OCR
Oxford Cambridge and RSA

Level 3 Certificate

Quantitative Problem Solving (MEI)

Unit **H867/02** Statistical Problem Solving

OCR Level 3 Certificate

Mark Schemes for June 2018

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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.

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

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	Mark	Guidance
1	(i)	Quota	**B1**	**Not** stratified
			[1]	
1	(ii)	There is no difference between the proportions of males and females answering Yes and No. More females say "Don't know"	**B1** **B1**	Other sensible answers possible
			[2]	
1	(iii)	**For** Data about the housing Survey of households **Against** Data relating to the risk of flooding Historical records	**B1** **B1** **B1** **B1**	Allow any reasonable description of relevant data, and any reasonable data collection method (which would enable collection of required data).
			[4]	
2	(i)	For 275, $z = \frac{275-250}{50} = 0.5$ For 250, $z = 0$ $\phi(0.5) - \phi(0) = 0.6915 - 0.5$ $= 0.1915$	**M1** **A1** **B1**	M1: standardisation of 275 attempted (ignore wrong sign or √ errors) A1: z=0.5 correct B1: 0.6915 – 0.5 seen SC: 0.6915 – 0.5 seen (no z-values) – **gets full marks** SC: Calculator answers must show the detail of what was entered. Full marks available.
			[3]	

<table>
<tr><th colspan="2">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>2</td><td>(ii)</td><td>
<table>
<tr><th>Interval</th><th>Probability</th><th>Normal model frequency</th><th>Miranda's frequency</th></tr>
<tr><td>250 - 275</td><td>0.1915</td><td>38.30</td><td>39</td></tr>
<tr><td>275 - 300</td><td>0.1499</td><td>29.98</td><td>29</td></tr>
<tr><td>300 - 325</td><td>0.0918</td><td>18.37</td><td>20</td></tr>
<tr><td>325 - 350</td><td>0.0441</td><td>8.81</td><td>8</td></tr>
<tr><td>Over 350</td><td>0.0228</td><td>4.56</td><td>5</td></tr>
</table>
Table 2.2
</td><td>B1</td><td>The figures have been obtained from a calculator. Accept slightly different figures from candidates using the given figures or tables.</td></tr>
<tr><td></td><td></td><td>All Miranda's frequencies are close to those for the Normal model</td><td>B1</td><td>One comment comparing the frequencies in the table</td></tr>
<tr><td></td><td></td><td>Fig 2.1 is close to being symmetrical about the mean (250 ms)</td><td>B1</td><td>One comment about the shape of the chart

allow ‘bell shaped’

SC B1: ‘data fits normal curve / is bell shaped’</td></tr>
<tr><td></td><td></td><td></td><td>[3]</td><td></td></tr>
</table>

Question		Answer	Mark	Guidance
2	(iii)	Most of their times are more than 3 standard deviations from Miranda's mean so their reactions are slow	M1	Accept "Miranda's times are generally much lower than these times" Can be implied by the explanation.
		Maybe this is the result of the wine they have drunk / they did less practice	A1	Their explanation must relate to their description. SC B1 if there are both right and wrong full answers
			[2]	
2	(iv)	**(*A*)** It is nearly a Normal distribution (with the same mode as Miranda's times)	B1	one comment related to the unimodality allow 'single peak' or 'approximately bell shaped' Allow a correct comment about 250.
		but it is skewed (to the right)	B1	one comment related to skew allow a reasonable description of 'skewed'**(?)** Allow a correct comment about the range.
		(*B*) This is because of some people who can be expected to take longer, for example beginners and those who have been drinking	B1	The explanation must relate to skew
			[3]	
3	(i)	Self-selected	B1	Accept Opportunity
			[1]	

Question		Answer	Mark	Guidance
3	(ii)	H_0: There is no **association/correlation** between **dose** and **change** in running time		**not** 'relationship' or 'dependence' Condone "increase" instead of "change"
		H_1: There is association/correlation between dose and change in running time	**B1**	**not** 'positive association' in H_1

Volunteer	Dose	Dose rank	$t_2 - t_1$	$(t_2 - t_1)$ rank	d	d^2
A	1.0	5	-0.3	**3**	**-2**	**4**
B	2.0	**9**	1.4	10	**1**	**1**
C	0.0	1	0.0	**5**	**4**	**16**
D	1.5	**7**	0.7	**8**	**1**	**1**
E	0.5	**3**	-0.6	1	**-2**	**4**
F	1.75	**8**	1.2	**9**	**1**	**1**
G	0.25	**2**	-0.1	**4**	**2**	**4**
H	0.75	**4**	-0.4	**2**	**-2**	**4**
I	1.25	**6**	0.6	**7**	**1**	**1**
J	2.25	10	**0.5**	6	**-4**	16
				Σ	0	**52**

B1 One fully correct row

B1 One fully correct 'rank' column

B1 Correct Σd^2

$$r_s = 1 - \frac{6\sum d^2}{n\left(n^2-1\right)} = 1 - \frac{6\times 52}{10\times 99}$$

M1 Attempt to use correct formula

$r_s = 0.6848$

A1 cao, art 0.68 or 0.685 (**not** f/t their table)

Critical value for n=10, 2-tailed, 5% significance level, is 0.6485

B1 0.6485 seen

Question		Answer	Mark	Guidance
		Since 0.6848 > 0.6485, Ho is rejected. (The evidence does not support H_0.)	**A1**	Dependent on M1 f/t their rs and cv if both clearly seen. This mark may be awarded for a context based comment.
			[8]	
3	**(iii)**	The Spearman test suggests a side effect is possible.	**B1**	One mark for each (different) sensible point
		The times for the 3rd test are almost the same as those for the 1st suggesting that any effects are short term	**B1**	
		The data for the first two tests suggest that lower doses decrease times (people run faster) but higher doses increase times (people run slower).	**B1**	
		A random sample is required. / A (much) larger study is required.		Comments about sample size or nature can score at most B1 in total.
			[3]	

Question		Answer	Mark	Guidance
4	(i)	The median is midway between those ranked 114 and 115. Macedonia and Azerbaijan are ranked equal 113 with GDP per capita of \$10 800. Ecuador is ranked 115 with GDP per capita of \$10 600. So the median is \$10 700.	**B1** **B1** **B1**	**not** 114^{th} give if 114.5 seen All correct countries, ranks and GDP values seen. cao
			[3]	
4	(ii)	The country with the greatest GDP per capita is Qatar at \$102 100 The country with the least GDP per Capita is Congo DDR at \$400 $\frac{\$102\,100 + \$400}{2} = \$51\,250$ This is very much greater than the median. It suggests that a large amount of wealth is concentrated in a small number of countries.	**B1** **M1** **A1**	Both correct GDPs Finding the average of their two numbers Needs an explicit comparison with the median **and** a comment concerning distribution of wealth. (does not need the correct median in (i)) **Not** 'there is a large difference between richest and poorest countries'
			[3]	

Question		Answer	Mark	Guidance
5	(i)	Population of Argentina is 43 024 374, birth rate is 16.88 per thousand Number of babies per year is $43\ 024\ 374 \times \frac{16.88}{1000} = 726\ 251\ (\approx 726\ 000)$	**B1** **M1** **A1**	both correct numbers seen using their numbers Allow 2 to 6 s.f., art 730 000
			[3]	
5	(ii)	$\frac{\text{Babies}}{\text{Females}} = \frac{726\ 251}{11\ 692\ 613} = 0.0621...\ (\approx 0.0621)$	**M1** **A1**	using their answer from (i) f/t their (i), allow 2 to 4 s.f.
			[2]	
5	(iii)	$0.0621 \times 40 = 2.48$ Average number of children per female	**B1** **B1**	f/t their (ii) Only give if "2.48" is between 1 and 10
			[2]	

<table>
<tr><th colspan="2">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>6</td><td>(i)</td><td>H_0: The proportion of countries with Low, Medium and High life expectancy is independent of whether the countries are islands or mainland countries

H_1: The proportion of countries with Low, Medium and High life expectancy depends on whether the countries are islands or mainland countries</td><td>B1</td><td>OR ‘life expectancy and location are Independent’

Both hypotheses correct

not ‘correlation’ or similar</td></tr>
<tr><td></td><td></td><td></td><td>[1]</td><td></td></tr>
<tr><td>6</td><td>(ii)</td><td>
<table>
<tr><th>Expected frequency, f_e</th><th>Low</th><th>Medium</th><th>High</th><th>Total</th></tr>
<tr><td>Islands</td><td>5.2</td><td>8</td><td>6.8</td><td>20</td></tr>
<tr><td>Mainland countries</td><td>7.8</td><td>12</td><td>10.2</td><td>30</td></tr>
<tr><td>Total</td><td>13</td><td>20</td><td>17</td><td>50</td></tr>
</table>
$X^2 = \frac{(5.2-1)^2}{5.2} + ...$

$X^2 = 3.3923 + 0.125 + 1.5059 + 2.2615 + 0.0833 + 1.0039 = 8.37$

$\nu = (3-1)\times(2-1) = 2$

Critical value = 5.991

8.37 > 5.991 so reject H_0 (the result is significant)</td><td>M1

A1

M1

A1

M1

A1

A1</td><td>At least one correct cell

All cells correct

Evidence of correct calculation

X^2 value, cao, at least 2 s.f.

Needs explicit comparison, correct X^2 and c.v.</td></tr>
<tr><td></td><td></td><td></td><td>[7]</td><td></td></tr>
</table>

<table>
<tr><th colspan="2">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>6</td><td>(iii)</td><td>Islands $\frac{5149.36}{68} = 75.725(8)...$

Mainland countries $\frac{10781.86}{(239-17-68)} = \frac{10781.86}{154} = 70.012...$</td><td>B1

B1</td><td>Accept 2 to 5 s.f.

Accept 2 to 5 s.f.

ignore any incorrect statements/working</td></tr>
<tr><td></td><td></td><td></td><td>[2]</td><td></td></tr>
<tr><td>6</td><td>(iv)</td><td>
<table>
<tr><td></td><td>P</td><td>Q</td><td>R</td><td>T</td></tr>
</table>
<table>
<tr><td>20</td><td>Island</td><td>Population</td><td>Life expectancy</td><td>Q × R</td></tr>
<tr><td>21</td><td>Barbados</td><td>289690</td><td>74.99</td><td>21723103</td></tr>
<tr><td>22</td><td>Comoros</td><td>766875</td><td>63.48</td><td>48680590</td></tr>
<tr><td>23</td><td>New Zealand</td><td>4401916</td><td>80.93</td><td>356247062</td></tr>
<tr><td>24</td><td>Total</td><td>5458481</td><td></td><td>426650755</td></tr>
<tr><td>25</td><td colspan="3"></td><td>78.16</td></tr>
</table>
</td><td>B1

B1

B1</td><td>One correct Q × R

Correct Q24

Correct T24 (allow if in T25)

Correct T25, 3 s.f. or better</td></tr>
<tr><td></td><td></td><td></td><td>[4]</td><td></td></tr>
</table>

Question		Answer	Mark	Guidance
6	(v)	The weighted mean is the best.	B1	
		The χ^2 test uses a sample not the whole population.	B1	Explicit comparison with χ^2 test
		It does not tell you which group has the greater life expectancy		
		The simple mean does not take the territories' populations into account	B1	Explicit comparison with simple mean
			[3]	

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