

ADVANCED GCE MATHEMATICS (MEI)

4767/01

Statistics 2

TUESDAY 15 JANUARY 2008

Morning

Time: 1 hour 30 minutes

Additional materials: Answer Booklet (8 pages)

Graph paper

MEI Examination Formulae and Tables (MF2)

INSTRUCTIONS TO CANDIDATES

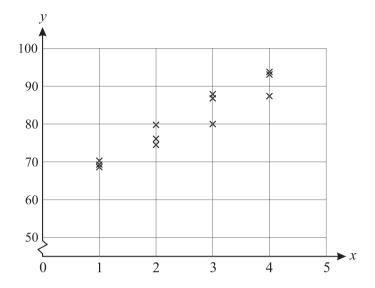
- Write your name, centre number and candidate number in the spaces provided on the answer booklet.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- You are permitted to use a graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is 72.
- 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.

This document consists of 4 printed pages.

A biology student is carrying out an experiment to study the effect of a hormone on the growth of plant shoots. The student applies the hormone at various concentrations to a random sample of twelve shoots and measures the growth of each shoot. The data are illustrated on the scatter diagram below, together with the summary statistics for these data. The variables *x* and *y*, measured in suitable units, represent concentration and growth respectively.



$$n = 12$$
, $\Sigma x = 30$, $\Sigma y = 967.6$, $\Sigma x^2 = 90$, $\Sigma y^2 = 78926$, $\Sigma xy = 2530.3$.

- (i) State which of the two variables x and y is the independent variable and which is the dependent variable. Briefly explain your answers. [3]
- (ii) Calculate the equation of the regression line of y on x.
- (iii) Use the equation of the regression line to calculate estimates of shoot growth for concentrations of
 - (*A*) 1.2,
 - (*B*) 4.3.

Comment on the reliability of each of these estimates.

[4]

[5]

- (iv) Calculate the value of the residual for the data point where x = 3 and y = 80. [3]
- (v) In further experiments, the student finds that using concentration x = 6 results in shoot growths of around y = 20. In the light of all the available information, what can be said about the relationship between x and y?

© OCR 2008 4767/01 Jan08

- A large hotel has 90 bedrooms. Sometimes a guest makes a booking for a room, but then does not arrive. This is called a 'no-show'. On average 10% of bookings are no-shows. The hotel manager accepts up to 94 bookings before saying that the hotel is full. If at least 4 of these bookings are no-shows then there will be enough rooms for all of the guests. 94 bookings have been made for each night in August. You should assume that all bookings are independent.
 - (i) State the distribution of the number of no-shows on one night in August. [2]
 - (ii) State the conditions under which the use of a Poisson distribution is appropriate as an approximation to a binomial distribution. [2]
 - (iii) Use a Poisson approximating distribution to find the probability that, on one night in August,
 - (A) there are exactly 4 no-shows,
 - (B) there are enough rooms for all of the guests who do arrive.

[5]

[4]

- (iv) Find the probability that, on all of the 31 nights in August, there are enough rooms for all of the guests who arrive. [2]
- (v) (A) In August there are $31 \times 94 = 2914$ bookings altogether. State the exact distribution of the total number of no-shows during August. [2]
 - (B) Use a suitable approximating distribution to find the probability that there are at most 300 no-shows altogether during August. [5]
- 3 In a large population, the diastolic blood pressure (DBP) of 5-year-old children is Normally distributed with mean 56 and standard deviation 6.5.
 - (i) Find the probability that the DBP of a randomly selected 5-year-old child is between 52.5 and 57.5.

The DBP of young adults is Normally distributed with mean 68 and standard deviation 10.

- (ii) A 5-year-old child and a young adult are selected at random. Find the probability that the DBP of one of them is over 62 and the other is under 62. [5]
- (iii) Sketch both distributions on a single diagram.
- (iv) For another age group, the DBP is Normally distributed with mean 82. The DBP of 12% of people in this age group is below 62. Find the standard deviation for this age group. [4]

[Question 4 is printed overleaf.]

© OCR 2008 4767/01 Jan08

4 (a) A researcher believes that there may be some association between a student's sex and choice of certain subjects at A-level. A random sample of 250 A-level students is selected. The table below shows, for each sex, how many study either or both of the two subjects, Mathematics and English.

	Mathematics only	English only	Both	Neither	Row totals
Male	38	19	6	32	95
Female	42	55	9	49	155
Column totals	80	74	15	81	250

Carry out a test at the 5% significance level to examine whether there is any association between a student's sex and choice of subjects. State carefully your null and alternative hypotheses. Your working should include a table showing the contributions of each cell to the test statistic. [12]

(b) Over a long period it has been determined that the mean score of students in a particular English module is 67.4 and the standard deviation is 8.9. A new teaching method is introduced with the aim of improving the results. A random sample of 12 students taught by the new method is selected. Their mean score is found to be 68.3. Carry out a test at the 10% level to investigate whether the new method appears to have been successful. State carefully your null and alternative hypotheses. You should assume that the scores are Normally distributed and that the standard deviation is unchanged.

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (OCR) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

OCR is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.

© OCR 2008 4767/01 Jan08

4767 Statistics 2

(i)	x is independent, y is dependent since the values of x are chosen by the student	B1 E1 dep	
	but the values of y are dependent on x	E1 dep	3
(ii)	\bar{x} = 2.5, \bar{y} = 80.63	B1 for \bar{x} and \bar{y} used	
	$Sxy = 2530.3 - 30 \times 967.6/12 = 111.3 = 7.42$	(SOI)	
	$b = \frac{Sxy}{Sxx} = \frac{2530.3 - 30 \times 967.6/12}{90 - 30^2/12} = \frac{111.3}{15} = 7.42$		
		M1 for attempt at gradient (b)	
	OR $b = \frac{2530.3/12 - 2.50 \times 80.63}{90/12 - 2.50^2} = \frac{9.275}{1.25} = 7.42$	A1 for 7.42 cao	
	Hence least squares regression line is: $y - \overline{y} = b(x - \overline{x})$	M1 for equation of line	
	\Rightarrow y - 80.63 = 7.42(x - 2.5)	A1 FT (b>0) for complete	_
	\Rightarrow y = 7.42x + 62.08	equation	5
(iii)	(A) For $x = 1.2$, predicted growth	M1 for at least one	
	$= 7.42 \times 1.2 + 62.08 = 71.0$	prediction attempted.	
	(B) For $x = 4.3$, predicted growth = $7.42 \times 4.3 + 62.08 = 94.0$	A1 for both answers (FT their equation if <i>b</i> >0)	
	= 7.42 ·· 4.5 · 02.00 = 54.0	(i i aion equation ii z e)	
	Valid relevant comments relating to the predictions such as :		
	Comment re interpolation/extrapolation Comment relating to the fact that $x = 4.3$ is only just	E1 (first comment)	4
	beyond the existing data.	E1 (second comment)	
	Comment relating to size of residuals near each		
	predicted value (need not use word 'residual')		
(iv)	$x = 3 \Rightarrow$	M1 for prediction	
	predicted $y = 7.42 \times 3 + 62.08 = 84.3$ Residual = $80 - 84.3 = -4.3$	M1 for subtraction	
	Residual	A1 FT (<i>b</i> >0)	3
	This point is a long or or of the second of	, ,	
(v)	This point is a long way from the regression line. The line may be valid for the range used in the	E1 E1 for valid in range	
	experiment but then the relationship may break down	E1 for either 'may	
	for higher concentrations, or the relationship may be	break down' <i>or</i>	
	non linear.	'could be non linear'	3
		or other relevant	
		comment	18
			10

(i)	Binomial (94,0.1)	B1 for binomial B1 dep for parameters	2
(ii)	n is large and p is small	B1, B1 Allow appropriate numerical ranges	2
(iii)	$\lambda = 94 \times 0.1 = 9.4$	B1 for mean	
	(A) $P(X = 4) = e^{-9.4} \frac{9.4^4}{4!} = 0.0269 \text{ (3 s.f.)}$ or from tables = $0.0429 - 0.0160 = 0.0269 \text{ cao}$ (B) Using tables: $P(X \ge 4) = 1 - P(X \le 3)$ = $1 - 0.0160 = 0.9840 \text{ cao}$	M1 for calculation or use of tables A1 M1 for attempt to find $P(X \ge 4)$ A1 cao	5
(iv)	P(sufficient rooms throughout August) = 0.9840 ³¹ = 0.6065	M1 A1 FT	2
(v)	(A) $31 \times 94 = 2914$ Binomial (2914,0.1) (B)Use Normal approx with $\mu = np = 2914 \times 0.1 = 291.4$ $\sigma^2 = npq = 2914 \times 0.1 \times 0.9 = 262.26$ $P(X \le 300.5) = P\left(Z \le \frac{300.5 - 291.4}{\sqrt{262.26}}\right)$	B1 for binomial B1 dep, for parameters B1 B1 B1 M1 B1 for continuity corr. M1 for probability	2
	$= P(Z \le 0.5619) = \Phi(0.5619) = 0.7130$	using correct tail A1 cao, (but FT wrong or omitted CC)	5

(i)	$X \sim N(56, 6.5^2)$		
	P(52.5 < X < 57.5) = P $\left(\frac{52.5 - 56}{6.5} < Z < \frac{57.5 - 56}{6.5}\right)$	M1 for standardizing	
	= P(-0.538 < Z < 0.231)	A1 for -0.538 and 0.231	
	$= \Phi(0.231) - (1 - \Phi(0.538))$ $= 0.5914 - (1 - 0.7046)$ $= 0.5914 - 0.2954$	M1 for prob. with tables and correct structure A1 CAO (min 3 s.f., to include use of difference column)	
	= 0.2960 (4 s.f.) <i>or</i> 0.296 (to 3 s.f.)	,	4
(ii)	P(5-year-old < 62) = P $\left(Z < \frac{62 - 56}{6.5}\right)$		
	$=\Phi(0.923)=0.8220$	B1 for 0.8220 or 0.1780	
	P(young adult < 62) = P $\left(Z < \frac{62 - 68}{10}\right)$	B1 for 0.2743 or 0.7257	
	= $\Phi(-0.6)$ = 1 - 0.7257 = 0.2743 P(One over, one under) = 0.8220 × 0.7257 + 0.1780 × 0.2743 = 0.645	M1 for either product M1 for sum of both products A1 CAO	5
(iii)	0.07	G1 for shape	
	0.06 0.05 0.04 0.03 0.02 0.01 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	G1 for means, shown explicitly or by scale G1 for lower max height in young adults G1 for greater variance in young adults	4
(iv)	$Y \sim N(82, \sigma^2)$ From tables $\Phi^{-1}(0.88) = 1.175$	B1 for 1.175 seen	
	$\frac{62-82}{\sigma}$ = -1.175	M1 for equation in σ with z-value	
	σ $-20 = -1.175 \sigma$	M1 for correct handling of LH tail	4
	$\sigma = 17.0$	A1 cao	
			17

$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	•	associali	on betwe	sex and en sex	and subje	ect;	
Male381963295Female4255949155Col80741581250EXPMathsEnglishBothNeitherRow sumMale30.4028.125.7030.7895Female49.6045.889.3050.22155Col80741581250CONTMathsEnglishBothNeitherMale1.9002.9580.0160.048Female1.1651.8130.0100.030 The read of the read	OBS	Math	English	Both	Neither	Row	1
Female4255949155Col80741581250EXPMathsEnglishBothNeitherRow sumMale30.4028.125.7030.7895Female49.6045.889.3050.22155Col80741581250CONTMathsEnglishBothNeitherMale1.9002.9580.0160.048Female1.1651.8130.0100.030 Refer to χ_3^2 Critical value at 5% level = 7.815 Result is significant There is evidence to suggest that there is some association between sex and subject choice. Wai if h_0H_1 reversed, or 'correlation' mentioned, do not award irst B1 or final E1B1 for Jack Jack Jack Jack Jack Jack Jack Jack						sum	
Col sum80741581250EXPMathsEnglishBothNeitherRow sumMale 30.40 28.12 5.70 30.78 95Female 49.60 45.88 9.30 50.22 155 Col sum80741581 250 CONTMathsEnglishBothNeitherMale 1.900 2.958 0.016 0.048 Female 1.165 1.813 0.010 0.030 W1 for summation A1 cao for X^2 Result is significantBothNeitherThere is evidence to suggest that there is some association between sex and subject choice.B1Result is significantE1There is evidence to suggest that there is some association between sex and subject choice.B1MS if $H_0 H_1$ reversed, or 'correlation' mentioned, do not award irst B1 or final E1B1H ₀ : $\mu = 67.4$; H_1 : $\mu > 67.4$ B1 for both correctWhere μ denotes the mean score of the population of students taught with the new method.B1 for both correctTest statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ B1 for 1.28210% level 1 tailed critical value of z = 1.282B1 for 1.2820.35 < 1.282 so not significant.		_					
sumMathsEnglishBothNeitherRow sumMale 30.40 28.12 5.70 30.78 95 Female 49.60 45.88 9.30 50.22 155 Col 80 74 15 81 250 CONTMathsEnglishBothNeitherMale 1.900 2.958 0.016 0.048 Female 1.165 1.813 0.010 0.030 Refer to χ_3^2 Corritical value at 5% level = 7.815 B1 for 3 deg of f B1 CAO for cvResult is significantE1There is evidence to suggest that there is some association between sex and subject choice.B1Result is significantE1There is final E1B1 for 40.48 B1 for both correctH ₀ : $\mu = 67.4$; H ₁ : $\mu > 67.4$ H ₁ : $\mu > 67.4$ B1 for both correctWhere μ denotes the mean score of the population of students taught with the new method.B1 for both correctTest statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ B1 for 1.282 10% level 1 tailed critical value of $x = 1.282$ B1 for 1.282 $0.35 < 1.282$ so not significant.B1 for comparisonThere is insufficient evidence to conclude that the mean proper is inversed by the provit capture part bandB1 for conclusion in	Female	42	55		49	155	
EXPMathsEnglishBothNeitherRow sumMale30.4028.125.7030.7895Female49.6045.889.3050.22155Col80741581250SumToroular the properties of the population of students taught with the new method.BothNeither Neither N	Col	80	74	15	81	250	
EXPMathsEnglishBothNeitherRow sumMale30.4028.125.7030.7895Female49.6045.889.3050.22155Col80741581250CONTMathsEnglishBothNeitherMale1.9002.9580.0160.048Female1.1651.8130.0100.030 Refer to χ^2_3 Critical value at 5% level = 7.815 Result is significant There is evidence to suggest that there is some association between sex and subject choice. NB if H ₀ H ₁ reversed, or 'correlation' mentioned, do not award irst B1 or final E1 H ₀ : μ = 67.4; H ₁ : μ >67.4 Where μ denotes the mean score of the population of students taught with the new method. Test statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ = 0.35 10% level 1 tailed critical value of z = 1.282 0.35 < 1.282 so not significant. There is insufficient evidence to reject H ₀ There is insufficient evidence to reject H ₀ There is insufficient evidence to conclude that the mean process is insufficient evidence to conclude that the mean experience interpreted by the new tenshing method. A1 for conclusion in the sum of the process in the process of the property is method.	sum]
EXPMathsEnglishBothNeitherRow sumMale30.4028.125.7030.7895Female49.6045.889.3050.22155Col sum80741581250CONTMathsEnglishBothNeitherMale1.9002.9580.0160.048Female1.1651.8130.0100.030 There is evidence to suggest that there is some association between sex and subject choice. NB if H₀ H₁ reversed, or 'correlation' mentioned, do not award irst B1 or final E1B1H₀: $μ = 67.4$; H₁: $μ > 67.4$ Where $μ$ denotes the mean score of the population of students taught with the new method.B1 for both correctHow there is insufficient evidence to reject H₀ There is insufficient evidence to reject H₀ There is insufficient evidence to reject H₀ 							
Male 30.40 28.12 5.70 30.78 95 Female 49.60 45.88 9.30 50.22 155 Col 80 74 15 81 250 M1 for valid attempt at $(O-E)^2/E$ A1 NB These M1 A1 marks cannot be implied by a correct final value of X^2 and $X^2 = 7.94$ Refer to χ^2_3 Critical value at 5% level = 7.815 Result is significant There is evidence to suggest that there is some association between sex and subject choice. Wis if H ₀ H ₁ reversed, or 'correlation' mentioned, do not award irist B1 or final E1 M1 for valid attempt at $(O-E)^2/E$ A1 NB These M1 A1 marks cannot be implied by a correct final value of X^2 M1 for summation A1 cao for X^2 B1 for 3 deg of f B1 CAO for cv B1 for 3 deg of f B1 CAO for cv B1 for 3 deg of f B1 CAO for cv B1 for 3 deg of f B1 CAO for cv B1 for 3 deg of f B1 CAO for cv B1 for 67.4; H ₁ : μ >67.4 Where μ denotes the mean score of the population of students taught with the new method. Fest statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ = 0.35 10% level 1 tailed critical value of $Z = 1.282$ 0.35 < 1.282 so not significant. There is insufficient evidence to reject H ₀ There is insufficient evidence to reject H ₀ There is insufficient evidence to conclude that the mean every is insufficient evidence to reject H ₀ A1 for comparison A1 for conclusion in	=>/5	1 8 4 41	- · ·	I D. ()	- N. 101	1_	
Male 30.40 28.12 5.70 30.78 95 Female 49.60 45.88 9.30 50.22 155 Col 80 74 15 81 250 CONT Maths English Both Neither Male 1.900 2.958 0.016 0.048 Female 1.165 1.813 0.010 0.030 Refer to χ^2_3 Critical value at 5% level = 7.815 Result is significant There is evidence to suggest that there is some association between sex and subject choice. WB if H ₀ H ₁ reversed, or 'correlation' mentioned, do not award irist B1 or final E1 Ho: $\mu = 67.4$; H ₁ : $\mu > 67.4$ Where μ denotes the mean score of the population of students taught with the new method. Test statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ = 0.35 10% level 1 tailed critical value of z = 1.282 0.35 < 1.282 so not significant. There is insufficient evidence to conclude that the mean experie is insufficient evidence to conclude that the mean experie is insufficient evidence to conclude that the mean experie is insufficient evidence to conclude that the mean experie is insufficient evidence to conclude that the mean experie is insufficient evidence to conclude that the mean experie is insufficient evidence to conclude that the mean experie is insufficient evidence to conclude that the mean experie is insufficient evidence to conclude that the mean experie is insufficient evidence to conclude that the mean experie is insufficient evidence to conclude that the mean experience in the proper is insufficient evidence to conclude that the mean experience in the proper is insufficient evidence to conclude that the mean experience in the proper is insufficient evidence to conclude that the mean experience in the proper is insufficient evidence to conclude that the mean experience in the proper is insufficient evidence to conclude that the mean experience in the proper is insufficient evidence to conclude that the mean experience in the proper is insufficient evidence to conclude that the mean experience in the proper is insufficient evidence to conclude that the mean experience in the proper is insufficient evidence to conclude that the mean ex	EXP	Maths	English	Both	Neitner		1 1 1
Female 49.60 45.88 9.30 50.22 155 Col 80 74 15 81 250 CONT Maths English Both Neither Male 1.900 2.958 0.016 0.048 Female 1.165 1.813 0.010 0.030 Refer to χ^2_1 Critical value at 5% level = 7.815 Result is significant There is evidence to suggest that there is some association between sex and subject choice. NB if H_0 H_1 reversed, or 'correlation' mentioned, do not award irst B1 or final E1 Ho: $\mu = 67.4$; H_1 : $\mu > 67.4$ Where μ denotes the mean score of the population of students taught with the new method. Test statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ = 0.35 10% level 1 tailed critical value of $z = 1.282$ 0.35 < 1.282 so not significant. There is insufficient evidence to reject H_0 There is insufficient evidence to reject H_0 There is insufficient evidence to reject H_0 There is insufficient evidence to conclude that the mean experse in prepared by the new thord.	Mala	20.40	20.42	<i>5</i> 70	20.70		
Col sum80741581250CONTMathsEnglishBothNeitherMale1.9002.9580.0160.048Female1.1651.8130.0100.030 $X^2 = 7.94$ M1 for summation A1 cao for X^2 Refer to χ_3^2 Critical value at 5% level = 7.815B1 for 3 deg of f B1 CAO for cvResult is significantB1E1There is evidence to suggest that there is some association between sex and subject choice.B1Result is final E1E1Ho: $\mu = 67.4$; H ₁ : $\mu > 67.4$ B1 for both correct b1 for definition of μ Where μ denotes the mean score of the population of students taught with the new method.B1 for both correct B1 for definition of μ Test statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ M1= 0.35M1A1 cao10% level 1 tailed critical value of $z = 1.282$ M10.35 < 1.282 so not significant.M1There is insufficient evidence to reject H ₀ M1 for comparisonThere is insufficient evidence to conclude that the mean peace is insufficient evidence to conclude that the mean peace is insufficient evidence to conclude that the mean peace is insufficient evidence to conclude that the mean experience and by the new tacking method				_			
CONT Maths English Both Neither Male 1.900 2.958 0.016 0.048 Female 1.165 1.813 0.010 0.030 Refer to χ_3^2 Critical value at 5% level = 7.815 Result is significant There is evidence to suggest that there is some association between sex and subject choice. NB if H ₀ H ₁ reversed, or 'correlation' mentioned, do not award dirst B1 or final E1 E1 H ₀ : $μ = 67.4$; H ₁ : $μ > 67.4$ Mhere $μ$ denotes the mean score of the population of students taught with the new method. B1 for both correct Test statistic = $\frac{68.3 - 67.4}{8.9 / \sqrt{12}} = \frac{0.9}{2.57}$ M1 = 0.35 M1 M1 A1 cao B1 for 1.282 M1 for comparison M1 for comparison A1 for conclusion in method				_			M1 for valid attempt at
CONTMathsEnglishBothNeitherMale 1.900 2.958 0.016 0.048 Female 1.165 1.813 0.010 0.030 Refer to χ_3^2 Critical value at 5% level = 7.815 Result is significantE1There is evidence to suggest that there is some association between sex and subject choice.E1NB if h ₀ H ₁ reversed, or 'correlation' mentioned, do not award irst B1 or final E1E1H ₀ : $\mu = 67.4$; H ₁ : $\mu > 67.4$ B1 for both correct bitudents taught with the new method.Test statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ M1= 0.35M110% level 1 tailed critical value of z = 1.282M1 for comparison0.35 < 1.282 so not significant.		80	/4	15	81	250	
CONTMathsEnglishBothNeitherMale 1.900 2.958 0.016 0.048 Female 1.165 1.813 0.010 0.030 M1 for summation A1 cao for X^2 M2 = 7.94B1 for 3 deg of f B1 CAO for cvRefer to χ_3^2 Critical value at 5% level = 7.815Result is significantThere is evidence to suggest that there is some association between sex and subject choice.NB if H_0H_1 reversed, or 'correlation' mentioned, do not award irist B1 or final E1H ₀ : $\mu = 67.4$; H_1 : $\mu > 67.4$ Where μ denotes the mean score of the population of students taught with the new method.B1 for both correctB1 for definition of μ M1A1 caoB1 for 1.282M3A1 caoB1 for 1.282M1 for comparisonA1 for conclusion in partners of the population of students taught with the new method.	Sum						-
CONTMathsEnglishBothNeitherMale1.9002.9580.0160.048Female1.1651.8130.0100.030Refer to χ_3^2 Critical value at 5% level = 7.815Result is significantThere is evidence to suggest that there is some association between sex and subject choice. NB if H ₀ H ₁ reversed, or 'correlation' mentioned, do not award irst B1 or final E1H ₀ : $\mu = 67.4$; H ₁ : $\mu > 67.4$ Where μ denotes the mean score of the population of students taught with the new method.Test statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ = 0.35M1A1 caoB1 for Doth correctB1 for definition of μ M1A1 caoB1 for 1.282M1 for comparisonThere is insufficient evidence to reject H ₀ There is insufficient evidence to conclude that the mean ever is interpreted by the new topologies methodA1 for conclusion in							
Male1.9002.9580.0160.048Female1.1651.8130.0100.030Refer to χ^2_3 Critical value at 5% level = 7.815Result is significantE1There is evidence to suggest that there is some association between sex and subject choice.RB if $H_0 H_1$ reversed, or 'correlation' mentioned, do not award lirst B1 or final E1 H_0 : $\mu = 67.4$; H_1 : $\mu > 67.4$ Where μ denotes the mean score of the population of students taught with the new method.Test statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ = 0.3510% level 1 tailed critical value of z = 1.2820.35 < 1.282 so not significant.	CONT	Math	s Fn	nlish	Both	Neither	cannot be implied by a
Female 1.165 1.813 0.010 0.030 M1 for summation A1 cao for X^2 B1 for 3 deg of f B1 CAO for cv B1 for 3 deg of f B1 CAO for cv B1 for 3 deg of f B1 CAO for cv B1 for 3 deg of f B1 CAO for cv B1 for 3 deg of f B1 CAO for cv B1 for 3 deg of f B1 CAO for cv B1 for 3 deg of f B1 CAO for cv B1 for 3 deg of f B1 CAO for cv B1 for 3 deg of f B1 CAO for cv B1 for definition of care in the following several severa				_			Soffeet intal value of A
Refer to χ^2_3 Critical value at 5% level = 7.815 Result is significant There is evidence to suggest that there is some association between sex and subject choice. Where μ denotes the mean score of the population of students taught with the new method. B1 for both correct B1 for both correct B1 for definition of μ M1 A1 cao B1 for both correct B1 for definition of μ M1 A1 cao B1 for conclusion in A1 for conclusion in		_					M1 for summation
Refer to χ_3^2 Critical value at 5% level = 7.815 Result is significant There is evidence to suggest that there is some association between sex and subject choice. NB if H ₀ H ₁ reversed, or 'correlation' mentioned, do not award first B1 or final E1 H ₀ : $\mu = 67.4$; H ₁ : $\mu > 67.4$ Where μ denotes the mean score of the population of students taught with the new method. Test statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ = 0.35 10% level 1 tailed critical value of z = 1.282 0.35 < 1.282 so not significant. There is insufficient evidence to reject H ₀ There is insufficient evidence to conclude that the mean exercise increased by the new teaching method. B1 B1 E1 B1 B1 E1 B1 B1 B1 E1 B1 for both correct B1 for definition of μ M1 A1 cao B1 for 1.282 M1 for comparison A1 for conclusion in							
Critical value at 5% level = 7.815 Result is significant There is evidence to suggest that there is some association between sex and subject choice. NB if $H_0 H_1$ reversed, or 'correlation' mentioned, do not award first B1 or final E1 $H_0: \mu = 67.4; H_1: \mu > 67.4$ Where μ denotes the mean score of the population of students taught with the new method. Fest statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ $= 0.35$ $10\% \text{ level 1 tailed critical value of } z = 1.282$ $0.35 < 1.282 \text{ so not significant.}$ There is insufficient evidence to reject H_0 There is insufficient evidence to conclude that the mean every is ingregated by the power targeting method. B1 A1 for comparison A1 for conclusion in	$X^2 = 7.94$						
Result is significant There is evidence to suggest that there is some association between sex and subject choice. NB if $H_0 H_1$ reversed, or 'correlation' mentioned, do not award irst B1 or final E1 $H_0: \mu = 67.4; H_1: \mu > 67.4$ Where μ denotes the mean score of the population of students taught with the new method. Fest statistic = $\frac{68.3 - 67.4}{8.9 / \sqrt{12}} = \frac{0.9}{2.57}$ $= 0.35$ $10\% \text{ level 1 tailed critical value of } z = 1.282$ $0.35 < 1.282 \text{ so not significant.}$ There is insufficient evidence to reject H_0 There is insufficient evidence to conclude that the mean every is increased by the power tageling method. E1 B1 for both correct B1 for definition of μ M1 A1 cao B1 for 1.282 M1 for comparison A1 for conclusion in		2					
There is evidence to suggest that there is some association between sex and subject choice. NB if H_0 H_1 reversed, or 'correlation' mentioned, do not award first B1 or final E1 $H_0: \mu = 67.4; H_1: \mu > 67.4$ Where μ denotes the mean score of the population of students taught with the new method. $H_0: \mu = 67.4; H_1: \mu > 67.4$ Where μ denotes the mean score of the population of students taught with the new method. $H_0: \mu = 67.4; H_1: \mu > 67.4$ $H_0: \mu = 67.4; H_1: \mu > 67.4$ $H_0: \mu = 67.4; H_1: \mu > 67.4$ $H_1: \mu > 67.4$ $H_1: \mu > 67.4$ $H_2: \mu > 67.4$ $H_3: \mu > 67.4$ $H_1: \mu > 67.4$ $H_1: \mu > 67.4$ $H_2: \mu > 67.4$ $H_3: \mu >$	Refer to χ	_					B1 CAO for cv
But for both correct with the new method. Test statistic = $\frac{68.3 - 67.4}{8.9 / \sqrt{12}} = \frac{0.9}{2.57}$ = 0.35 There is insufficient evidence to conclude that the mean every is ingregated by the new togething method. But for both correct but for both correct but for conclusion in the second is ingregated by the new togething method. But for both correct but	Refer to χ	lue at 5%		7.815			B1 CAO for cv
NB if H_0H_1 reversed, or 'correlation' mentioned, do not award first B1 or final E1 H ₀ : $\mu = 67.4$; H ₁ : $\mu > 67.4$ Where μ denotes the mean score of the population of students taught with the new method. Fest statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ $= 0.35$ B1 for both correct B1 for definition of μ M1 A1 cao B1 for 1.282 M1 for comparison A1 for conclusion in	Refer to χ Critical va Result is s	lue at 5% significan	t		horo io oo	ma	B1 CAO for cv
First B1 or final E1 H ₀ : μ = 67.4; H ₁ : μ >67.4 Where μ denotes the mean score of the population of students taught with the new method. Fest statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ $= 0.35$ B1 for both correct B1 for definition of μ M1 A1 cao B1 for comparison M1 A1 cao B1 for comparison M1 A1 cao B1 for comparison A1 for conclusion in	Refer to χ Critical va Result is s There is e	lue at 5% significan vidence	t to sugge	st that th			B1 CAO for cv
Where μ denotes the mean score of the population of students taught with the new method. Fest statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ $= 0.35$ M1 A1 cao B1 for definition of μ M1 A1 cao B1 for 1.282 M1 for comparison There is insufficient evidence to reject H ₀ There is insufficient evidence to conclude that the mean exercise increased by the new togething method. A1 for conclusion in	Refer to χ Critical va Result is s There is e associatio	lue at 5% significan vidence n betwee	t to sugge en sex ar	st that th	ct choice.		B1 CAO for cv B1 E1
Where μ denotes the mean score of the population of students taught with the new method. B1 for definition of μ Test statistic = $\frac{68.3 - 67.4}{8.9 / \sqrt{12}} = \frac{0.9}{2.57}$ $= 0.35$ M1 A1 cao B1 for 1.282 B1 for 1.282 M1 for comparison There is insufficient evidence to reject H ₀ There is insufficient evidence to conclude that the mean exercise increased by the new togething method. A1 for conclusion in	Refer to χ Critical va Result is s There is e associatio NB if H_0 H_1	lue at 5% significan vidence in between reversed	t to sugge en sex ar	st that th	ct choice.		B1 CAO for cv B1 E1
Test statistic = $\frac{68.3 - 67.4}{8.9/\sqrt{12}} = \frac{0.9}{2.57}$ = 0.35 10% level 1 tailed critical value of z = 1.282 0.35 < 1.282 so not significant. There is insufficient evidence to reject H ₀ There is insufficient evidence to conclude that the mean exercise increased by the new togething method. A1 for conclusion in	Refer to χ Critical va Result is s There is e associatio NB if H ₀ H ₁ first B1 or f	lue at 5% significan vidence in between reversed inal E1	t to sugge en sex ar , or 'corre	st that th	ct choice.		B1 CAO for cv B1 E1
Test statistic = $\frac{8.9}{12} = \frac{6.5}{2.57} = 0.35$ A1 cao 10% level 1 tailed critical value of z = 1.282 0.35 < 1.282 so not significant. There is insufficient evidence to reject H ₀ There is insufficient evidence to conclude that the mean exercise increased by the new togething method. A1 for conclusion in	Refer to χ Critical va Result is s There is e associatio NB if H ₀ H ₁ first B1 or f H ₀ : μ = 67 Where μ 0	lue at 5% significan vidence in between reversed inal E1	to sugge en sex ar , or 'correl u >67.4 he mean	st that the subject ation' me	ect choice. entioned, c	do not awar	B1 CAO for cv B1 E1 B1 for both correct
= 0.35 10% level 1 tailed critical value of $z = 1.282$ 0.35 < 1.282 so not significant. There is insufficient evidence to reject H_0 There is insufficient evidence to conclude that the mean exercise increased by the new togething method. A1 for conclusion in	Refer to χ Critical va Result is s There is e associatio NB if H ₀ H ₁ first B1 or f H ₀ : μ = 67 Where μ 0	lue at 5% significan vidence in between reversed inal E1	to sugge en sex ar , or 'correl u >67.4 he mean	st that the subject ation' me	ect choice. entioned, c	do not awar	B1 CAO for cv B1 E1 B1 for both correct
10% level 1 tailed critical value of $z = 1.282$ 0.35 < 1.282 so not significant. There is insufficient evidence to reject H_0 There is insufficient evidence to conclude that the mean exercise increased by the new togething method. A1 for conclusion in	Refer to χ Critical va Result is s There is e associatio NB if H ₀ H ₁ first B1 or f H ₀ : μ = 67 Where μ c students t	lue at 5% significan vidence in between reversed inal E1 .4; H ₁ : µ lenotes the aught with	to sugge en sex ar , or 'correl u >67.4 he mean h the ne	st that the subject ation' most score of which the state of the state	of the population	do not awar	B1 CAO for cv B1 E1 B1 for both correct B1 for definition of μ
0.35 < 1.282 so not significant. There is insufficient evidence to reject H ₀ There is insufficient evidence to conclude that the mean exercise increased by the new togething method. A1 for conclusion in	Refer to χ Critical va Result is s There is e associatio NB if H ₀ H ₁ first B1 or f H ₀ : μ = 67 Where μ c students t	lue at 5% significan vidence in between reversed inal E1 .4; H_1 : μ lenotes the aught with stic = $\frac{68}{8}$.	to sugge en sex ar, or 'correl u > 67.4 he mean th the new $\frac{3-67.4}{9/\sqrt{12}}$	st that the subject ation' most score of which the state of the state	of the population	do not awar	B1 CAO for cv B1 E1 B1 for both correct B1 for definition of μ M1
There is insufficient evidence to conclude that the mean A1 for conclusion in	Refer to χ Critical va Result is some secondary of the	lue at 5% significan vidence in between reversed in E1 .4; H_1 : μ lenotes the aught with estic = $\frac{68}{8}$. = 0.38	to sugge en sex ar, or 'correl u > 67.4 he mean th the new $\frac{3-67.4}{9/\sqrt{12}}$	st that the subject ation' measurement of the state of t	of the population	do not awar	B1 CAO for cv B1 E1 B1 for both correct B1 for definition of μ M1 A1 cao
ecore is increased by the new teaching method	Refer to χ Critical va Result is some second of the sec	lue at 5% significant vidence in between reversed in al E1 .4; H_1 : μ lenotes the aught with stic = $\frac{68}{8}$. 1 tailed 682 so no	to sugge en sex are, or 'correll' $J > 67.4$ he meanth the new $\frac{3-67.4}{9/\sqrt{12}}$ or itical vata significations.	st that the subject ation' more score of which the state of zero ant.	of the population of the popul	do not awar	B1 CAO for cv B1 E1 B1 for both correct B1 for definition of μ M1 A1 cao B1 for 1.282
	Refer to χ Critical va Result is some services of the servi	lue at 5% significan vidence in between reversed inal E1 .4; H_1 : μ lenotes the aught with stic = $\frac{68}{8}$. 1 tailed 682 so non sufficient	to sugge en sex ar, or 'correll' $a > 67.4$ he meanth the new $\frac{3-67.4}{9/\sqrt{12}}$ or titical vata significant evidence	st that the subject ation' more score of which the state of $\frac{0.9}{2.57}$ and the second state of zero.	of the population of the popul	do not award	B1 CAO for cv B1 E1 B1 for both correct B1 for definition of μ M1 A1 cao B1 for 1.282 M1 for comparison

4767: Statistics 2

General Comments

The majority of candidates were well-prepared for this examination, continuing the pattern of recent years. It was evident that no question stood out as being either more difficult or more straightforward than the others. In general, candidates' abilities to structure answers to questions involving hypothesis tests, using correct notation and terminology, have shown improvement. As in recent sessions, many candidates struggled to obtain marks for explanation/interpretation, but otherwise scored well. The overall standard was high.

Comments on Individual Questions

Section A

- 1) (i) The majority correctly identified *x* as the independent variable, realising that growth depended on the hormone concentration. Few candidates stated that *x* was controlled.
 - (ii) Well answered with most candidates gaining full marks. Those leaving the equation of the regression line in unsimplified form were penalised. No extra credit was given to those candidates who calculated the p.m.c.c.
 - (iii) Most candidates successfully used their equations to obtain estimates of shoot growth, and the comments on the reliability of their estimates were generally as required. A number of candidates commented that the estimates were similar to the values on the graph, gaining no credit. The most successful used the idea of interpolation/extrapolation.
 - (iv) Most managed to obtain two of the three available marks, losing out on the final mark by providing a positive rather than negative residual.
 - (v) This part was poorly answered with only a few candidates obtaining full marks. Most candidates commented entirely about the context, completely avoiding discussion about the mathematical model and its suitability in the range given.
- 2) (i) Well answered. Several candidates used n = 90, leading to problems in the later parts of the question. In such questions it is expected that candidates will provide parameters and not just quote "binomial".
 - (ii) Well answered. Some candidates missed the point of this question and simply churned out comments relating to the conditions for a Poisson model to be used, generally, and not as an approximation to the binomial distribution.
 - (iii) A Well answered, with many candidates scoring full marks.
 - (iii) B Most candidates realised what was required, but some failed to correctly obtain the value of $P(X \ge 4)$.
 - (iv) Well answered.
 - (v) A Some candidates missed out on the marks here by writing down the Normal approximating distribution at this stage, bypassing the binomial distribution.

Report on the Units taken in January 2008

- (v) B The Normal distribution was handled well. Many candidates failed to use an appropriate continuity correction and were penalised. Many used a Normal approximation to the Poisson distribution, leading to loss of accuracy.
- 3) (i) Mostly well answered, but many candidates lost the final accuracy mark through using z-values rounded to 2 d.p..
 - (ii) This proved difficult for many. Inappropriate attempts at continuity corrections were seen. Nonetheless, many managed to complete the question using the correct probability calculation with their values.
 - (iii) Well answered on the whole. Most candidates managed to draw a diagram containing two Normal curves and correctly label their means on a horizontal axis. Many managed to draw sketches which highlighted the difference in variance, but did not realise that this meant the curve for adults would have a lower maximum value.
 - (iv) Well answered. Some candidates lost marks through failing to handle the negative *z*-value correctly. A small number gave a negative value for σ.
- 4) (i) Well answered. Most candidates provided correct hypotheses. In calculating the test statistic, most candidates managed to work to an appropriate level of accuracy, helped by the lack of a need to round expected frequencies, and gained full marks for this. Some candidates failed to provide a table (or list) showing individual contributions to the test statistic despite being requested in the question, and hence lost marks. Most candidates correctly identified the correct number of degrees of freedom and critical value, and went on to make an appropriate conclusion.
 - (ii) Reasonably well answered. Most candidates scored a mark for providing correct hypotheses, but candidates still find the mark for defining μ as the population mean elusive. Indeed, many defined μ as the sample mean. Most candidates managed to obtain the correct test statistic and critical value then make an appropriate conclusion. A small number of inappropriate comparisons were seen, usually involving comparing a *z*-value with a probability. Several candidates treated the value 68.3 as a single observation rather than a sample mean and were penalised.