OCR
Oxford Cambridge and RSA

GCE

Quantitative Methods (MEI)

Unit **G244**: Introduction to Quantitative Methods (MEI)

Advanced Subsidiary GCE

Mark Scheme for June 2017

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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 for GCE Mathematics (MEI) Statistics strand

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 Unless units are specifically requested, there is no penalty for wrong or missing units as long as the answer is numerically correct and expressed either in SI or in the units of the question. (e.g. lengths will be assumed to be in metres unless in a particular question all the lengths are in km, when this would be assumed to be the unspecified unit.)

We are usually quite flexible about the accuracy to which the final answer is expressed and we do not penalise over-specification.

When a value is given in the paper
Only accept an answer correct to at least as many significant figures as the given value. This rule should be applied to each case.

When a value is not given in the paper
Accept any answer that agrees with the correct value to 2 s.f.

ft should be used so that only one mark is lost for each distinct error made in the accuracy to which working is done or an answer given. Refer cases to your Team Leader where the same type of error (e.g. errors due to premature approximation

leading to error) has been made in different questions or parts of questions.

There are some mistakes that might be repeated throughout a paper. If a candidate makes such a mistake, (eg uses a calculator in wrong angle mode) then you will need to check the candidate's script for repetitions of the mistake and consult your Team Leader about what penalty should be given.

There is no penalty for using a wrong value for *g*. E marks will be lost except when results agree to the accuracy required in the question.

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.

Marks designated as cao may be awarded as long as there are no other errors. E marks are lost unless, by chance, the given results are established by equivalent working.

'Fresh starts' will not affect an earlier decision about a misread.

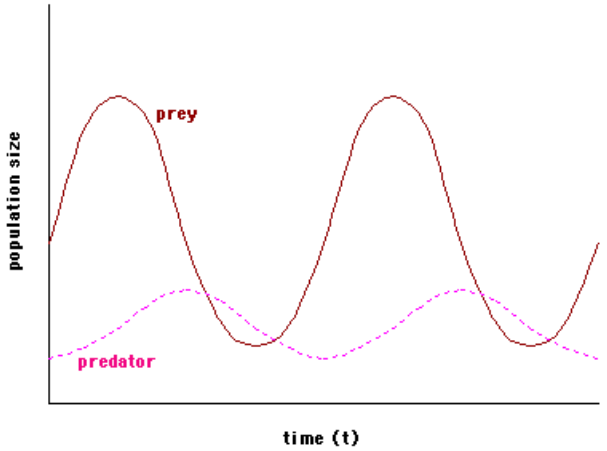
Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

i If a graphical calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers (provided, of course, that there is nothing in the wording of the question specifying that analytical methods are required). Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.

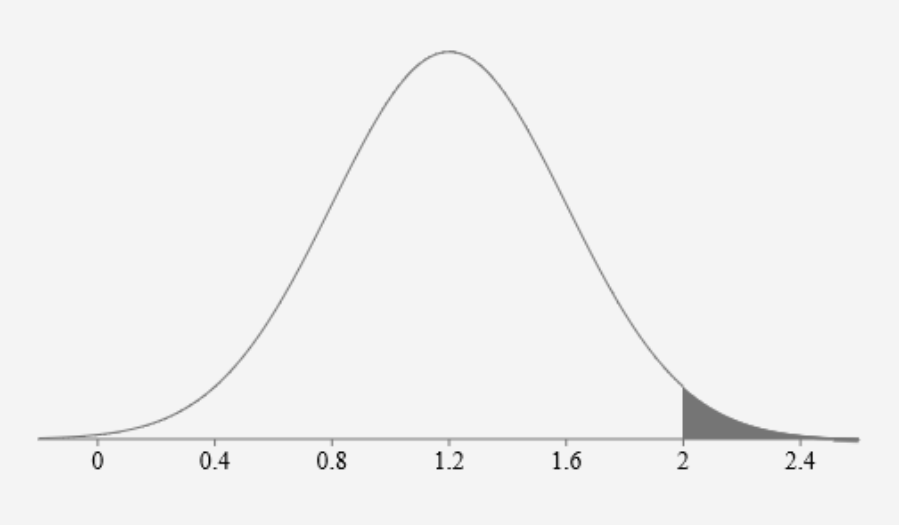
j If in any case the scheme operates with considerable unfairness consult your Team Leader.

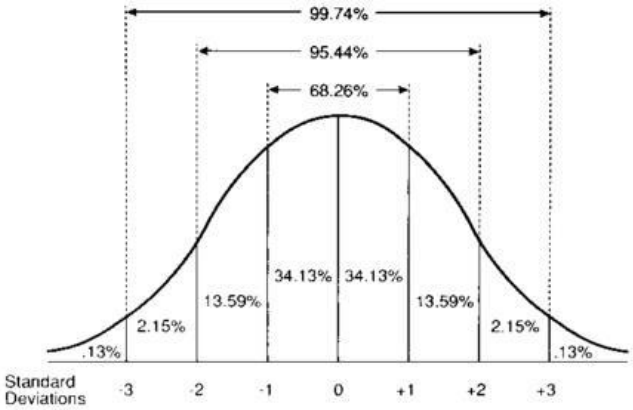
Question			Answer	Marks	Guidance
1	(i)		Marathon is 42195 metres or Time is 7377 seconds	B1	Converting to common units
			Speed is $\frac{42195}{7377} = 5.7198... \text{ m s}^{-1}$	M1	Finding speed
			Time for 100 m is $\frac{100}{5.7198}$	M1	Use of speed to find time Award this mark and the previous M mark if the intermediate step of calculating speed is omitted in a method that should lead to the correct answer, eg $\frac{7377}{42195} \times 100$
			$= 17.48483... = 17.48$ s (to nearest 0.01 s)	A1	Allow 17 s or better.
				[4]	
	(ii)		Their "17.4…" - 9.58 (= 7.9…) or their "$\frac{17.4 \ldots}{9.58}$" (= 1.8249…)	M1	Calculates difference or makes comparison Follow through from part (i)
			$\frac{7.9 \ldots}{9.58} \times 100$ or $1.82 \ldots \times 100 - 100$ or $(1.82 \ldots - 1) \times 100$	M1	Divides by original and multiples by 100 for percentage of original amount or multiplies comparison by 100 and subtracts 100. Follow through from part (i)
			82.5%	A1	Accept [82 - 83 %] without wrong working
				[3]	

2	**(i)**		The horizontal scale is unclear (as not evenly spaced).	B1	Any other sensible answer. e.g 'The data have been obtained by extrapolation.', 'There is no vertical axis.' Do not allow improvements to the graph. Require comment specific to this graph so allow 'small populations are difficult to read' but not 'not very accurate' unless related to y scale
			The vertical scale goes negative (which is not possible).	**B1**	
				[2]	
	(ii)	**(*A*)**	42000 × 2.5 = 105 000	B1	Allow [84,000 , 126,000].
		(*B*)	Lower bound = 41 500 × 2 = 83 000	**B1**	Use of boundary values for both variables must be shown as answer given Allow 83 000 ÷ 2 = 41 500
			Upper bound = 42 500 × 3 = 127 500	**B1**	Accept 42 499 x 3 (= 127497)
				[3]	
	(iii)	**(*A*)**	Fluctuating	**B1**	o.e.
		(*B*)	2005 and 2009	**B1**	
		(*C*)	The badger population is (also) fluctuating (which shows the danger of trying to infer a trend from just two observations of such a population).	**B1**	
				[3]	

	(iv)		There may be other causes for the decline in hedgehog numbers.	**B1**	Any reasonable criticism of the given statement. For example It is not certain that badger numbers are rising. Do not allow general comments such as ‘no evidence’.  http://www.tiem.utk.edu/~gross/bioed/bealsmodules/predator-prey.html
				[1]	

3	**(i)**	**(*A*)**	G11	= I6 - F6	**B1**	Accept = I3 - F6. oe
		(*B*)	I3	= C8*C18*C17/100	**B1**	Multiplications
					B1	Division by 100 oe for example = C17/100*C8*C18
		(*C*)	F3	= C4/C5	**B1**	oe
					[4]	Deduct maximum of one mark in part i for not keeping to common spreadsheet conventions e.g. missing equals or circular reference or × rather than * Where SUM is used it should include brackets e.g. =SUM(I6 – F6). Ignore extra brackets, cell references to the cell being filled and prefixes/suffixes where logic of formula is unaffected.
	(ii)		Shed = (£800 ÷ 4) = £200 per year or Eggs (= 250 × 6 × 20 ÷ 100) = £300		**M1**	Calculates cost of new shed or takings from new estimate of eggs
			(Total credits = £300 or decrease in credits of £60) (Total debits = £200 + £20 + £84 = £304 or increase in debits of £100) "£300" – "£304" or £"156" - £"60" - £"100"		**M1**	Total credits – total debits or original profit + increase in credits - increase in debits
			Loss of £4		**A1**	Accept correct answer obtained from working over a 4 year period.
					[3]	

4	**(i)**	**(*A*)**	(The points nearly make a) straight line	**B1**	Or equivalent Allow 'close to the line'
		(*B*)	Where the line crosses the horizontal axis	**B1**	Allow x axis.
		(*C*)	The line goes through (1.6, 1) and 1.6 - 1.2 = 0.4 so 1 sd = 0.4	**B1**	oe Allow the gradient of the line
			Alternative The values of *h* lie between 0.2 and 2.05 so the range is just over 2 standard deviations either side of the mean.		
				[3]	
	(ii)		Bell shaped curve	**B1**	
			1.2 coincident with maximum	**B1**	
			The horizontal scale is consistent with the spread of the graph  http://onlinestatbook.com/2/calculators/normal_dist.html	**B1**	Points approximately (allow +/- 20 percentage points) follow: h — Relative Height 0 — 1% 0.4 — 13% 0.8 — 60% 1.2 — 100% 1.6 — 60% 2 — 13% 2.4 — 1%
				[3]	

	(iii)		$h = 2$ is 2 standard deviations from the mean	**B1**	
			5% of a Normal distribution lie further than 2 standard deviations from the mean	**B1**	Or 95% lie within 2 standard deviations. Can be implied by use of 34% and 13.5%. 
			So 2½% of values of *h* lie above 2 metres.	**B1**	Allow [2, 3] %
			The councillor is wrong. The correct figure is 1 in 40.	**B1**	Allow 1 in 50 to 1 in 30.
				[4]	

4	**(iv)**	***(A)***	From 2000 onwards there have been 5 floods in 17 years.	**B1**	Comment on the present situation (frequent flooding) Accept high (over 1000 mm) rainfall in recent (since 1997) years (from Fig. 4.4) only 1 flood in 1999-2007 but 4 floods in 2008-2016 (from Fig. 4.3).
			This is much greater than the 1 in 40 years before 2000.	**B1**	Comparison with pre-2000 (less frequent flooding) Accept 1 in 50 years (from Fig 4.1) no high rainfall (above 1000 mm) before 1997 (only 1 flood in 1999-2007 but 4 floods in 2008-2016) so risk increases from 1/9 to 4/9
		(B)	Fig 4.3 shows that the change occurred at about the time the housing estate was built.	**B1**	Timing: Only one flood prior to building of housing estate but 5 since (from Fig. 4.1 and Fig. 4.3). Allow alternative: no step change from building on the flood plain as river height fluctuates.
			Fig 4.4 shows suggests that the rainfall has not greatly increased over this time (but has become more variable).	**B1**	Association: Floods in 2009 and 2014 attributable to increased rainfall (around 1200 mm) but floods in 2008 and 2016 when rainfall was below 1000 mm (and 2003 only just over 1000 mm) which only produced one flood in previous years (e.g. 1951, 1952, 1955, 1965, 1967, 1970, 1981). Allow alternative: maximum river height and rainfall have increased and are associated.
			So the housing estate seems to provide the better explanation.	**B1**	Dependent on both previous marks. Allow climate change if supported by alternatives.
				[5]	

5	**(i)**		0220, 0540, 1420, 1740	**B1**	For at least two times Allow 0210 to 0230, 0530 to 0550, 1410 to 1430, 1730 to 1750
				[1]	
	(ii)		Tangent drawn at (12, 6.5)	**M1**	
			Tangent used to estimate gradient	**M1**	e.g. gradient triangle with 4 metres in 3 hours
			The tide is falling at 1.33 metres per hour	**A1**	Consistent with the candidate's tangent Accept [1, 1.5] metres per hour
				[3]	
	(iii)				

Time	4	5	6	7	8	9	10	11	12	13	14	15	16
Rise		0.5	1.0	1.5	**1.5**	**1**	**0.5**	**-0.5**	-1	-1.5	-1.5	-1	-0.5
Depth, *d* m	2	2.5	3.5	5	**6.5**	**7.5**	**8**	**7.5**	6.5	5	3.5	2.5	2

				B1 **B1**	1 mark for 1 correct value 2 marks for all 8 correct values
			Points plotted on grid	**B1**	1 mark for given points
			It is a very close match	**B1**	Allow 'very accurate'
				[4]	

5	**(iv)**		The tide takes longer coming in than going out	**B1**	Any two sensible comments, one of which should be in context, i.e. allow one mark for asymmetric, negative/left skew or more frequent observations (but not 'more accurate')
			(Low tide at) 0400 is lower than (low tide at) 1600	**B1**	Higher low water and lower low water tides are not the same or maximum/ high tide different times/ values, or comment on model smooth but measurements show stand in high water with flat top.
				[2]	

6	**(i)**		½ × 392 = 196 hertz	**B1**	
				[1]	
	(ii)		(3520 ÷ 2^4 = 220) The note is A	**B1**	
			It is 4 octaves above middle	**B1**	Technically A_8 but allow 5^{th} octave counting from middle A as 1^{st} octave.
				[2]	
	(iii)		1 000 000 000 = 10^9 so the multiple is 10^9	**M1**	Or use of m and index solution e.g. $(\sqrt[10]{10})^{n} = 10^{9}$ $(10)^{n/10} = 10^{9}$ n = 90
			Loudness is 9 × 10 + 18 = 108 decibels	**A1**	
				[2]	

	(iv)		Middle C is 261.6 hertz.	B1	
			(The point (261.6, 12) is between the two lines) so the patient can hear it	B1	Or at 12 decibels the patient can hear up to around 600 hertz
			… with the left but not right ear.	B1	
				[3]	
	(v)	***(A)***	46 - 34 = 12 decibels	B1	Allow a reading from a similar pair of points Accept from 10 to 14 decibels (inclusive)
		(B)	1.2589^{12}	M1	FT from part (*A*)
			The multiple is (15.84… =) 16 (to 2 sf)	A1	Follow through to between 10 and 25 times.
				[3]	
6	**(vi)**		The patient has less good hearing for high notes.	B1	Any two sensible comments Do not accept 'the higher the frequency the higher the decibels' as data must be interpreted in context or 'humans can hear 250 to 8000 hertz' as this is the range of the test not human hearing.
			One ear is not consistently better than the other over the range of notes tested.	B1	Accept 'the left ear can hear quieter sounds than the right for most frequencies' but not 'the left and right ear hear different frequencies at different decibels'.
				[2]	

<table>
<tr><td>7</td><td>(i)</td><td></td><td>Best fuel economy 30 miles per US gallon</td><td>B1</td><td></td></tr>
<tr><td></td><td></td><td></td><td>30 × 1.2 = 36 So 36 miles per imperial gallon</td><td>B1</td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td>[2]</td><td></td></tr>
<tr><td></td><td>(ii)</td><td colspan="4"><table>
<tr><td>v</td><td>45</td><td>50</td><td>55</td><td>60</td><td>65</td><td>70</td><td>75</td><td>80</td></tr>
<tr><td>c</td><td>48</td><td>49.5</td><td>50</td><td>49.5</td><td>48</td><td>45.5</td><td>42</td><td>37.5</td></tr>
</table></td><td>B1
B1
B1</td><td>For 1 correct entry
For 3 correct entries
For 5 correct entries</td></tr>
<tr><td></td><td></td><td></td><td></td><td>[3]</td><td></td></tr>
<tr><td></td><td>(iii)</td><td></td><td>Points plotted correctly and smooth curve</td><td>B1</td><td>Allow if 4 points plotted correctly</td></tr>
<tr><td></td><td></td><td></td><td></td><td>[1]</td><td></td></tr>
<tr><td></td><td>(iv)</td><td></td><td>Similarity Rises to a maximum and then declines</td><td>B1</td><td>Any sensible correct statement
Same maximum of 55 mph or similar shape</td></tr>
<tr><td></td><td></td><td></td><td>Difference Fuel economy for the Emerald is much higher</td><td>B1</td><td>Any sensible correct statement
Accept mpg values (initial value 48 mpg compared with 10 mpg) or higher range of velocities covered by graph (45-80 mph rather than 5-75 mph) or vertical scale (starting at 35 and not 0) exaggerates loss of efficiency above 55 mph (which is proportionately less than for other cars 25% vs. 28%).</td></tr>
<tr><td></td><td></td><td></td><td></td><td>[2]</td><td></td></tr>
</table>

7	**(v)**		At 55 mph the fuel economy is 50 mpg; at 80 mph it is 37.5 mpg	**B1**	
			$\frac{50-37.5}{50}\times 100$	**M1**	May use 37.5 ÷ 50 then subtract from 1 and multiply by 100 (or multiply by 100 and subtract from 100).
			= 25%	**A1**	
				[3]	

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