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Mathematics: analysis and approaches
Standard level
Paper 1

8 May 2023

Zone A afternoon | **Zone B** morning | **Zone C** afternoon

Candidate session number

1 hour 30 minutes

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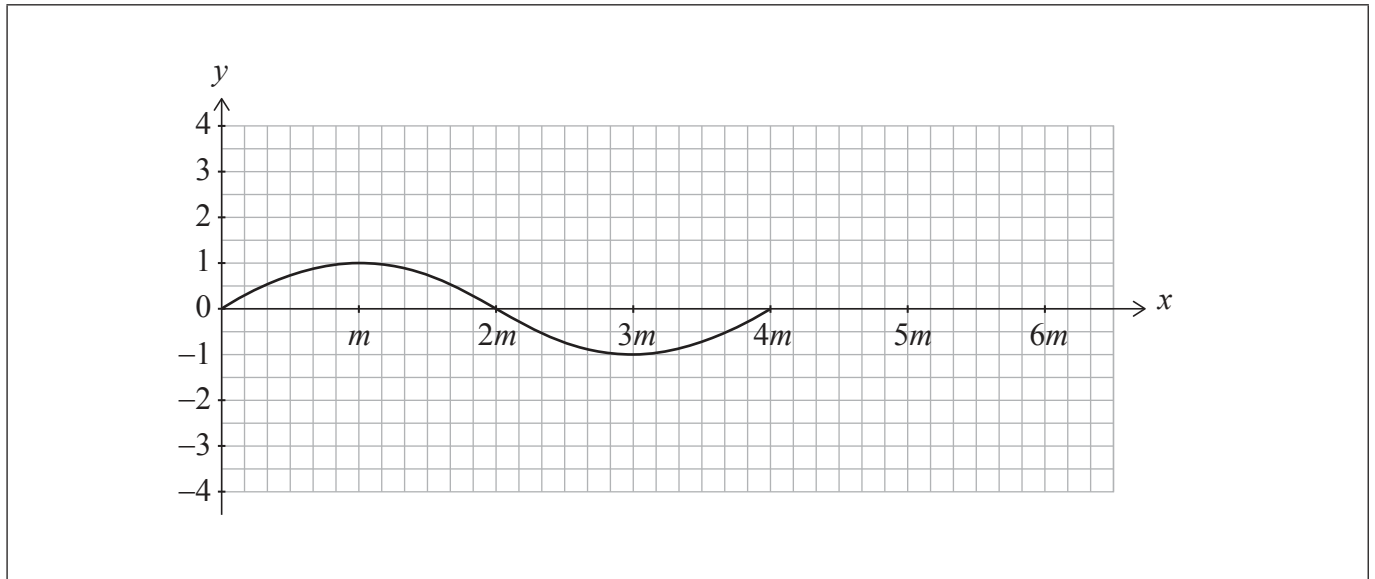
Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- You are not permitted access to any calculator for this paper.
- Section A: answer all questions. Answers must be written within the answer boxes provided.
- Section B: answer all questions in the answer booklet provided. Fill in your session number on the front of the answer booklet, and attach it to this examination paper and your cover sheet using the tag provided.
- Unless otherwise stated in the question, all numerical answers should be given exactly or correct to three significant figures.
- A clean copy of the **mathematics: analysis and approaches formula booklet** is required for this paper.
- The maximum mark for this examination paper is **[80 marks]**.



6. [Maximum mark: 6]

The function f is defined by $f(x) = \sin qx$, where $q > 0$. The following diagram shows part of the graph of f for $0 \leq x \leq 4m$, where x is in radians. There are x -intercepts at $x = 0, 2m$ and $4m$.



(a) Find an expression for m in terms of q . [2]

The function g is defined by $g(x) = 3\sin \frac{2qx}{3}$, for $0 \leq x \leq 6m$.

(b) On the axes above, sketch the graph of g . [4]

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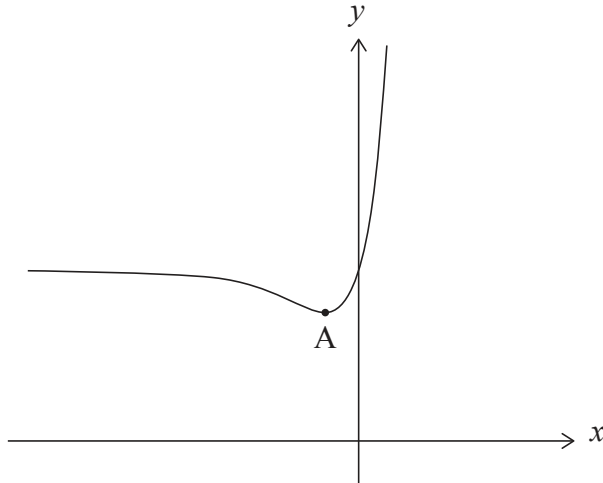
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Section B

Answer **all** questions in the answer booklet provided. Please start each question on a new page.

7. [Maximum mark: 13]

The function h is defined by $h(x) = 2xe^x + 3$, for $x \in \mathbb{R}$. The following diagram shows part of the graph of h , which has a local minimum at point A .



- (a) Find the value of the y -intercept. [2]
- (b) Find $h'(x)$. [2]
- (c) Hence, find the coordinates of A . [5]
- (d) (i) Show that $h''(x) = (2x + 4)e^x$.
(ii) Find the values of x for which the graph of h is concave-up. [4]



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8. [Maximum mark: 14]

Consider the arithmetic sequence u_1, u_2, u_3, \dots .

The sum of the first n terms of this sequence is given by $S_n = n^2 + 4n$.

- (a) (i) Find the sum of the first five terms.
(ii) Given that $S_6 = 60$, find u_6 . [4]
- (b) Find u_1 . [2]
- (c) Hence or otherwise, write an expression for u_n in terms of n . [3]

Consider a geometric sequence, v_n , where $v_2 = u_1$ and $v_4 = u_6$.

- (d) Find the possible values of the common ratio, r . [3]
- (e) Given that $v_{99} < 0$, find v_5 . [2]



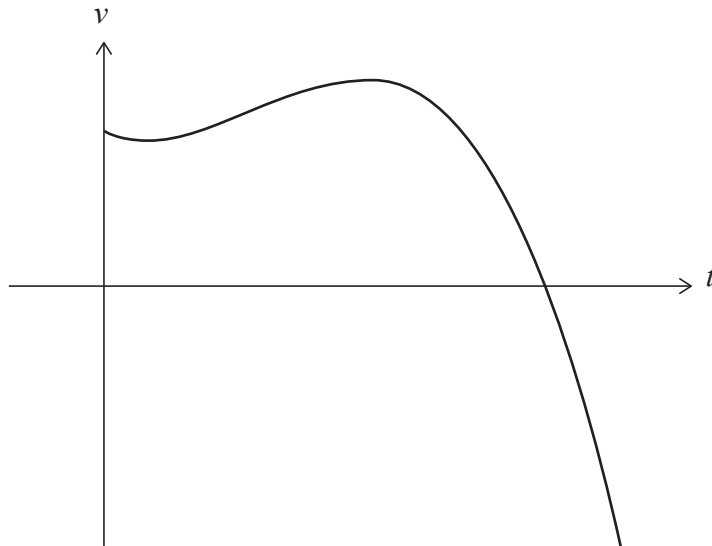
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9. [Maximum mark: 17]

An object moves along a straight line. Its velocity, $v \text{ m s}^{-1}$, at time t seconds is given by

$$v(t) = -t^3 + \frac{7}{2}t^2 - 2t + 6, \text{ for } 0 \leq t \leq 4. \text{ The object first comes to rest at } t = k.$$

The graph of v is shown in the following diagram.



At $t = 0$, the object is at the origin.

- (a) Find the displacement of the object from the origin at $t = 1$. [5]
- (b) Find an expression for the acceleration of the object. [2]
- (c) Hence, find the greatest speed reached by the object before it comes to rest. [5]
- (d) Find the greatest speed reached by the object for $0 \leq t \leq 4$. [2]
- (e) Write down an expression that represents the distance travelled by the object while its speed is increasing. Do not evaluate the expression. [3]

References:

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12EP10

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12EP11

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12EP12