GCE

Further Mathematics B (MEI)

Unit **Y412/01**: Statistics A

Advanced Subsidiary GCE

Mark Scheme for June 2018

Annotations and abbreviations

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 a result or establishing a given result
dep*	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
AG	Answer given
awrt	Anything which rounds to
BC	By Calculator
DR	This indicates that the instruction **In this question you must show detailed reasoning** appears in the question.

Subject-specific Marking Instructions for A Level Mathematics B (MEI)

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, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
If you are in any doubt whatsoever 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, e.g. 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, e.g. 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, what is acceptable will be detailed in the mark scheme. If this is not the case please, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
      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   As noted in the specification, answers should be given exactly when possible. Otherwise answers should be given to a degree of accuracy appropriate to the context. When a value is given in the paper only accept an answer correct to at least as many significant figures as the given value. This rule should be applied to each case. Over-specification is penalised no more than once on each question and no more than three times in total.

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   For a genuine misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A mark in the question. Marks designated as cao may be awarded as long as there are no other errors. E marks are lost unless, by chance, the given results are established by equivalent working. 'Fresh starts' will not affect an earlier decision about a misread. Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

i   If a graphical calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers (provided, of course, that there is nothing in the wording of the question specifying that analytical methods are required). Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.

Question			Answer	Marks	AOs		Guidance
1	**(i)**		Poisson(6.1)	**B1** [1]	3.3	Do not insist on the parameter shown	Accept Po(6.1) Do not accept Po
	(ii)		6.1	**B1** [1]	1.1		
	(iii)		$P(\geq 6) = 0.570$ (0.57024...)	**B1** [1]	1.1		Accept 0.57 Accept 0.5702
	(iv)		New mean = 36.6 $P(\geq 36) = 0.562$ (0.56157...)	**M1** **A1** [2]	1.1a 1.1	For mean	36.6 or 6.1×6 seen Accept 0.56, 0.5616
	(v)		New mean = 9.5 $P(\leq 9) = 0.5218...$ $P(\leq 15) = 0.9665...$ $P(10 \leq X \leq 15) = 0.445$ (0.44470...)	**M1** **A1** [2]	1.1a 1.1	For mean **and** one correct probability	Accept 0.44 www Accept 0.4447
2	**(i)**		Because if 4 are matched correctly then the fifth must also be matched correctly	**B1** [1]	2.2a		Do not allow 1 - ∑others
	(ii)		$\frac{1}{5} \times \frac{1}{4} \times \frac{1}{3} \times \frac{1}{2}\left(\times \frac{1}{1}\right)$ $\left(= \frac{1}{120}\right)$ AG	**M1** **E1** [2]	1.1a 2.4	Or: there are 5! = 120 possible arrangements of which only one is correct.	Do not allow 1 - ∑others Accept 1/5!
	(iii)			**B1** **B1** [2]	1.1 1.1	For **line** graph with axes labelled. Correct linear scale used for probabilities **and** visibly correct heights of lines/points	B0 if tops of lines/points joined.
	(iv)		$E(X) = 1$ $Var(X) = 1$	**B1** **B1** [2]	1.1a 1.1		
	(v)		$\frac{31}{120}$ oe	**B1** [1]	1.1		Accept 0.258 or better

Question			Answer	Marks	AOs		Guidance
	(vi)		$1 - \left(\dfrac{119}{120}\right)^{12}$ $= 0.0955 \quad (0.095541\ldots)$	M1 A1 [2]	1.1a 1.1		Accept 0.096, 0.09554
3	(i)		Because the scatter diagram does not suggest a bivariate Normal distribution since it is does not appear to be roughly elliptical (seems to possibly have two 'islands')	E1 E1 [2]	3.5a 3.5b	For not from bivariate Normal dist^n For not elliptical	Do not accept 'data is not bivariate Normal' Do not accept 'Normal bivariate'
	(ii)		Rank x: 1 2 3 4 5 6 7 8 9 10 / Rank y: 9 8 10 5 6 7 2 1 4 3 $r_s = -0.818 \quad (= -9/11)$	M1 A1 A1 [3]	1.1a 1.1 1.1	For using ranks For correct ranks for y	Accept **both** reversed Accept -0.82, -0.8182 or better
	(iii)		H_0: There is no association between level of dissolved oxygen and amount of radium. H_1: There is association between level of dissolved oxygen and amount of radium.	B1 B1	3.3 1.2	B1 for H_0 B1 for H_1 and population soi Hypotheses must be in context (allow hypotheses in terms of x & y) NB H_0 H_1 NOT ito ρ	Hypotheses as shown in answer column should be understood to imply population
			For $n = 10$, 1% critical value = 0.7939	B1	1.1		No further marks from here if wrong cv used.
			$0.818 > 0.7939$ so significant/Reject H_0.	M1	1.1	M1 for sensible comparison with 0.7939, leading to a conclusion, provided $|r_s| < 1$	
			The evidence suggests that there is some association between level of dissolved oxygen and amount of radium.	A1 [5]	2.2b	For non-assertive correct conclusion in context and in terms of H_1. FT their r_s	See additional notes.
	(iv)		The significance level is the probability of rejecting the null hypothesis when in fact it is true.	E1	2.4		
			e.g. If there is no association between x and y only about 1 sample in 100 would lead to the conclusion that there is an association between x and y.	E1 [2]	1.2	For relating this to the context.	

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Question			Answer	Marks	AOs		Guidance
4	(i)		$0.88^5 \times 0.12$ $= 0.0633$	M1 A1 **[2]**	3.3 1.1	For $(1-p)^5 \times p$ with their p cao	 Accept 0.06333 Accept 0.063 www
	(ii)		$(0.88^6 = 0.46440…. =)\ 0.464$ to 3sf	B1 **[1]**	1.1		Accept 0.4644 Accept 0.46 www
	(iii)	A	$(^1/_{0.12} =)\ 8.33$ to 3 sf	B1 **[1]**	1.1	For 25/3 oe	Accept 8.3www Accept 8.333 or better
		B	$\frac{1-0.12}{0.12^2} = 61.1$	B1 **[1]**	1.1	For 61.1 or better	
	(iv)		B(10, 0.12) stated or $1 - 0.658…$ seen 0.342 (0.34172...)	M1 A1 **[2]**	3.3 1.1		 Accept 0.34 www Accept 0.3417
	(v)		$9 \times 0.88^8 \times 0.12^2$ $= 0.0466$ (0.046608…)	M1 A1 **[2]**	1.1a 1.1	$9 \times (1-p)^8 \times p^2$ with their p	 Accept 0.047 www Accept 0.04661
5	(i)	A	Sample size = 104	B1 **[1]**	2.2a		
		B	H_0: No association between smoking status and type of worker. H_1: Some association between smoking status and type of worker.	B1 **[1]**	1.2	Hypotheses in context – may be written in terms of independence	
	(ii)		$C11 = \frac{31}{104} \times 54 = 16.10$ $C15 = \frac{(15-16.10)^2}{16.10} = 0.0746$ $B16 = \frac{(13-10.4712)^2}{10.4712} = 0.6107$	M1 A1 M1 A1 **[4]**	1.1a 1.1 1.1a 1.1	(NB This can be calculated by subtraction) M1 for $\frac{(O-E)^2}{E}$ applied at least once. A1 for both correct.	Accept awrt 16.1 www For C15 accept answers between 0.0746 and 0.0752 For B16 accept awrt 0.611

Question			Answer	Marks	AOs		Guidance
	(iii)		Degrees of freedom = 4 seen	B1	3.3		
			Critical value = 7.779	B1	1.1	No further marks from here if wrong.	
			Test statistic = 9.66				
			9.66 > 7.779 significant/reject H_0	M1	2.2b	M1 for sensible comparison with 7.779, leading to a conclusion	
			The evidence suggests that there is some association between smoking status and type of worker.	A1	3.5a	For non-assertive correct conclusion in terms of H_1.	See additional notes.
				[4]			
	(iv)		For 'Managerial' (large) contributions (of 2.1358 and 4.8017) show that fewer than expected are smokers and more are ex-smokers (and numbers of never smoked are as expected).	E1	3.5a	For correct comments relating to both of the large contributions.	Must compare observed and expected frequencies. No marks for general comments or for statements about likelihood.
			For 'Production line' (small) contributions show the numbers are as expected.	E1	3.5a		Max 1/3 if no mention of contributions.
			For 'Administrative' the (large) contribution (of 1.4964) suggests that fewer than expected are ex-smokers. (The numbers of smokers and never smoked are as expected).	E1	3.5a	For correct comment relating to the large contribution.	No ISW for additional incorrect comments
				[3]			
6	(i)	A	$x = 45$, $y = 15.5357$	B1	1.1		Accept 15.5 or better
			$x = 60$, $y = 19.0157$	B1	1.1		Accept 19 or better
				[2]			
		B	$x = 45$ involves interpolation (and points are fairly close to line) so probably a reasonably good estimate	E1	3.5a		
			$x = 60$ involves extrapolation so probably not a good estimate	E1	3.5b		
				[2]			
	(ii)		To estimate the mean value of x from a value of y, you would need to calculate the equation of the regression line of x on y,	E1	3.5b	For indication that the use of the regression line of x on y is required.	
			then substitute $y = 16$ into this equation.	E1	3.5c		
				[2]			
	(iii)		PMCC = $\sqrt{0.5748}$ = 0.758	B1	1.1		Accept 0.76, 0.7582
				[1]			

Question			Answer	Marks	AOs		Guidance
	(iv)		Because $r^2 = 0.5748$ the fit is (moderately) good	**E1**	**2.2a**	Referring to 0.5748, or r^2 is quite large, as supporting good fit	
			and because the points lie (fairly) close to a straight line.	**E1** **[2]**	**2.4**	For reference to points being close to a line as supporting a good fit.	

Additional notes RE:Non-assertive conclusions relating to H_1 in hypothesis tests
There is insufficient evidence to **believe/suggest/indicate** that there is an association between…
There is insufficient evidence to **believe/suggest/indicate** that… …are not independent.
There is sufficient evidence to **believe/suggest/indicate** that there is an association between…
There is sufficient evidence to **believe/suggest/indicate** that… …are not independent.

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