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Mathematics: applications and interpretation
Standard level
Paper 1

15 May 2025

Zone A afternoon | **Zone B** afternoon | **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.
- A graphic 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: applications and interpretation SL formula booklet** is required for this paper.
- The maximum mark for this examination paper is **[80 marks]**.



Answers must be written within the answer boxes provided. 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.

1. [Maximum mark: 6]

Hot air balloons are available in many sizes for different numbers of passengers.



The following table shows the recommended minimum volume of a hot air balloon, in cubic metres, for a specific number of passengers.

Number of Passengers (x)	1	2	4	5	7	15
Recommended Minimum Volume (y)	1000	1350	2225	2500	3150	5800

- (a) Use your graphic display calculator to find the Pearson's product-moment correlation coefficient, r , for these values. [2]
- (b) (i) Find the equation of the regression line y on x for this data in the form $y = ax + b$.
(ii) State what the value of a means in the context of the question. [2]
- (c) Use your regression equation from part (b)(i) to find the recommended minimum volume of a balloon for 10 passengers. [2]

(This question continues on the following page)



(Question 1 continued)

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24EP03

Turn over

2. [Maximum mark: 5]

A car manufacturer collected data about preferred car colour from drivers in various age groups. The results are presented in the following table.

	Preferred car colour				Total
	White	Black	Silver	Red	
$18 \leq \text{Age} < 25$	12	7	4	17	40
$25 \leq \text{Age} < 45$	15	b	10	12	58
$\text{Age} \geq 45$	12	18	16	6	52
Total	39	46	30	35	150

(a) Write down the value of b .

[1]

The car manufacturer performs a χ^2 test for independence, at the 1 % significance level, to determine if there is significant evidence that different age groups have different car colour preferences.

The null hypothesis and alternative hypothesis are defined as:

H_0 : age and car colour preference are independent.

H_1 : age and car colour preference are not independent.

The χ^2 critical value for this test is 16.81.

(b) Find the χ^2 test statistic.

[2]

(c) Write down the conclusion to the test, in context. Give a reason for your answer.

[2]

(This question continues on the following page)



(Question 2 continued)

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24EP05

Turn over

3. [Maximum mark: 5]

A bakery sells boxes of cupcakes at the following prices:

- a small box, containing 1 cupcake, costs \$4.50
- a medium box, containing 6 cupcakes, costs \$23.50
- a large box, containing 12 cupcakes, costs \$44.75.

Medium box



In a particular week, the bakery sold 88 boxes containing a total of 383 cupcakes. The bakery collected \$1486 from cupcake sales for the week.

The number of boxes of cupcakes sold during the week can be represented by

$$x + y + z = 88,$$

where x is the number of small boxes sold, y is the number of medium boxes sold, and z is the number of large boxes sold.

(a) Write down an equation in terms of x , y , and z to represent

- (i) the number of cupcakes sold during the week.
- (ii) the money collected from sales of cupcakes for the week.

[3]

(b) Hence, use your graphic display calculator to determine the number of medium boxes that were sold during the week.

[2]

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(Question 3 continued)

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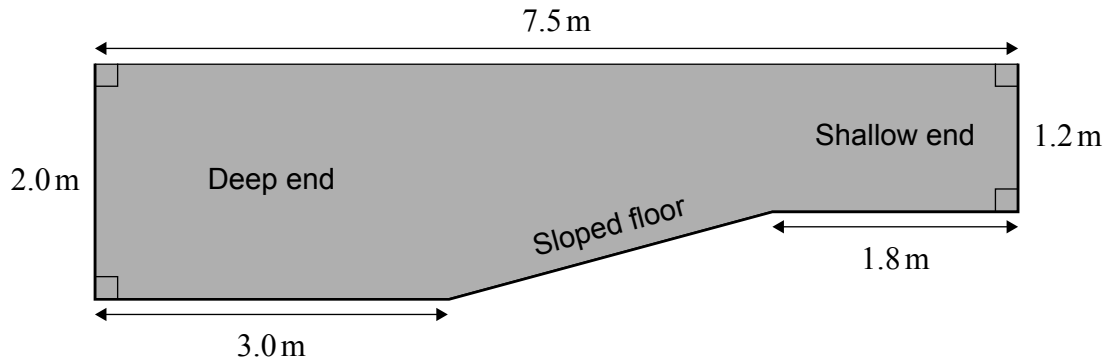
24EP07

Turn over

4. [Maximum mark: 5]

A swimming pool has a shallow end where the depth of the water is 1.2 m and a deep end where the depth of the water is 2.0 m. A cross-section of the water in the swimming pool, with additional dimensions, is shown in the diagram.

diagram not to scale



A safety regulation states that the gradient of the sloped floor of the swimming pool, as shown in the cross-section, must not be greater than $\frac{1}{3}$.

(a) Show that the swimming pool satisfies the safety regulation.

[2]

The time to fill the pool with water is inversely proportional to the water flow rate, in litres per minute, of the hose being used. A hose with a water flow rate of 300 litres per minute will completely fill this pool from empty in 4.5 hours if the hose is run continuously.

(b) Determine the time it takes to completely fill the pool from empty, using a hose run continuously with a water flow rate of 170 litres per minute.

[3]

(This question continues on the following page)



(Question 4 continued)

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24EP09

Turn over

5. [Maximum mark: 7]

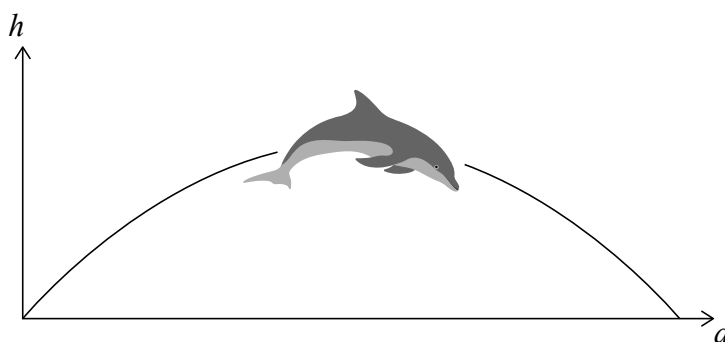
A dolphin jumps out of water. The path of its jump can be modelled by a quadratic function using the following variables:

d is the horizontal distance from the point where the dolphin leaves the water

h is the height of the dolphin above the surface of the water.

All distances are measured in metres, from the point where the dolphin leaves the water.

diagram not to scale



On a particular jump, the dolphin first reaches a height of 5.1 m above the surface of the water when the horizontal distance is 3 m and again when the horizontal distance is 8.5 m.

- (a) Write down the equation of the axis of symmetry of the quadratic function. [2]

The quadratic function that models the dolphin's jump is $h(d) = -0.2d^2 + bd$, where $d > 0$ and b is a constant.

- (b) Calculate the value of b . [2]
 (c) Find the horizontal distance when the dolphin re-enters the water. [2]
 (d) Explain what a negative h -value would mean in this context. [1]

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(Question 5 continued)

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24EP11

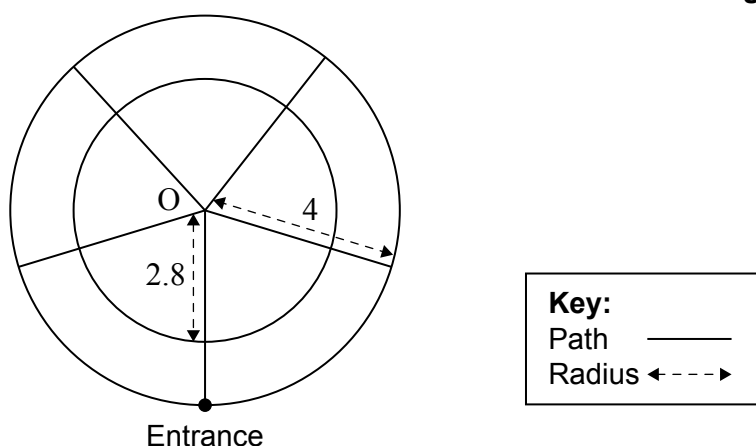
Turn over

6. [Maximum mark: 6]

A child's game is played by making paths in the snow. First, two circular paths are made using the same centre, O . The radius of the smaller circle is 2.8 m , and the radius of the larger circle is 4 m . Additional paths are then made from O to the outer edge of the larger circle, dividing each circle into 5 equal sectors, as shown in the following diagram.

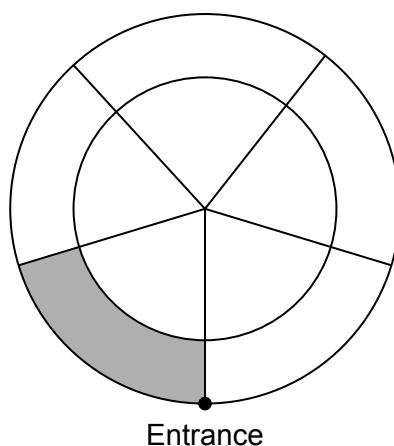
For your calculations, ignore the widths of the paths.

diagram not to scale



Each region **between** paths will be coloured with environmentally friendly dye. The shaded region below will be coloured orange.

diagram not to scale



Maureen has enough orange dye to cover an area of 6 m^2 .

(a) Show that Maureen has enough orange dye to cover the shaded region.

[3]

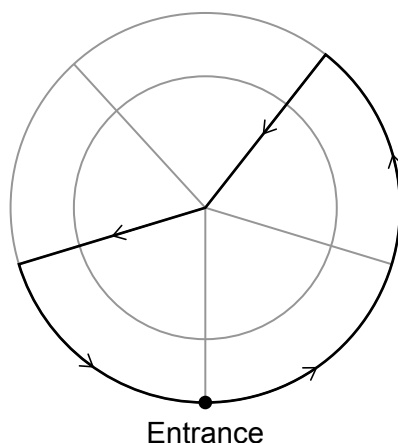
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(Question 6 continued)

During the game, the players start at the entrance and must travel only along the paths made in the snow. Maureen travels from the entrance along the path shown in the following diagram.

diagram not to scale



- (b) Calculate the distance Maureen travels along this path, starting from the entrance and returning to the entrance.

[3]

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7. [Maximum mark: 5]

Children inherit genes from their biological parents that determine their eye colour.

Maria and Alex plan to have 5 children. The probability that a child born to Maria and Alex will have brown eyes is 0.75. It is assumed that a child's eye colour is independent of any other child's eye colour.

Maria and Alex wish to predict how many of their 5 children will have brown eyes.

- (a) State one criterion, in addition to independence, that would support them using a binomial distribution to find probabilities for their prediction. [1]
- (b) Calculate the probability that
 - (i) exactly 3 of the 5 children will have brown eyes.
 - (ii) at least 4 of the 5 children will have brown eyes. [4]

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8. [Maximum mark: 7]

Consider a function of the form $f(x) = 2x^{-2} + bx^{-1} + c$, where b and c are constants.
The graph of $y = f(x)$ has a gradient of 0.208 at $x = 5$.

(a) Determine the value of b . [5]

(b) Show that $f(x)$ is increasing at $x = 3.5$ [2]

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9. [Maximum mark: 4]

Consider the function $f(x) = x^3 - 9x^2 + 23x - 15$ for $0 \leq x \leq 5$.

The graph of $f(x)$ crosses the x -axis when $x = 1$, $x = 5$ and $x = a$.

(a) Find the value of a . [2]

(b) Use your graphic display calculator to find the area enclosed by the curve $y = f(x)$ and the x -axis, when $1 \leq x \leq a$. [2]

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10. [Maximum mark: 7]

A manufacturer designs hats that businesses can order.

For an order of 15 hats or fewer, the price per hat is p euros (EUR). For larger orders, the price of **each** hat after the first 15 ordered is reduced by 5 EUR.

$C(n)$ represents the total cost of purchasing n hats from the manufacturer.

(a) Write down an expression in terms of p for the total cost of ordering 15 hats. [1]

(b) Write down an equation for $C(n)$, in terms of p and n , for the total cost of ordering n hats when $n > 15$. [3]

A company decides to order 100 hats. The mean price per hat for this order is 25.73 EUR.

(c) (i) Calculate the exact total cost of the order.

(ii) Hence, determine the value of p , correct to 2 decimal places. [3]

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

Answers written on this page
will not be marked.



11. [Maximum mark: 5]

Mongolia is one of the coldest countries in the world, with the air temperature in winter as low as -40°C . It can feel even colder if a wind is blowing. This effect is called wind chill.

On a day when the air temperature is -40°C , the approximate wind chill index, W , can be calculated by the equation

$$W = -34.1 - 7.33 \ln(v),$$

where v is the wind speed, in kilometres per hour (km h^{-1}).

- (a) Find the approximate wind chill index on a day when the air temperature is -40°C and the wind speed is measured as 13 km h^{-1} . [2]

Due to errors in the measuring device, the percentage error in the **approximate wind chill index** calculated in part (a) could be as high as 6%.

- (b) Predict the maximum **and** the minimum wind chill index for this day. [3]

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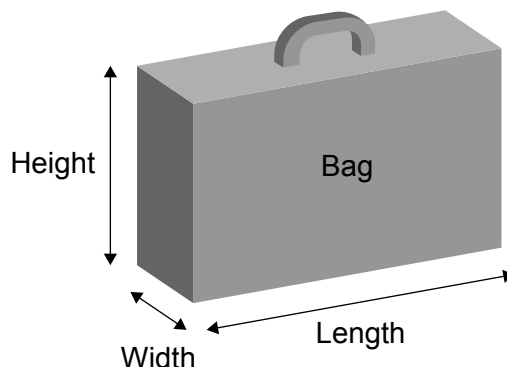
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12. [Maximum mark: 9]

An airline restricts the size of bags by stating that the sum of a bag's width, length, and height (ignoring the handle) must not exceed a fixed value, M .

diagram not to scale



$$\text{Width} + \text{Length} + \text{Height} \leq M$$

A company is designing a cuboid-shaped bag so that the sum of the bag's width, length, and height **equals** M . Their design will have a length equal to three times its width.

As the width of the design varies, its volume changes according to the equation

$$\frac{dV}{dw} = 690w - 36w^2,$$

where w is the width in centimetres and V is the volume in cubic centimetres.

- (a) Use your graphic display calculator to find the value of w that will produce the maximum volume. [2]
- (b) Show that the maximum volume of the bag to three significant figures is $42\,200\text{ cm}^3$. [4]
- (c) Hence find the value of M . [3]

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(Question 12 continued)

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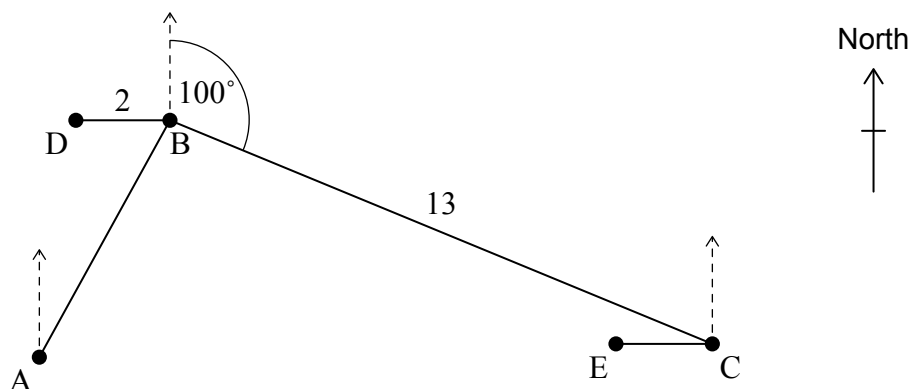
24EP21

Turn over

13. [Maximum mark: 9]

Ticky is sailing a boat in the ocean. For the first part of her trip, she plans to start at point A and travel to point B. She then plans to turn and travel 13 km on a bearing of 100° to point C as shown in the following diagram.

diagram not to scale



Due to navigational error in the first part of the trip, Ticky arrives at point D instead of point B. Point D is 2 km due west of point B.

(a) Determine

(i) the size of $\hat{DBC}$.

(ii) the distance from point D to point C.

(iii) the bearing Ticky must use to travel directly from point D to point C.

[7]

Due to navigational error in the second part of the trip, Ticky arrives at point E instead of point C. Point E is 2 km due west of point C.

(b) Write down the distance between point D and point E. Justify your answer.

[2]

(This question continues on the following page)



(Question 13 continued)

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References:

3. ONYXprj, 2017. *Realistic cupcakes and cookies. Biscuits muffins packaging, creamy and chocolate bakery products in white box vector illustration* [image online] Available at: <https://www.gettyimages.co.uk/detail/illustration/realistic-cupcakes-and-cookies-biscuits-royalty-free-illustration/1257757782> [Accessed 19 April 2024]
Source adapted.

