OCR
Oxford Cambridge and RSA

GCE

Statistics (MEI)

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

Advanced Subsidiary GCE

Mark Scheme for June 2014

1. These are the annotations, (including abbreviations), including those used in scoris, which are used when marking

Annotation	Meaning of annotation
BP	Blank Page – this annotation **must** be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.

Annotation in scoris	Meaning
✓and ✘	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	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

2. **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) 2.128888446667 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
1	**(i)**		Assume the underlying population (of reductions) is distributed symmetrically	B1	Do not accept "not necessarily Normal" Condone "the distribution is symmetrical"
			and that the sample is random.	B1	Condone "the data is random"
			H_0: population median = 15	B1	If population not stated then
			H_1: population median > 15	B1	SC1 for H_0: median = 15, H_1:median >15
			Actual differences		
			1 9 12 7 −4 −2 11 6 3 5	B1	
			Associated ranks	M1*	For ranking differences
			1 8 10 7 4 2 9 6 3 5	A1	
			$T = 4 + 2 = 6$	B1	$T^+ = 49$
			$\therefore T = 6$	B1	
			From $n = 10$ tables – at the 5% level of significance in a one-tailed Wilcoxon single sample test, the critical value of T is 10	M1	Use of $n = 10$ (may be implied by use of cv = 10)
				A1	No further A marks from here if incorrect
			$6 < 10 \therefore$ the result is significant	M1dep*	For sensible comparison leading to a conclusion
			The evidence supports the dietician's belief	A1	For non-assertive conclusion in context.
				[13]	
1	**(ii)**		Normality of underlying population (of reductions)	B1	
				[1]	
2	**(i)**		Sample mean = 2.4 ÷ 15 = 0.16	B1	
			$t = \dfrac{0.16 - 0}{0.374/\sqrt{15}} = 1.66$ (3.s.f.)	M1 A1	CAO
			14 degrees of freedom	B1	
			At 5% level, critical value of t is 2.145	B1	For ± 2.145. No further A marks from here if incorrect.
			$1.66 < 2.145$ so the result is	M1	
			not significant	A1	For not significant o.e.
			Insufficient evidence to suggest that the mean difference is not zero	A1	For non-assertive conclusion in context. Allow "not enough evidence to suggest the tests are not equally accurate"
				[8]	

	Question		Answer	Marks	Guidance
2	**(ii)**		$0.19 \pm 2.201 \times \dfrac{0.281}{\sqrt{12}}$	M1 B1 M1	Centred on 0.19 2.201 Structure using their "2.201"
			(0.0115, 0.369)	A1 A1	Allow (0.011, 0.369)
				[5]	
2	**(iii)**		Population variance unknown	B1	Or sample too small to justify use of Z
				[1]	
3	**(i)**		$241.2 \div 10 = 24.12$	B1	
				[1]	
3	**(ii)**		H_0: $\mu = 24$ & H_1: $\mu \neq 24$	B1 B1	For hypotheses in terms of μ. If other symbols are used, population must be stated
			Where μ represents the (population) mean <u>weight</u>	B1	For defining μ.
			$z = \dfrac{24.12 - 24}{0.3/\sqrt{10}} = 1.265$	M1 A1	If numerator reversed then M1A0B1M1A0A0 max
			At 5% level, critical value of z is 1.96	B1	For ± 1.96. No further A marks from here if incorrect
			$1.265 < 1.96$ so the result is	M1	For sensible comparison based on the Normal distribution.
			not significant.	A1	
			Insufficient evidence to suggest that the mean weight is not 24 grams.	A1	For non-assertive conclusion in context
				[9]	
3	**(iii)**		mean = 24.7 + 24.7 + 24.7 + 24.7 + 24.7 + 24.7	B1	B1 for mean = 148.2
			variance = $0.4^2 + 0.4^2 + 0.4^2 + 0.4^2 + 0.4^2 + 0.4^2$	B1	B1 for variance = 0.96
			ie Total, $T \sim N(148.2, 0.96)$ $P(T > 150) = P(Z > 1.837\ldots)$		
			$= 1 - \Phi(1.837\ldots) = 1 - 0.9669 = 0.0331$	M1	For structure of probability calculation using their mean and variance.
				A1	
				[4]	

Question			Answer	Marks	Guidance
4	(i)		$\sqrt{\dfrac{1784 - 200 \times 2.6^2}{199}} = 1.473$ Variance $= 1.473^2 = 2.169\ldots$	M1A1	For sample standard deviation.
			The mean is approximately equal to the variance so this does not discredit the use of a Poisson model.	E1 **[3]**	Allow suitable alternatives. FT their variance calculated from given data provided its value is stated.
4	(ii)		Using $X \sim$ Poisson(2.6) $P(X = 4) = e^{-2.6} \times 2.6^4 \div 4! = 0.14142\ldots$ $0.14142\ldots \times 200 = 28.284.. \ (= 28.28 \ \text{A.G.})$	M1* M1dep* A1 **[3]**	Attempt at Poisson calculation For $P(X = 4) \times 200$
4	(iii)		H_0: The Poisson model is suitable H_1: The Poisson model is not suitable	B1	No need to specify parameter
			Cells merged	B1	<table><tr><td></td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>≥ 6</td></tr><tr><td>Observed</td><td>7</td><td>47</td><td>49</td><td>46</td><td>25</td><td>19</td><td>7</td></tr><tr><td>Expected</td><td>14.86</td><td>38.62</td><td>50.21</td><td>43.52</td><td>28.28</td><td>14.71</td><td>9.8</td></tr></table>
				M1 A1	Attempt at $(f_o - f_e)^2 \div f_e$ Contributions (approx): 4.1574, 1.8183, 0.0292, 0.1413, 0.3804, 1.2511, 0.8 Allow A1 if one correct contribution seen.
			Test statistic $= 8.578$	A1	For correct total
			Degrees of freedom $= 7 - 1 - 1 = 5$	B1	
			Critical value $= 11.07$	B1	
			$8.578 < 11.07$	M1	FT their chi-squared CV and test statistic
			Result is not significant	A1	
			Insufficient evidence to suggest that the Poisson model is not a good fit to these data.	A1 **[10]**	

Question			Answer	Marks	Guidance
5	**(i)**		H$_0$: No association between age and brand loyalty H$_1$: There is an association between age and brand loyalty	B1	

Expected frequencies		Brand loyalty	
		Returning customer	First time customer
Age (in years)	Under 35	23.187	13.813
	35 to 50	45.747	**27.253**
	Over 50	**25.067**	14.933

M1 — Any suitable method. May be implied by a correct expected frequency.
A1 — Both correct. Allow 25.066 and 27.254.

Expected frequencies		Brand loyalty	
		Returning customer	First time customer
Age (in years)	Under 35	0.142	0.238
	35 to 50	1.312	**2.202**
	Over 50	**1.404**	2.357

M1
A1 — Allow 1.405 and 2.2015

$X^2 = 7.655$ — A1 — For TS rounding to 7.66

2 degrees of freedom — B1

Critical value for 5% significance level is 5.991 — B1 — No further A marks from here if incorrect.

As 7.655 > 5.991 the result is significant — M1 A1 — FT their TS

There is evidence to suggest an association between age and brand loyalty. — A1

[11]

Question			Answer	Marks	Guidance
5	**(ii)**		The low contributions (of 0.142 and 0.238) for the Under 35 age group shows that the observed frequencies were as expected if there was no association, whereas	B1	For coherent comment with reference to contribution(s) for the Under 35 age group (reference may be implicit).
			the larger contributions for the other two age groups indicate that there were fewer returning customers than expected in the 35 to 50 age group…	B1	For coherent comment with reference to contribution(s) for either of the other two age groups (reference may be implicit).
			…and more returning customers than expected in the Over 50 age group	B1	Allow sensible alternatives. E.g. reference linking level of association between age and brand loyalty to size of contribution for individual cells.
				[3]	