OCR
Oxford Cambridge and RSA

Level 3 Certificate

Quantitative Problem Solving (MEI)

Unit **H867/02** Statistical Problem Solving

OCR Level 3 Certificate in Quantitative Problem Solving

Mark Schemes for June 2016

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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.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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

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	(i)	Her time is very predictable when she walks. (It is about 25 minutes.) On a good day driving is quicker, (taking about 8 minutes,) but on a bad day it can take her much longer.	**B1** **B1**	Allow any two **different** sensible comments relating to the times
			[2]	
1	(ii)(*A*)	The day of the week of each journey The starting time of each journey	**B1** **B1**	Allow any sensible answer (eg the weather conditions that day, traffic conditions, whether there was a detour) Do not allow: distance to work, date
	(ii)(*B*)	She should time herself on more journeys and record this additional information	**B1**	
		Alternative for (B): Description of how to make a decision based on data from (A)	**B1**	Must be consistent with (A)
			[3]	

Question		Answer	Marks	Guidance
2	(i)	Self-selected	B1	Accept Opportunity
			[1]	
2	(ii)	It is bell shaped	B1	Accept 'It decreases from the centre symmetrically'.
		Mean = 7, sd = 3, so Mean ± 1 sd is from 4 to 10	M1	Use of given Normal distribution
		68% of a Normal distribution lies within this range	A1	Allow 67 – 69%
		Total frequency from 4 to 10 is 4 + 5 + 5= 14 or 70% of the data (≈ 68%)	B1	70% must be seen and compared to their previous answer
		Alternative		
		Total frequency is 20 and 68% of 20 is 13.6		
		Observed frequency from 4 to 10 is 4 + 5 + 5= 14 (≈ 13.6)	A1	13.6 must be seen
		30 hours is $\frac{30-7}{3} = 7.7$ standard deviations from the mean.	M1	
		However virtually all of a Normal distribution is included within 3 standard deviations of the mean.	A1	
		Alternative		
		Mean + 3sd	M1	Allow mean + 2sd (= 13)
		= 16 and compare to 30	A1	
		Special Case		
		Argument based on the range of the sample	SC B1	
			[6]	

Question		Answer	Marks	Guidance
2	(iii)	Total number of hours for all 20 boys = 20 × 7.5 = 150 (9000 minutes) Total for those playing less than 10 hours is given by 18 × 4⅔ = 84 hours (5040 minutes) So the other two spent 150 - 84 = 66 hours (3960 minutes)	M1 A1	Valid strategy seen. Or average of art 33
		Alternative If the other two spent 30 hours the mean would be 7.2 hours (432 minutes)	 A1	
		So at least one of them one spent more than 30 hours.	A1	FT
			[3]	
2	(iv)	Only a small minority of children spend anything like 30 hours playing computer games. They spend more than 30 hours on school work The newspaper should give its sources of information. The newspaper gives no evidence that playing computer games is damaging children. Etc.	B1 B1	Two sensible but different points
			[2]	

<table>
<tr><th colspan="2">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3</td><td>(i)</td><td>H_0 The proportions of the different species of bat are independent of the site

H_1 The proportions are not independent of the site</td><td>

B1

[1]</td><td>Allow ‘association’ but not ‘correlation’.

Allow ‘numbers of different bats’

Allow missing Ho, H1 if right way round.</td></tr>
<tr><td>3</td><td>(ii)</td><td>
<table>
<tr><th>Observed frequency, f_o</th><th>A</th><th>B</th><th>Total</th></tr>
<tr><td>Pipistrelles</td><td>135</td><td>91</td><td>226</td></tr>
<tr><td>Noctule</td><td>10</td><td>5</td><td>15</td></tr>
<tr><td>Serotine</td><td>10</td><td>5</td><td>15</td></tr>
<tr><td>Horseshoe Bat</td><td>20</td><td>2</td><td>22</td></tr>
<tr><td>Total</td><td>175</td><td>103</td><td>278</td></tr>
</table>
Table 3.1

The numbers of other bats are too small to be included in the test</td><td>B1

B1</td><td>

Accept They are not a coherent group oe</td></tr>
<tr><td></td><td></td><td></td><td>[2]</td><td></td></tr>
</table>

Question		Answer	Marks	Guidance
3	(iii)			

Expected frequency, f_e	A	B	Total
Pipistrelle	$(\frac{175\times226}{278}=)$142.266	$(\frac{103\times226}{278}=)$83.734	226
Noctule	9.442	5.558	15
Serotine	9.442	5.558	15
G horseshoe	13.849	8.151	22
Total	175	103	278

Table 3.2

Answer	Marks	Guidance
	M1	Attempt at correct calculation
		Accept rounding to 1 or 2 decimal places
	A1	Accept truncation after 3 or more decimal places
$X^2=\frac{(142.266-135)^2}{142.266}+\ldots$	M1	Attempt at correct calculation (at least one term seen)
= 0.3711 + 0.6305 + 0.0321 + 0.0560 + 0.0321 + 0.0560 + 2.7320 + 4.6417		No FT except for rounding
= 8.55153	A1	
Correct method for drawing a conclusion	M1	Attempt to compare their "8.55" to a critical value
$\nu=(4-1)\times(2-1)=3$ and Critical value at the 5% significance level is 7.815	B1	Both seen
(Since 8.55 > 7.815) the alternative hypothesis is accepted. (The evidence suggests that the proportions of the different species of bats are dependent on the site.)	A1	FT their "8.55" and CV
The greatest influence comes from the Greater horseshoe bats	B1	
	[8]	

Question		Answer	Marks	Guidance
3	(iv)	The data show a major difference between the sites for the Greater horseshoe bats. This is confirmed by the test result.	**B1** **B1**	A comment about the *data* in the table, can be about overall number of bats A comment about the test, must relate to proportions of different species
			[2]	

Question		Answer	Marks	Guidance
4	(i)	Japan: Population 127 103 388, Birth rate 8.07 Number of babies = $\frac{127\ 103\ 388 \times 8.07}{1000}$ = 1 025 724 or about 1 026 000	 **M1** **A1**	 Can use rounded values Accept without rounding Must round to 1 026 000
			[2]	
	(ii)	Number of deaths = $\frac{127\ 103\ 388 \times 9.38}{1000} = 1\ 192\ 230$ New population = 127 103 388 + 1 025 724 - 1 192 230 = 126 936 882 Japan's population is decreasing	**M1** **A1** **B1**	Needs complete strategy to find change in population Accept without rounding Must round to 126 937 000
			[3]	

Question		Answer	Marks	Guidance
5	(i)	239	B1	Can be seen in C241/239
		Either use the Σ command on cells C2 to C240, or enter =SUM(C2:C240) into C241	B1	Or equivalent
		Enter =C241/239 into C242	B1	Or equivalent
		30019474.02... rounding to 30 019 500	B1	FT 29 894 393 from n = 240 30 145 606 from n = 238
		Malaysia = 30 073 353, Uzbekistan = 28 929 716	B1	Both seen
		One is above and the other one below 30 019 500	B1	Explicit comparison
			[6]	
5	(ii)	Malaysia is ranked 43 so 43 countries have above the mean population	B1	
		Uzbekistan is ranked 44 so 239 - 43 = 196 countries have below the mean population	B1	FT: (239 – above answer) FT their n from (i)
		There are a lot of small countries and a few large ones, (notably China and India which have a large effect on the mean).	B1	
			[3]	

Question		Answer	Marks	Guidance
6	(i)	It is not representative, being from tail of the GDP per capita distribution It is a small sample.	B1	Or other valid statements
			[1]	
6	(ii)	They are numbers 7, 37, 67, ... 217 in the spreadsheet. 7 is a (random) starting point and then every 30. $\left(\frac{239}{8} \approx 30\right)$	B1 B1	 Accept systematic sample
			[2]	

<table>
<tr><th colspan="2">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6</td><td>(iii)</td><td>H_0 There is no association between Population and GDP per capita
H_1 There is negative association between Population and GDP per capita</td><td>B1</td><td></td></tr>
<tr><td></td><td></td><td>
<table>
<tr><th>Country</th><th>Population</th><th>GDP</th><th>Pop rank</th><th>GDP rank</th><th>d</th><th>d^2</th></tr>
<tr><td>Angola</td><td>19 088 106</td><td>6300</td><td>3</td><td>6</td><td>-3</td><td>9</td></tr>
<tr><td>Mozambique</td><td>24 692 144</td><td>1200</td><td>2</td><td>8</td><td>-6</td><td>36</td></tr>
<tr><td>Kiribati</td><td>104 488</td><td>6400</td><td>8</td><td>5</td><td>3</td><td>9</td></tr>
<tr><td>Haiti</td><td>9 996 731</td><td>1300</td><td>4</td><td>7</td><td>-3</td><td>9</td></tr>
<tr><td>Hong Kong</td><td>7 112 688</td><td>52 700</td><td>5</td><td>2</td><td>3</td><td>9</td></tr>
<tr><td>Slovenia</td><td>1 998 292</td><td>27 400</td><td>7</td><td>3</td><td>4</td><td>16</td></tr>
<tr><td>Norway</td><td>5 147 792</td><td>55 400</td><td>6</td><td>1</td><td>5</td><td>25</td></tr>
<tr><td>Mexico</td><td>120 286 655</td><td>15 600</td><td>1</td><td>4</td><td>-3</td><td>9</td></tr>
<tr><td></td><td></td><td></td><td></td><td>Σ</td><td>0</td><td>122</td></tr>
</table>

$r_s = 1 - \frac{6\sum d^2}{n(n^2-1)} = 1 - \frac{6\times 122}{8\times(64-1)} = -0.452...$

Critical value for $n = 8$ and 1-tail test at 5% significance level is 0.6429

Since 0.452 < 0.6429 the result is not significant. (The null hypothesis is accepted. The data do not support Jessica's conjecture.)</td><td>B1

B1

B1

M1
A1

M1

A1</td><td>Rankings

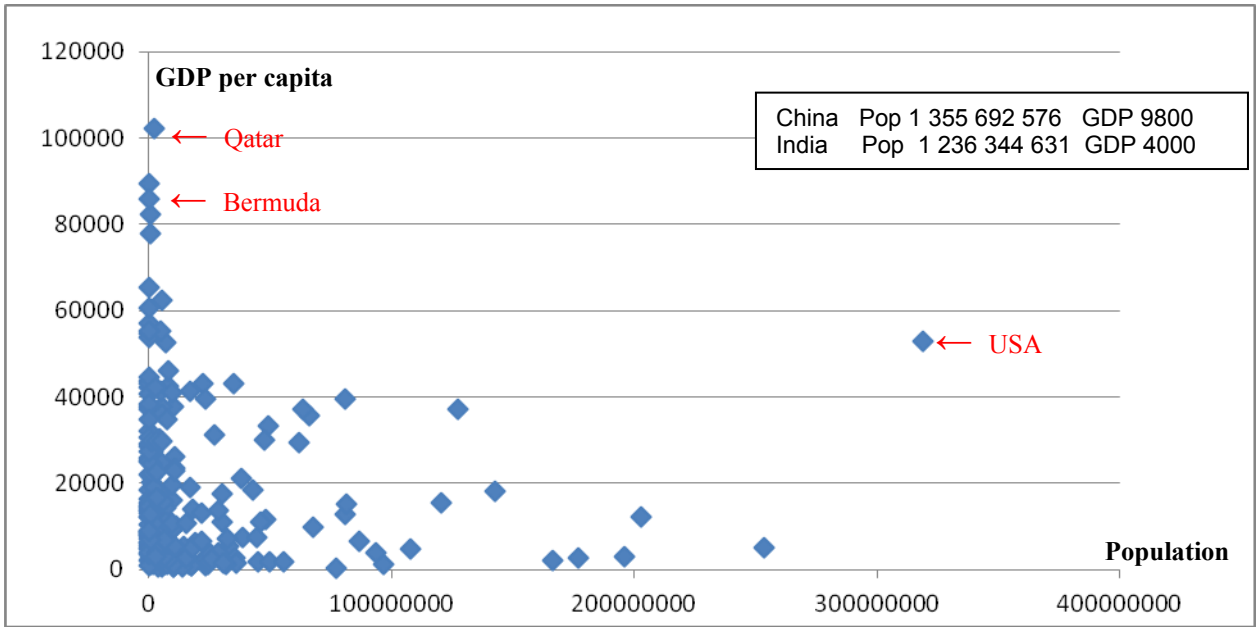
Finding d (FT)

Finding and summing d^2 (FT)

Attempt formula for r_S
FT their ‘122’

Correct procedure: Finding a critical value and comparing to their r_S

Correct CV and conclusion FT from H_1 (CV=0.7381)</td></tr>
<tr><td></td><td></td><td></td><td>[8]</td><td></td></tr>
</table>

Question		Answer	Marks	Guidance
6	(iv)		**B1** **B1** **B1** **[3]**	Qatar Bermuda USA
6	(v)	The evidence (from the hypothesis test) does not support the conjecture. USA is an anomaly. All the other countries with high GDP per capita are small. (So conjecture is supported.) If the few (about 20) countries with the highest GDP per capita are not considered then the scatter diagram does not suggest any correlation.	**B1** **B1** **[2]**	Allow other sensible comments about the evidence 'Conjecture supported' needs evidence

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

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