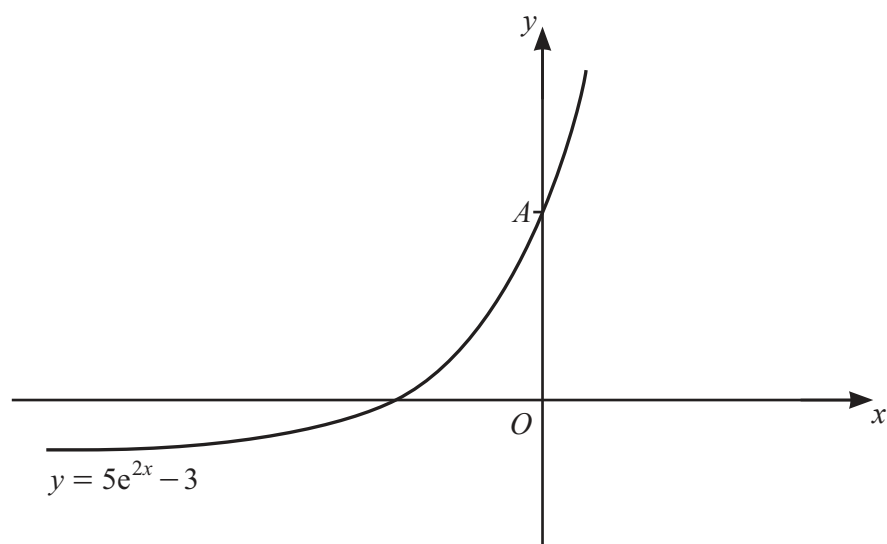
7

(b) (i) Given that $n \geq 4$, show that $(n-3) \times {}^nC_3 = 4 \times {}^nC_4$. [2]

(ii) Given that ${}^nC_3 = 5n$, where $n \geq 3$, show that n satisfies the equation $n^2 - 3n - 28 = 0$.
Hence find the value of n . [4]

8

6



The diagram shows the curve $y = 5e^{2x} - 3$. 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 AB . [6]

- 7 Variables x and y are such that $y = \frac{4x^3 + 2 \sin 8x}{1-x}$. Use differentiation to find the approximate change in y as x increases from 0.1 to $0.1 + h$, where h is small. [6]

10**8 (a)** The functions f and g are defined by

$$f(x) = \sec x \quad \text{for } \frac{\pi}{2} < x < \frac{3\pi}{2}$$

$$g(x) = 3(x^2 - 1) \quad \text{for all real } x.$$

(i) Find the range of f . [1]

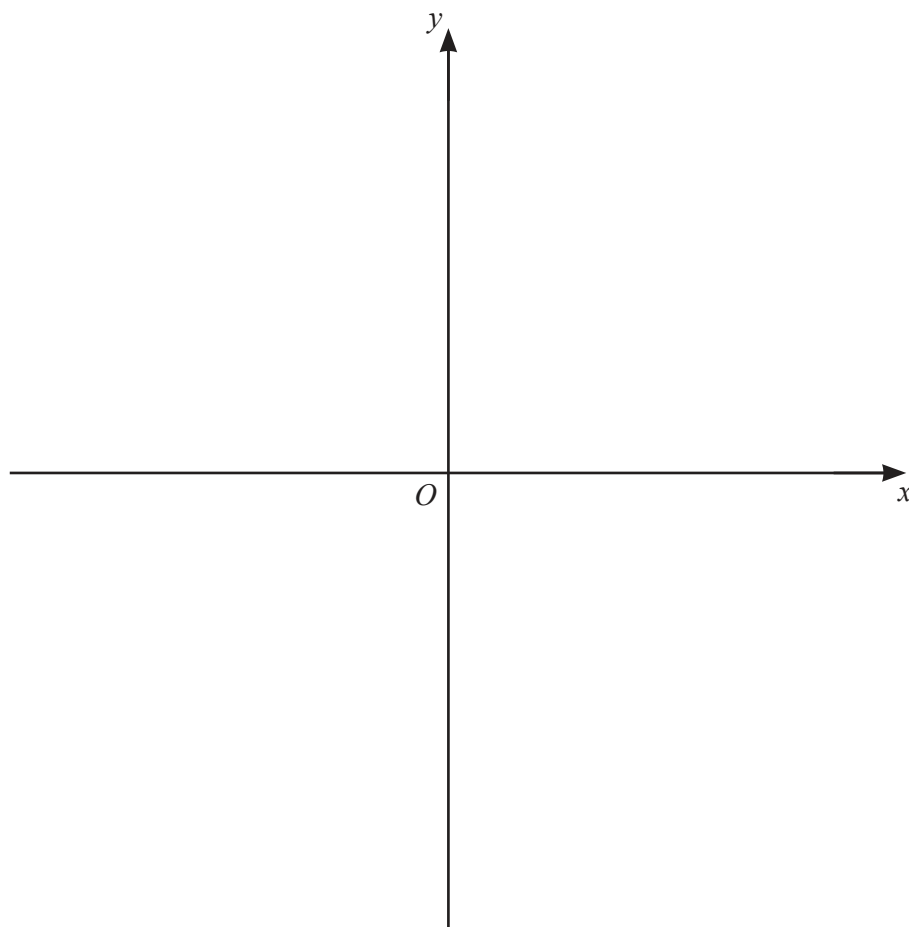
(ii) Solve the equation $f^{-1}(x) = \frac{2\pi}{3}$. [3]

(iii) Given that gf exists, state the domain of gf . [1]

(iv) Solve the equation $gf(x) = 1$. [5]

11

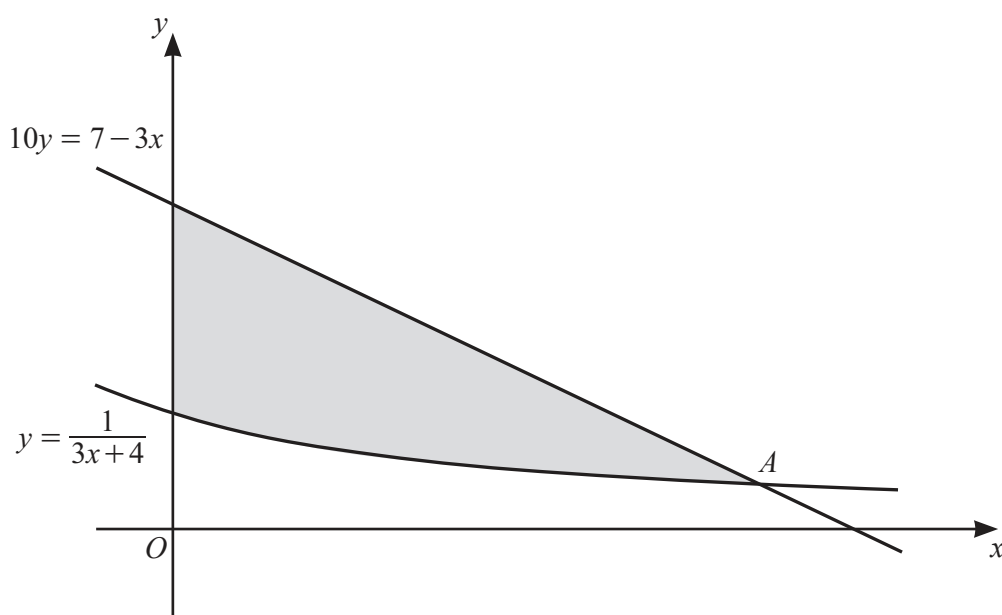
- (b) The function h is defined by $h(x) = \ln(4-x)$ for $x < 4$. Sketch the graph of $y = h(x)$ and hence sketch the graph of $y = h^{-1}(x)$. Show the position of any asymptotes and any points of intersection with the coordinate axes. [4]



9 (a) Show that $\int_1^8 \frac{x+4}{\sqrt[3]{x}} dx = 36.6$.

[3]

(b)



The diagram shows part of the line $10y = 7 - 3x$ and part of the curve $y = \frac{1}{3x+4}$.

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.

[8]

Continuation of working space for Question 9(b).

14

- 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 $a = -17d$.
[6]

- (ii)** Find the value of r . [2]

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- (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 .

[7]

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