Mathematics: applications and interpretation

Standard level

Paper 1

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.
- 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 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: 7]

The following data show the weights, in kilograms, of six dogs at a veterinary clinic

12.5 9.8 14.2 25.6 25.6 22.3

(a) For these six dogs, find

(i) the mean weight.

(ii) the median weight.

(iii) the modal weight.

(iv) the range of the weights.

A new dog, Max, is brought to the clinic. His weight is measured as 18.7 kg to the nearest tenth of a kilogram.

(b) Find Max's minimum possible weight.

(This question continues on the following page)

[6]

[1]

(Question 1 continued)

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[1]

[1]

[1]

2. [Maximum mark: 6]

A librarian surveys a group of students to find out if they have borrowed fiction and non-fiction books from the school library. The results of the survey are shown in the following Venn diagram.



(a) Write down the number of students surveyed.

(b) Write down the number of students who have not borrowed a non-fiction book. [1]

A student is chosen at random from those surveyed.

(c) Find the probability that this student has borrowed both fiction and non-fiction

books.

Let F be the event: a student has borrowed a fiction book. Let N be the event: a student has borrowed a non-fiction book.

(d) Find $P(F \cup N)$.

(e) State whether the events F and N are mutually exclusive. Justify your answer. [2]

(Question 1 continued)

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3. [Maximum mark: 7]

A marine biologist is studying the population of a rare species of fish in a protected lagoon. On 1 January 2025, the population is estimated to be 100 fish. Due to conservation efforts, the population is expected to increase each month, following a geometric sequence where r = 1.05.

(a) Use this model to estimate the fish population in December 2025. [2]

(b) Use this model to estimate the total fish population increase during the year

(i) 2025.

(ii) 2026.

[5]

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4. [Maximum mark: 7]

Maggie made an experiment to model the temperature of a cooling brownie. She placed it on the kitchen table at 07:00. The temperature, T, of the brownie (in °C) is modeled by the function

 $T = 25 + 50 b^{-t}$

where t is the number of hours after 07:00.

(a) Find the initial temperature of the brownie at 07:00.	
The temperature of the brownie reaches 55°C at 08:00.	
(b) Find the value of b.	[2]
(c) Write down the value of the room temperature	
(d) Draw the graph $T = 25 + 50 b^{-t}$ of on the following set of axes.	[2]



(This question continues on the following page)

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(Question 4 continued)

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5. [Maximum mark: 6]

Cecilia wants to construct a pool in her house and deposits \$80,000 into a savings account with a nominal annual interest rate of r%, **compounded monthly**. After one year, the amount in the account has increased to \$84,100.

(a) Find the value of **r**.

[3]

Cecilia withdraws the \$84,100 and places it in an annuity that earns a nominal annual interest rate of 5.8%, **compounded monthly**. She will withdraw \$7,000 at the end of each month to cover the construction costs.

(b) Find the amount of money remaining in the annuity at the end of **six months**. Express your answer to the nearest dollar. [3]

6. [Maximum mark: 6]

Three cellphone towers are installed in a rural area at locations A(2, 6), B(10, 8), and C(12, 4). The signal coverage is analyzed using perpendicular bisectors of the segments joining the towers.



The perpendicular bisector of [BC] intercepts the axes at coordinates (0, 0, 5) and (-1, 0).

(a) Write down the equation of the perpendicular bisector of [*BC*] [2]

The equation of the perpendicular bisector of [AB] is y = -4x + 31.

(b) Find the coordinates of point G, where the perpendicular bisectors meet. Give your answer to four significant figures. [2]

A Voronoi diagram is used to determine the area best covered by each cellphone tower.

(c) Draw, clearly, the edges of the Voronoi diagram on the given diagram. [2]

(Question 6 continued)

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[3]

[2]

7. [Maximum mark: 6]

The height of the tide in the Río de la Plata, in meters, can be modeled by the function

h(t) = 2.5cos(30 t) + 3

where t is the time in hours after midnight.

- (a) (i) Write down the maximum height throughout the day.
 - (ii) Find how many hours it takes for the tide to complete a full cycle.
 - (iii) Identify the average water level over time.
- (b) Calculate the height of the tide at 7:00 AM.
- (c) Find the first time after midnight when the tide reaches a height of 4 meters. [1]



8. [Maximum mark: 6]

The speed of a car, S, in miles per hour (mph), can be converted to kilometers per hour (km/h) using the formula:

$$K = 1.609S$$

where K is the speed in km/h and S is the speed in mph.

(a) (i) Find a formula for converting a speed in kilometers per hour to miles per hour.

(ii) Find the speed in miles per hour that corresponds to 100 km/h. [3]

Over a long journey, the mean speed of a car was recorded as 65 mph with a standard deviation of 8 mph.

(b) (i) Find the mean speed of the car in kilometers per hour.

(ii) Find the variance of the car's speed in kilometers per hour.

[3]



9. [Maximum mark: 8]

Sofia is studying the melting of an ice cube in a warm room. Initially, the cube has side lengths of 8 mm. This information is illustrated in the following diagrams.



Sofia predicts that, as the ice melts, each side length will decrease at a constant rate of 0.15 mm per minute.

(a) (i) Find the length of one side of the ice cube 30 minutes after it is placed in the room.

(ii) Find the volume of the ice cube 30 minutes after it is placed in the room. [3]

Let the function V(t) represent the volume of the ice cube, in mm^3 , t minutes after it is placed in the room. V(t) is given by

$$V(t) = 512 - 28.5t + 0.51t^{2} - 0.0032t^{3}, \quad for \ 0 \le t \le 35.$$

(b) Find V'(t)

[2]

(c) Find the rate of change of the volume of the ice cube at t = 30. [2]

(d) State one reason why the side length of the ice cube may not always decrease at a constant rate. [1]

(Question 9 continued)

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10. [Maximum mark: 8]

When studying trees, researchers use a model in which the volume (*V cubic meters*) of a tree trunk is directly proportional to the cube of its height (*h meters*).



(a) (i) Use the model to find an expression for V in terms of h.

(ii) Hence find the volume of a tree with a height of 6.5 meters, given that a tree of

height **7 meters** has a volume of **8.75 cubic meters**. [4]

'Kleiber's law' states that the water uptake (W) of a tree is inversely proportional to the square of its height.

The water uptake of a 10m tree is k times the water uptake of a 7 m tree.

(b) Find the value of k.

[4]

(Question 10 continued)

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11. [Maximum mark: 5]

The following diagram shows a semicircular window with center O and diameter XY. A rectangular glass panel ODEF is also shown, such that DE = 10 cm and OD = 6 cm.



Diagram not to scale

Find the length of the arc EY.

12. [Maximum mark: 8]

Sophia organizes a fundraising event for an animal shelter by running a game where participants draw a card from a shuffled deck. Each card determines whether a player wins or loses money. The possible outcomes and their probabilities are shown in the following table.

Outcome	Probability
Win \$4	45%
Lose \$4	15%
Lose \$6	25%
Lose \$10	15%

Let X represent the amount that a player wins in this game.

- (a) (i) Find the expected value of X.
 - (ii) Interpret your answer to part (a) (i).

[3]

To encourage a player to continue playing, Sophia increases the winning prize for the second game they play from \$7 to \$8. For each successive game, the winning prize continues to increase by \$1.

Liam plays k games. The kth game is fair.

(b) (i) Find the value of k.

(ii) Explain why Sophia expects to raise money from the games Liam plays. [5]

(Question 12 continued)

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