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ADDITIONAL MATHEMATICS

0606/23

Paper 2

May/June 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 Solve the equation $4|7x-3|-5=9$.

[3]

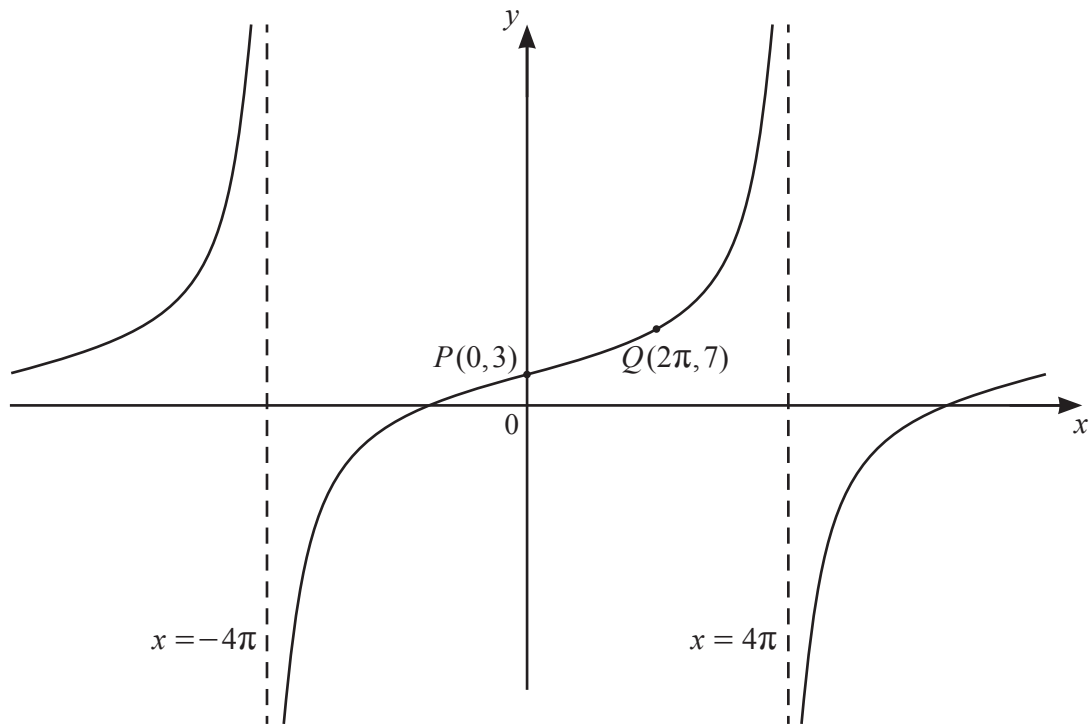
2 **DO NOT USE A CALCULATOR IN THIS QUESTION.**

Variables x and y are related by the equation $y = kx^2$. When $x = 1 + \sqrt{2}$, $y = 1 - \sqrt{2}$. Find the value of k , giving your answer in the form $a + b\sqrt{c}$, where a , b and c are integers. [4]

- 3 The points A , B and C have coordinates $(2, 6)$, $(6, 1)$ and (p, q) respectively. Given that B is the mid-point of AC , find the equation of the line that passes through C and is perpendicular to AB . Give your answer in the form $ax + by = c$, where a , b and c are integers. [5]

- 4 (a) Find the range of values of x satisfying the inequality $(5x - 1)(6 - x) < 0$. [2]

- (b) Show that the equation $(2k + 1)x^2 - 4kx + 2k - 1 = 0$, where $k \neq -\frac{1}{2}$, has distinct, real roots. [3]



The diagram shows part of the graph of $y = a \tan bx + c$. The graph has vertical asymptotes at $x = -4\pi$ and $x = 4\pi$ and passes through the points P and Q .

(a) Write down the period of $a \tan bx + c$. [1]

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

6 The polynomial $p(x)$ is such that $p(x) = 6x^3 + ax^2 - 52x + b$, where a and b are integers. It is given that $p(x)$ is divisible by $2x - 3$ and that $p'(1) = 4$.

(a) Find the values of a and b . [5]

DO NOT USE A CALCULATOR IN THIS PART OF THE QUESTION.

(b) Using your values of a and b , factorise $p(x)$ fully. [3]

7 (a) (i) Write down the set of values of x for which $\lg(5x-3)$ exists. [1]

(ii) Solve the equation $\lg(5x-3) = 1$. [1]

(b) It is given that $\log_y x = 4 + \frac{1}{2}\log_y 64 + \log_y 162$, where $y > 0$. Find an expression for y in terms of x . Simplify your answer. [5]

8 (a) Differentiate $y = 2xe^{4x}$ with respect to x . [2]

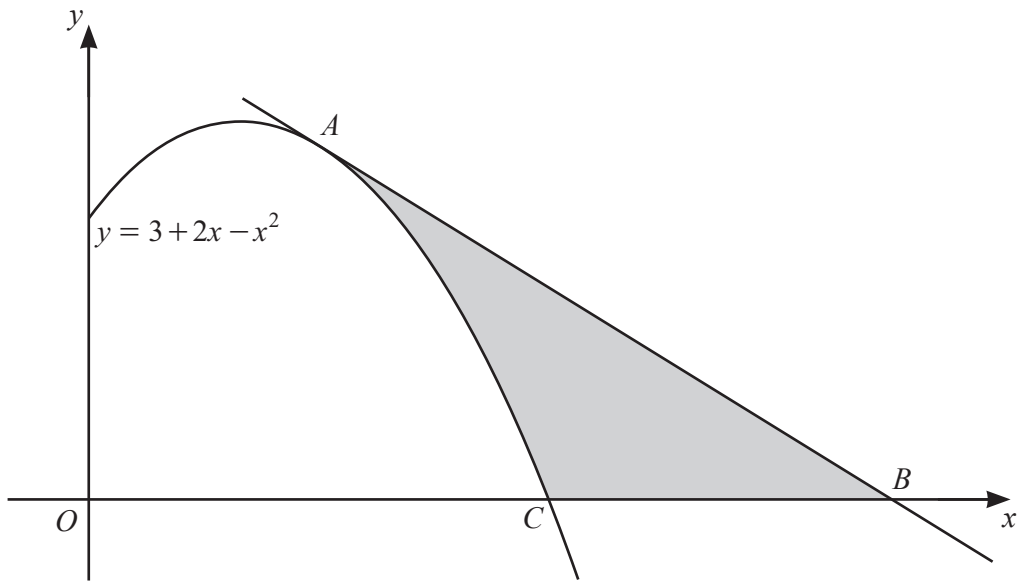
(b) Hence find $\int xe^{4x} dx$. [4]

9 (a) Find the unit vector in the direction of $40\mathbf{i} - 9\mathbf{j}$. [2]

(b) The position vectors of points P and Q relative to an origin O are \mathbf{p} and \mathbf{q} respectively. The point R lies on the line PQ and is between P and Q such that $\frac{PR}{PQ} = k$.

(i) Write down the set of all possible values of k . [1]

(ii) Given that the position vector of R relative to O is $\lambda\mathbf{p} + \mu\mathbf{q}$ show that $\lambda + \mu = 1$. [3]



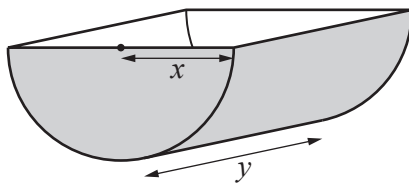
The diagram shows part of the curve $y = 3 + 2x - x^2$. The point A lies on the curve and has an x -coordinate of 1.5. The tangent to the curve at A meets the x -axis at B . The curve meets the x -axis at C . Find the area of the shaded region. [10]

Continuation of working space for Question 10.

- 11 (a) The sum of the first 20 terms of an arithmetic progression is 1100. The sum of the first 70 terms is 14350. Find the 12th term. [6]

- (b) The first three terms of a geometric progression are $x+6$, $x-9$, $\frac{1}{2}(x+1)$. Show that x satisfies the equation $x^2 - 43x + 156 = 0$. Hence show that a sum to infinity exists for each possible value of x . [7]

12 In this question all lengths are in centimetres.



A container is a half-cylinder, open as shown. It has length y and uniform cross-section of radius x . The volume of the container is 25 000. Given that x and y can vary and that the outer surface area, S , of the container has a minimum value, find this value. [8]

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