GCE

Mathematics (MEI)

Advanced GCE

Unit **4767**: Statistics 2

Mark Scheme for January 2011

Marking instructions for GCE Mathematics (MEI): Statistics strand

1. You are advised to work through the paper yourself first. Ensure you familiarise yourself with the mark scheme before you tackle the practice scripts.

2. You will be required to mark ten practice scripts. This will help you to understand the mark scheme and will not be used to assess the quality of your marking. Mark the scripts yourself first, using the annotations. Turn on the comments box and make sure you understand the comments. You must also look at the definitive marks to check your marking. If you are unsure why the marks for the practice scripts have been awarded in the way they have, please contact your Team Leader.

3. When you are confident with the mark scheme, mark the ten standardisation scripts. Your Team Leader will give you feedback on these scripts and approve you for marking. (If your marking is not of an acceptable standard your Team Leader will give you advice and you will be required to do further work. You will only be approved for marking if your Team Leader is confident that you will be able to mark candidate scripts to an acceptable standard.)

4. Mark strictly to the mark scheme. If in doubt, consult your Team Leader using the messaging system within *scoris*, by email or by telephone. Your Team Leader will be monitoring your marking and giving you feedback throughout the marking period.

   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.

5. 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.

6. 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.

7. 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.

8. 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. 3 significant figures may often be the norm for this, but this always needs to be considered in the context of the problem in hand. For example, in quoting probabilities from Normal tables, we generally expect *some* evidence of interpolation and so quotation to 4 decimal places will often be appropriate. But even this does not always apply – quotations of the standard critical points for significance tests such as 1.96, 1.645, 2.576 (maybe even 2.58 – but not 2.57) will commonly suffice, especially if the calculated value of a test statistic is nowhere near any of these values. Sensible discretion *must* be exercised in such cases.

Discretion must also be exercised in the case of small variations in the degree of accuracy to which an answer is given. For example, if 3 significant figures are expected (either because of an explicit instruction or because the general context of a problem demands it) but only 2 are given, loss of an accuracy ("A") mark is likely to be appropriate; but if 4 significant figures are given, this should not normally be penalised. Likewise, answers which are slightly deviant from what is expected in a very minor manner (for example a Normal probability given, after an attempt at interpolation, as 0.6418 whereas 0.6417 was expected) should not be penalised.

However, answers which are *grossly* over- or under-specified should normally result in the loss of a mark. This includes cases such as, for example, insistence that the value of a test statistic is (say) 2.128888446667 merely because that is the value that happened to come off the candidate's calculator. Note that this applies to answers that are given as final stages of calculations; intermediate working should usually be carried out, and quoted, to a greater degree of accuracy to avoid the danger of premature approximation.

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.

9.   **Rules for crossed out and/or replaced work**

    If work is crossed out and not replaced, examiners should mark the crossed out work if it is legible.

    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 two or more attempts are made at a question, and just one is not crossed out, examiners should ignore the crossed out work and mark the work that is not crossed out.

    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.

10.   Genuine misreading (of numbers or symbols, occasionally even of text) occurs. If this results in the object and/or difficulty of the question being considerably changed, it is likely that all the marks for that question, or section of the question, will be lost. However, misreads are often such that the object and/or difficulty remain substantially unaltered; these cases are considered below.

    The simple rule is that *all* method ("M") marks [and of course all independent ("B") marks] remain accessible but at least some accuracy ("A") marks do not. It is difficult to legislate in an overall sense beyond this global statement because misreads, even when the object and/or difficulty remains unchanged, can vary greatly in their effects. For example, a misread of 1.02 as 10.2 (perhaps as a quoted value of a sample mean) may well be catastrophic; whereas a misread of 1.6748 as 1.6746 may have so slight an effect as to be almost unnoticeable in the candidate's work.

    A misread should normally attract *some* penalty, though this would often be only 1 mark and should rarely if ever be more than 2. Commonly in sections of questions where there is a numerical answer either at the end of the section or to be obtained and commented on (eg the value of a test statistic), this answer will have an "A" mark that may actually be designated as "cao" [correct answer only]. This should be interpreted *strictly* – if the misread has led to failure to obtain this value, then this "A" mark must be withheld even if all method marks have been earned. It will also often be the case that such a mark is implicitly "cao" even if not explicitly designated as such.

    On the other hand, we commonly allow "fresh starts" within a question or part of question. For example, a follow-through of the candidate's value of a test statistic is generally allowed (and

often explicitly stated as such within the marking scheme), so that the candidate may exhibit knowledge of how to compare it with a critical value and draw conclusions. Such "fresh starts" are not affected by any earlier misreads.

A misread may be of a symbol rather than a number – for example, an algebraic symbol in a mathematical expression. Such misreads are more likely to bring about a considerable change in the object and/or difficulty of the question; but, if they do not, they should be treated as far as possible in the same way as numerical misreads, *mutatis mutandis*. This also applied to misreads of text, which are fairly rare but can cause major problems in fair marking.

The situation regarding any particular cases that arise while you are marking for which you feel you need detailed guidance should be discussed with your Team Leader.

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

11.   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.

12.   For answers scoring no marks, you must either award NR (no response) or 0, as follows:

    Award NR (no response) if:
- Nothing is written at all in the answer space
- There is a comment which does not in any way relate to the question being asked ("can't do", "don't know", etc.)
- There is any sort of mark that is not an attempt at the question (a dash, a question mark, etc.)

    The hash key [#] on your keyboard will enter NR.

    Award 0 if:
- There is an attempt that earns no credit. This could, for example, include the candidate copying all or some of the question, or any working that does not earn any marks, whether crossed out or not.

13.   The following abbreviations may be used in this mark scheme.

M1	method mark (M2, etc, is also used)
A1	accuracy mark
B1	independent mark
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
ft	follow through
isw	ignore subsequent working

oe	or equivalent
rot	rounded or truncated
sc	special case
soi	seen or implied
www	without wrong working

14. Annotating scripts. The following annotations are available:

✓and ✖

BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working (after correct answer obtained)
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 is also available to highlight any particular points on a script.

15. The comments box will be used by the Principal Examiner to explain his or her marking of the practice scripts for your information. Please refer to these comments when checking your practice scripts.

    Please do not type in the comments box yourself. Any questions or comments you have for your Team Leader should be communicated by the *scoris* messaging system, e-mail or by telephone.

16. Write a brief report on the performance of the candidates. Your Team Leader will tell you when this is required. The Assistant Examiner's Report Form (AERF) can be found on the Cambridge Assessment Support Portal. This should contain notes on particular strengths displayed, as well as common errors or weaknesses. Constructive criticisms of the question paper/mark scheme are also appreciated.

17. Link Additional Objects with work relating to a question to those questions (a chain link appears by the relevant question number) – see scoris assessor Quick Reference Guide page 19-20 for instructions as to how to do this – this guide is on the Cambridge Assessment Support Portal and new users may like to download it with a shortcut on your desktop so you can open it easily! For AOs containing just formulae or rough working not attributed to a question, tick at the top to indicate seen but not linked. When you submit the script, *scoris* asks you to confirm that you have looked at all the additional objects. Please ensure that you have checked all Additional Objects thoroughly.

18. The schedule of dates for the marking of this paper is displayed under 'OCR Subject Specific Details' on the Cambridge Assessment Support Portal. It is vitally important that you meet these requirements. If you experience problems that mean you may not be able to meet the deadline then you must contact your Team Leader without delay.

Question 1

(i)	**EITHER:** $S_{xy} = \Sigma xy - \dfrac{1}{n}\Sigma x \Sigma y = 1398.56 - \frac{1}{14} \times 139.8 \times 140.4$ $\quad = -3.434$ $S_{xx} = \Sigma x^2 - \dfrac{1}{n}(\Sigma x)^2 = 1411.66 - \frac{1}{14} \times 139.8^2 = 15.657$ $S_{yy} = \Sigma y^2 - \dfrac{1}{n}(\Sigma y)^2 = 1417.88 - \frac{1}{14} \times 140.4^2 = 9.869$ $r = \dfrac{S_{xy}}{\sqrt{S_{xx}S_{yy}}} = \dfrac{-3.434}{\sqrt{15.657 \times 9.869}}$ $\quad = -0.276$ **OR:** $\text{cov}(x,y) = \dfrac{\sum xy}{n} - \overline{x}\,\overline{y} = 1398.56/14 - 9.9857 \times 10.0286$ $\quad\quad = -0.2454$ $\text{rmsd}(x) = \sqrt{\dfrac{S_{xx}}{n}} = \sqrt{(15.657/14)} = \sqrt{1.1184} = 1.0575$ $\text{rmsd}(y) = \sqrt{\dfrac{S_{yy}}{n}} = \sqrt{(9.869/14)} = \sqrt{0.7049} = 0.8396$ $r = \dfrac{\text{cov}(x,y)}{rmsd(x)\,rmsd(y)} = \dfrac{-0.2454}{1.0575 \times 0.8396}$ $\quad = -0.276$ NB: using only 3dp in calculating $\overline{x}$ and $\overline{y}$ leads to answer of 0.284 which is still in the acceptable range	M1 for method for S_{xy} M1 for method for at least one of S_{xx} or S_{yy} A1 for at least one of S_{xy}, S_{xx}, S_{yy} correct M1 for structure of r A1 (-0.27 to -0.28 to 2dp) M1 for method for cov (x,y) M1 for method for at least one msd A1 for at least one of cov (x,y), msd(x), msd(y) correct M1 for structure of r A1 (-0.27 to -0.28 to 2dp)		**5**	If $\overline{x}$ and $\overline{y}$ used in rounded form, be generous with first A1 Structure of r needs to be fully correct in all parts – the first two M1 marks must have been earned and $r = \dfrac{S_{xy}}{\sqrt{S_{xx}S_{yy}}}$ applied. If $\overline{x}$ and $\overline{y}$ used in rounded form, be generous with first A1 Structure of r needs to be fully correct in all parts – the first two M1 marks must have been earned and $r = \dfrac{\text{cov}(x,y)}{rmsd(x)\,rmsd(y)}$ applied.

(ii)	H_0: $\rho = 0$ H_1: $\rho \neq 0$ (two-tailed test) where ρ is the population correlation coefficient For $n = 14$, 5% critical value = –0.5324 Since –0.276 > –0.5324 the result is not significant. Thus we do not have sufficient evidence to reject H_0 There is not sufficient evidence at the 5% level to suggest that there is correlation between birth rate and death rate	B1 for H_0, H_1 in symbols B1 for defining ρ B1 for critical value (+ or -) M1 for a sensible comparison leading to a conclusion (provided that $-1 < r < 1$) A1 for correct result ft their r B1 ft for conclusion in context		Condone hypotheses written in words and context. e.g. allow H_0: There is no correlation between x & y, H_1: There is correlation between x & y. (i.e. allow x & y as 'context' since these are defined in the question) NB If hypotheses given only in words and 'association' mentioned then do not award first B1 and last B1 For hypotheses written in words, candidates must make it clear that they are testing for evidence of correlation in the population. One-tailed test cv = (-) 0.4575 Comparison should be between the candidate's value of r from part (i) and an appropriate cv (i.e. the sign of the cv and the sign of r should be the same). NOTE If result not stated but final conclusion is correct award SC1 to replace the final A1 B1
			6	
(iii)	The underlying population must have a bivariate Normal distribution. Since the scatter diagram has a roughly elliptical shape.	B1 E1 for elliptical shape		Not bivariate and Normal
			2	
(iv)	Because this data point is a long way from the other data and it is below and to the right of the other data. It does bring the validity of the test into question since this extra data point is so far from the other points and so there is less evidence of ellipticity.	E1 for a long way E1 for below and to the right of. E1 for does cast doubt on validity E1 for less elliptical		Indication that the point is (possibly) an outlier For identifying the position of this point (allow in terms of x and y) Allow 'no' but only with with suitable explanation e.g. the sample is still too small to provide evidence either for or against the presence of ellipticity.
			4	
		TOTAL	**17**	

Question 2

<table>
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<td>(i)</td>
<td>

Mean $= \dfrac{\Sigma xf}{n} = \dfrac{0+15+24+27+16+10}{50}$

$= \dfrac{92}{50} = 1.84$

Variance $= \dfrac{1}{n-1}\left(\Sigma fx^2 - n\overline{x}^2\right)$

$= \dfrac{1}{49}\left(258 - 50 \times 1.84^2\right)$

$= 1.81$ (to 2 d.p.)

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B1 for mean

M1 for calculation

A1

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Use of MSD gets M1 A0
Standard deviation gets M0 A0 unless "Variance = 1.81" is seen.

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<td>(ii)</td>
<td>Because the mean is close to the variance</td>
<td>B1</td>
<td>1</td>
<td>Must compare mean and their variance as found in part (i)</td>
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<td>(iii)</td>
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(A) P(No sultanas) $= e^{-1.84}\dfrac{1.84^0}{0!}$

$= 0.159$ (3 s.f.)

(B) P(At least two sultanas) $=$

$1 - e^{-1.84}\dfrac{1.84^0}{0!} - e^{-1.84}\dfrac{1.84^1}{1!}$

$= 1 - 0.159 - 0.292 = 0.549$

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M1 for probability calc.

A1

M1 for P(1)
M1 for
$1 - [P(0) + P(1)]$ used
A1 cao

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[1.8 leads to 0.1653]

Or attempt to find P(2) + P(3) + P(4) +
…+ P(8)

Use of $\lambda = 1.8$ loses both accuracy marks
[1.8 leads to $1 - 0.4296 = 0.5372$]

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<td>(iv)</td>
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$\lambda = 5 \times 1.84 = 9.2$
Using tables: $P(X \geq 10) = 1 - P(X \leq 9)$

$= 1 - 0.5611$ (= 0.4389 **NB ANSWER GIVEN**)

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B1 for mean (SOI)
M1 for $1 - P(X \leq 9)$

A1

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Any λ

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(v)	P(2 out of 6 contain at least ten sultanas) $= \binom{6}{2} \times 0.4389^2 \times 0.5611^4 = 0.2864$	M1 for $p^2 \times q^4$ M1 dep for coefficient A1	**3**	$p + q = 1$ Coefficient of 15 as part of a binomial calculation ft if p rounded from part (iv)
(vi)	Use Normal approx with $\mu = np = 60 \times 0.4389 = 26.334$ $\sigma^2 = npq = 60 \times 0.4389 \times 0.5611 = 14.776$ $P(X > 30) = P\left(Z > \dfrac{30.5 - 26.334}{\sqrt{14.776}} \right)$ $= P(Z > 1.0838) = 1 - \Phi(1.0838)$ $= 1 - 0.8608$ $= 0.1392$	B1 for μ B1 for σ^2 B1 for correct continuity correction M1 for probability using correct tail. FT their μ & σ^2 A1 **cao**	**5**	**SOI** Allow 26.3 Allow 14.8 … …(giving P($Z > 1.091..$) = 0.137 3sf) But do not FT wrong or omitted CC
			20	

Question 3

(i)	(A) P(X < 325)
	
	 $= P\left(Z < \dfrac{325 - 355}{52}\right)$
	
	    $= P(Z < -0.577)$
	
	    $= 1 - \Phi(0.577) = 1 - 0.7181$
	
	    $= 0.2819$
	
	 (B) P(300 < X < 400)
	 $= P\left(\dfrac{300-355}{52} < Z < \dfrac{400-355}{52}\right)$
	
	    $= P\left(-1.058 < Z < 0.865\right)$
	 $= \Phi(0.865) - (1 - \Phi(1.058))$
	 $= 0.8065 - (1 - 0.8549)$
	 $= 0.6614$ (0.6615 from GDC)
		M1 for standardising
		
		 M1 for correct structure
		
		 A1 CAO
		
		 M1 for standardising both
		
		 M1 for correct structure
		
		 A1 CAO
			3
			
			 3
				NB When a candidate's answers suggest that (s)he appears to have neglected to u... difference column of the Normal distribution tables penalise the first occurrence only.
				 Ignore spurious continuity corrections & allow reversal of numerator
				
				 i.e. correct tail (including below a negative *z*)
				
				 Allow answers which round to 0.282
				
				 Penalise spurious continuity corrections
				
				 Allow 0.663 if penalised inappropriate table use already
				 Use of standard deviation = √52 or 52² can earn M1 for structure only in each part – max 2/6

(ii)	From tables $\Phi^{-1}(0.2) = -0.8416$ $\dfrac{k - 355}{52} = -0.8416$ $k = 355 - 0.8416 \times 52 = 311.2$	B1 for ± 0.8416 seen M1 for equation in *k* A1 CAO	**3**	NOT 1 – 0.8416 Equation must be equivalent to this. Penalise use of + 0.8416 unless numerator has been reversed. Condone other *z* values but use of probabilities here, e.g. use of 0.2 or $\Phi(0.2) = 0.5793$, gets M0 A0 Allow 311

(iii)	H_0: $\mu = 355$; H_1: $\mu \neq 355$. Where μ denotes the population mean (reaction time for women) Test statistic = $\dfrac{344 - 355}{52/\sqrt{25}} = \dfrac{-11}{10.4} = -1.058$ 5% level 2 tailed critical value of $z = 1.96$ $-1.058 > -1.96$ so not significant. There is not sufficient evidence to reject H_0 There is insufficient evidence to conclude that women have a different reaction time from men in this experiment.	B1 for use of 355 in hypotheses B1 for both correct B1 for definition of μ M1 must include $\sqrt{25}$ A1 B1 for 1.96 M1 for a sensible comparison leading to a conclusion A1 for correct conclusion in words in context		Use of 355 in hypotheses and hypotheses given in terms of μ no or x, etc. unless letter used is clearly defined as population mean Allow $+ 1.058$ only if later compared with $+ 1.96$ Or -1.96 Do not accept 'men and women have same reaction time'
			8	
		TOTAL	**17**	

Question 4

(i)	H_0: no association between pebble size and site H_1: some association between pebble size and site;	B1		Must be in context NB if H_0 H_1 reversed, or 'correlation' mentioned, do not award first B1 or final E1	

EXPECTED	Site A	Site B	Site C
Large	13.70	9.44	13.86
Medium	33.33	22.96	33.70
Small	42.96	29.60	43.44

M1 A2 for expected values (to 2 dp)

(allow A1 for at least one row or column correct)

1d.p.can get M1A1A0
M1A2 can be implied by correct contributions/final answer

CONTRIB'N	Site A	Site B	Site C
Large	0.1226	0.6940	1.0731
Medium	0.8533	1.5484	3.7861
Small	0.3793	0.3913	1.2744

M1 for valid attempt at $(O-E)^2/E$

A1

NB These (M1A1) marks cannot be implied by a correct final value of X^2.
A1 for at least 1 row/column correct

$X^2 = 10.12$

M1 for summation
A1 for X^2

Dependent on previous M1

Refer to χ_4^2

B1 for 4 deg of freedom

Critical value at 5% level = 9.488

B1 CAO for cv

Award only if no incorrect working seen

Result is significant

B1 ft their 'sensible' X^2 and critical value

Allow reject H_0. B0 if critical value of 0.711 (lower tail) or 2.776 (t distribution) used.

There is evidence to suggest that there is some association between pebble size and site

E1 must be consistent with their X^2

12

Dependent on previous B1
SC1 (to replace B1E1 if first B1B1 earned where 'significant' not stated but final statement is correct)

(ii)				NOTE For each site, some reference to contributions needed (explicitly or implicitly).
	Site A Contributes least to x^2 showing that frequencies are as expected if there were no association. OR Contribution of 0.8533 implies that there are (slightly) fewer medium pebbles than expected.	E2,1,0	**2**	Award E2 only if no incorrect additional comment made. Allow large/small 'as expected' or 'more than expected' and medium 'as expected' or 'less than expected' for E1 (if contribution not mentioned)
	Site B Contribution of 1.5484 implies that there are fewer medium pebbles than expected.	E2,1,0	**2**	Award E2 only if no incorrect additional comment made. Allow large/small 'as expected' or 'more than expected' and medium 'less than expected' for E1 (if contribution not mentioned)
	Site C Contribution of 3.7861 implies that there are **a lot** more medium than expected. NB MAX 3/6 for answers not referring to contributions (explicitly or implicitly).	E2,1,0 Need 'a lot more' for E2	**2**	Award E2 only if no incorrect additional comment made. Allow large/small 'fewer than expected' and medium 'more than expected' for E1 (if contribution not mentioned)
		TOTAL	**18**	

Additional notes re Q1(ii)

For those carrying out a one-tailed test, B0 B1 B1 M1 A1 B1 is available provided that working is consistent with a one-tailed test being used.
For the final B1 to be earned, the conclusion should refer to alternative hypothesis used. e.g. 'There is not sufficient evidence at the 5% level to suggest that there is a **negative** correlation between birth rate and death rate'.

If the cv is taken from the Spearman's Test table (i.e. -0.5385 and -0.4637) then the third B1 will be lost.
If other 'sensible' cvs are used then only B1 B1 B0 M1 A0 B0 available. Use of t distribution leads to B1 B1 B0 M0 A0 B0 max.

Additional notes re Q3(iii)

Critical Value Method
$355 - 1.96 \times 52 \div \sqrt{25}$ gets M1B1
$= 334.6\ldots$ gets A1
$334.6 < 344$ gets M1for sensible comparison
A1 still available for correct conclusion in words & context

Confidence Interval Method
CI centred on 344
$+$ or $- 1.96 \times 52 \div \sqrt{25}$ gets M1 B1
$= (323.62, 364.384)$ A1
contains 355 gets M1
A1 still available for correct conclusion in words & context

Probability Method
Finding P(sample mean < 344) $= 0.1451$ gets M1 A1 B1
$0.1451 > 0.025$ gets M1 for a sensible comparison if a conclusion is . $0.1451 > 0.05$ gets M1 A0 unless using one tailed test
A1 still available for correct conclusion in words & context.
Condone P(sample mean > 344) $= 0.8549$ for M1 but only allow A1 if later compared with 0.975 at which point the final M1and A1 are still available

One-tailed test
Max B1 B0 B1 M1 A1 B1 (for cv $= -1.645$) M1 A1 (provided that the conclusion relates to H_1: $\mu < 355$, e.g. there is insufficient evidence to suggest that women have a lower reaction time than men in this experiment).

Consistent use of $\sigma = \sqrt{52}$
Do not penalise in parts (ii) and (iii).