Diploma Programme
Programme du diplôme
Programa del Diploma

Mathematics: analyses and approaches
Higher level
Mock paper 2

Monday May 11th 2026 (morning)

Candidate session number

1 hour and 20 min

Instructions to candidates

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- A graphical display calculator is required for this paper.
- Answer all questions.
- Answers must be written within the answer boxes 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: analyses and aproaches formula booklet** is required for this paper.
- The maximum mark for this examination paper is **[61 marks]**

3 pages

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1. A factory makes two types of ink ribbons for typewriters, black (B) and black and red (BR). The amount of ink per metre of ribbon depends on the type of ribbon: black ribbons have 6.2 g of ink per metre, with a standard deviation of 0.29 g, and the black and red ribbons have a mean of 6.8 with a standard deviation of 0.34 g.
60% of the ribbons made are black.
a) Find the probability that a randomly selected black ribbon has an amount of ink per metre below 6.1 g [2]
b) 12 black ribbons are selected for inspection. Find the probability that exactly 5 of them have less than 6.1g of ink per metre. [2]
c) Find the probability that, from a ribbon picked randomly among all that are made in a given day, it has less than 6.1 g of ink per metre. [3]
d) A randomly selected ribbon is inspected and found to have less than 6.1 g of ink per metre. Calculate the probability that it is a B ribbon. [4]
e) The machine making the B ribbons is adjusted so that the standard deviation is now σ. Calculate σ knowing that now the probability of finding a ribbon with less than 6.1g of ink per metre among all the ribbons made in one day is 0.157 [5]

2. Consider the set of six-digit positive integers that can be formed from the digits 0 , 1 , 2 , 3 , 4 , 5 , 6 , 7 , 8 and 9.
Find the total number of six-digit positive integers that can be formed such that
a) the digits are distinct [2]
b) the digits are distinct and are in increasing order. [2]

3. Two events A and B are independent, and p(A) = 3p(B)
Knowing that the $p(A \cup B) = 0.68$, calculate p(B) [6]

4. Considering the functions:

$$f(x) = 2^x - \frac{1}{2^x}, x \in \mathbb{R} \quad \text{and} \quad g(x) = \frac{x-1}{x^2 - 2x - 3}, x \in \mathbb{R}, x \neq -1, x \neq 3$$

a) Prove that f is an odd function [2]

b) Solve the inequality $f(x) \geq g(x)$ [4]

5. The total number of children, y , visiting a park depends on the highest temperature, T , in degrees Celsius (° C) . A park official predicts the total number of children visiting his park on any given day using the model $y = -0.6T^2 + 23T + 110$, where $10 \leq T \leq 35$.

a) Use this model to estimate the number of children in the park on a day when the highest temperature is 25 ° C . [2]

An ice cream vendor investigates the relationship between the total number of children visiting the park and the number of ice creams sold, x . The following table shows the data collected on five different days.

Continued on next page

Total number of children (y)	81	175	202	346	360
Ice creams sold (x)	15	27	23	35	46

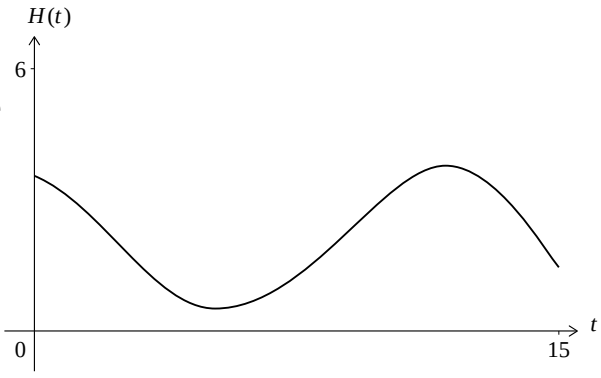
(b) Find an appropriate regression equation that will allow the vendor to predict the number of ice creams sold on a day when there are y children in the park. [3]

(c) Hence, use your regression equation to predict the number of ice creams that the vendor sells on a day when the highest temperature is 25 ° C . [2]

6. Given the complex number $z=\cos\frac{11\pi}{18}+i\sin\frac{11\pi}{18}$

a) Find the smallest value of n that satisfies the equation $z^n=-i$ where n is an integer. [4]
b) Hence or otherwise, describe a single geometric transformation applied to z on the Argand diagram that results in z^{10} [3]

7.Sule Skerry and Rockall are small islands in the Atlantic Ocean, in the same time zone.
On a given day, the height of water in metres at Sule Skerry is modelled by the function
$H(t)=1.63\sin(0.513(t-8.20))+2.13$
where t is the number of hours after midnight.
The following graph shows the height of the water for 15 hours, starting at midnight.
At low tide the height of the water is 0.50 m.
At high tide the height of the water is 3.76 m.
All heights are given correct to two decimal places.
The length of time between the first low tide and the first high tide is 6 hours and m minutes.



a) Find the value of m to the nearest integer. [3]

b) Between two consecutive high tides, determine the length of time, in hours, for which the height of the water is less than 1 metre. [2]

On the same day, the height of water at the second island, Rockall, is modelled by the function
$h(t)=a\sin(b(t-c))+d$, where t is the number of hours after midnight, and a , b , c , d > 0 .
The first low tide occurs at 02:41 when the height of the water is 0.40 m.
The first high tide occurs at 09:02 when the height of the water is 2.74 m.
c) Find the values of a, b, c and d. [7]

When t = T , the height of the water at Sule Skerry is the same as the height of the water at Rockall for the first time.

d) Find the value of T.[2]

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Mathematics: analyses and approaches
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Mock paper 3

Monday May 11th 2026 (morning)

40 min

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1. Consider two numbers, x_1 and x_2 , real positive numbers so that $x_1+x_2=12$.

a) Find the product of x_1 and x_2 as a function of x_1 only. [2]
b) Find the value of x_1 for which the product is maximum [1]
c) Show that the maximum product is 36 [1]

Consider $M_n(S)$ to be the maximum product of n positive real numbers with a sum of S, where n is an integer and S is real.

For n=2 the maximum product can be expressed as $M_2(S)=\left(\frac{S}{2}\right)^2$

d) Verify that $M_2(S)=\left(\frac{S}{2}\right)^2$ is true for S=12 [1]

Consider n positive real numbers, x_1, x_2, x_3 ,... , x_n

The **geometric mean** is defined as $(x_1 \cdot x_2 \cdot x_3 \cdot ... \cdot x_n)^{1/n}$
It is given that the geometric mean is always less than or equal than the arithmetic mean, so

$$(x_1 \cdot x_2 \cdot x_3 \cdot ... \cdot x_n)^{\frac{1}{n}} \leq \frac{(x_1+x_2+x_3+...+x_n)}{n}$$

e) Prove that the geometric mean and the arithmetic mean are equal when $x_1=x_2=x_3=...=x_n$ [2]

f) Use this result to prove that $M_n(S)=\left(\frac{S}{n}\right)^n$ [4]

g) Hence calculate the value of
i) $M_3(12)$ [1]
ii) $M_4(12)$ [1]
iii) $M_5(12)$ [1]

Let P(S) denote the maximum value of $M_n(S)$ across all possible values of n (which is an integer).

h) Write down the value of P(12) and the value of n at which it occurs. [2]

i) Write down the value of P(20) and the value of n at which it occurs. [3]

2. This question asks you to investigate the conditions for the existence of complex roots of polynomial equations of degree 3 and 4.

The cubic equation $x^3+px^2+qx+r=0$ where p, q and r are real, has roots α, β and γ.

a) By expanding $(x-\alpha)(x-\beta)(x-\gamma)$ show that
$p=-(\alpha+\beta+\gamma)$ [1]
$q=\alpha\beta+\beta\gamma+\gamma\alpha$ [1]
$r=-\alpha\beta\gamma$ [1]
b) Show that $p^2-2q=\alpha^2+\beta^2+\gamma^2$ [3]
c) Hence show that $(\alpha-\beta)^2+(\beta-\gamma)^2+(\alpha-\gamma)^2=2p^2-6q$ [3]
d) Given that $p^2<3q$ deduce that α, β and γ cannot be real [2]