

**Wednesday 8 June 2016 – Morning**

**AS GCE MEI STATISTICS**

**G242/01 Statistics 2 (Z2)**

**QUESTION PAPER**

Candidates answer on the Printed Answer Book.

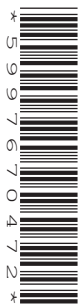
**OCR supplied materials:**

- Printed Answer Book G242/01
- MEI Examination Formulae and Tables (MF2)

**Other materials required:**

- Scientific or graphical calculator

**Duration:** 1 hour 30 minutes



## INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found in the centre of the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **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.
- Do **not** write in the bar codes.
- 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.

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- 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**.
- The Printed Answer Book consists of **12** pages. The Question Paper consists of **4** pages. Any blank pages are indicated.

## INSTRUCTION TO EXAMS OFFICER/INVIGILATOR

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

- 1 A biologist is studying a particular species of wading bird. She believes that there may be an association between wing length and the time in the migration season when the birds migrate. She decides to carry out a test. A random sample is collected as birds migrate to their breeding grounds. The results are as follows.

		Time of migration	
		Early	Late
Wing length	length < 108 mm	14	8
	108 mm $\leq$ length $\leq$ 113 mm	11	16
	length > 113 mm	4	19

The following tables show some of the expected frequencies and contributions to the test statistic.

<b>Expected frequencies</b>		Time of migration	
		Early	Late
Wing length	length < 108 mm		13.139
	108 mm $\leq$ length $\leq$ 113 mm		16.125
	length > 113 mm	9.264	13.736

<b>Contributions to the test statistic</b>		Time of migration	
		Early	Late
Wing length	length < 108 mm		2.0099
	108 mm $\leq$ length $\leq$ 113 mm		0.0010
	length > 113 mm	2.9910	2.0172

- (i) Calculate the remaining expected frequencies and contributions. Carry out the test at the 5% level of significance. [11]

The biologist states that ‘birds with longer wings migrate later’.

- (ii) With reference to the contributions to the test statistic, discuss the biologist’s statement. [3]

- 2 An air charter company uses single-engine aircraft which can transport up to 10 passengers and their luggage. The weight, in kg, of luggage transported on each flight with 10 passengers follows a Normal distribution with mean 280 and variance 400.

(i) Calculate the probability that the weight of luggage is more than 250 kg for a particular flight with 10 passengers. [3]

The weight, in kg, of individual passengers is Normally distributed with mean 65 and variance 225. You may assume that weights of passengers are independent.

(ii) Calculate the probability that the total weight of 10 passengers does not exceed 700 kg. [5]

To meet safety regulations, the total combined weight,  $T$  kg, of the 10 passengers and their luggage must not exceed 1020 kg. You may assume that weights of passengers and weights of luggage are independent.

(iii) Show that  $T \sim N(930, 2650)$ . [2]

(iv) Calculate  $P(T > 1020)$  and draw a diagram showing the area corresponding to this probability. [3]

- 3 A petrochemical company is carrying out an appraisal of a newly discovered oil reservoir to determine whether it is suitable for development. Test rigs are installed at 12 randomly selected sites. The oil pressure at each site is recorded. The results, in appropriate units, are as follows.

187	232	328	201	198	234
287	165	275	149	258	144

The reservoir is considered to be suitable for development if its average pressure exceeds 200.

(i) Stating any necessary assumption, use a Wilcoxon test to examine, at the 5% significance level, whether these data provide evidence that the reservoir is suitable for development. [12]

(ii) What further assumption is necessary in order to carry out a hypothesis test on the mean of the underlying population? State, with a reason, the test that would be used. [3]

- 4 A conservation group is monitoring the numbers of dormice present in a large area of woodland. The woodland is divided into squares of equal area. Fifty of these squares are selected and the number of dormice present in each square is recorded. The results are as follows.

Number of dormice	0	1	2	3	4
Observed frequency	13	18	10	6	3

The sample mean for these data is 1.36.

- (i) Calculate the sample standard deviation for these data and explain why an investigation of the goodness of fit of a Poisson model might be appropriate. [3]

It is decided to carry out a  $\chi^2$  test for the goodness of fit of the Poisson model, using a mean of 1.36 calculated from the data. Some of the expected frequencies are shown in the table below.

Number of dormice	0	1	2	3	$\geq 4$
Expected frequency	12.833	17.453	11.868		

- (ii) Calculate the remaining expected frequencies. [5]

- (iii) Carry out the test using a 5% level of significance. State any necessary assumption. [8]

- 5 Keith works in a factory that produces doors for the building trade. He is expected to assemble doors in an average time of 15 minutes per door. He believes that he is assembling doors at a satisfactory rate. Keith records the times taken to assemble 12 doors. The times, in minutes, are as follows.

15	16	13	15	14	15
14	15	16	17	13	14

- (i) Calculate the sample mean and obtain an estimate for the variance of the underlying population. [2]

Keith wishes to calculate a confidence interval using these data.

- (ii) Explain why Keith should base his confidence interval on the  $t$  distribution rather than the Normal distribution. State any necessary assumptions. [4]

- (iii) Obtain a 95% confidence interval for the mean assembly time per door. [6]

- (iv) With reference to the confidence interval found in part (iii), comment briefly on Keith's belief. [2]

**END OF QUESTION PAPER**

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## Wednesday 8 June 2016 – Morning

### AS GCE MEI STATISTICS

G242/01 Statistics 2 (Z2)

**PRINTED ANSWER BOOK**

Candidates answer on this Printed Answer Book.

**OCR supplied materials:**

- Question Paper G242/01 (inserted)
- MEI Examination Formulae and Tables (MF2)

**Other materials required:**

- Scientific or graphical calculator

**Duration:** 1 hour 30 minutes



Candidate forename		Candidate surname	
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Centre number						Candidate number				
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<b>1 (i)</b>	<b>(continued)</b>
	<b>1 (ii)</b>

<b>2 (i)</b>	
<b>2 (ii)</b>	



<b>2 (iii)</b>	
<b>2 (iv)</b>	



<b>3 (i)</b>	<b>(continued)</b>
	<b>3 (ii)</b>

<b>4 (i)</b>	
<b>4 (ii)</b>	

<b>4 (iii)</b>	



<b>5 (iii)</b>	
<b>5 (iv)</b>	





**GCE**

**Statistics (MEI)**

Unit **G242**: Statistics 2 (Z2)

Advanced Subsidiary GCE

**Mark Scheme for June 2016**

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.




All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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## Annotations and abbreviations

Annotation in scoris	Meaning
 and 	
<b>BOD</b>	Benefit of doubt
<b>FT</b>	Follow through
<b>ISW</b>	Ignore subsequent working
<b>M0</b> <b>M1</b>	Method mark awarded 0, 1
<b>A0</b> <b>A1</b>	Accuracy mark awarded 0, 1
<b>B0</b> <b>B1</b>	Independent mark awarded 0, 1
<b>SC</b>	Special case
	Omission sign
<b>MR</b>	Misread
Highlighting	
Other abbreviations in mark scheme	Meaning
E1	Mark for explaining
U1	Mark for correct units
G1	Mark for a correct feature on a graph
M1 dep*	Method mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working

**Subject-specific Marking Instructions for GCE Mathematics (MEI) Statistics strand**

- a Annotations should be used whenever appropriate during your marking.

**The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks.** It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

- b An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

- c The following types of marks are available.

**M**

A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, eg by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

**A**

Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

**B**

Mark for a correct result or statement independent of Method marks.

**E**

A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

- d When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep \*' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.
- e The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

- f Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise.

Candidates are expected to give numerical answers to an appropriate degree of accuracy. 3 significant figures may often be the norm for this, but this always needs to be considered in the context of the problem in hand. For example, in quoting probabilities from Normal tables, we generally expect *some* evidence of interpolation and so quotation to 4 decimal places will often be appropriate. But even this does not always apply – quotations of the standard critical points for significance tests such as 1.96, 1.645, 2.576 (maybe even 2.58 – but not 2.57) will commonly suffice, especially if the calculated value of a test statistic is nowhere near any of these values. Sensible discretion *must* be exercised in such cases.

Discretion must also be exercised in the case of small variations in the degree of accuracy to which an answer is given. For example, if 3 significant figures are expected (either because of an explicit instruction or because the general context of a problem demands it) but only 2 are given, loss of an accuracy ("A") mark is likely to be appropriate; but if 4 significant figures are given, this should not normally be penalised. Likewise, answers which are slightly deviant from what is expected in a very minor manner (for example a Normal probability given, after an attempt at interpolation, as 0.6418 whereas 0.6417 was expected) should not be penalised. However, answers which are *grossly over-* or *under-specified* should normally result in the loss of a mark. This includes cases such as, for example, insistence that the value of a test statistic is (say) 2.12888446667 merely because that is the value that happened to come off the candidate's calculator. Note that this applies to answers that are given as final stages of calculations; intermediate working should usually be carried out, and quoted, to a greater degree of accuracy to avoid the danger of premature approximation.

The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.

g Rules for replaced work

If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

NB Follow these maths-specific instructions rather than those in the assessor handbook.

h Genuine misreading (of numbers or symbols, occasionally even of text) occurs. If this results in the object and/or difficulty of the question being considerably changed, it is likely that all the marks for that question, or section of the question, will be lost. However, misreads are often such that the object and/or difficulty remain substantially unaltered; these cases are considered below.

The simple rule is that *all* method ("M") marks [and of course all independent ("B") marks] remain accessible but at least some accuracy ("A") marks do not. It is difficult to legislate in an overall sense beyond this global statement because misreads, even when the object and/or difficulty remains unchanged, can vary greatly in their effects. For example, a misread of 1.02 as 10.2 (perhaps as a quoted value of a sample mean) may well be catastrophic; whereas a misread of 1.6748 as 1.6746 may have so slight an effect as to be almost unnoticeable in the candidate's work.

A misread should normally attract *some* penalty, though this would often be only 1 mark and should rarely if ever be more than 2. Commonly in sections of questions where there is a numerical answer either at the end of the section or to be obtained and commented on (eg the value of a test statistic), this answer will have an "A" mark that may actually be designated as "cao" [correct answer only]. This should be interpreted *strictly* – if the misread has led to failure to obtain this value, then this "A" mark must be withheld even if all method marks have been earned. It will also often be the case that such a mark is implicitly "cao" even if not explicitly designated as such.

On the other hand, we commonly allow "fresh starts" within a question or part of question. For example, a follow-through of the candidate's value of a test statistic is generally allowed (and often explicitly stated as such within the marking scheme), so that the candidate may exhibit knowledge of how to compare it with a critical value and draw conclusions. Such "fresh starts" are not affected by any earlier misreads.

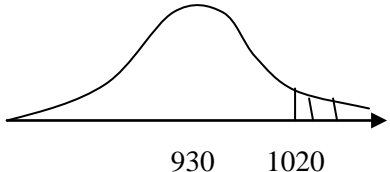
A misread may be of a symbol rather than a number – for example, an algebraic symbol in a mathematical expression. Such misreads are more likely to bring about a considerable change in the object and/or difficulty of the question; but, if they do not, they should be treated as far as possible in the same way as numerical misreads, *mutatis mutandis*. This also applied to misreads of text, which are fairly rare but can cause major problems in fair marking.

The situation regarding any particular cases that arise while you are marking for which you feel you need detailed guidance should be discussed with your Team Leader.

Note that a miscopy of the candidate's own working is not a misread but an accuracy error.





Question	Answer	Marks	Guidance
2 (i)	$P(\text{weight of luggage} > 250)$ $= P(Z > (250 - 280)/20) = P(Z > -1.5)$ $= P(Z < 1.5)$ $= 0.9332$	<b>M1</b> <b>M1</b> <b>A1</b>  <b>[3]</b>	Standardising Structure cao
2 (ii)	Total weight $\sim N(65+65+65+\dots+65,$ $225+225+\dots+225)$  $P(\text{Total weight} \leq 700) = P(Z \leq 1.054\dots)$ $= 0.854$	<b>B1</b> <b>M1*</b> <b>A1</b> <b>depM1*</b> <b>A1</b>  <b>[5]</b>	For mean of total = 650 For variance of sum Variance = 2250 Correct structure Correct to 3 decimal places
2 (iii)	$T$ is the sum of independent Normal variables the mean = $650 + 280 (=930)$ And the variance = $2250 + 400 (=2650)$	<b>B1</b> <b>B1</b> <b>[2]</b>	
2 (iv)	$P(T > 1020) = 0.0403$ (from tables)  	<b>B1</b>  <b>B1</b>  <b>B1</b>  <b>[3]</b>	For answers rounding to 0.040  For bell-shaped curve with mean indicated  For indicating area
3 (i)	Assume that the <b>underlying population</b> of oil pressures is <b>distributed symmetrically</b>  $H_0$ : population median = 200 $H_1$ : population median $> 200$  Actual differences -13 32 128 1 -2 34 87 -35 75 -51 58 -56	<b>B1</b>   <b>B1</b> <b>B1</b>   <b>B1</b>	Do not accept “not necessarily Normal”   If population not stated then B1B0

Question	Answer	Marks	Guidance
	Associated ranks <b>3</b> 4 12 1 <b>2</b> 5 11 <b>6</b> 10 7 9 <b>8</b> $T = 3 + 2 + 6 + 7 + 8 = 26$ $\therefore T = 26$ From $n = 12$ tables – at the 5% level of significance in a one-tailed Wilcoxon single sample test, the critical value of $T$ is 17 $26 > 17 \therefore$ the result is not significant The evidence does not suggest that the reservoir is suitable for development	<b>M1</b> <b>A1</b> <b>B1</b> <b>B1</b> <b>M1</b>  <b>A1</b> <b>M1</b> <b>A1</b>  <b>[12]</b>	FT their differences FT For $T^+ = 52$ or $T = 26$ FT their ranks For test statistic FT Use of $n = 12$  No further marks from here if incorrect  For not significant Non-assertive conclusion in context
3 (ii)	Normality of the underlying population Use a $t$ test Small sample & unknown population variance	<b>B1</b> <b>B1</b> <b>B1</b>  <b>[3]</b>	Condone $T$ test B1 for either of these
4 (i)	Sample standard deviation = 1.174 (3d.p.) Sample variance = 1.378 (3d.p.) mean $\approx$ variance supports the view that a Poisson model might be appropriate.	<b>B1</b> <b>B1</b> <b>E1</b>  <b>[3]</b>	cao cao Allow 1.38 FT suitable comment using their variance
4 (ii)	Using Poisson(1.36) $P(3) = e^{-1.36} \times 1.36^3 \div 3! \quad (= 0.107603\dots)$ $P(3) \times 50$ $= 5.380$ (3 d.p.) $50 - (12.833 + 17.453 + 11.868 + \mathbf{5.380})$ $= 2.466$	 <b>M1</b> <b>M1</b> <b>A1</b> <b>M1</b> <b>A1</b>	

Question	Answer	Marks	Guidance																		
		[5]																			
4 (iii)	<p>Assume that the sample was randomly selected</p> <p><math>H_0</math>: The Poisson model is suitable  <math>H_1</math>: The Poisson model is not suitable</p> <table border="1"> <tr> <td></td> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td><math>\geq 4</math></td> </tr> <tr> <td>Obs</td> <td>13</td> <td>18</td> <td>10</td> <td>6</td> <td>3</td> </tr> <tr> <td>Exp</td> <td>12.833</td> <td>17.453</td> <td>11.868</td> <td>5.380</td> <td>2.466</td> </tr> </table> <p>Merge last two columns Observed = 9, Expected = 7.846  Contributions 0.00217 0.01714 0.29402 0.16973  Attempt at sum of <math>(f_o - f_e)^2 \div f_e</math>  Test statistic = 0.4831</p> <p><math>4 - 1 - 1 = 2</math> degrees of freedom  Critical value = 5.991  <math>0.4831 &lt; 5.991</math> not significant  Evidence does not suggest that the Poisson model is not a good fit to these data.</p>		0	1	2	3	$\geq 4$	Obs	13	18	10	6	3	Exp	12.833	17.453	11.868	5.380	2.466	<p><b>B1</b></p> <p><b>B1</b></p> <p><b>M1</b></p> <p><b>A1</b></p> <p><b>B1</b></p> <p><b>B1</b></p> <p><b>M1</b></p> <p><b>A1</b></p> <p><b>[8]</b></p>	<p>Condone “good fit” for “suitable”</p> <p>cao</p> <p>Allow 0.483 and accept awrt 0.48www</p> <p>No further marks from here if wrong.</p> <p>For not significant  Allow equivalent, non-assertive statement.</p>
	0	1	2	3	$\geq 4$																
Obs	13	18	10	6	3																
Exp	12.833	17.453	11.868	5.380	2.466																
5 (i)	<p>Sample mean = 14.75  Estimate for population variance = 1.477</p>	<p><b>B1</b></p> <p><b>B1</b></p> <p><b>[2]</b></p>	<p>Allow 1.4773</p>																		
5 (ii)	<p>Small sample  Unknown population variance  Normality of underlying population  Random sample</p>	<p><b>B1</b></p> <p><b>B1</b></p> <p><b>B1</b></p> <p><b>B1</b></p> <p><b>[4]</b></p>																			

Question		Answer	Marks	Guidance
5	(iii)	<p>C.I. based on the <math>t</math> distribution</p> <p>11 degrees of freedom</p> $14.75 \pm 2.201 \times \frac{1.2154}{\sqrt{12}}$ <p>(13.978, 15.522) correct to 3 d.p.</p>	<p><b>B1</b></p> <p><b>M1</b></p> <p><b>B1</b></p> <p><b>M1</b></p> <p><b>A1A1</b></p> <p><b>[6]</b></p>	<p>SOI can be implied by use of 2.201</p> <p>M1 centred on 14.75 FT their mean</p> <p>B1 for 2.201</p> <p>M1 for structure using their <math>t</math> value</p> <p>Allow (13.98, 15.52) FT their mean</p>
5	(iv)	<p>As this interval contains 15</p> <p>There is not enough evidence to suggest that Keith is incorrect in his belief.</p>	<p><b>E1</b></p> <p><b>E1</b></p> <p><b>[2]</b></p>	<p>For suitable non-assertive statement.</p>

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