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Oxford Cambridge and RSA

Friday 16 June 2023 – Afternoon

A Level Further Mathematics B (MEI)

Y432/01 Statistics Minor

Time allowed: 1 hour 15 minutes

9970716358

You must have:
- the Printed Answer Booklet
- the Formulae Booklet for Further Mathematics B (MEI)
- a scientific or graphical calculator

QP

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided in the **Printed Answer Booklet**. If you need extra space use the lined pages at the end of the Printed Answer Booklet. The question numbers must be clearly shown.
- Fill in the boxes on the front of the Printed Answer Booklet.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.
- Give your final answers to a degree of accuracy that is appropriate to the context.
- Do **not** send this Question Paper for marking. Keep it in the centre or recycle it.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- This document has **8** pages.

ADVICE
- Read each question carefully before you start your answer.

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1 A fair spinner has ten sectors, labelled 1, 2, …, 10. In order to start a game, Kofi has to obtain an 8, 9 or 10 on the spinner.

(a) Find the probability that Kofi starts the game on the third spin. **[2]**

(b) Find the probability that Kofi takes at least 5 spins to start the game. **[1]**

(c) Determine the probability that the number of spins required to start the game is within 1 standard deviation of its mean. **[5]**

2 A company manufactures batches of twenty thousand tins which are subsequently filled with fruit. The company tests tins from each batch to make sure that they are strong enough. The test is easy and cheap to carry out, but when a tin has been tested it is no longer suitable for filling with fruit.

(a) (i) Explain why a sample size of 5 tins per batch may not be appropriate in this case. **[1]**

(ii) Explain why a sample size of 1000 tins per batch may not be appropriate in this case. **[1]**

The company tests a sample of 30 tins from each batch.

(b) Explain why it would **not** be sensible for the sample to consist of the final 30 tins produced in a batch. **[1]**

(c) Give **two** features that the sample should have. **[2]**

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3 A fair four-sided dice has its faces numbered 0, 1, 2, 3. The dice is rolled three times. The discrete random variable X is the sum of the lowest and highest scores obtained.

(a) Show that $\mathrm{P}(X = 1) = \frac{3}{32}$. **[3]**

The table below shows the probability distribution of X.

r	0	1	2	3	4	5	6
$\mathrm{P}(X = r)$	$\frac{1}{64}$	$\frac{3}{32}$	$\frac{13}{64}$	$\frac{3}{8}$	$\frac{13}{64}$	$\frac{3}{32}$	$\frac{1}{64}$

(b) In this question you must show detailed reasoning.

Find each of the following.

- $\mathrm{E}(X)$
- $\mathrm{Var}(X)$ **[4]**

(c) The random variable Y represents the sum of 10 values of X.

(i) State a property of the 10 values of X that would make it possible to deduce the standard deviation of Y. **[1]**

(ii) Given that this property holds, determine the standard deviation of Y. **[2]**

4 Eve lives in a narrow lane in the country. She wonders whether the number of vehicles passing her house per minute can be modelled by a Poisson distribution with mean μ. She counts the number of vehicles passing her house over 100 randomly selected one-minute intervals. The results are shown in **Table 4.1**.

Table 4.1

Number of vehicles	0	1	2	3	4	5	6	7	8	9	10	$\geqslant 11$
Frequency	36	33	14	10	4	1	0	0	1	0	1	0

(a) Use the results to find an estimate for μ. **[1]**

The spreadsheet in **Fig. 4.2** shows data for a χ^2 test to assess the goodness of fit of a Poisson model. The sample mean from part **(a)** has been used as an estimate for the population mean. Some of the values in the spreadsheet have been deliberately omitted.

Fig. 4.2

	A	B	C	D	E
1	Number of vehicles	Observed frequency	Poisson probability	Expected frequency	Chi-squared contribution
2	0	36	0.2725	27.2532	2.8073
3	1	33	0.3543	35.4291	
4	2	14			3.5400
5	$\geqslant 3$	17			0.5145
6					

(b) Calculate the missing values in each of the following cells, giving your answers correct to **4** decimal places.

- C4
- D5
- E3

[4]

(c) **In this question you must show detailed reasoning.**

Carry out the χ^2 test at the 5% significance level. **[6]**

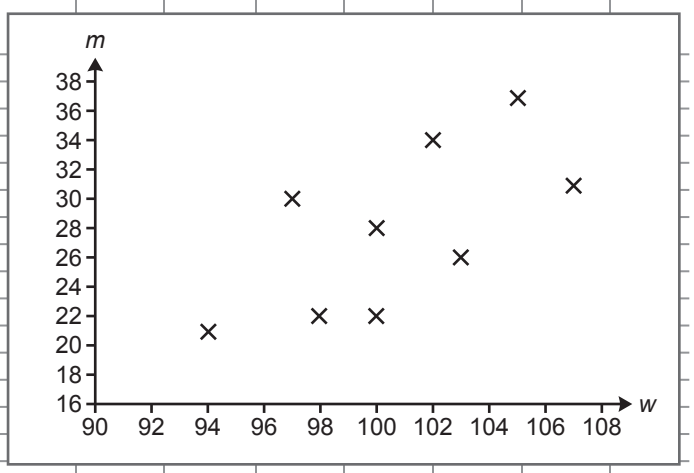
(d) Eve checks her data and notices that the two largest numbers of vehicles per minute (8 and 10) occurred when some horses were being ridden along the lane, causing delays to the vehicles. She therefore repeats the analysis, missing out these two items of data. She finds that the value of the χ^2 test statistic is now 4.748. The number of degrees of freedom of the test is unchanged.

Make **two** comments about this revised test. **[2]**

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5 An ornithologist is investigating the link between the wing length and the mass of small birds, in order to try to predict the mass from the wing length without having to weigh birds. The ornithologist takes a random sample of 9 birds and measures their wing lengths w mm and their masses m g. The spreadsheet below shows the data, together with a scatter diagram which illustrates the data.

	A	B
1	Wing length w mm	Mass m g
2	100	28
3	98	22
4	107	31
5	100	22
6	97	30
7	103	26
8	105	37
9	102	34
10	94	21



(a) Find the equation of the regression line of m on w, giving the coefficients correct to **3** significant figures. **[2]**

(b) Use the equation which you found in part **(a)** to estimate the mass for each of the following wing lengths.

- 99 mm
- 110 mm

[2]

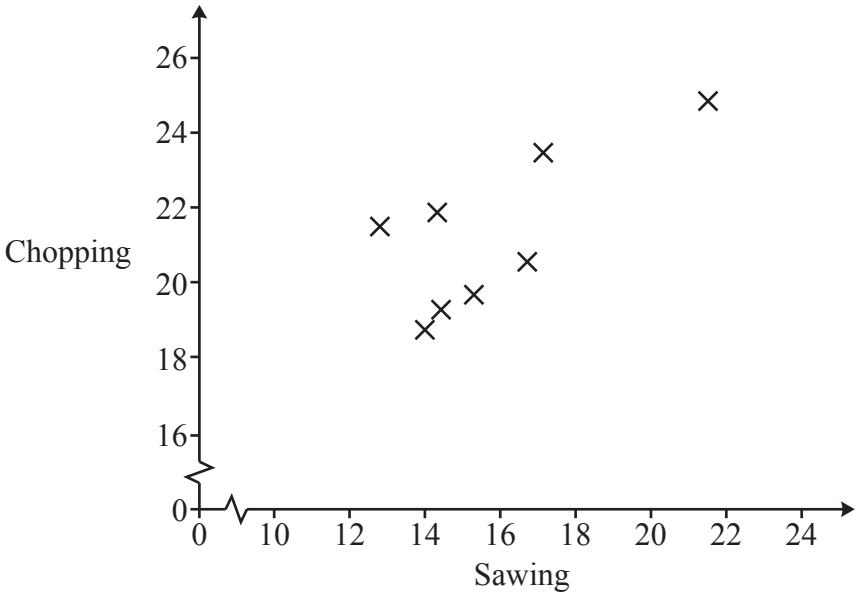
(c) Comment on the reliability of your estimates. **[2]**

(d) The equation of the regression line of w on m is $w = 0.473m + 87.5$. A friend of the ornithologist suggests that this equation could also be used to estimate the masses of birds from their wing lengths.

Comment on this suggestion. **[2]**

6 Each competitor in a lumberjacking competition has to perform various disciplines for which they are timed. A spectator thinks that the times for two of the disciplines, chopping wood and sawing wood, are related. The table and the scatter diagram below show the times of a random sample of 8 competitors in these two disciplines.

Competitor	A	B	C	D	E	F	G	H
Sawing	17.1	16.7	14.3	14.0	12.8	21.5	15.3	14.4
Chopping	23.5	20.6	21.9	18.8	21.5	24.8	19.7	19.3



(a) The spectator decides to carry out a hypothesis test to investigate whether there is any relationship.

Explain why the spectator decides that a test based on Pearson's product moment correlation coefficient may **not** be valid. **[2]**

(b) Determine the value of Spearman's rank correlation coefficient. **[3]**

(c) Carry out a hypothesis test at the 5% significance level to investigate whether there is positive association between sawing and chopping times. **[5]**

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7 The discrete random variable X has a uniform distribution over the set of all integers between 100 and n inclusive, where n is a positive integer with $n > 100$.

(a) Given that n is even, determine $\mathrm{P}\left(X < \frac{100+n}{2}\right)$. **[3]**

(b) Determine the variance of the sum of 50 independent values of X, giving your answer in the form $a(n^2 + bn + c)$, where a, b and c are constants. **[3]**

END OF QUESTION PAPER

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