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 2024

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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.

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.

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. **Annotations and abbreviations**

Annotation	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
awrt	Anything which rounds to

6. **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	AO
1	**(a)**		The children in the school will be safer OR Accidents caused by speed will be reduced	**B1**	Accept any valid reason eg There will be fewer accidents eg It will stop/reduce speeding	**AO3**
				[1]		
	(b)	**(i)**	Self-selected	**B1**		**AO2**
		(ii)	Most people/residents (respondents) use Oak Road on school days	**B1**	Allow every day/often/regularly eg Most people/drivers are heading to/past the school regularly Not something that cannot be justified from the 8 responses eg "the road is very busy" or "most residents use the road"	**AO2**
		(iii)	Two clear points: People with children are in favour of the speed bumps People without children are against the speed bumps	**B1** **B1**	 If B0B0 then allow **SCB1B0** for connection between speed bumps and children, eg views on speed bumps are linked to whether or not people have children at the school	**AO3** **AO3**
				[4]		

Question			Answer	Marks	Guidance	AO
1	**(c)**	**(i)**	Question 4	**B1***		**AO2**
			There were fewer responses (112) than for the others (133 each)	**depB1**	Allow without sight of 112 and 133	**AO1**
		(ii)	Some adults don't like to tell people their ages OR Respondents might have thought the question was not relevant or appropriate to speed bumps	**B1**	Accept eg "too personal/sensitive" or "might take offence"	**AO3**
		(iii)	It does not show the association/correlation/relationship between the answers at an individual level eg Does not show the links/patterns in people's answers eg Would be better if categorised into groups with/without children at school	**B1**	Their answer must be explanatory/interpretive Accept reference to bias, but only if part of a clear explanation eg "does not show whether people were biased/influenced because they had children at school (or not)"	**AO3**
				[4]		

Question		Answer	Marks	Guidance	AO
2	(a)	33 minutes 57 seconds	B1		AO1
			[1]		
	(b)	B1:B8	B1		AO2
			[1]		

Question		Answer	Marks	Guidance	AO
2	**(c)**	Criticism 1: A relevant criticism of any part of the statement	**B1**	Allow sensible answers in context for each	**AO3**
		Criticism 2: A d**ifferent** relevant criticism of any part of the statement	**B1**	<u>Note:</u> Second criticism must be fundamentally different from the first	**AO3**
		<u>Examples:</u>		<u>Good responses are likely to refer to:</u>	
		The group of 8 people/dataset is too small (to make predictions)		- Size of group - Group not representative - Normal Distribution - External factors	
		The 8 people may not be representative (of other participants)		Any valid explanation/implication that the wide range of participants, compared to the group of 8, will affect Parkrun results is B1	
		A bigger group of runners won't necessarily have the same characteristics (24 mins/6mins)			
		Fitness levels / demographic may affect Parkrun results			
		Mean of 24 is fast and unlikely to be the average Parkrun time		Only allow "the sample is too small" if there is a clear link to the context	
				<u>Not:</u>	
		There's no evidence that Parkrun results will follow a Normal distribution		A wrong statement or one that can't be justified from the information	
		The times are not symmetrical, or bell shaped		"Statistics can't prove anything" (unless in context)	
		You can't predict Parkrun mean / standard deviation with any certainty		"A lot of people is too vague" unless this is explained further	
				"There is a large range of times in this group" unless this is explained further	
		Times may depend upon weather conditions			
			[2]		

Question			Answer	Marks	Guidance	AO
2	**(d)**	**(i)**	Standard areas: 18 is ($\pm$) 2 sd $\rightarrow$ area in each tail $\rightarrow$ **2.5%** oe Z score: $z = (\pm)\frac{18-30}{6} = (\pm)2$ $\rightarrow$ **2.5**% oe Calculator or tables: $P(X \leq 18)$ $\rightarrow$ **0.0227** or **1 − 0.9972** oe	**M1**	**Must get to** 2.5% or 0.0227 or 0.0228 oe Allow awrt 2.3%	**AO2**
			2.5% of 400 = 10 So 10 people under 18 mins OR 0.0227 × 400 = 9(.307) So 9 people under 18 mins	**A1**	Accept 9 or 10 Final answer must be an integer	**AO2**
	(d)	**(ii)**	Standard areas: 36 is ($\pm$) 1 sd $\rightarrow$ area in each tail $\rightarrow$ **is 16%** oe Z score: $z = (\pm)\frac{36-30}{6} = (\pm)1$ $\rightarrow$ **16**% oe Calculator or tables: $P(X \geq 36)$ $\rightarrow$ **0.1587 or 1 − 0.8413** oe	**M1**	**Must get to** 16% or 0.1587 oe Allow awrt 15.9%	**AO2**
			16% of 400 = 64 So 64 people take 36 mins or more OR 0.1587 × 400 = 63(.48) So 63 people take 36 mins or more	**A1**	Accept 63 or 64 Final answer must be an integer	**AO2**
				[4]		

Question		Answer	Marks	Guidance	AO
2	(e)	Any relevant feature that shows the distribution of the 400 times is not normal: eg The histogram is (positively/right) skewed eg Not symmetrical	B1*	Oe eg Mean or median not in the centre eg The histogram is not bell shaped B0 the histogram is negatively/left skewed	AO3
		A clear explanation of <u>their feature</u> which <u>relates to Parkrun</u> participants: eg Some participants are very slow eg Wide range of fitness levels at Parkrun eg Lots of runners are faster than the middle times	depB1	Their explanation should be clear enough to follow, but may lack some detail/accuracy <u>Note:</u> there are **not** more above/below 30 in the diagram, so arguments based only on this are B0 B0 if their reason is too vague or doesn't make sense	AO3
			[2]		

Question		Answer	Marks	Guidance	AO
3	(a)	Option **A**	**B1**		**AO2**
			[1]		
	(b)		**B1** **B1**	3 correct entries Fully correct	**AO1** **AO1**
		[2]			

(b) table:

Expected frequency, f_e	Sleep loss			
Treatment	None	Mild	Severe	Total
None	10.5	10.5	9.0	30
Standard	**14**	**14**	**12**	**40**
New	17.5	17.5	15.0	50
Total	42	42	36	**120**

Question		Answer	Marks	Guidance	AO
3	**(c)**	X^2　　$=$　　0.214... 　+　　2.880.. 　+　　1.777... 　　　$+$　　5.785... 　+　　0.642.. 　+　　12.000... 　　　$+$　　6.300... 　+　　**0.357...** 　+　　4.266... 　　　　　$=$　　**34.2 CAO 1dp**	**B1** **B1**	awrt 0.357	AO1 AO1
			[2]		
	(d)	Degrees of freedom:　　　　$v = (3 - 1) \times (3 - 1)$	**M1***	Attempt to find v using $(r - 1)(c - 1)$ with r and c as 3 or 4	AO2
		$v = 4$	**A1**	4 seen implies correct method $\begin{array}{c} \underline{5} \\ 3.841 \\ 5.991 \\ 7.815 \\ \fbox{9.488} \\ 11.07 \\ 12.59 \\ 14.07 \\ 15.51 \\ \underline{16.92} \end{array}$	AO1
		$34.2 > 9.488$	**DM1**	Correctly compare *their* χ^2 with the 2-tail $\chi^2_{v,5\%}$ critical value that matches their stated DOF	AO1
		The test is significant OR Reject H$_0$　　OR Accept H_1 OR The proportions of people with sleep loss are dependent upon the treatment	**A1**	Correct conclusion following **fully** correct work Allow: there is an association between sleep loss and treatment. Do not accept correlation.	AO2
			[4]		

Question		Answer	Marks	Guidance	AO
3	**(e)**	No, there is not enough evidence to refuse a license, because .. .. OR Yes, there is enough evidence to refuse a license, because .. .. <u>NO:</u> eg .. the new treatment has the best 'no sleep loss' figures .. the new treatment has fewer people with severe sleep loss than the standard treatment <u>The following examples could be used for YES or NO:</u> eg .. the sample size (120) **is too small for a drug trial** .. sleep loss is subjective, and the effects of disease may outweigh sleep loss .. because the test is not about whether the new treatment is better or worse .. the chi-squared test shows that sleep loss **depends on** no/standard/new treatment and further research is needed	**M1** **A1**	Yes or no, with a relevant attempt at justification Any reasonable justification in context, which may be some correct, relevant numerical analysis eg the sample size is too small M1A0 Yes, followed by contradictory justification M1A0 No, followed by contradictory justification M1A0 M0 The bed was uncomfortable M0 The temperature may have affected them A correct justification Allow .. because drugs trials should have a more stringent significance level	**AO2** **AO3**
			[2]		

Question		Answer	Marks	Guidance	AO
4	**(a)**	Population: **11 147 407** Growth rate: **-0.29 (%)** or -0.0029	**M1**	Allow 0.29% Both numbers can be implied from calculations or correct answer Note: 99.71% or 0.9971 is ok for M1 and this also implies decrease	**AO1**
		Decrease: $\frac{0.29}{100} \times 11\ 147\ 407$ $\rightarrow 32\ 327(.48\ldots)$ oe	**A1**	awrt 32 000, but no need to round off Decrease must be justified by sight of negative sign or 'decrease' 'reduction' 'lower' etc **at least once, anywhere in the answer** for A1	**AO2**
			[2]		

Question		Answer	Marks	Guidance	AO
	(b)	(see table below)	**B1**	For answer in range 260 052 to 260 053	**AO2**
			B1	For answer in range 2 905 963 to 2 905 964	**AO1**
			[2]		

Country	Population p	Growth rate $r\ \%$	$\dfrac{p \times r}{100}$
Bermuda	70 864	0.45	319
Canada	35 623 680	**0.73**	**260 053**
Greenland	57 713	-0.03	-17
St Pierre and Miquelon	5533	-1.08	-60
United States	326 625 791	0.81	2 645 669
Total	362 383 581	0.88	**2 905 964**

Question		Answer	Marks	Guidance	AO
4	**(c)**	Simon's method: $0.88 \div 5 = 0.176$ $\frac{362\,383\,581 \times 0.176}{100} = 637\,795$ $\rightarrow$ gives 638 thousand or 638 000	**B1**	Answers must be rounded to nearest 1000	**AO2**
		Tara's method: 2 905 964 $\rightarrow$ gives 2906 thousand or 2 906 000	**B1**	Allow **B1FT** for their answer from table in 4b rounded correctly to nearest 1000	**AO2**
			[2]		
	(d)	**Tara's method is better,** because .. .. eg it is based on the actual numbers of people and the growth rate in each country eg Simon's method gives all countries equal weighting which is not appropriate eg Simon's method uses averages inappropriately/incorrectly	**E1**	This mark is for the reasoning. Any sensible statement. <u>Not:</u> Tara, because it's simpler or quicker or easier	**AO3**
			[1]		
	(e)	The estimated increase is 77 million or 77 000 000 **CAO**	**B1**		**AO2**
			[1]		
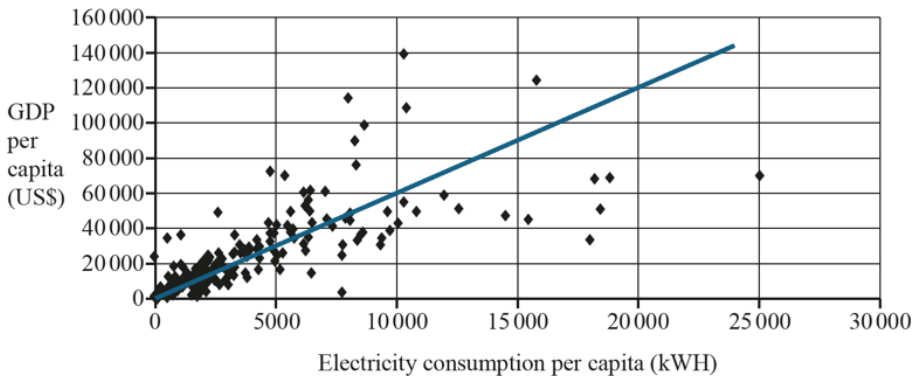
Question		Answer	Marks	Guidance	AO
5	**(a)**	Namibia: Population 2 484 780 Land area 824 292 (km^2)	**B1**	Both answers required. Allow without units	**AO1**

Question		Answer	Marks	Guidance	AO
			[1]		
	(b)	3.01 **CAO 2dp**	**B1**		**AO1**
		Number of people per **square** kilometre (in Namibia)	**B1**	OR population per km^2 OR population density	**AO3**
			[2]		
	(c)	The population of Africa	**B1**	OR Population of N and S Africa	**AO2**
			[1]		
	(d)	40.32	**B1**	Awrt to 40.3	**AO1**
		The number of people per **square** kilometre of Africa	**B1**	OR population per km^2 of Africa OR population density of Africa OR population density of North and South Africa	**AO3**
			[2]		
	(e)	The (large) desert causes the Namibian population density to be lower eg Not many people can live in a desert eg There's a large area of land that's uninhabitable	**B1**	A correct reason <u>Not</u> The pop density of Namibia is **wrong** because of the desert area	**AO2**
			[1]		

Question		Answer	Marks	Guidance	AO
5	(f)	If it was included, the calculation for P180 would require **division** by zero which the spreadsheet cannot do eg Cannot **divide** by zero eg You cannot work out **1000 ÷ 0**	B1	B0: 1000/0 = 0 B0: C180/D180 = 0	AO3
			[1]		
	(g)	**6 CAO**	B1		AO2
			[1]		

Question		Answer	Marks	Guidance	AO
6	**(a)**	Attempt at consumption for Algeria divided by population of Algeria $$\frac{53\,440 \times 1\,000\,000}{40\,969\,443} \quad \text{or} \quad \frac{53\,440}{40\,969\,443}$$	**M1**		**AO2**
		$= 1304.38(678..) = \mathbf{1304}$ **AG**	**A1**	Must show 1304.4 or better before the given answer If using $53440 \div 40969443$ then must see $\times 1000000$ or '$\times$ million' to show 1304.4 or better before the given answer	**AO1**
			[2]		
	(b)	(H_1:) There is a **positive** association (between electricity consumption and GDP per capita)	**B1**	OR positive correlation	**AO2**
			[1]		

Question		Answer	Marks	Guidance	AO
6	(c)	(table below)			

Country	Electricity per capita (kWH pa)	Electricity rank, x	GDP per capita (US$)	GDP rank, y	$d = x - y$	d^2
Malawi	103	8	1200	8	0	0
Canada	14502	1	48100	2	-1	1
Chile	3820	3	24600	4	-1	1
India	818	7	7200	7	0	0
Dominica	1183	5	12000	5	0	0
Poland	3672	4	29300	3	**1**	**1**
Sweden	12 590	2	51300	1	**1**	**1**
Fiji	899	6	9900	6	**0**	**0**
				Total		**4**

Question		Answer	Marks	Guidance	AO
			B1	Table correct	AO2
		$$r_s = 1 - \frac{6\sum d^2}{n(n^2 - 1)} \qquad = 1 - \frac{6 \times 4}{8(8^2 - 1)}$$	**M1**	Attempt to use correct formula, implied by $r_s = 0.95$. Allow one slip in use of formula	AO2
		$$r_s = 0.95(238..)$$	**A1**	OR $\frac{20}{21}$ oe	AO1
		$0.95(238) > \mathbf{0.6429}$	**M1**	Correctly compare *their* r_s with the **correct** critical value	AO2
		The test result is significant OR Reject H_0 and accept H_1 OR There is evidence to suggest a positive association between electricity consumption and GDP capita	**A1**	Accept positive correlation A0: there is association A0: there is correlation A0: the relationship is significant	AO3
			[5]		

Question			Answer	Marks	Guidance	AO
6	**(d)**	**(i)**		**B1**	Line through: (10 000, 60 000) and (20 000, 120 000)	**AO2**
		(ii)	Yes, the line is suitable as it fits the data quite well Yes, the line is suitable because there are about the same number of points either side of the line	**B1**	<u>Note:</u> This B1 can be awarded for a correct description, regardless of their line drawn in 6di B0: it shows positive correlation B0: most of the points are on the line Allow **B1FT** for an appropriate explanation of why the incorrect line they have drawn is not suitable	**AO2**
		(iii)	Below	**B1**		**AO3**
				[3]		

Question			Answer	Marks	Guidance	AO
6	**(e)**		**Statement 1:** <u>Examples</u> Yes, there's positive correlation (between electricity consumption and GDP) Yes, electricity is more available in richer countries therefore consumption is higher Yes, richer countries consume more power because of their industry/tech No, the graph shows there are countries (outliers) for which statement 1 is not true No, the industry in a richer country may use more electricity, rather than the people	**B1**	Must see justified or not justified with a clear explanation <u>Do not accept:</u> **No,** because the correlation is weak	**AO3**
			Statement 2: <u>Examples</u> No, as most electricity is consumed by industry, rather than rich people/individuals No, taxing the rich will have no impact on electricity consumption or emissions No, some people/countries choose to consume mostly green electricity which has less environmental impact, therefore raising taxes would be unfair Yes, taxing the rich might have an impact on reducing their electricity consumption	**B1**	Must see justified or not justified with a clear explanation that references electricity consumption	**AO3**
				[2]		

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