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Mathematics: applications and interpretation
Higher level
Paper 1

8 May 2023

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

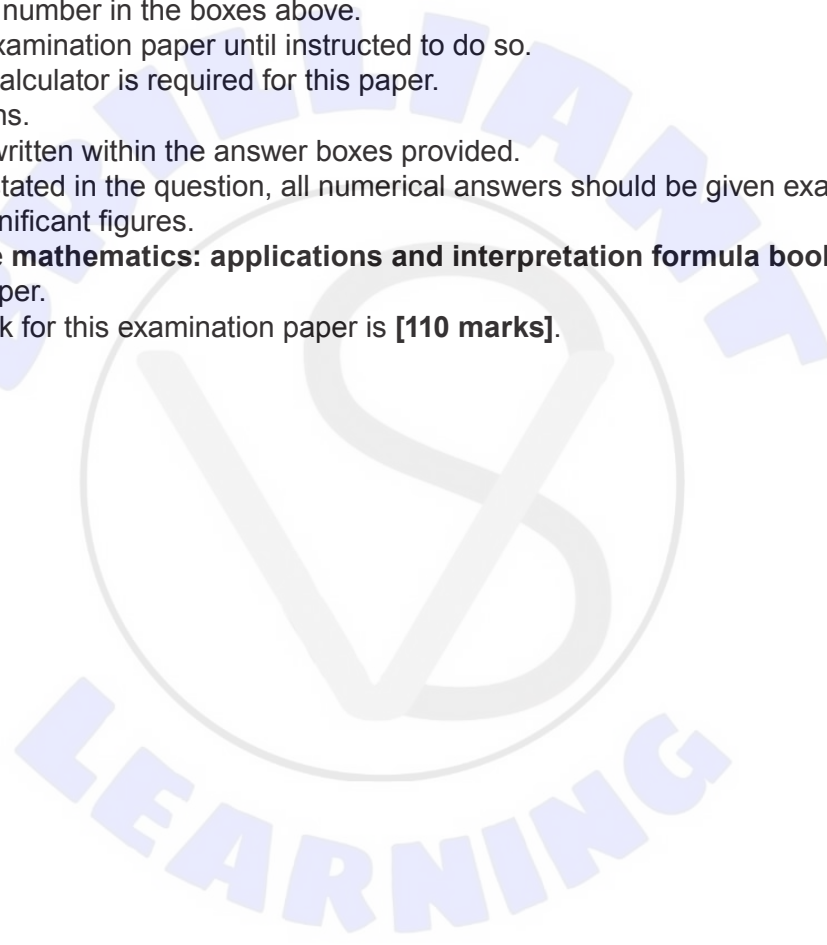
Candidate session number

2 hours

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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 formula booklet** is required for this paper.
- The maximum mark for this examination paper is **[110 marks]**.





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Answers written on this page
will not be marked.



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]

A player throws a basketball. The height of the basketball is modelled by

$$h(t) = -4.75t^2 + 8.75t + 1.5, \quad t \geq 0,$$

where h is the height of the basketball above the ground, in metres, and t is the time, in seconds, after it was thrown.

- (a) Find how long it takes for the basketball to reach its maximum height. [2]
- (b) Assuming that no player catches the basketball, find how long it would take for the basketball to hit the ground. [2]

Another player catches the basketball when it is at a height of 1.2 metres.

- (c) Find the value of t when this player catches the basketball. [2]
- (d) Write down one limitation of using $h(t)$ to model the height of the basketball. [1]

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2. [Maximum mark: 4]

A company that owns many restaurants wants to determine if there are differences in the quality of the food cooked for three different meals: breakfast, lunch and dinner.

Their quality assurance team randomly selects 500 items of food to inspect. The quality of this food is classified as perfect, satisfactory, or poor. The data is summarized in the following table.

		Quality			Total
		Perfect	Satisfactory	Poor	
Meal	Breakfast	101	124	7	232
	Lunch	68	81	5	154
	Dinner	35	69	10	114
Total		204	274	22	500

A χ^2 test at the 5% significance level is carried out to determine if there is significant evidence of a difference in the quality of the food cooked for the three meals.

The critical value for this test is 9.488.

The hypotheses for this test are:

H_0 : The quality of the food and the type of meal are independent.

H_1 : The quality of the food and the type of meal are not independent.

- (a) Find the χ^2 statistic. [2]
- (b) State, with justification, the conclusion for this test. [2]

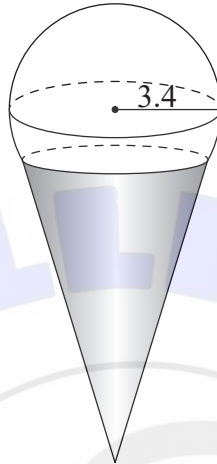
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6. [Maximum mark: 5]

Ruhi buys a scoop of ice cream in the shape of a sphere with a radius of 3.4 cm. The ice cream is served in a cone, and it may be assumed that $\frac{1}{5}$ of the volume of the ice cream is inside the cone. This is shown in the following diagram.

diagram not to scale



(a) Calculate the volume of ice cream that is not inside the cone. [3]

The cone has a slant height of 11 cm and a radius of 3 cm.

The outside of the cone is covered with chocolate.

(b) Calculate the surface area of the cone that is covered with chocolate. Give your answer correct to the nearest cm^2 . [2]

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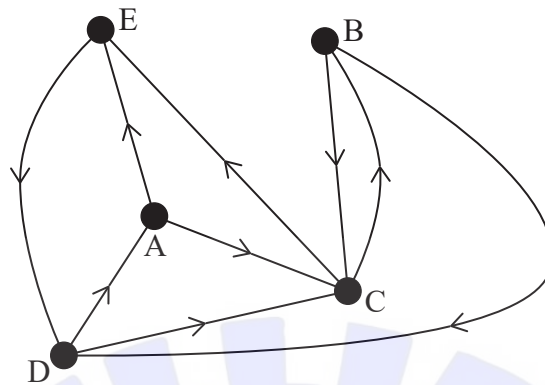
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8. [Maximum mark: 7]

The following directed, unweighted, graph shows a simplified road network on an island, connecting five small villages marked A to E.



(a) Construct the adjacency matrix M for this network. [3]

Beatriz the bus driver starts at village E and drives to seven villages, such that the seventh village is A.

- (b) (i) Determine how many possible routes Beatriz could have taken, to travel from E to A.
- (ii) Describe one possible route taken by Beatriz, by listing the villages visited in order. [4]

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9. [Maximum mark: 9]

At a running club, Sung-Jin conducts a test to determine if there is any association between an athlete's age and their best time taken to run 100m. Eight athletes are chosen at random, and their details are shown below.

Athlete	A	B	C	D	E	F	G	H
Age (years)	13	17	22	18	19	25	11	36
Time (seconds)	13.4	14.6	13.4	12.9	12.0	11.8	17.0	13.1

Sung-Jin decides to calculate the Spearman's rank correlation coefficient for his set of data.

- (a) Complete the table of ranks. [2]

Athlete	A	B	C	D	E	F	G	H
Age rank			3					
Time rank							1	

- (b) Calculate the Spearman's rank correlation coefficient, r_s . [2]
- (c) Interpret this value of r_s in the context of the question. [1]
- (d) Suggest a mathematical reason why Sung-Jin may have decided not to use Pearson's product-moment correlation coefficient with his data from the original table. [1]
- (e) (i) Find the coefficient of determination for the data from the original table.
- (ii) Interpret this value in the context of the question. [3]

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