

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

A2 GCE

4767/01

MATHEMATICS (MEI)

Statistics 2

QUESTION PAPER

WEDNESDAY 15 JUNE 2016: Morning

**DURATION: 1 hour 30 minutes
plus your additional time allowance**

MODIFIED ENLARGED

Candidates answer on the Printed Answer Book or any suitable paper provided by the centre. The Printed Answer Book may be enlarged by the centre.

OCR SUPPLIED MATERIALS:

None

OTHER MATERIALS REQUIRED:

Scientific or graphical calculator

READ INSTRUCTIONS OVERLEAF



INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book or on the paper provided by the centre. Please write clearly and in capital letters.

IF YOU USE THE PRINTED ANSWER BOOK, WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED IN THE PRINTED ANSWER BOOK. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

Use black ink. HB pencil may be used for graphs and diagrams only.

Read each question carefully. Make sure you know what you have to do before starting your answer.

Answer ALL the questions.

You are permitted to use a scientific or graphical calculator in this paper.

Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [] at the end of each question or part question on the Question Paper.

You are advised that an answer may receive NO MARKS unless you show sufficient detail of the working to indicate that a correct method is being used.

The total number of marks for this paper is 72.

Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER/INVIGILATOR

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- 1 A researcher believes that there may be negative association between the quantity of fertiliser used and the percentage of the population who live in rural areas in different countries. The data below show the percentage of the population who live in rural areas and the fertiliser use measured in kg per hectare, for a random sample of 11 countries.**

Percentage of population	33	6	58	35	81	69	61	7	74	71	17
Fertiliser use	76	44	6	68	3	10	7	176	5	137	157

- (i) Draw a scatter diagram to illustrate the data. [3]**
- (ii) Explain why it might not be valid to carry out a test based on the product moment correlation coefficient in this case. [2]**
- (iii) Calculate the value of Spearman's rank correlation coefficient. [5]**
- (iv) Carry out a hypothesis test at the 1% significance level to investigate the researcher's belief. [6]**
- (v) Explain the meaning of '1% significance level'. [1]**
- (vi) In order to carry out a test based on Spearman's rank correlation coefficient, what modelling assumptions, if any, are required about the underlying distribution? [1]**

- 2 When a genetic sequence of plant DNA is given a dose of radiation, some of the genes may mutate. The probability that a gene mutates is 0.012. Mutations occur randomly and independently.**

(i) Explain the meanings of the terms ‘randomly’ and ‘independently’ in this context. [2]

A short stretch of DNA containing 20 genes is given a dose of radiation.

(ii) Find the probability that exactly 1 out of the 20 genes mutates. [2]

A longer stretch of DNA containing 500 genes is given a dose of radiation.

(iii) Explain why a Poisson distribution is an appropriate approximating distribution for the number of genes that mutate. [2]

(iv) Use this Poisson distribution to find the probability that there are

(A) exactly two genes that mutate, [3]

(B) at least two genes that mutate. [2]

A third stretch of DNA containing 50 000 genes is given a dose of radiation.

(v) Use a suitable approximating distribution to find the probability that there are at least 650 genes that mutate. [5]

- 3 Many types of computer have cooling fans. The random variable X represents the lifetime in hours of a particular model of cooling fan. X is Normally distributed with mean 50 600 and standard deviation 3400.**
- (i) Find $P(50\,000 < X < 55\,000)$. [3]**
- (ii) The manufacturers claim that at least 95% of these fans last longer than 45 000 hours. Is this claim valid? [3]**
- (iii) Find the value of h for which 99.9% of these fans last h hours or more. [3]**
- (iv) The random variable Y represents the lifetime in hours of a different model of cooling fan. Y is Normally distributed with mean μ and standard deviation σ . It is known that $P(Y < 60\,000) = 0.6$ and $P(Y > 50\,000) = 0.9$. Find the values of μ and σ . [5]**
- (v) Sketch the distributions of lifetimes for both types of cooling fan on a single diagram. [4]**

- 4 (a) A random sample of 80 GCSE students was selected to take part in an investigation into whether attitudes to mathematics differ between girls and boys. The students were asked if they agreed with the statement 'Mathematics is one of my favourite subjects'. They were given three options 'Agree', 'Disagree', 'Neither agree nor disagree'. The results, classified according to sex, are summarised in the table below.

	Agree	Disagree	Neither
Male	17	13	8
Female	12	11	19

The contributions to the test statistic for the usual χ^2 test are shown in the table below.

	Agree	Disagree	Neither
Male	0.7550	0.2246	1.8153
Female	0.6831	0.2032	1.6424

- (i) Calculate the expected frequency for females who agree. Verify the corresponding contribution, 0.6831, to the test statistic. [3]
- (ii) Carry out the test at the 5% level of significance. [6]

- (b) The level of radioactivity in limpets (a type of shellfish) in the sea near to a nuclear power station is regularly monitored. Over a period of years it has been found that the level (measured in suitable units) is Normally distributed with mean 5.64. Following an incident at the power station, a researcher suspects that the mean level of radioactivity in limpets may have increased. The researcher selects a random sample of 60 limpets. Their levels of radioactivity, x (measured in the same units), are summarised as follows.

$$\sum x = 373$$

$$\sum x^2 = 2498$$

Carry out a test at the 5% significance level to investigate the researcher's belief. [11]

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