

OCR

Oxford Cambridge and RSA

Tuesday 9 June 2015 – Morning

A2 GCE MATHEMATICS (MEI)

4768/01 Statistics 3

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:

- Printed Answer Book 4768/01
- MEI Examination Formulae and Tables (MF2)

Other materials required:

- Scientific or graphical calculator

Duration: 1 hour 30 minutes



INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found inside the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book.** Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

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- The number of marks is given in brackets [] at the end of each question or part question on the Question Paper.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **12** pages. The Question Paper consists of **4** pages. Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER/INVIGILATOR

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

- 1 (a) A stratified sample of pupils at secondary schools in a particular local authority is to be chosen in order to collect information on absenteeism. In the local authority there are 4 secondary schools, A, B, C and D, with 1310, 1453, 843 and 1110 pupils respectively.
- (i) How many pupils should be chosen from each school in a stratified sample of 500 so that each school is represented proportionally? [3]
- (ii) Suggest two possible criteria for stratification other than by school. [2]
- (iii) State one advantage of choosing a stratified sample. [1]
- (b) At a large secondary school, the median number of half days absent per pupil per year (based on several years' records) was known to be 23. Last year the school carried out a drive to lower the number of absences. A random sample of 12 pupils had been absent for the following numbers of half days during the year.

14 10 15 13 35 9 24 19 30 26 29 8

A Wilcoxon single sample test is to be carried out to see if the drive has been successful.

- (i) Why might a Wilcoxon test be appropriate? [1]
- (ii) What distributional assumption is needed for the test? [1]
- (iii) Carry out the test, using a 5% level of significance. [10]
- 2 The distribution of the random variable X is thought to be well modelled by the following probability density function:

$$f(x) = \begin{cases} k(1+x) & \text{for } 0 \leq x < 5, \\ 0 & \text{elsewhere,} \end{cases}$$

where k is a positive constant.

- (i) Find the value of k . [3]
- (ii) Show that $P(a \leq X < a+1) = \frac{1}{35}(2a+3)$ for $0 \leq a \leq 4$. [2]

A random sample of 50 observations of X is summarised as follows.

x	$0 \leq x < 1$	$1 \leq x < 2$	$2 \leq x < 3$	$3 \leq x < 4$	$4 \leq x < 5$
Frequency	1	5	7	20	17

- (iii) Test at the 10% level of significance whether the distribution of X is well modelled by $f(x)$. [10]
- (iv) With reference to your calculations in part (iii) discuss briefly the outcome of the test. [2]

- 3 In agricultural research the oil content, as a percentage of the whole grain, of a cereal can be measured using near infra-red spectroscopy. An investigation into the effect of a particular treatment on the oil content of a certain cereal is being carried out. A sample of 10 plots of land is chosen and each plot is divided in half. In one half of each plot the cereal is grown with the treatment and in the other half the cereal is grown without the treatment. Subsequently the percentage oil content of the cereal for each half of each plot is measured and the results are as follows.

Plot	A	B	C	D	E	F	G	H	I	J
With treatment	41.1	44.3	42.4	48.2	52.4	54.6	35.9	33.6	51.1	47.0
Without treatment	42.5	37.7	42.1	32.4	42.7	41.5	36.9	31.7	52.6	41.2

A paired t test with a 5% level of significance is to be used to see if the treatment appears to make any difference to the mean percentage oil content of the cereal.

- (i) Explain what is meant by a 5% level of significance in a hypothesis test. [2]
 - (ii) State the conditions necessary for the test to be carried out. [3]
 - (iii) Assuming the conditions stated in part (ii) are met, carry out the test. [10]
 - (iv) Find a 90% confidence interval for the population mean difference in the percentage oil content with and without the treatment. [4]
- 4 Paul has been trying a new route to work in the mornings. He collects a large random sample of times, in minutes, and calculates a 95% confidence interval for the population mean time by this route. The confidence interval is (45.369, 47.231) and the sample variance is 20.3.

- (i) Explain what is meant by a 95% confidence interval for a population mean. [1]
- (ii) Calculate the sample mean and the sample size. [4]

Paul reverts to his usual route and the time, in minutes, to travel to work each morning is modelled by a random variable which is Normally distributed with mean 41.3 and variance 11.7. The time, in minutes, for Paul to travel home each evening is modelled by a random variable which is Normally distributed with mean 44.8 and variance 14.2. In the rest of this question all journeys are by Paul's usual route and may be assumed to be independent of each other.

- (iii) Calculate the probability that, on a randomly chosen day, Paul's total travelling time will be less than 90 minutes. [3]
- (iv) Calculate the probability that, on a randomly chosen day, the time for Paul to travel home will be more than 5 minutes longer than the time to travel to work. [4]
- (v) Calculate the probability that, in a randomly chosen five-day week, the mean time for Paul to travel to work on Monday and Tuesday will be more than 3 minutes longer than his mean time to travel to work on Wednesday, Thursday and Friday. [6]

END OF QUESTION PAPER



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Candidate forename		Candidate surname	
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Centre number						Candidate number				
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1(a)(i)	
1(a)(ii)	
1(a)(iii)	
1(b)(i)	
1(b)(ii)	

1(b)(iii)	
	(answer space continued on next page)

1(b)(iii)	(continued)
2 (i)	

2 (ii)

2 (iii)

(answer space continued on next page)

2 (iii)	(continued)
2 (iv)	

3 (i)	
3 (ii)	
3 (iii)	

(answer space continued on next page)

3 (iv)	
4 (i)	

4 (ii)	

4 (iii)	

4 (iv)	

4 (v)	

(answer space continued on next page)

4 (v) (continued)	



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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 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.

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 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.

Question			Answer	Marks	Guidance																																							
1	(a)	(i)	$\frac{500}{4716} \times \dots$ $= 138.88\dots, 154.05\dots, 89.37\dots, 117.68\dots$ $= 139, \quad 154, \quad 89, \quad 118$	M1 A1 A1 [3]	Correct factor used for at least one school. All correct and given to at least 1 dp. FT any errors in the previous line provided that sum = 500.																																							
1	(a)	(ii)	e.g. Sex (gender) Year group	B1 B1 [2]	Allow reasonable alternatives including ethnicity, birth date, distance from school																																							
1	(a)	(iii)	e.g. Provides information on each stratum (as well as the population).	B1 [1]	Or representative																																							
1	(b)	(i)	We have no information about the background population.	E1 [1]	o.e. Must include "population" o.e.																																							
1	(b)	(ii)	Symmetry.	B1 [1]																																								
1	(b)	(iii)	$H_0: m = 23$ $H_1: m < 23$ where m is the population median number of days absent. <table border="1" style="margin-left: 20px; margin-top: 10px;"> <thead> <tr> <th>Absences</th> <th>-23</th> <th>Rank of diff </th> </tr> </thead> <tbody> <tr><td>14</td><td>-9</td><td>7</td></tr> <tr><td>10</td><td>-13</td><td>10</td></tr> <tr><td>15</td><td>-8</td><td>6</td></tr> <tr><td>13</td><td>-10</td><td>8</td></tr> <tr><td>35</td><td>12</td><td>9</td></tr> <tr><td>9</td><td>-14</td><td>11</td></tr> <tr><td>24</td><td>1</td><td>1</td></tr> <tr><td>19</td><td>-4</td><td>3</td></tr> <tr><td>30</td><td>7</td><td>5</td></tr> <tr><td>26</td><td>3</td><td>2</td></tr> <tr><td>29</td><td>6</td><td>4</td></tr> <tr><td>8</td><td>-15</td><td>12</td></tr> </tbody> </table>	Absences	-23	Rank of diff	14	-9	7	10	-13	10	15	-8	6	13	-10	8	35	12	9	9	-14	11	24	1	1	19	-4	3	30	7	5	26	3	2	29	6	4	8	-15	12	B1 B1 M1 M1 A1	Both. Accept hypotheses in words, but must include "population". Do NOT allow symbols other than m unless clearly and explicitly stated to be a <u>population median</u> . Adequate definition of m to include "population". for subtracting 23. for ranks. ft if ranks wrong.
Absences	-23	Rank of diff																																										
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Question		Answer	Marks	Guidance
		$W_+ = 1 + 2 + 4 + 5 + 9 = 21$ Refer to Wilcoxon single sample tables for $n = 12$. Lower 5% point is 17 (or upper is 61 if 57 used). Result is not significant. Insufficient evidence to suggest that the median number of days absent has been reduced.	B1 M1 A1 A1 A1 [10]	$(W_- = 3 + 6 + 7 + 8 + 10 + 11 + 12 = 57)$ No ft from here if wrong. i.e. a 1-tail test. No ft from here if wrong. ft only c's test statistic. Dependent on all 3 M marks ft only c's test statistic. Dependent on all 3 M marks. Conclusion in context to include "on average" o.e.
2	(i)	Require $\int_0^5 k(1+x)dx = 1$ $\int_0^5 k(1+x)dx = k \left(x + \frac{x^2}{2} \right) \Big _0^5 = k \left(5 + \frac{25}{2} \right) - k \times 0 = \frac{35k}{2}$ $\therefore \frac{35k}{2} = 1 \quad \therefore k = \frac{2}{35} \quad \text{Not } 0.057\dots$	M1 A1 A1 [3]	Set up correct integral, including limits which may appear later. Allow method based on area, e.g., a trapezium. Integral correctly evaluated, or correct area obtained, in terms of k . Set equal to 1 and rearranged for k .
2	(ii)	$P(a \leq X < a+1) = \int_a^{a+1} \frac{2}{35}(1+x)dx$ $= \frac{2}{35} \left((a+1) + \frac{(a+1)^2}{2} - a - \frac{a^2}{2} \right)$ $= \frac{2}{35} \left(1 + \frac{2a+1}{2} \right) = \frac{1}{35}(2a+3)$	M1 A1 [2]	Set up correct integral, including limits which may appear later. Allow method based on area, e.g., a trapezium. Allow candidate's value of k . AG. Must be shown convincingly.
2	(iii)	H_0 : The model is suitable / fits the data. H_1 : The model is not suitable / does not fit the data. Expected frequencies are: $50 \times \left(\frac{3, 5, 7, 9, 11}{35} \right)$ $= \left(\frac{30, 50, 70, 90, 110}{7} \right)$ $= 4.2857, 7.1428/9, 10, 12.8571, 15.7142/3$	B1 M1 A1	Both hypotheses. Must be the right way round. Do not accept "data fit model" oe. Accept either fractions or decimals.

Question		Answer	Marks	Guidance
		Merge first 2 cells: Obs f = 6, Exp f = 11.4285 $X^2 = 2.5786 + 0.9 + 3.9683 + 0.1052$ $= 7.552$ Refer to χ^2_3 . Upper 10% point is 6.251. Significant. Sufficient evidence to suggest that the pdf of X is not well modelled by f(x)..	M1 M1 A1 M1 A1 A1 A1 [10]	Merge first 2 cells Calculation of X^2 . Independent of previous mark. Awrt 7.55 Allow correct df (= cells – 1) from differently grouped table and ft. critical value only. Otherwise, no ft if wrong. No ft from here if wrong. $P(X^2 > 7.552) = 0.0562$. If cells not merged χ^2_4 10% point is 7.779; $P(X^2 > 8.135) = 0.0867$. ft only c's test statistic. ft only c's test statistic. Do not accept "data do not fit model" oe.
2	(iv)	e.g. The model overestimates for $0 \leq x < 2$. The model underestimates for $3 \leq x < 4$. "Large discrepancy" but no direction E1 max	E1 E1 [2]	Any 2 points relating to or explaining the outcome of the test. Other possibilities might include: The test would not have been significant at 5%. The sample is a bit small making it difficult to assess.
3	(i)	5% represents the probability of rejecting the null hypothesis when it is, in fact, true.	E1 E1 [2]	
3	(ii)	Must assume: Normality of population of <u>differences</u> . Sample is random.	B1 B1 B1 [3]	Ignore references to unknown variance and/or sample size.
3	(iii)	$H_0: \mu_D = 0$ $H_1: \mu_D \neq 0$ Where μ_D is the (population) mean difference in percentage oil content.	B1 B1	Both. Accept alternatives e.g. $\mu_A - \mu_B$ etc provided adequately defined. Hypotheses in words only must include "population". Do NOT allow " $\bar{X} = \dots$ " or similar unless \bar{X} is clearly and explicitly stated to be a <u>population</u> mean. For adequate verbal definition. Allow absence of "population" if correct notation μ is used.

Question	Answer	Marks	Guidance
	<p><u>MUST</u> be PAIRED COMPARISON t test. Differences (with – without) are: –1.4 6.6 0.3 15.8 9.7 13.1 –1.0 1.9 –1.5 5.8 $\bar{x} = 4.93$ $s_{n-1} = 6.310(4)$ ($s_{n-1}^2 = 39.822(3)$)</p> <p>Test statistic is $\frac{4.93 - 0}{\frac{6.310}{\sqrt{10}}}$</p> <p style="text-align: center;">= 2.470(4).</p> <p>Refer to t_9. Double-tailed 5% point is ± 2.262.</p> <p>Significant.</p> <p>Sufficient evidence to suggest that the treatment appears to make a difference to the mean percentage oil content of the cereal.</p>	<p>M1 A1</p> <p>M1</p> <p>A1</p> <p>M1 A1</p> <p>A1</p> <p>A1</p> <p>[10]</p>	<p>Allow “without – with” if consistent with alternatives for hypotheses above. Do not allow $s_n = 5.9886$ ($s_n^2 = 35.8401$).</p> <p>Allow c’s \bar{x} and/or s_{n-1}. Allow alternative: $0 + (c’s 2.262) \times \frac{6.3104}{\sqrt{10}}$ (= 4.514) for subsequent comparison with \bar{x}. (Or $\bar{x} - (c’s 2.262) \times \frac{6.3104}{\sqrt{10}}$ (= 0.416) for comparison with 0.)</p> <p>c.a.o. but fit from here in any case if wrong. Use of $10 - \bar{x}$ scores M1A0, but fit.</p> <p>No fit from here if wrong. Must be minus 2.262 for “without – with” unless absolute values are being compared. No fit from here if wrong. $P(t > 2.4704) = 0.03554$.</p> <p>fit only c’s test statistic as long as it includes their $\frac{s}{\sqrt{n}}$</p> <p>fit only c’s test statistic as above Conclusion in context to include “on average” o.e.</p>
3 (iv)	<p>CI is given by $4.93 \pm$</p> <p style="text-align: center;">1.833 $\times \frac{6.3104}{\sqrt{10}}$</p> <p style="text-align: center;">= $4.93 \pm 3.6577 = (1.271(9), 8.588(1))$</p>	<p>M1</p> <p>B1 M1</p> <p>A1</p> <p>[4]</p>	<p>ZERO/4 if not same distribution as test. Same wrong distribution scores maximum M1B0M1A0. Recovery to t_9 is OK. Allow c’s \bar{x}. 1.833 seen. Allow c’s s_{n-1}.</p> <p>c.a.o. Must be expressed as an interval.</p>

Question		Answer	Marks	Guidance
4	(i)	In repeated sampling, 95% of all confidence intervals constructed in this way will contain the true mean.	E1 [1]	
4	(ii)	Mean = $(45.369 + 47.231)/2 = 46.3$ $47.231 = 46.3 + \sqrt{20.3} \times 1.96 / \sqrt{n}$ $n = \frac{1.96^2 \times 20.3}{0.931^2} \approx 89.97(2) \quad \therefore n = 90$	B1 B1 M1 A1 [4]	cao Sight of 1.96. Or equivalent. Must be an integer. FT candidate's mean.
4	(iii)	Time to work $X \sim N(41.3, 11.7)$ Time to home $Y \sim N(44.8, 14.2)$ $X + Y \sim N(86.1, 25.9)$ $P(X + Y < 90) = \Phi\left(\frac{90 - 86.1}{\sqrt{25.9}} = 0.7663\right) = 0.7783$	B1 B1 B1 [3]	Mean Variance cao
4	(iv)	Require $P(Y - X > 5)$ $Y - X \sim N(3.5, 25.9)$ $P(Y - X > 5) = 1 - \Phi\left(\frac{5 - 3.5}{\sqrt{25.9}} = 0.2947\right) = 1 - 0.6159 = 0.3841$	M1 B1 B1 A1 [4]	Allow equivalent alternatives, e.g. $Y > X + 5$ or $X - Y < -5$ Mean Variance cao
4	(v)	Require $P\left(\frac{X_1 + X_2}{2} > \frac{X_3 + X_4 + X_5}{3} + 3\right)$ Mean = $3(41.3 + 41.3) - 2(41.3 + 41.3 + 41.3) = 0$ Variance = $\frac{1}{4}(11.7 + 11.7) + \frac{1}{9}(11.7 + 11.7 + 11.7) = 9.75$	M1 A1 B1 M1 A1	For considering some \bar{X}_2 and \bar{X}_3 For $\bar{X}_2 - \bar{X}_3 > 3$ For 0 For 1/4, 1/9, and 11.7 seen o.e. For 9.75

Question			Answer	Marks	Guidance
			$P(Z > \frac{3-0}{\sqrt{9.75}}) = 1 - 0.8317 = 0.1683$	A1	cao
				[6]	

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GCE Mathematics (MEI)			Max Mark	a	b	c	d	e	u
4751	01 C1 – MEI Introduction to advanced mathematics (AS)	Raw	72	63	58	53	48	43	0
		UMS	100	80	70	60	50	40	0
4752	01 C2 – MEI Concepts for advanced mathematics (AS)	Raw	72	56	50	44	39	34	0
		UMS	100	80	70	60	50	40	0
4753	01 (C3) MEI Methods for Advanced Mathematics with Coursework: Written Paper	Raw	72	56	51	46	41	36	0
4753	02 (C3) MEI Methods for Advanced Mathematics with Coursework: Coursework	Raw	18	15	13	11	9	8	0
4753	82 (C3) MEI Methods for Advanced Mathematics with Coursework: Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
		UMS	100	80	70	60	50	40	0
4754	01 C4 – MEI Applications of advanced mathematics (A2)	Raw	90	74	67	60	54	48	0
		UMS	100	80	70	60	50	40	0
4755	01 FP1 – MEI Further concepts for advanced mathematics (AS)	Raw	72	62	57	53	49	45	0
		UMS	100	80	70	60	50	40	0
4756	01 FP2 – MEI Further methods for advanced mathematics (A2)	Raw	72	65	58	52	46	40	0
		UMS	100	80	70	60	50	40	0
4757	01 FP3 – MEI Further applications of advanced mathematics (A2)	Raw	72	59	52	46	40	34	0
		UMS	100	80	70	60	50	40	0
4758	01 (DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	63	57	51	45	38	0
4758	02 (DE) MEI Differential Equations with Coursework: Coursework	Raw	18	15	13	11	9	8	0
4758	82 (DE) MEI Differential Equations with Coursework: Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
		UMS	100	80	70	60	50	40	0
4761	01 M1 – MEI Mechanics 1 (AS)	Raw	72	62	54	46	39	32	0
		UMS	100	80	70	60	50	40	0
4762	01 M2 – MEI Mechanics 2 (A2)	Raw	72	54	47	40	33	27	0
		UMS	100	80	70	60	50	40	0
4763	01 M3 – MEI Mechanics 3 (A2)	Raw	72	64	56	48	41	34	0
		UMS	100	80	70	60	50	40	0
4764	01 M4 – MEI Mechanics 4 (A2)	Raw	72	53	45	38	31	24	0
		UMS	100	80	70	60	50	40	0
4766	01 S1 – MEI Statistics 1 (AS)	Raw	72	61	54	47	41	35	0
		UMS	100	80	70	60	50	40	0
4767	01 S2 – MEI Statistics 2 (A2)	Raw	72	65	60	55	50	46	0
		UMS	100	80	70	60	50	40	0
4768	01 S3 – MEI Statistics 3 (A2)	Raw	72	64	58	52	47	42	0
		UMS	100	80	70	60	50	40	0
4769	01 S4 – MEI Statistics 4 (A2)	Raw	72	56	49	42	35	28	0
		UMS	100	80	70	60	50	40	0
4771	01 D1 – MEI Decision mathematics 1 (AS)	Raw	72	56	51	46	41	37	0
		UMS	100	80	70	60	50	40	0
4772	01 D2 – MEI Decision mathematics 2 (A2)	Raw	72	54	49	44	39	34	0
		UMS	100	80	70	60	50	40	0
4773	01 DC – MEI Decision mathematics computation (A2)	Raw	72	46	40	34	29	24	0
		UMS	100	80	70	60	50	40	0
4776	01 (NM) MEI Numerical Methods with Coursework: Written Paper	Raw	72	56	50	45	40	34	0
4776	02 (NM) MEI Numerical Methods with Coursework: Coursework	Raw	18	14	12	10	8	7	0
4776	82 (NM) MEI Numerical Methods with Coursework: Carried Forward Coursework Mark	Raw	18	14	12	10	8	7	0
		UMS	100	80	70	60	50	40	0
4777	01 NC – MEI Numerical computation (A2)	Raw	72	55	47	39	32	25	0
		UMS	100	80	70	60	50	40	0
4798	01 FPT - Further pure mathematics with technology (A2)	Raw	72	57	49	41	33	26	0
		UMS	100	80	70	60	50	40	0

GCE Statistics (MEI)										
			Max Mark	a	b	c	d	e	u	
G241	01	Statistics 1 MEI (Z1)	Raw	72	61	54	47	41	35	0
			UMS	100	80	70	60	50	40	0
G242	01	Statistics 2 MEI (Z2)	Raw	72	55	48	41	34	27	0
			UMS	100	80	70	60	50	40	0
G243	01	Statistics 3 MEI (Z3)	Raw	72	56	48	41	34	27	0
			UMS	100	80	70	60	50	40	0

GCE Quantitative Methods (MEI)										
			Max Mark	a	b	c	d	e	u	
G244	01	Introduction to Quantitative Methods MEI	Raw	72	58	50	43	36	28	0
G244	02	Introduction to Quantitative Methods MEI	Raw	18	14	12	10	8	7	0
			UMS	100	80	70	60	50	40	0
G245	01	Statistics 1 MEI	Raw	72	61	54	47	41	35	0
			UMS	100	80	70	60	50	40	0
G246	01	Decision 1 MEI	Raw	72	56	51	46	41	37	0
			UMS	100	80	70	60	50	40	0