OCR
RECOGNISING ACHIEVEMENT

Friday 21 June 2013 – 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 in the centre of 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.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- 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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- 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.

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1 In the past, the times for workers in a factory to complete a particular task had a known median of 7.4 minutes. Following a review, managers at the factory wish to know if the median time to complete the task has been reduced.

(i) A random sample of 12 times, in minutes, gives the following results.

6.90 7.23 6.54 7.62 7.04 7.33 6.74 6.45 7.81 7.71 7.50 6.32

Carry out an appropriate test using a 5% level of significance. **[10]**

(ii) Some time later, a much larger random sample of times gives the following results.

$$n = 80 \qquad \Sigma x = 555.20 \qquad \Sigma x^2 = 3863.9031$$

Find a 95% confidence interval for the true mean time for the task. Justify your choice of which distribution to use. **[6]**

(iii) Describe briefly one advantage and one disadvantage of having a 99% confidence interval instead of a 95% confidence interval. **[2]**

2 A company supplying cattle feed to dairy farmers claims that its new brand of feed will increase average milk yields by 10 litres per cow per week. A farmer thinks the increase will be less than this and decides to carry out a statistical investigation using a paired *t* test. A random sample of 10 dairy cows are given the new feed and then their milk yields are compared with their yields when on the old feed. The yields, in litres per week, for the 10 cows are as follows.

Cow	A	B	C	D	E	F	G	H	I	J
Old feed	144	130	132	146	137	140	140	149	138	133
New feed	148	139	138	159	138	148	146	156	147	145

(i) Why is it sensible to use a paired test? **[1]**

(ii) State the condition necessary for a paired *t* test. **[2]**

(iii) Assuming the condition stated in part **(ii)** is met, carry out the test, using a significance level of 5%, to see whether it appears that the company's claim is justified. **[10]**

(iv) Find a 95% confidence interval for the mean increase in the milk yield using the new feed. **[4]**

3 The random variable X has the following probability density function, $\mathrm{f}(x)$.

$$\mathrm{f}(x) = \begin{cases} kx(x-5)^2 & 0 \leqslant x < 5 \\ 0 & \text{elsewhere} \end{cases}$$

(i) Sketch $\mathrm{f}(x)$. **[3]**

(ii) Find, in terms of k, the cumulative distribution function, $\mathrm{F}(x)$. **[3]**

(iii) Hence show that $k = \frac{12}{625}$. **[2]**

The random variable X is proposed as a model for the amount of time, in minutes, lost due to stoppages during a football match. The times lost in a random sample of 60 matches are summarised in the table. The table also shows some of the corresponding expected frequencies given by the model.

Time (minutes)	$0 \leqslant x < 1$	$1 \leqslant x < 2$	$2 \leqslant x < 3$	$3 \leqslant x < 4$	$4 \leqslant x < 5$
Observed frequency	5	15	23	11	6
Expected frequency			17.76	9.12	1.632

(iv) Find the remaining expected frequencies. **[3]**

(v) Carry out a goodness of fit test, using a significance level of 2.5%, to see if the model might be suitable in this context. **[8]**

4 A company that makes meat pies includes a "small" size in its product range. These pies consist of a pastry case and meat filling, the weights of which are independent of each other. The weight of the pastry case, C, is Normally distributed with mean 96 g and variance 21 g^2. The weight of the meat filling, M, is Normally distributed with mean 57 g and variance 14 g^2.

(i) Find the probability that, in a randomly chosen pie, the weight of the pastry case is between 90 and 100 g. **[4]**

(ii) The wrappers on the pies state that the weight is 145 g. Find the proportion of pies that are underweight. **[3]**

(iii) The pies are sold in packs of 4. Find the value of w such that, in 95% of packs, the total weight of the 4 pies in a randomly chosen pack exceeds w g. **[5]**

(iv) It is required that the weight of the meat filling in a pie should be at least 35% of the total weight. Show that this means that $0.65M - 0.35C \geqslant 0$. Hence find the probability that, in a randomly chosen pie, this requirement is met. **[6]**

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE.

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Candidate forename		Candidate surname	

Centre number						Candidate number				

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Turn over

1 (i)	
	(answer space continued on next page)

1 (i)	**(continued)**
1 (ii)	

1 (iii)	
2 (i)	
2 (ii)	
2 (iii)	
	(answer space continued on next page)

2 (iii)	(continued)

2 (iv)	
3 (i)	

3 (ii)	
3 (iii)	

3 (iv)	

3 (v)

4 (i)	
4 (ii)	

4 (iii)	
4 (iv)	
	(answer space continued on next page)

4 (iv)	(continued)

GCE

Mathematics (MEI)

Advanced GCE

Unit **4768:** Statistics 3

Mark Scheme for June 2013

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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

Annotations and abbreviations

Annotation 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.

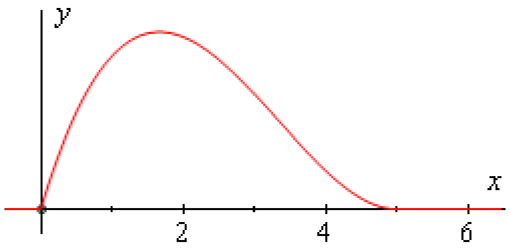
Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

Question			Answer	Marks	Guidance
1	(i)		H_0: $m = 7.4$ H_1: $m < 7.4$ where m is the population median time.	B1 B1	Both. Accept hypotheses in words, but must include "population". Do NOT allow symbols other than m unless clearly and explicitly stated to be a population median. Adequate definition of m to include "population".
			(see table below)	M1 M1 A1	for subtracting 7.4. for ranking. All correct. ft if ranks wrong.
			$W_+ = 2 + 4 + 5 + 7 = 18$	B1	($W_- = 1 + 3 + 6 + 8 + 9 + 10 + 11 + 12 = 60$)
			Refer to Wilcoxon single sample tables for $n = 12$.	M1	No ft from here if wrong.
			Lower 5% point is 17 (or upper is 61 if 60 used).	A1	i.e. a 1-tail test. No ft from here if wrong.
			Result is not significant.	A1	ft only c's test statistic.
			Insufficient evidence to suggest that the median time has been reduced.	A1	ft only c's test statistic. Conclusion in context.
				[10]	

Times	−7.4	Rank of |diff|
6.90	−0.50	8
7.23	−0.17	3
6.54	−0.86	10
7.62	0.22	4
7.04	−0.36	6
7.33	−0.07	1
6.74	−0.66	9
6.45	−0.95	11
7.81	0.41	7
7.71	0.31	5
7.50	0.10	2
6.32	−1.08	12

Question			Answer	Marks	Guidance
1	(ii)		$\bar{x} = 6.94 \quad s = 0.37$	B1	Accept $s^2 = 0.1369$. Beware use of msd (0.13518875) or rmsd (0.3676(8)). Do not allow here or below.
			CI is given by 6.94 ±	M1	ft c's $\bar{x}$ ±.
			1.96	B1	1.96 seen.
			$\times \frac{0.37}{\sqrt{80}}$	M1	ft c's s but not rmsd.
			= 6.94 ± 0.0811 = (6.859, 7.021)	A1	c.a.o. Must be expressed as an interval. [rmsd gives 6.94 ± 0.0805(7) = (6.8594(2), 7.0205(7))]
			Normal distribution can be used because the sample size is large enough for the Central Limit Theorem to apply.	E1	CLT essential
				[6]	
1	(iii)		Advantage: A 99% confidence interval is more likely to contain the true mean.	E1	O.e.
			Disadvantage: A 99% confidence interval is less precise/wider.	E1	O.e.
				[2]	
2	(i)		A paired test would eliminate any differences between individual cattle.	E1	
				[1]	
2	(ii)		Must assume: Normality of population …	B1	
			… of differences.	B1	
				[2]	

Question			Answer	Marks	Guidance
2	(iii)		H_0: $\mu_D = 10$ H_1: $\mu_D < 10$	B1	Both. Accept alternatives e.g. $\mu_D > -10$ for H_1, or $\mu_A - \mu_B$ etc provided adequately defined. Hypotheses in words only must include "population". Do NOT allow "$\bar{X} = \ldots$" or similar unless $\bar{X}$ is clearly and explicitly stated to be a <u>population</u> mean.
			Where μ_D is the (population) mean increase/difference in milk yield. <u>MUST</u> be PAIRED COMPARISON *t* test.	B1	For adequate verbal definition. Allow absence of "population" if correct notation μ is used.
			Differences (increases) (after – before) are: 4 9 6 13 1 8 6 7 9 12	M1	Allow "before – after" if consistent with alternatives for hypotheses above.
			$\bar{x} = 7.5 \quad s_{n-1} = 3.566(8) \quad (s_{n-1}^2 = 12.722(2))$	A1	Do not allow $s_n = 3.3837$ ($s_n^2 = 11.45$).
			Test statistic is $\dfrac{7.5 - 10}{\frac{3.5668}{\sqrt{10}}}$	M1	Allow c's $\bar{x}$ and/or s_{n-1}. Allow reversed numerator compared with 2.2164 Allow alternative: 10 – (c's 1.833) × $\dfrac{3.5668}{\sqrt{10}}$ (= 7.933) for subsequent comparison with $\bar{x}$. (Or $\bar{x}$ + (c's 1.833) × $\dfrac{3.5668}{\sqrt{10}}$ (= 9.567) for comparison with 10.)
			= –2.2164.	A1	c.a.o. but ft from here in any case if wrong. Use of $10 - \bar{x}$ scores M1A0, but ft.
			Refer to t_9.	M1	No ft from here if wrong.
			Single-tailed 5% point is –1.833.	A1	Must be minus 1.833 unless absolute values are being compared. No ft from here if wrong. P($t < -2.2164$) = 0.0269.
			Significant.	A1	ft only c's test statistic.
			Sufficient evidence to suggest that the mean milk yield has not increased by 10 litres (per cow per week).	A1	ft only c's test statistic. Conclusion in context to include "on average" o.e. Accept "Sufficient evidence to suggest that the **company's** claim is not justified." o.e.
				[10]	

Question			Answer	Marks	Guidance
2	(iv)		CI is given by $7.5 \pm$ $2{\cdot}262$ $\times \dfrac{3.5668}{\sqrt{10}}$ $= 7.5 \pm 2.5514 = (4.948, 10.052)$	M1 B1 M1 A1 **[4]**	ZERO/4 if not same distribution as test. Same wrong distribution scores maximum M1B0M1A0. Recovery to t_9 is OK. Allow c's $\bar{x}$. 2.262 seen. Allow c's s_{n-1}. c.a.o. Must be expressed as an interval.
3	(i)			G1 G1 G1 **[3]**	Curve, through the origin and in the first quadrant only. A single maximum; curve returns to $y = 0$; nothing to the right of $x = 5$. No t.pt at $x = 0$; t.pt. at $x = 5$; (5, 0) labelled (p.i. by an indicated scale).
3	(ii)		$\text{F}(x) = k\int_0^x t(t-5)^2\,\text{d}t$ $= k\left[\dfrac{t^4}{4} - \dfrac{10t^3}{3} + \dfrac{25t^2}{2}\right]_0^x$ $= k\left(\dfrac{x^4}{4} - \dfrac{10x^3}{3} + \dfrac{25x^2}{2}\right)$	M1 M1 A1 **[3]**	Correct integral for F(x) with limits (which may appear later). Correctly integrated. Limits used correctly to obtain expression. Condone absence of "–0". Do not require complete definition of F(x). Dependent on both M1's

Question			Answer	Marks	Guidance
3	(iii)		$F(5) = 1$ $\therefore k\left(\frac{5^4}{4} - \frac{10\times 5^3}{3} + \frac{25\times 5^2}{2}\right) = 1$ $\therefore k\left(\frac{1875 - 5000 + 3750}{12}\right) = 1$ $\therefore k \times \frac{625}{12} = 1$ $\therefore k = \frac{12}{625}$	M1 A1 **[2]**	Substitute $x = 5$ and equate to 1. Expect to see evidence of at least this line of working (oe) for A1. Convincingly shown. Beware printed answer.
3	(iv)		For $0 \le x < 1$, Expected f = 60 × F(1) $= 60 \times \frac{12}{625}\left(\frac{1^4}{4} - \frac{10\times 1^3}{3} + \frac{25\times 1^2}{2}\right) = 10.848$ For $1 \le x < 2$, Expected f = 60 – Σ(the rest) = 20.64	M1 A1 B1 **[3]**	Use of 60 × F(x) with correct k. Allow also 31.488 – frequency for $1 \le x < 2$ provided that one found using F(x). Allow either frequency found by integration. FT 31.488 – previous answer. Or allow 60 × (F(2) – F(1))

Question			Answer	Marks	Guidance
3	(v)		H_0: The model is suitable / fits the data. H_1: The model is not suitable / does not fit the data.	B1	Both hypotheses. Must be the right way round. Do not accept "data fit model" oe.
			Merge last 2 cells: Obs f = 17, Exp f = 10.752	M1	
			$X^2 = 3.1525 + 1.5411 + 1.5460 + 3.6307$	M1	Calculation of X^2.
			$= 9.870$	A1	c.a.o.
			Refer to χ_3^2.	M1	Allow correct df (= cells – 1) from wrongly grouped table and ft. Otherwise, no ft if wrong.
			Upper 2.5% point is 9.348.	A1	No ft from here if wrong. $P(X^2 > 9.870) = 0.0197$.
			Significant.	A1	ft only c's test statistic.
			Sufficient evidence to suggest that the model is not suitable in this context.	A1	ft only c's test statistic. Conclusion in context. Do not accept "data do not fit model" oe.
				[8]	
4			$C \sim N(96, 21)$ $M \sim N(57, 14)$		When a candidate's answers suggest that (s)he appears to have neglected to use the difference columns of the Normal distribution tables penalise the first occurrence only.
4	(i)		$P(90 < C < 100)$		
			$= P\left(\frac{90-96}{\sqrt{21}} < Z < \frac{100-96}{\sqrt{21}}\right)$	M1	For standardising. Award once, here or elsewhere. SC – candidates with consistent variances of 21² and 14² can be awarded all M and B marks
			$= P(-1.3093 < Z < 0.8729)$	A1	Either side correct. SC – 0.2857, 0.1905
			$= 0.8086 - (1 - 0.9047)$	A1	Both table values correct. Or 0.8086 – 0.0953 SC 0.5755 – (1 – 0.6125)
			$= 0.7133$	A1	c.a.o.
				[4]	
4	(ii)		Total weight $T \sim N(153, 35)$	B1	Mean.
				B1	Variance. Accept sd = 5.916… SC 637 sd = 25.239
			$P(T < 145) = P\left(Z < \frac{145-153}{\sqrt{35}} = -1.3522\right)$		
			$= 1 - 0.9118 = 0.0882$	A1	c.a.o.
				[3]	

Question			Answer	Marks	Guidance
4	(iii)		$T_1 + T_2 + T_3 + T_4 \sim \text{N}(612, 140)$	B1 B1	Mean. Variance. Accept sd = 11.832… SC = 2548 sd = 50.478
			Require w such that P(this > w) = 0.95	M1	
			$\therefore w = 612 - 1.645 \times \sqrt{140}$	B1	1.645 seen.
			= 592.5(3)	A1	c.a.o.
				[5]	
4	(iv)		Require $M \geq 0.35(M + C)$	M1	Formulate requirement.
			$\therefore 0.65M \geq 0.35C$		
			$\therefore 0.65M - 0.35C \geq 0$	A1	Convincingly shown. Beware printed answer.
			$0.65M - 0.35C \sim$	B1	Mean.
			N((0.65 × 57) – (0.35 × 96) = 3.45,	M1	For use of at least one of $0.65^2 \times \ldots$ or $0.35^2 \times \ldots$
			$(0.65^2 \times 14) + (0.35^2 \times 21) = 8.4875$)	A1	Variance. Accept sd = 2.913… SC variance = 136.83 sd = 11.70
			P(This ≥ 0) $= \text{P}\left(Z \geq \frac{0 - 3.45}{\sqrt{8.4875}} = -1.1842 \right)$		
			= 0.8818	A1	c.a.o.
				[6]	

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GCE

Mathematics (MEI)

Advanced GCE **A2 7895-8**

Advanced Subsidiary GCE **AS 3895-8**

OCR Report to Centres

June 2013

4768 Statistics 3

General Comments

As might be expected on a question paper at this level, the scripts indicated that most candidates knew what they were doing most of the time. In addition, there were very few scripts which showed evidence of candidates running out of time. In general, candidates seemed to be far more comfortable carrying out calculations than with the other requirements of the paper such as producing hypotheses and conclusions, interpreting results and providing definitions. In addition, as in January, many scripts suffered from a lack of precision. This manifested itself in many ways; inadequate hypotheses, over-assertive conclusions, over-specified final answers (yet too little accuracy carried forward in calculations), inaccurate reading of tables, and a large number of scripts which were very difficult to read.

Comments on Individual Questions

1 **Task in a factory – Wilcoxon single sample test**

1(i) Most candidates were able to score well on this part, with full marks being the most common outcome. However, a large number of candidates lost marks through a lack of precision in the presentation of the hypotheses and conclusion. The hypotheses should concern the population parameter *m*, which should then be defined as the *population* median time. Most candidates knew to subtract 7.4 and to rank the absolute values. Only a few ranked from largest to smallest. Most candidates were able to obtain the correct critical value from the relevant table, and only a few thought the test value to be significant. Many conclusions were either too assertive or lacked context.

1(ii) Most candidates are able to construct a confidence interval correctly. A few candidates used 1.645 instead of 1.96 and many gave anything up to 10 significant figures in their interval. . It was pleasing to see the overwhelming majority of candidates correctly opted to use s_{n-1} rather than s_n, but a surprising number were unable to use the standard deviation formula correctly. To justify the use of the Normal distribution many candidates simply stated that *n* was large, which was insufficient. The use of the Central Limit Theorem was required.
Ans: (6.859, 7.021)

1(iii) This part question produced one of the weakest responses from the candidates. Some candidates were able to give succinct responses about the probability of capturing the population mean and the width of the interval; others tended to give much longer responses which often included a discussion of imaginary hypotheses.

2 **Milk yields – paired *t* test**

2(i) About half of the candidates realised that the elimination of the differences between cows was the key point. Others wanted to eliminate the difference between feeds and many felt that a paired test was appropriate simply because there were two sets of data.

2(ii) The great majority of candidates were able to score at least one mark here, usually for the normality of the population. However, many did not mention that it was the normality of the differences that was important, and many that did failed to mention that it was the population of differences.

2(iii) This part was answered very well by most candidates, with full marks being the most common score. Again, the most common causes of lost marks were inadequate hypotheses and over-assertive conclusions. Most candidates were able to find the differences and then calculate the values of $\bar{x}$ and s_{n-1} correctly, with very few using s_n. The test statistic was almost invariably calculated correctly and compared with the correct value of *t*. Occasionally the degrees of freedom were incorrectly stated, with 8, 10 and 11 all seen. A few candidates also used the two-tailed 5% point rather than the single-tailed. A few candidates felt the result was not significant and some gave conclusions without context.

2(iv) Again, most candidates showed that they were able to construct a confidence interval. There were a small minority of candidates who switched to the Normal distribution and this was a costly error. A significant number of candidates gave too many significant figures in their answer. A few candidates appeared to misread the questions as the *mean increased yield*.
Ans: (4.948, 10.05)

3 **Stoppages during a football match – probability density function and goodness of fit test**

3(i) Most candidates were able to produce a reasonable sketch. The most common error by far was a lack of a stationary point at $x = 5$. Only a few sketches involved values of x outside the range $0 \le x \le 5$. Very few sketches had the wrong basic shape.

3 (ii) Virtually all candidates knew that they had to integrate $\mathrm{f}(x)$, but many produced an integral with no limits at all, or even with limits of 0 and 5. A smaller minority of candidates claimed that $\mathrm{F}(x) = \int_0^t \mathrm{f}(x)dx$. Not surprisingly, virtually all candidates were able to integrate $\mathrm{f}(x)$.

3(iii) This part was very well done with virtually all candidates stating F(5) = 1. Candidates do need to be aware that full working needs to be shown when the final answer has been given in the question.

3(iv) This part was extremely well done.
Ans: 10.848, 20.64

3(v) Most candidates knew how to carry out this test with full marks often seen. Most candidates were able to give satisfactory hypotheses, although some gave too little detail with hypotheses like “fits” and “does not fit”. Candidates were expected to merge the last two cells and most did so. A small minority also merged the first two cells. The calculation of X^2 was, in general, correctly done and compared with the correct value of χ_3^2. Candidates who had not merged cells as expected were given credit for the work that followed. A few candidates felt that a value of X^2 in excess of the critical value was not a significant result.

4 **Meat pies – linear combinations of Normal distributions**

4(i) Many candidates misinterpreted the information given in this question. This affected all parts of the question. The information given was variance $21\,\text{g}^2$, but many interpreted this to mean that the variance was 21^2.
In general candidates were comfortable with this part of the question and scored well.
Ans: 0.7133

4(ii) The vast majority of candidates knew what to do here and only a few candidates read the tables inaccurately or chose the wrong tail.
Ans: 0.0882

4(iii) Most candidates were able to find the mean and variance of the total weight of 4 pies, although a few multiplied the variance of 1 pie by 16. The great majority gave the correct value of 1.645, although 1.96 was occasionally seen. A few candidates then gave a value in the wrong tail.
Ans: 592.5

4(iv) This part led to a wide range of responses from candidates. The demonstration that $0.65M - 0.35C \geq 0$ led to a large number of vague attempts at justification. Many included a mixture of equalities and inequalities. Others revolved around equating the weight of a pie to 1. Many candidates made no serious attempt.

In the calculation, most candidates were able to find the mean of the distribution, but many made errors in the variance. The most common errors were the use of 0.65 and 0.35 instead of their squares, subtracting the two variances instead of adding and using the multipliers the wrong way round.
Ans: 0.8818

For a description of how UMS marks are calculated see:
www.ocr.org.uk/learners/ums_results.html

Unit level raw mark and UMS grade boundaries June 2013 series

AS GCE / Advanced GCE / AS GCE Double Award / Advanced GCE Double Award

GCE Mathematics (MEI)

		Max Mark	a	b	c	d	e	u
4751/01 (C1) MEI Introduction to Advanced Mathematics	Raw	72	62	56	51	46	41	0
	UMS	100	80	70	60	50	40	0
4752/01 (C2) MEI Concepts for Advanced Mathematics	Raw	72	54	48	43	38	33	0
	UMS	100	80	70	60	50	40	0
4753/01 (C3) MEI Methods for Advanced Mathematics with Coursework: Written Paper	Raw	72	58	52	46	40	33	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
4753 (C3) MEI Methods for Advanced Mathematics with Coursework	UMS	100	80	70	60	50	40	0
4754/01 (C4) MEI Applications of Advanced Mathematics	Raw	90	66	59	53	47	41	0
	UMS	100	80	70	60	50	40	0
4755/01 (FP1) MEI Further Concepts for Advanced Mathematics	Raw	72	63	57	51	45	40	0
	UMS	100	80	70	60	50	40	0
4756/01 (FP2) MEI Further Methods for Advanced Mathematics	Raw	72	61	54	48	42	36	0
	UMS	100	80	70	60	50	40	0
4757/01 (FP3) MEI Further Applications of Advanced Mathematics	Raw	72	60	52	44	36	28	0
	UMS	100	80	70	60	50	40	0
4758/01 (DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	62	56	51	46	40	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
4758 (DE) MEI Differential Equations with Coursework	UMS	100	80	70	60	50	40	0
4761/01 (M1) MEI Mechanics 1	Raw	72	57	49	41	33	25	0
	UMS	100	80	70	60	50	40	0
4762/01 (M2) MEI Mechanics 2	Raw	72	50	43	36	29	22	0
	UMS	100	80	70	60	50	40	0
4763/01 (M3) MEI Mechanics 3	Raw	72	64	56	48	41	34	0
	UMS	100	80	70	60	50	40	0
4764/01 (M4) MEI Mechanics 4	Raw	72	56	49	42	35	29	0
	UMS	100	80	70	60	50	40	0
4766/01 (S1) MEI Statistics 1	Raw	72	55	48	41	35	29	0
	UMS	100	80	70	60	50	40	0
4767/01 (S2) MEI Statistics 2	Raw	72	58	52	46	41	36	0
	UMS	100	80	70	60	50	40	0
4768/01 (S3) MEI Statistics 3	Raw	72	61	55	49	44	39	0
	UMS	100	80	70	60	50	40	0
4769/01 (S4) MEI Statistics 4	Raw	72	56	49	42	35	28	0
	UMS	100	80	70	60	50	40	0
4771/01 (D1) MEI Decision Mathematics 1	Raw	72	58	52	46	40	35	0
	UMS	100	80	70	60	50	40	0
4772/01 (D2) MEI Decision Mathematics 2	Raw	72	58	52	46	41	36	0
	UMS	100	80	70	60	50	40	0
4773/01 (DC) MEI Decision Mathematics Computation	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	44	38	31	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
4776 (NM) MEI Numerical Methods with Coursework	UMS	100	80	70	60	50	40	0
4777/01 (NC) MEI Numerical Computation	Raw	72	55	47	39	32	25	0
	UMS	100	80	70	60	50	40	0
4798/01 (FPT) Further Pure Mathematics with Technology	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 (Z1) Statistics 1	Raw	72	55	48	41	35	29	0
	UMS	100	80	70	60	50	40	0
G242/01 (Z2) Statistics 2	Raw	72	55	48	41	34	27	0
	UMS	100	80	70	60	50	40	0
G243/01 (Z3) Statistics 3	Raw	72	56	48	41	34	27	0
	UMS	100	80	70	60	50	40	0