Diploma Programme
Programme du diplôme
Programa del Diploma

Mathematics: analysis and approaches
Standard level
Paper 2

16 May 2025

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

Candidate session number

1 hour 30 minutes

Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- A graphic display calculator is required 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 SL formula booklet** is required for this paper.
- The maximum mark for this examination paper is **[80 marks]**.

2225 – 7120

11 pages

Full marks are not necessarily awarded for a correct answer with no working. Answers must be supported by working and/or explanations. Solutions found from a graphic display calculator should be supported by suitable working. For example, if graphs are used to find a solution, you should sketch these as part of your answer. Where an answer is incorrect, some marks may be given for a correct method, provided this is shown by written working. You are therefore advised to show all working.

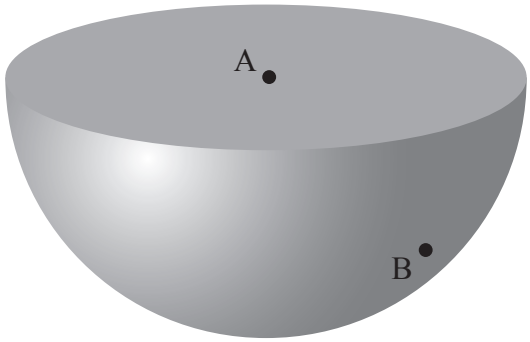
Section A

Answer **all** questions. Answers must be written within the answer boxes provided. Working may be continued below the lines, if necessary.

1. [Maximum mark: 5]

The following diagram shows a solid hemisphere with centre $\mathrm{A}(6, -1, -3)$.

Point $\mathrm{B}(4, -5, -9)$ lies on the curved surface.



(a) Find AB, the radius of the hemisphere. [2]

(b) Hence, find the total surface area of the solid hemisphere. [3]

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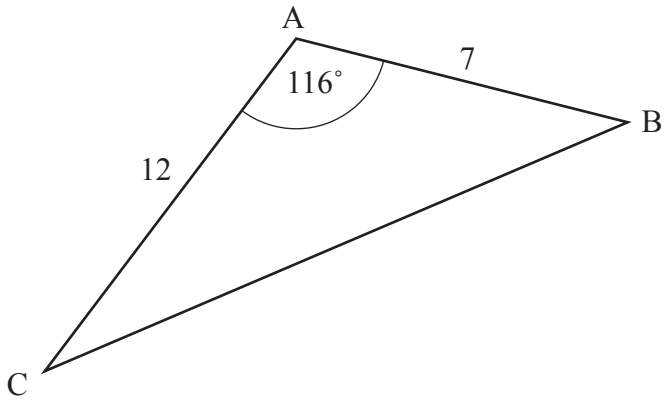
2. [Maximum mark: 6]

The following diagram shows a triangle ABC, with $AB = 7$, $AC = 12$ and $B\hat{A}C = 116°$.

diagram not to scale



(a) Find BC. [3]

(b) Find $A\hat{C}B$. [3]

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3. [Maximum mark: 5]

Consider the expansion of $(x + k)^{11}$, where $k > 0$.

(a) Write down the number of terms in the expansion. [1]

In the expansion, the coefficient of x^7 is 1320.

(b) Find the value of k. [4]

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4. [Maximum mark: 6]

A supermarket analyses the shopping habits of its customers.

The number of times, X, each customer visits the supermarket in a week is given by the following probability distribution.

x	1	2	3	4	5	≥ 6
$P(X = x)$	$1.5a$	$2a$	0.281	a	0.026	0

(a) (i) Find the value of a.

(ii) Write down the mode of X. [3]

(b) Find the mean of X. [2]

The manager wants to know why customers come to their supermarket. They survey the first 50 customers to arrive at the supermarket on a particular day.

(c) Identify which one of the following best describes the manager's sampling method. Circle your answer. [1]

Simple random / Systematic / Convenience / Quota / Stratified

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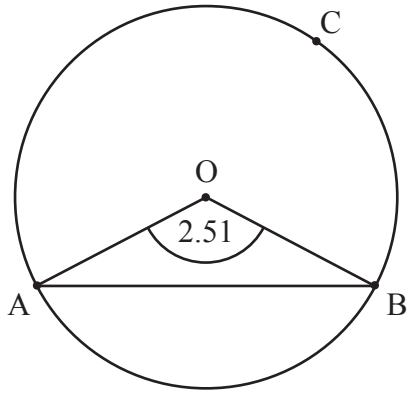
5. [Maximum mark: 5]

The following diagram shows a circle with centre O.

Points A, B and C lie on the circle.

diagram not to scale



The area of triangle AOB is $26\,\text{cm}^2$ and $A\hat{O}B = 2.51$ radians.

Find the length of arc ACB.

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6. [Maximum marks: 7]

Consider the function $f(x) = \frac{(2x+a)^3}{(x+5)^2}$, where $x \neq -5$ and $a \in \mathbb{R}^+$.

(a) Find an expression for $f'(x)$, in terms of a. [3]

When $x = 1$, the tangent to the graph of f makes an angle of $70°$ to the horizontal.

(b) Find the two possible values of a. [4]

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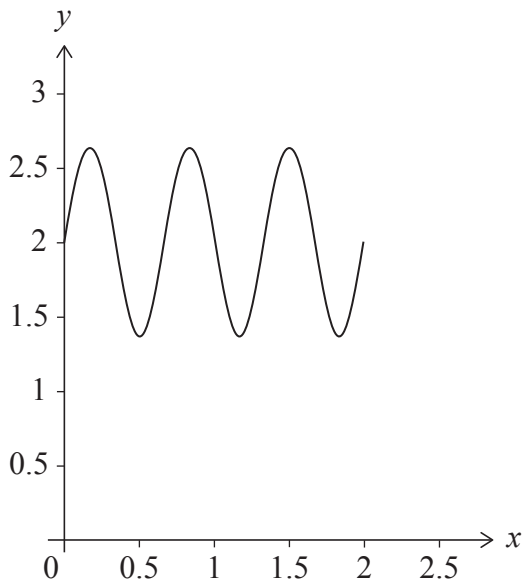
Do **not** write solutions on this page.

Section B

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

7. [Maximum mark: 15]

Consider the function $f(x) = \frac{2}{\pi}\sin(3\pi x) + 2$, where $0 \le x \le 2$. The following diagram shows the graph of f.



(a) (i) Write down the amplitude of f.

(ii) Find the period of f. [3]

(b) The point P has coordinates $(1.63, 2.16)$. State whether P lies above, below or on the graph of f. Justify your answer. [3]

The line L_1 has equation $x - 6y + 11 = 0$.

(c) Write down the gradient of the line L_1. [1]

(This question continues on the following page)

Do **not** write solutions on this page.

(Question 7 continued)

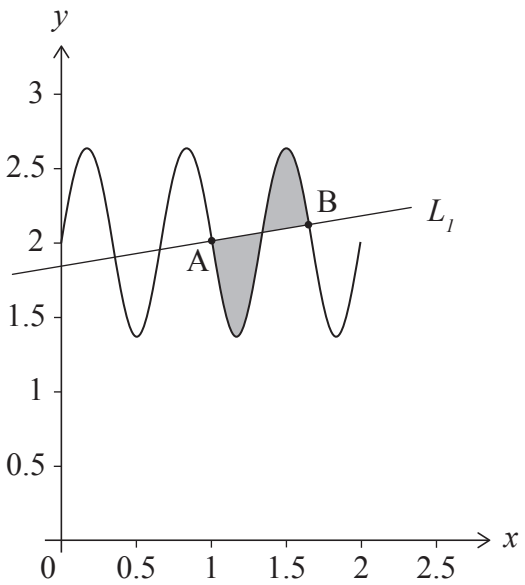
The line L_1 is normal to the graph of f at point $\mathrm{A}(1, 2)$.

The line L_2 is tangent to the graph of f at A.

(d) (i) Find the gradient of L_2.

(ii) Hence, or otherwise, find the equation of L_2. [3]

The line L_1 intersects the graph of f at another point B, where the x-coordinate of B is greater than 1.5. This is shown in the following diagram.



(e) Find the coordinates of B. [2]

The shaded region is enclosed by the graph of f and the line L_1 between A and B.

(f) Find the area of the shaded region. [3]

Do **not** write solutions on this page.

8. [Maximum mark: 17]

Consider a discrete random variable X.

(a) State two conditions required for X to be modelled by a binomial distribution. [2]

A water theme park has two rides: *Daifong* and *Torbellino*. Each visitor's decision to ride on either *Daifong* or *Torbellino* is made independently of any other person.

From previous records, it is expected that 37% of the visitors on any particular day will ride *Daifong*.

On Saturday, 1900 people will visit the theme park.

(b) Find the number of people that are expected to ride *Daifong*. [2]

(c) Find the probability that

(i) 712 people will ride *Daifong*;

(ii) between 684 and 712 people, inclusive, will ride *Daifong*. [4]

(d) Given that between 684 and 712 people, inclusive, will ride *Daifong*, find the probability that at most 692 people will ride *Daifong*. [4]

The ride *Torbellino* is more popular at the theme park. It is expected that 61% of the visitors on any particular day will ride *Torbellino*.

It can be assumed that the probability a person will ride *Daifong* is independent of them riding *Torbellino*.

(e) Find the probability that a person will ride both *Daifong* and *Torbellino*. [2]

Next Tuesday n people will visit the theme park. The probability that at most 500 people will ride *Torbellino* is approximately 0.693.

(f) Find the value of n. [3]

Do **not** write solutions on this page.

9. [Maximum mark: 14]

Two athletes, Fiona and Lucy, compete in a 200 metres race along a straight track.

Fiona's velocity, in m s^{-1}, during the race can be modelled by $v(t) = \dfrac{8.14\,t}{\sqrt{t^2 + 0.2}}$, where $t \geq 0$. Time, t, is measured in seconds from when the race starts.

(a) (i) Write down the value of $v(1)$.

(ii) Find the time when Fiona's velocity is $5\,\text{m s}^{-1}$. [3]

(b) Find the time when Fiona's acceleration is $4\,\text{m s}^{-2}$. [2]

(c) (i) Write down the limit of $v(t)$ as t approaches infinity.

(ii) State a reason why the value in part (c)(i) is not valid in the context of this question. [3]

Lucy's velocity, in m s^{-1}, during the race can be modelled by $w(t) = \dfrac{8\,t}{\sqrt{t^2 + 0.3}}$, where $t \geq 0$.

Fiona completes the race and crosses the finishing line in front of Lucy.

(d) Find the distance Lucy is from the finishing line when Fiona completes the 200 metres. [6]

Please **do not** write on this page.

Answers written on this page
will not be marked.