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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.



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]

(This question continues on the following page)



4. [Maximum mark: 6]

Angel has \$ 520 in his savings account. Angel considers investing the money for 5 years with a bank. The bank offers an annual interest rate of 1.2% compounded quarterly.

- (a) Calculate the amount of money Angel would have at the end of 5 years with the bank. Give your answer correct to two decimal places. [3]

Instead of investing the money, Angel decides to buy a phone that costs \$ 520. At the end of 5 years, the phone will have a value of \$ 30. It may be assumed that the depreciation rate per year is constant.

- (b) Calculate the annual depreciation rate of the phone. [3]

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5. [Maximum mark: 6]

The lengths of the seeds from a particular mango tree are approximated by a normal distribution with a mean of 4 cm and a standard deviation of 0.25 cm.

A seed from this mango tree is chosen at random.

- (a) Calculate the probability that the length of the seed is less than 3.7 cm. [2]

It is known that 30% of the seeds have a length greater than k cm.

- (b) Find the value of k . [2]

For a seed of length d cm, chosen at random, $P(4 - m < d < 4 + m) = 0.6$.

- (c) Find the value of m . [2]

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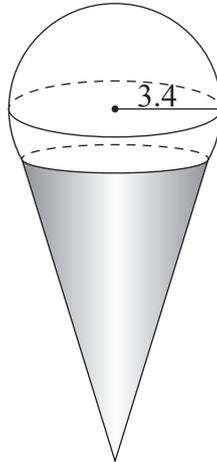
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6. [Maximum mark: 5]

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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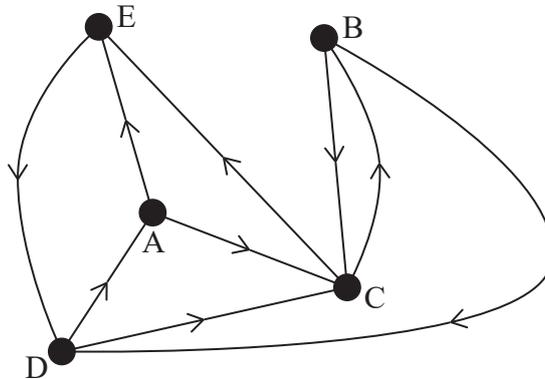
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8. [Maximum mark: 7]

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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Turn over

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]

(This question continues on the following page)



12. [Maximum mark: 5]

A spherical balloon is being inflated such that its volume is increasing at a rate of $15 \text{ cm}^3 \text{ s}^{-1}$.

(a) Find the radius of the balloon when its volume is $288\pi \text{ cm}^3$. [2]

(b) Hence or otherwise, find the rate of change of the radius at this instant. [3]

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