Diploma Programme
Programme du diplôme
Programa del Diploma

Mathematics: applications and interpretation
Standard level
Paper 2

16 May 2025

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

1 hour 30 minutes

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- A graphic display calculator is required for this paper.
- Answer all the questions in the answer booklet 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]**.

2225 – 7310

9 pages

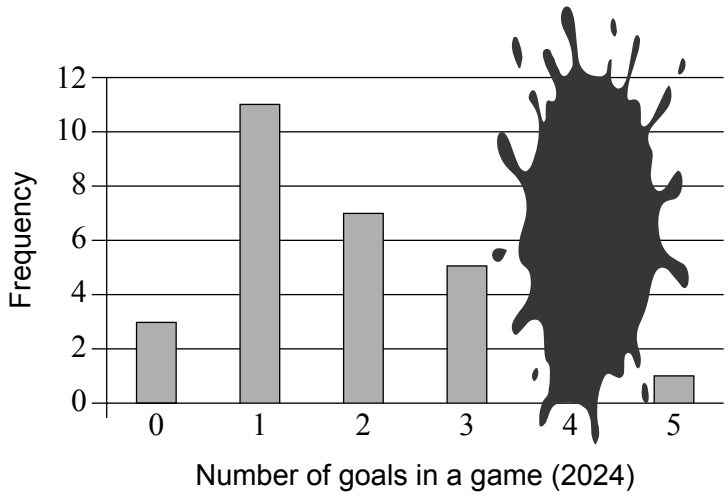
Answer **all** questions in the answer booklet provided. Please start each question on a new page. Full marks are not necessarily awarded for a correct answer with no working. Answers must be supported by working and/or explanations. Solutions found from a graphic display calculator should be supported 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: 15]

Paul has a bar graph for the total number of goals scored in each game of a soccer tournament in 2024. The bar graph is shown below, however the frequency of 4 goals in a game is unreadable.

Paul uses this bar graph to create a frequency table.

Bar graph



Frequency table

Number of goals in a game (2024)	Frequency
0	3
1	11
2	7
3	k
4	p
5	1

(a) Write down the value of k. [1]

Paul knows that the mean number of goals per game scored during the tournament was 2.2.

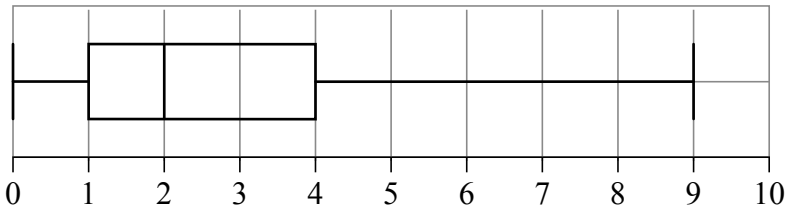
(b) (i) Write down an equation for the mean in terms of p.

(ii) Determine the value of p. [3]

(This question continues on the following page)

(Question 1 continued)

Data for the number of goals per game in the **2025 soccer tournament** are shown in the following box and whisker diagram.



Number of goals in a game (2025)

After comparing the box and whisker diagram from the 2025 tournament with the frequency table from the 2024 tournament, Paul concludes that the distribution of goals is consistent between the two tournaments.

(c) State two observations that support Paul's conclusion using values from the data to compare any **two** of:

range, symmetry, median, and interquartile range. [3]

Paul plans to watch all the games from the **2024** tournament in a random order.
He will watch each game once.

For the first game he watches, he defines event F as:

"scoring either 0 goals or exactly 1 goal".

(d) Write down the event(s) from the table that are equivalent to F'. There may be more than one correct event. [2]

Event	Description
A	Scoring exactly 2 goals in this game
B	Scoring more than 1 goal in this game
C	Scoring at least 2 goals in this game
D	Scoring either 0 goals or exactly 1 goal in all games except this game
E	Not scoring 0 goals or exactly 1 goal in any game

(e) If exactly 1 goal was scored in the first game Paul watches, write down the probability that exactly 1 goal was scored in the second game he watches. Give your answer as a fraction. [2]

(f) Calculate the probability that 5 goals were scored in the first game that Paul watches **and** 0 goals were scored in the second game he watches. [4]

2. [Maximum mark: 15]

Give all answers in this question to the nearest dollar.

Anika invested $10\,000$ Canadian dollars (CAD) in an account which earns a nominal annual interest rate of 3.4%, compounded monthly.

(a) Calculate the value of Anika's investment after 6 years. [3]

Anika wants to purchase a house that costs $225\,000\,\text{CAD}$. Anika uses the value obtained in part (a) to make an initial payment on the house and takes out a loan to pay the rest.

(b) Determine the amount of Anika's loan. [1]

Anika amortizes her loan over 15 years. She arranges to make a loan payment at the end of each month. The nominal annual interest rate for the loan is 6.4%, compounded half-yearly.

(c) Determine Anika's monthly loan payment. [5]

After 2 complete years, Anika decides to increase her monthly loan payment to $2200\,\text{CAD}$. At the time, the remaining amount of the loan is $194\,572\,\text{CAD}$.

(d) (i) Calculate the amount by which the loan will decrease during the next 3 complete years.

(ii) Determine the total interest that Anika will pay over this 3-year period. [6]

3. [Maximum mark: 17]

Felix is training for a competition consisting of running and swimming. He plans to train for 12 weeks to prepare for the competition.

The running part of the competition is a $5\,\text{km}$ race. During the 12 weeks, Felix runs on **3 days each week**. On the first day of training, Felix runs $2\,\text{km}$. Each subsequent day that he runs, he increases his distance by 5%.

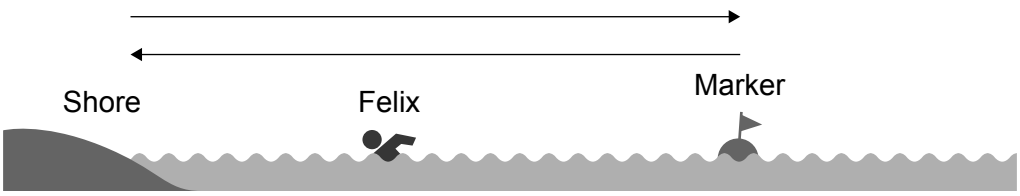
(a) Explain why the distances of each of Felix's runs form a geometric sequence and state the common ratio. [2]

(b) Find the total distance of Felix's first 15 runs. [2]

A published recommendation states that, on the last day of training, an athlete should run a distance that is at least twice as far as the race distance.

(c) Show that Felix's final run of his 12-week training plan meets this recommendation. [3]

For the swimming part of the competition, competitors must swim $375\,\text{m}$ out to a marker in the water and then $375\,\text{m}$ back to the shore.



Felix plans to swim **2 times per week** to train for the swimming portion of the competition. On each day he swims in the 1st week, Felix swims out to a marker that is $80\,\text{m}$ from the shore, and then swims back to shore.

At the start of each subsequent week, the marker is moved to increase the distance between the marker and the shore by a constant amount. Felix swims a total distance of $704\,\text{m}$ in the 4th week.

The distances that Felix swims each week form an arithmetic sequence, where each term, u_n, is the **total distance** he swims in the nth week.

(d) (i) Find u_1.

(ii) Determine the increase in the total distance Felix swims each week.

(iii) Hence calculate the distance between the marker and the shore in the 2nd week of training. [7]

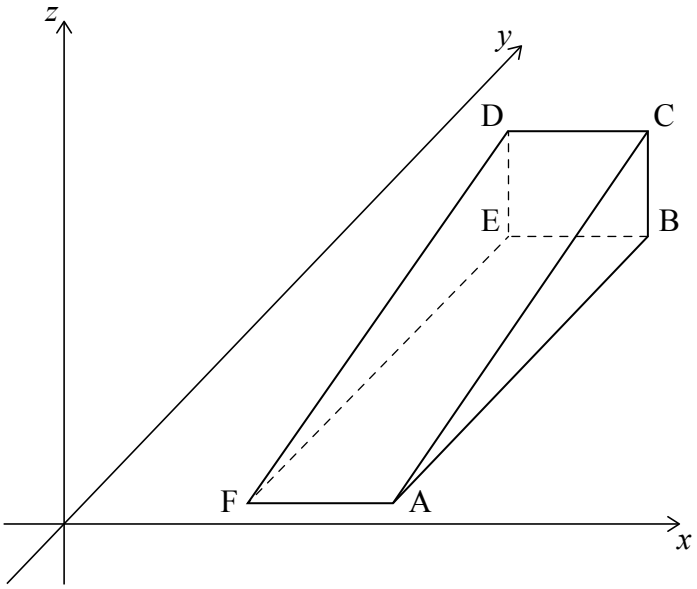
(e) Calculate the distance of Felix's final swim in his 12th week of training. [3]

4. [Maximum mark: 14]

AirFlow Industries is designing a doorstop in the shape of a triangular prism, $ABCDEF$.

The points $A(13, 1, 0)$, $B(13, 25, 0)$ and $C(13, 25, 7)$ are the coordinates of the vertices of one of the triangular faces of the prism. Point $D(4, 25, 7)$ is another vertex as shown in the following diagram. All the measurements are in centimetres.

diagram not to scale



(a) Write down the coordinates of F. [2]

(b) Find AC. [2]

(c) Show that triangle ABC is a right-angled triangle. [2]

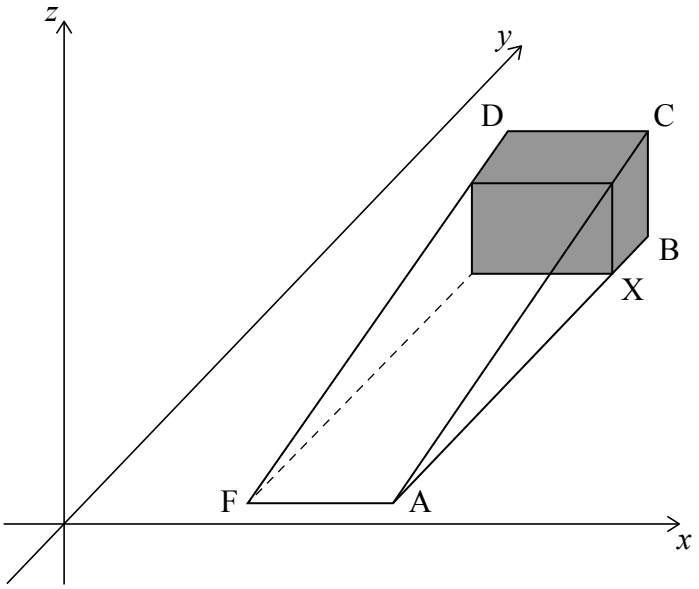
(d) Find the volume of material needed to make the doorstop. [3]

(This question continues on the following page)

(Question 4 continued)

To lower the cost of the doorstop, AirFlow decides to reduce its volume to $625\,\text{cm}^3$ by removing the shaded section shown in the following diagram. The remaining triangular faces are still right-angled triangles.

diagram not to scale



The length of the smaller doorstop, AX, can be calculated by

$$\text{AX} = \text{AB} \times \sqrt{\frac{V_S}{V_O}}$$

where V_S is the volume of the smaller doorstop, and V_O is the volume of the original doorstop, both in cubic centimetres.

(e) Find AX. [2]

The material needed to make the doorstop costs 0.025 US dollars (USD) per cubic centimetre. The production of each doorstop requires 10% more material than its final volume, due to wastage in the production process.

To make a profit, the company will sell the doorstop for 20% more than the cost of the material.

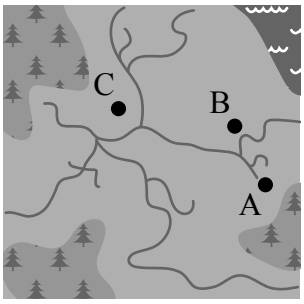
(f) Determine the price, to two decimal places, the company will charge for the **new** doorstop. [3]

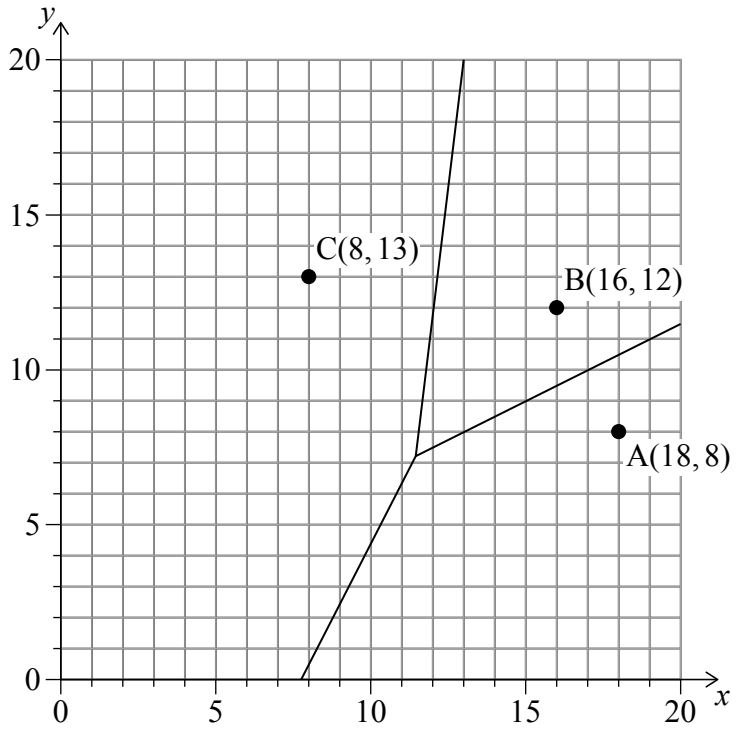
5. [Maximum mark: 19]

The locations of three fire stations within a 50 by 50 kilometre rural area of Japan are shown on the following map.

A Voronoi diagram can be used to determine the part of the rural area for which each fire station is responsible. The Voronoi diagram for the three fire stations is shown on the coordinate grid beside the map, where 1 unit represents $2.5\,\text{km}$.

Map





(a) (i) Find the midpoint of $[\text{BC}]$.

(ii) Find the gradient of the perpendicular bisector of $[\text{BC}]$.

(iii) Hence find the equation of the edge between sites B and C. [6]

(b) (i) Identify the fire station that is expected to respond, based on the Voronoi diagram, if a fire is reported at a location with coordinates $(14, 10)$. Justify your response.

(ii) Suggest a reason why a different fire station might respond to this fire. [2]

(This question continues on the following page)

(Question 5 continued)

A fire is reported at a location D with coordinates $\left(11\frac{1}{3}, 7\frac{1}{6}\right)$. The distance of D from A on the Voronoi diagram, to six significant figures, is 6.71855 units ($16.7964\,\mathrm{km}$ on the map).

(c) (i) Show that the distance of D from B, to six significant figures, is also 6.71855 units.

(ii) Show that any of the three fire stations would be expected to respond to the fire reported at D. [4]

The equation of the edge between fire stations A and B is $y = 0.5x + 1.5$. The edge between fire stations A and C has an x-intercept of 7.75.

(d) (i) Determine the area, to the nearest square unit, of the region within the given Voronoi diagram for which fire station A is responsible.

(ii) Hence, calculate the actual area, in square kilometres, of this region. [7]