Level 3 Certificate

Quantitative Problem Solving (MEI)

Unit **H867/02** Statistical Problem Solving

OCR Level 3 Certificate

Mark Schemes for June 2017

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

Subject-specific Marking Instructions

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.

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.

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.

gh   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	Level
1	**(i) (*A*)**	There are $35 + 10 + 16 + 6 + 33 = 100$ businesses	**B1**	100 seen or implied	**2**	**E**
		For example $\frac{1}{5} \times 35 = 7$ so he selects 7 small shops	**B1**	For two correct answers (need not be rounded)	**1**	**E**
		He selects 7 small shops, 2 large shops, 3 guest houses, 1 hotel and 7 restaurants	**B1**	All correct including sensible rounding	**2**	**E**
	(i) (*B*)	The sample is stratified.	**B1**		**1**	**E**
			[4]			
	(ii)	$0 \times 3 + 1 \times 2 + ..,, + 10 \times 2 = 77$	**B1**	77 or 77 000 seen	**2**	**E**
		$77 \times 5 = 385$	**M1**		**1**	**E**
		$385 \times 1000 = 385\,000$ so £385 000	**A1**	ft their '77'	**1**	**E**
			[3]			
	(iii)	Some of the responses may be overstated. The businesses will benefit from the tourist information centre staying open. They rounded up to the nearest 1000.	**B1**	Any reasonable comment that refers to overestimate rather than general uncertainty.	**3**	**A**
			[1]			

2 (i)

Systolic	Diastolic	S rank	D rank	d	d^2
158	95	6	2	4	16
178	88	2	4½	-2.5	6.25
174	97	3	1	2	4
162	85	5	7	-2	4
170	88	4	4½	-0.5	0.25
156	84	8	**8**	**0**	**0**
128	87	10	6	4	16
179	93	1	3	-2	4
157	83	7	**9**	**-2**	**4**
154	79	9	**10**	**-1**	**1**
			Σ		**55.5**

Correct ranking

All correct   **B1**   1   E

   B1   1   E

$$r_s = 1 - \frac{6\sum d^2}{n(n^2-1)} = 1 - \frac{6 \times 55.5}{10 \times (100-1)}$$

M1   (Allow calculation based on use of pmcc on ranks)   2   E

Has to use $n = 10$.

$r_s = 0.6636...$

A1   FT from their value of Σd^2 2   C

The r_S calculation can be seen in part ii.

[4]

2	(ii)	H_0: There is no association between S and D		'association' or 'correlation'		
		H_1: There is positive association between S and D	B1	Both H_0 and H_1 correct. (Must be correctly labelled or in the correct order.)	2	C
		(1-tail test)			2	C
		The critical value (for $n = 10$ at the 5% level) is 0.5636	B1	0.5636 seen		
		$0.6636 > 0.5636$ (so the test is significant)	M1	Comparison seen or implied	2	C
		The evidence supports the alternative hypothesis that there is positive association (between systolic and diastolic blood pressure).	A1	Correct conclusion, with some interpretation (e.g. "there is positive association", need not mention blood pressure), from correct CV, but ft their r_S from i.	3	C
			[4]			
2	(iii)	The general trend is down	B1	Accept "It tells Simon about trends in his blood pressure" oe Accept "Medicines are working" Accept numerical values from graph.	3	E
		There is considerable fluctuation	B1		3	C
			[2]			

2	(iv)	(*A*) No accurate information on any particular day but, because S and D are correlated, we have some approximate information.	**B1**	In either (A) or (B) there must be a statement that the diastolic pressure is correlated with the systolic from the graph. Award 1 mark for two correct statements without this reason. The graph provides and upper bound for D. Can't refer to the values from the table.	**3**	**A**
		(*B*) As S and D are correlated, the doctor can conclude that D decreases / there is considerable fluctuation in D.	**B1**	Either statement Can't refer to the values from the table.	**3**	**A**
			[2]			

3	(i)								If the numbers are rounded to the nearest integer, award max 1 mark.		

Expected frequency, f_e		**Low**	**Medium**	**High**	**Total**
	Owls	15.6	16.2	16.2	**48**
	Hawks	**15.6**	**16.2**	**16.2**	**48**
	Crows	**20.8**	**21.6**	21.6	**64**
	Total	**52**	**54**	**54**	**160**

		B1	Hawks row	2	E
		B1	Crows row	1	E

			[2]		

3	(ii)					Accept answers given to 1dp (rounded or truncated)		

X^2	**Low**	**Medium**	**High**
Owls	5.9077	0.0025	5.9284
Hawks	**2.0103**	**5.9284**	**1.0889**
Crows	**11.1077**	**4.2667**	**1.4519**

		B1	2 correct values	2	C
		B1	All correct	1	A
$X^2 = 37.69(25)$		B1	Total (ft their table)	1	A

			[3]		

3	(iii)	$v = (3-1) \times (3-1) = 4$	B1	Can be implied by 13.28	2	A
		Critical value at the 1% significance level is 13.28	M1		2	A
		Since 37.69 > 13.28, the test is significant.	A1	Comparison can be in words.	1	A
			[3]			
3	(iv)	(*A*) There is (strong) evidence that some types of bird are more at risk from the rat poison than others.	B1	Answers for (A) and (B) can be interchanged. Must refer to different types of birds.	3	E
		(*B*) The rat poison is indeed killing birds.	B1	Accept other sensible answers e.g. Crows are least affected; More crows died	3	C
			[2]			

4	(a)	Cayman Islands: Population 54 914, GDP per capita 43 800 US$	B1		2	E
		Total GDP = 54 914 × 43 800 (= 2 405 233 200 US$)	M1	For multiplication (must be popxGDP)	2	E
		= 2405 million US$	A1	Must be rounded correctly	1	C
			[3]			
4	(b)	(Iceland: Population 317 351, Birth rate 13.09)			2	E
		Deaths: $317351 \times 6.20 \div 1000 = 1968$ (to the nearest whole number)	M1	Either births or deaths; condone use of incorrect country.	3	C
		Births: $317351 \times 13.09 \div 1000 = 4154$ (to the nearest whole number)	A1	Cao both births and deaths		
		Increase (= 4154 − 1968) = 2186 (or 2187)				
		To the nearest 100 the increase is 2200	A1	Don't allow decimal answers. Accept answers from early rounding (art 2100).	1	C
		It is assumed that immigration and emigration can be ignored.	B1	Allow any other sensible modelling assumption	3	A
			[4]			

		ALTERNATIVE				
		(Iceland: Population 317 351, Birth rate 13.09)				
		Difference between birth and death rates: 13.09 – 6.20 (= 6.89)	**M1**			
		Change = 371 351 × 6.89 ÷ 1000 (= 2186)	**A1**			
		To the nearest 100 the increase is 2200	**A1**	Don't allow decimal answers. Accept answers from early rounding (art 2100).		
		It is assumed that immigration and emigration can be ignored.	**B1**	Allow any other sensible modelling assumption		

5	(i)					
			B1	Both points required but need not be labelled (ignore incorrect labelling)	**2**	**C**
			[1]			
5	(ii)	(*A*) Most points lie on or near the straight line	**B1**	Condone reference to "line of best fit"	**2**	**E**
		(*B*) The points are not exactly on the line	**B1**		**2**	**E**
		(*C*) The line crosses the horizontal axis at 57.3	**B1**	Accept "The median is about 57.3" oe	**1**	**E**
			[3]			

5	(iii)	$57.3 - 2 \times 4.8 = 47.7$ $57.3 + 2 \times 4.8 = 66.9$ None of the points on the graph have life expectance < 47.7 or > 66.9 In the Normal distribution 5% of the points are more than 2 standard deviations from the mean 5% of 43 = 2.15 So about 2 values would be expected to be more than 2 standard deviations from the mean.		z-values for lowest and highest values: -1.6375 (Chad) and +1.7604 (Ghana)		
			B1	Some comparison needed (z-scores are sufficient)	**2**	**E**
			M1	5% or 95% seen	**3**	**C**
			A1	2 seen	**3**	**C**
			[3]			
5	(iv)	(*A*) Bimodal	**B1**		**2**	**E**
		(*B*) Monaco	**B1**		**1**	**E**
			[2]			
5	(v)	The life expectancy in Europe is much higher than in mainland Sub-Saharan Africa The distribution is nowhere near Normal for Europe but quite close for Africa	**B1** **B1**	Any two sensible, different comments (e.g. comparison of ranges)	**3** **3**	**E** **E**
			[2]			
5	(vi)	Most East European countries have life expectancy in the 70s whereas for most West European countries it is in the 80s. This explains the bimodal distribution.	**B1**		**3**	**A**
			[1]			

Question		Answer				Marks	Guidance	AO	Level
6	**(i)**	**(A)**							

(A)

	A	**B**	**C**	**D**
1	Country	x, GDP per capita (in 10 000 US$)	y, Medical doctors (per 1000 people)	$M = \dfrac{y}{x}$
2	Algeria	0.75	1.21	1.61
3	Angola	0.63	0.17	**0.27**
4	Ecuador	1.06	1.69	**1.59**
5	Indonesia	0.52	0.20	**0.38**
6	Iran	1.28	0.89	0.70
7	Iraq	0.71	0.61	0.86
8	Kuwait	4.21	1.79	0.43
9	Libya	1.13	1.90	1.68
10	Nigeria	0.28	0.40	1.43
11	Qatar	10.21	2.76	0.27
12	Saudi Arabia	3.13	0.94	0.30
13	UAR	2.99	1.93	0.65
14	Venezuela	1.36	1.94	1.43

For the table rows above — Marks: **B1**, Guidance: Cao (to 2dp), AO: **1**, Level: **E**

(B) The formula in cell D7 is   = C7/B7 — Marks: **B1**, Guidance: Allow "=C2/B2 copied down", AO: **1**, Level: **E**

Marks total: **[2]**

6	(ii)	**Column B:** Nigeria is the poorest of the OPEC countries as measured by per capita GDP	**B1**	oe	2	E
		Column C: Nigeria has one of the lowest (third lowest) numbers of doctors per 1000 people	**B1**	oe	2	E
		Column D: Nigeria is spending more of its money on doctors than most other OPEC countries	**B1**	This mark requires an element of interpretation.	3	A
			[3]			
	(iii)	*M* gives an indication of how much of a country's wealth is being spent on health for ordinary people.	**B1**	Any reasonable answer, eg "*M* shows up differences between countries."	3	A
			[1]			
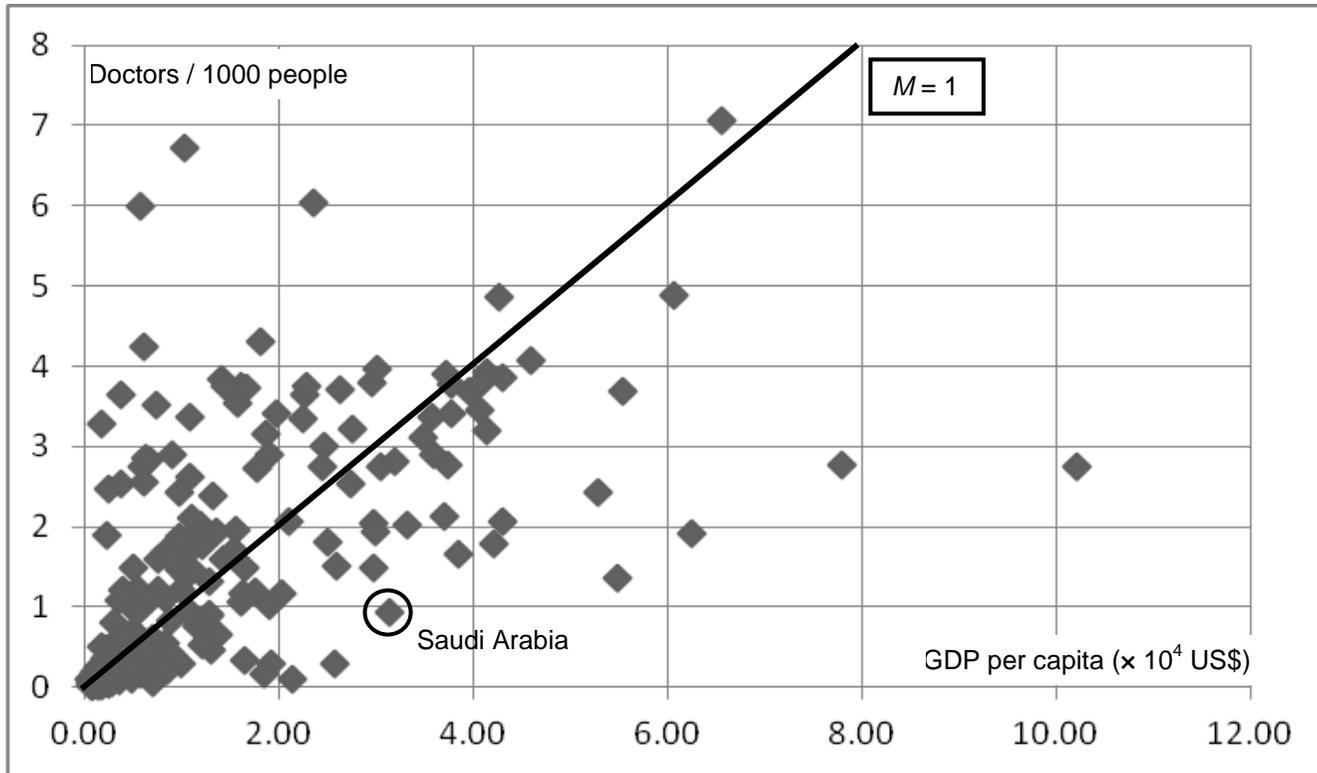
6	(iv)					
			M1	Reasonable line	**2**	**E**
			A1	*M* must follow through as gradient of the line drawn	**3**	**A**
			B1		**1**	**C**
			[3]			

The scatter graph shows:
- y-axis: Doctors / 1000 people (0 to 8)
- x-axis: GDP per capita ($\times 10^4$ US$) (0.00 to 12.00)
- Line with $M = 1$
- Point circled labelled "Saudi Arabia"

	(v)	There is a definite correlation between x and y. / It shows whether there is a correlation. It is sensible to look at the two variables together.	**B1**	Any sensible comments	**3**	**A**
		The value also shows that the correlation is not perfect.	**B1**		**3**	**A**
		This is shown in the scatter diagram.				
		Many points are far from the line of best fit and so could be interesting for the investigation.				
			[2]			

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