Level 3 Certificate

Mathematics

H869/02: Core Maths B (MEI): Statistical problem solving

OCR Level 3 Certificate Core Maths B (MEI)

Mark Scheme for June 2022

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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.

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MARKING INSTRUCTIONS

PREPARATION FOR MARKING
RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **number of required** standardisation responses.

   YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or the RM Assessor messaging system, or by email.

5. **Crossed Out Responses**
   Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

Rubric Error Responses – Optional Questions
Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

Multiple Choice Question Responses
When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).
When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses
When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**)
Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth **two or more marks**)
If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response)
Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6.   Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, then add a tick to confirm that the work has been seen.

7.   Award No Response (NR) if:
   - there is nothing written in the answer space

   Award Zero '0' if:
   - anything is written in the answer space and is not worthy of credit (this includes text and symbols).

   Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

8.   The RM Assessor **comments box** is used by your team leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
   If you have any questions or comments for your team leader, use the phone, the RM Assessor messaging system, or e-mail.

9.   *Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.*

10. For answers marked by levels of response: Not applicable in F501
   a. **To determine the level** – start at the highest level and work down until you reach the level that matches the answer
   b. **To determine the mark within the level**, consider the following

Descriptor	Award mark
On the borderline of this level and the one below	At bottom of level
Just enough achievement on balance for this level	Above bottom and either below middle or at middle of level (depending on number of marks available)
Meets the criteria but with some slight inconsistency	Above middle and either below top of level or at middle of level (depending on number of marks available)
Consistently meets the criteria for this level	At top of level

11. **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
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

12. **Subject-specific Marking Instructions**

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, with 3 significant figures often being the norm. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. 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   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.

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

I   Anything in the mark scheme which is in square brackets […] is not required for the mark to be earned, but if present it must be correct.

Question		Answer	Marks	Guidance
1	(a)	Opportunity	B1	
			[1]	
	(b)	<table><tr><td>Score</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Frequency</td><td>21</td><td>1</td><td>2</td><td>11</td><td>12</td></tr></table>	B1	All correct
			[1]	
	(c)	The total of the frequencies in Fig. 1.3 is 47 and should be 48.	B1	Or The sum of the frequencies for D is 11 not 12
			[1]	
	(d)	Bimodal	B1	
			[1]	

1	(e)(i)	$21 + 2 + 6 + 44 + 60 \ (= 133)$	**M1**	Sum of Scores $\times$ Frequencies
		$(133) \div 47$	**M1**	Dividing by 47 or 48
		2.83	**A1**	Cao For all three marks use $A \Rightarrow M$
			[3]	
		Special case for Misread	**MR**	
		A $\dfrac{36}{12}=3.00$ B $\dfrac{33}{12}=2.75$ C $\dfrac{37}{12}=3.08$ D $\dfrac{27}{11}=2.45$	**SC M1** **SC A1**	Finding at least two numerically correct answers All four answers numerically correct
	(ii)	It is not representative of any of the responses	**B1**	Or other sensible answer. Eg The mean is between the two lowest scores.
			[1]	

2	(a)	(i)	Mean is $40 \times 30.5 \div 100 = 12.2$ m (3 sf)	**B1**	Units must be shown
			Standard deviation $= 8 \times 30.5 \div 100 = 2.44$ m	**B1**	Accept 2.4
		(ii)	The figures of 40 ft and 8 ft have almost certainly been rounded	**B1**	Trees are hard to measure accurately It is a sample of trees
				[3]	
	(b)			**B1** **B1**	Position of 12 Intervals of 2
				[2]	

2	(c)	The trees are either 10 m to 12 m or over 12 m. (Over 12 m are 50%)	M1	A reasonable division of "over 10m" into strips. Condone cut off at 3 sd.
		10 m is 1 sd less than the mean	M1	Correct use of sd in finding the area of at least one strip
		so 10m to 12 m are ½ × 68% = 34%		Allow 33.3% from use of ⅔ for 68%.
		Total is 50% + 34 % = 84%	A1	Allow 84.13% (tables) or 83.3% (use of ⅔ for 68%) else cao. A ⟹ M
			[3]	
	(d)	Reading from the frequency chart,		
		3 + 23 + 21 + 14 + 16 + 11 + 9 + 12 + 7 + 5 + 1 = 122		
		50% of 254 =127	M1	Complete method attempted
		127 - 122 = 5 died	A1	Cao
			[2]	
	(e)	It is like the right hand half of a Normal distribution	B1	Any sensible comment.
				Eg The distribution has a positive skew
			[1]	

3	(a)	H_0: There is no association between the steps taken and hours of sleep	B1	Condone "correlation" or "relationship" for "association"
		H_1: There is a positive association	B1	"Positive" must be seen. Must match H_o
			[2]	

3 (b)

Day	Steps	Steps rank x	Sleep	Sleep rank Y	$d = x - y$	d^2		
Mon	6459	7	6.4	6	1	1	B1	Monday row correct
Tue	6871	6	6.8	5	1	1		
Wed	7762	4	7.4	3	1	1		
Thu	6967	5	5.9	7	-2	4		
Fri	12678	1	7.7	2	-1	1		
Sat	12511	2	8.1	1	1	1		
Sun	12413	3	7.3	4	-1	1		
				$\sum$	(0)	10	B1	All correct but condone Σd not given

Fig. 3.3

$r_s = 1 - \dfrac{6\sum d^2}{n\left(n^2-1\right)} = 1 - \dfrac{6\times10}{7\times\left(49-1\right)}$	M1	Quoting the formula is not enough. Sensible attempt at substitution is required
$r_s = 0.8214...$	A1	cao, at least 2 dp
	[4]	

3	(c)	Critical value is 0.7143	B1	The equivalent critical value for the pmcc is 0.6694. If this is used instead of 0.7143, give B0 but then allow FT for the next mark
		$0.8214... > 0.7143$	M1	Comparison of r_s and the critical value. FT their value of r_s and for a critical value of 0.6694
		The alternative hypothesis is accepted	A1	Cao. Only award this mark for a fully correct answer but condone the absence of the word "positive" if H_1 is stated as part of the answer.
			[3]	
3	(d)	eg You cannot prove anything with statistics	B1	Any sensible statistical criticisms. They must be different. eg The same data were used in the test as those that set up the theory. Spearman's test is for association not correlation. The sample size is small. The sample is not random
		eg Correlation does not imply causation	B1	
			[2]	

4	**(a)**	**Population** 93920 **Birth rate (per 1000)** 13.7 **Growth rate (%)** 0.77%		**B1**	All three correct
				[1]	
	(b)(i)	**Babies** $\dfrac{13.7 \times 93920}{1000}$ = 1286.7 ... (so about 1290)		**B1**	FT from part (a). Accept any reasonable accuracy
				[1]	
	(b)(ii)	**Population** $\dfrac{0.77}{100} \times 93920$ = 723.18... (so about 720)		**M1** **A1**	 Accept any reasonable accuracy
				[2]	
	(c)	**Deaths** $\dfrac{7.1 \times 93920}{1000} = 666.8...$ **Increase in population** = Births + Immigrants - Deaths **Immigrants** = 723.2 + 666.8 -1286.7 = 103.3 so about 100 per year		**B1** **M1** **A1**	 Award all 3 marks if 103 seen.
				[3]	

5	(a)(i)	France 41.4, Japan 47.3, United States 38.1, Zambia 16.8	**B1**	At least three correct
	(a)(ii)	Zambia, United States, France, Japan	**B1**	FT for correct order
			[2]	
	(b)	Median is about typical people in the present population, life expectancy is about how far into the future they can expect to live.	**B1**	Any sensible comment
			[1]	
	(c)	=AVERAGE(F2:F57)	**B1**	
			[1]	
	(d)	Mean - 2 × sd = 21.2 - 2 × 5.3 = 10.6, Mean + 2 × sd = 21.2 + 2 × 5.3 = 31.8	**B1**	
		(No countries are below 10.6.)		
		Above 31.8 are: Mauritius: St Helena group and Seychelles.	**B1**	
			[2]	
		Special Cases for mean ±1 sd and for mean ±3 sd		Both limits and countries must be shown
		Mean ± 1 sd gives 5.3 and 26.5	**SC**	
		3 from Angola, Mali, Niger, Uganda. Algeria, Libya, Morocco, Tunisia, South Africa, Mauritius: St Helena group and Seychelles.	**B1**	If more than 3 countries are given take the first 3 and then apply ISW to the rest.
		Mean ± 3 sd gives 5.3 and 37.1	**SC**	
		Only the group of Saint Helena, Ascension and Tristan da Cunha	**B1**	May be given as one country or three

(e)	For	The remaining countries have similar population types	**B1**	Any reasonable statistical statement
	Against	Other continents need to be treated similarly to allow fair comparisons	**B1**	Any reasonable statistical statement
			[2]	
(f)	A large number of school places need to be provided		**B1**	Any sensible answer
			[1]	

6	(a)	Statement C	B1	
			[1]	
	(b)	Expected frequency $= \dfrac{36 \times 26}{227}$	M1	Reasonable attempt
		$= 4.12$	A1	Cao with at least 2dp Accept 4.1233
		$4.12 < 5$	B1	FT for answers < 5
			[3]	

(c)

	Observed frequency, f_o			Expected frequency, f_e				
	Slow	**Fast**	**Total**	**Slow**	**Fast**	**Total**		
Africa	10	46	**56**	37.004 ...	18.996 ...	56		
America	22	4	**26**	17.180 ...	8.819 ...	26	B1	2 correct non-Total entries
Asia	32	18	**50**	33.039...	16.960 ...	50		Accept rounded answers: 17.181. 8.819, 33.040, 7.802, 16.282
Caribbean	19	4	**23**	15.198 ...	7.801 ...	23		
Europe	47	1	**48**	31.718 ...	16.281 ...	48		Accept these answers rounded to 1 or 2 decimal places.
Oceania	20	4	**24**	15.859 ...	8.141	24		
Total	**150**	**77**	**227**	**150**	**77**	**227**	B1	All correct

			[2]	

6	(d)(i)	$\sum\dfrac{(f_o-f_e)^2}{f_e} =$ 19.71 + 38.39 + 1.35 + 2.63 + 0.03 + 0.06 + 0.95 + 1.85 + 7.36 + 14.34 + 1.08 + 2.11 (= 89.86) = 89.9 (1 dp)	**B1** **B1**	One correct entry in the bottom row (ie from Oceania). Condone rounding errors (eg 1.09, 2.12 and 2.10) 89.9 Working with 5 decimal places gives 89.87598. Candidates' answers will vary slightly according to when they applied the rounding. Accept 89.8 or 89.9.
			[2]	
	d(ii)	The smallest contribution is from Asia Slow	**B1**	Allow 0.03
			[1]	

6	(e)	Degrees of freedom = $(6 - 1) \times (2 - 1)$	**M1**	Attempt to find degrees of freedom
		$= 5$	**A1**	Cao
		Critical value = 15.09	**B1**	A $\Rightarrow$ M if 15.09 given
		$89.9 > 15.09$	**M1**	Comparison of X^2 and their Critical value
		H_0 is rejected. The evidence suggests that growth rate is not independent of the region.	**A1**	No FT. This mark should only be given if part (e) is fully correct.
			[5]	

Reference		Assessment Objective			Question
Qu	Part	AO1	AO2	AO3	Total
1.	(a)			1	1
	(b)		1		1
	(c)			1	1
	(d)		1		1
	(e)	2		2	4
2.	(a)	2		1	3
	(b)		2		2
	(c)	1	2		3
	(d)		2		2
	(e)			1	1
3.	(a)	2			2
	(b)	3	1		4
	(c)	1	1	1	3
	(d)			2	2
4.	(a)	1			1
	(b)		3		3
	(c)			3	3
5	(a)	1	1		2
	(b)			1	1
	(c)			1	1
	(d)		2		2
	(e)			2	2
	(f)			1	1
6	(a)			1	1
	(b)		3		3
	(c)	2			2
	(d)		2	1	3
	(e)	1	3	1	5

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