Level 3 Certificate

Core Maths B (MEI)

H869/02: Statistical Problem solving

OCR Level 3 Certificate

2021 Mark Scheme (DRAFT)

This is a DRAFT mark scheme. It has not been used for marking as this paper did not receive any entries in the series it was scheduled for. It is therefore possible that not all valid approaches to a question may be captured in this version. You should give credit to such responses when marking learner's work.

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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.

1. 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

2. **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)			Opportunity	B1		1
					[1]		
	(b)	(i)		Not consistent			
				95 < 197 (so the number seeing their own doctor is smaller than the number seeing any doctor)	B1		3
		(ii)		Consistent	B1		3
				46 have a preference and 48 have no preference (and 48>46)	B1		2
		(iii)		Not consistent	B1		3
				Compare mean appointments per patient	M1		2
				Male $\frac{125}{39}=3.2(051...)$, Female $\frac{167}{55}=3.0(036...)$ (and 3.2>3.0)	A1	Allow 39/125 = 0.312, 55/167 = 0.329.. and 0.312< 0.329	2
					[6]		
	(c)			Too many females	B1	Any two sensible comments	3
				Too many older people	B1	They must be different	3
					[2]		

2	**(a)**	Mean 0	**B1**		**2**
		Standard deviation 1	**B1**		**2**
			[2]		
	(b)	68% of observations lie within mean ± 1 standard deviation (and -1.0 is 1 standard deviation below the mean).	**M1**		**2**
		$\frac{1}{2}\times(100-68)\%=16\%$	**A1**		**2**
			[2]		
		Alternative using cumulative distribution			
		Area required = 1 - $\phi(1)$	**M1**		**2**
		1 - 0.8413 = 0.1587 so 16% (to 2 s.f.)	**A1**		**2**
	(c)	$\phi(1.5)=0.9332$			
		93% or 93.3% or 93.32%	**B1**		**1**
			[1]		
	(d)	$(z=)\frac{107.5-110}{2.5}=-1$, so 16%	**B1**		**2**
			[1]		

	(e)	$106.5 \leq y < 107.5$	**B1**	Allow 106.5 to 107.5	**1**
			[1]		
	(f)	$\frac{21}{30}=70\%$	**B1**		**2**
			[1]		
2	**(g)**	In favour: The thickness of the ice has clearly reduced. Against: This does not prove it was global warming	**B1** **B1**	Accept any reasonable explanation	**3** **3**
			[2]		
	(h)	It would reduce the mean of the data in Fig.2.2 (from 107.2 to 106.9)	**B1**		**2**
			[1]		

<table>
<tr><td>3</td><td>(a)</td><td>A</td><td>B1</td><td></td><td>3</td></tr>
<tr><td></td><td></td><td></td><td>[1]</td><td></td><td></td></tr>
<tr><td>3</td><td>(b)</td><td>
<table>
<tr><th>Expected frequency, f_e</th><th>One-year old</th><th>Two-year old</th><th>Adult</th><th>Total</th></tr>
<tr><td>River A</td><td>206.25</td><td>80.625</td><td>13.125</td><td>300</td></tr>
<tr><td>River B</td><td>181.5</td><td>70.95</td><td>11.55</td><td>264</td></tr>
<tr><td>River C</td><td>162.25</td><td>63.425</td><td>10.325</td><td>236</td></tr>
<tr><td>Total</td><td>550</td><td>215</td><td>35</td><td>800</td></tr>
</table>
</td><td>B1

B1</td><td>One of the entries for river C

All entries correct</td><td>1

1</td></tr>
<tr><td></td><td></td><td></td><td>[2]</td><td></td><td></td></tr>
<tr><td>3</td><td>(c)</td><td>$\frac{(181.5-165)^2}{181.5}=1.5$ or $\frac{(165-181.5)^2}{181.5}=1.5$</td><td>B1</td><td></td><td>1</td></tr>
<tr><td></td><td></td><td>$X^2 = 30(.14...)$.</td><td>B1</td><td></td><td>1</td></tr>
<tr><td></td><td></td><td>$\nu=(3-1)\times(3-1)=4$</td><td>M1</td><td></td><td>2</td></tr>
<tr><td></td><td></td><td>Critical value = 9.488...</td><td>A1</td><td></td><td>2</td></tr>
<tr><td></td><td></td><td>30 > 9.488 so H_o is rejected.</td><td>M1</td><td></td><td>2</td></tr>
<tr><td></td><td></td><td>The proportions are not the same in the different rivers.</td><td>A1</td><td></td><td>3</td></tr>
<tr><td></td><td></td><td></td><td>[6]</td><td></td><td></td></tr>
</table>

3	**(d)**	River C is less suited for salmon than the other two rivers	**B1**	Any sensible conjecture	**3**
			[1]		

4	(a)		Population: 19 196 246 (people) Total road length: 15 450 (km)	B1	Both	1
				[1]		
	(b)	(i)	Assume each person takes 1.5 m from hand to hand	M1	Any reasonable assumed value	3
			Total length covered is 19 196 246 × 1.5 m = 28 794 km	M1	Converting into km or □	3
			28 794 > 15 450 so all the roads are covered	A1	Comparison required	3
		(ii)	Canada: Population 35 623 680 Road length 1 042 300 km 35 623 680 × 1.5 ÷ 1000 = 53 435..52 53 435..52 < 1 042 300 So No	B1	Full answer needed The span must be consistent with **(i)**.	3
				[4]		

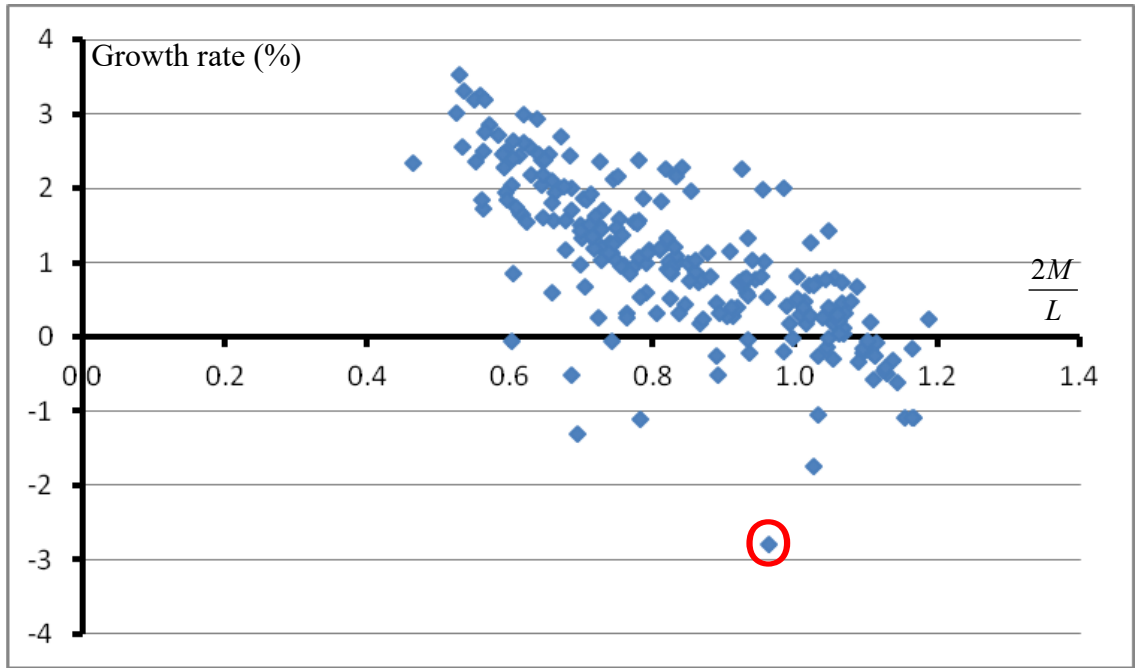
5	(a)	(i)	**Fig. 1** Stable **Fig. 2** Increasing	**B1**	Both answers required	**2**
		(ii)	**Fig. 1** Median = 40	**B1**	cao	**2**
			Fig. 2 (In order the bars represent 20%, 15%, 15%, 12%, 11%,10%, 9%, 8% Since 20% + 15% + 15% = 50%, the median is at the right of the third bar.) Median = 30	**B1**	cao	**2**
				[3]		
	(b)	UK Median = 40.5, Life expectancy = 80.8 ½ × 80.8 = 40.4 ≈40.5		**B1**		**2**
				[1]		
	(c)	Japan $M = 47.3$, $L = 85.3$		**B1**		**1**
		$\frac{2\times47.3}{85.3}$=1.109(02...) so is 1.11 to 2 decimal places.		**B1**		**3**
				[2]		

5	(d)	H_0: There is no association between $\frac{2M}{L}$ and annual population growth rate. H_1: There is a (negative) association between $\frac{2M}{L}$ and annual population growth rate.	**B1**	Both required Accept correlation	**1**
			[1]		
	(e)	**Fig. 5.3**	**B1**	All correct	**1**

Country	$\frac{2M}{L}$	$\frac{2M}{L}$ **rank** ***x***	**Growth rate**	**Growth rate rank** ***y***	***d* = *x* - *y***	d^2
Zambia	0.64	7	2.93	1	6	36
Canada	1.03	2	0.73	5	-3	9
Venezuela	0.74	6	1.24	3	3	9
Iraq	0.53	8	2.55	2	6	36
Japan	1.11	**1**	-0.21	**8**	**-7**	**49**
France	1.01	3	0.39	7	-4	16
Australia	0.94	4	1.03	4	0	0
Fiji	0.79	5	0.60	6	-1	1
					$\sum d^2 =$	**156**

In part (f) allow complete FT from part (e) for a 2-tail test based on H_1: There is association ...

5		$r_S = 1 - \frac{6 \times 156}{8 \times (64-1)}$	**M1**	Attempt to calculate r_s	**1**
		$r_S = -0.8571...$			
		Critical value = 0.6429	**M1**	Attempt to find cv FT for 2-tail test cv =0.7381	**1**
		Since 0.8571 > 0.6429 , H_0 is rejected	**A1**	Both figures correct	**2**
		The evidence suggests there is a negative association between $\frac{2M}{L}$ and annual population growth rate	**B1**	Comment in words	**3**
			[5]		

5	(f)	(i)		B1	cao	2
		(ii)	The growth rate is negative because although the birth rate is not particularly low, many people are emigrating (to New Zealand and Australia).	B1		3
				[2]		

6	(a)	**Numerical value** 40 969 448 ÷ 2 381 741 = 17.20(14...)		B1		2
				[1]		
	(b)	(i)	**Formula in P2** =C2/D2	B1		2
		(ii)	**Holy See** It would involve division by zero.	B1		2
				[2]		
	(c)	3 significant figures		B1		2
				[1]		
	(d)	**High population density** City states		B1	Or equivalent	3
		Low population density Desert countries		B1	Or Remote islands, Cold countries	3
				[2]		
	(e)	No correlation		B1	Accept Low or weak correlation	1
				[1]		

	(f)	Countries with high population density, those ranked 1 to 6, are near the vertical axis.	**B1**		**1**
		Countries with low population density, those ranked 230 to 235, are near the horizontal axis.	**B1**		**1**
			[2]		
	(g)	The line of best fit goes negative which is impossible	**B1**		**3**
		The points representing countries with high population density are nowhere near the line of best fit.	**B1**	Accept any reasonable response.	**2**
			[2]		

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