Version 1.0: 0706

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Statistics 6380

SS06 Statistics 6

Mark Scheme

2006 examination – June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Key To Mark Scheme And Abbreviations Used In Marking

M	mark is for method
m or dM	mark is dependent on one or more M marks and is for method
A	mark is dependent on M or m marks and is for accuracy
B	mark is independent of M or m marks and is for method and accuracy
E	mark is for explanation

√or ft or F	follow through from previous incorrect result	MC	mis-copy
CAO	correct answer only	MR	mis-read
CSO	correct solution only	RA	required accuracy
AWFW	anything which falls within	FW	further work
AWRT	anything which rounds to	ISW	ignore subsequent work
ACF	any correct form	FIW	from incorrect work
AG	answer given	BOD	given benefit of doubt
SC	special case	WR	work replaced by candidate
OE	or equivalent	FB	formulae book
A2,1	2 or 1 (or 0) accuracy marks	NOS	not on scheme
–*x* EE	deduct *x* marks for each error	G	graph
NMS	no method shown	c	candidate
PI	possibly implied	sf	significant figure(s)
SCA	substantially correct approach	dp	decimal place(s)

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded. However, there are situations in some units where part marks would be appropriate, particularly when similar techniques are involved. Your Principal Examiner will alert you to these and details will be provided on the mark scheme.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

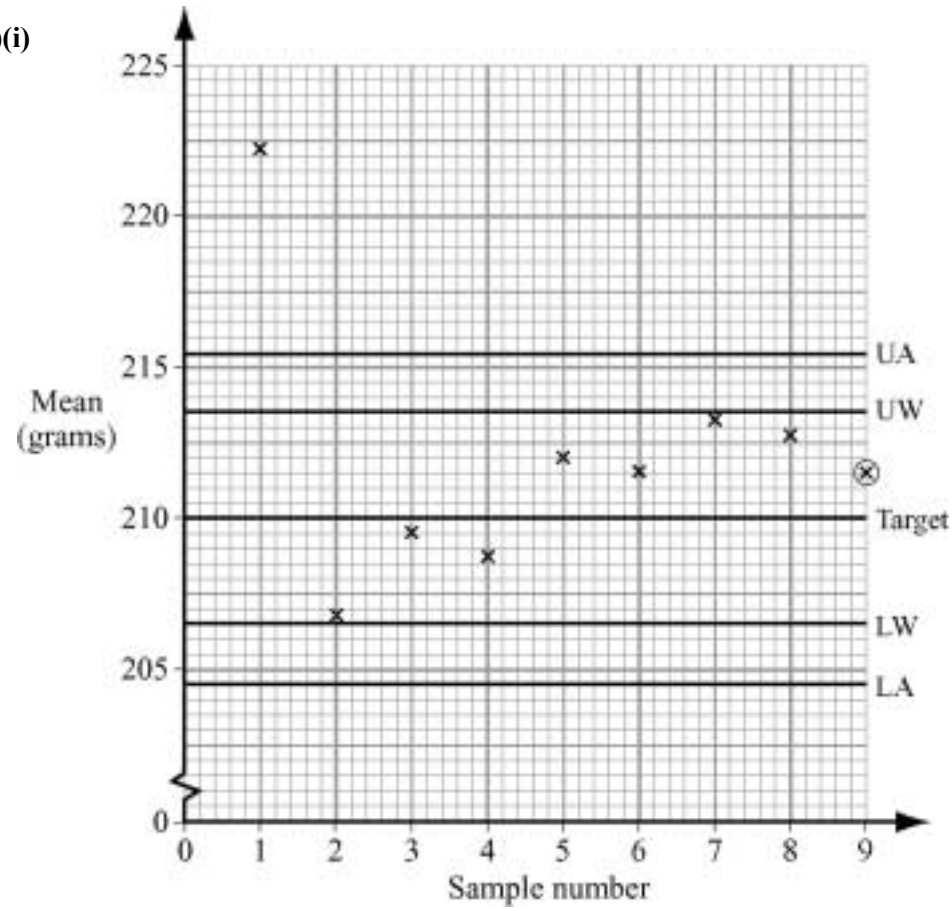
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

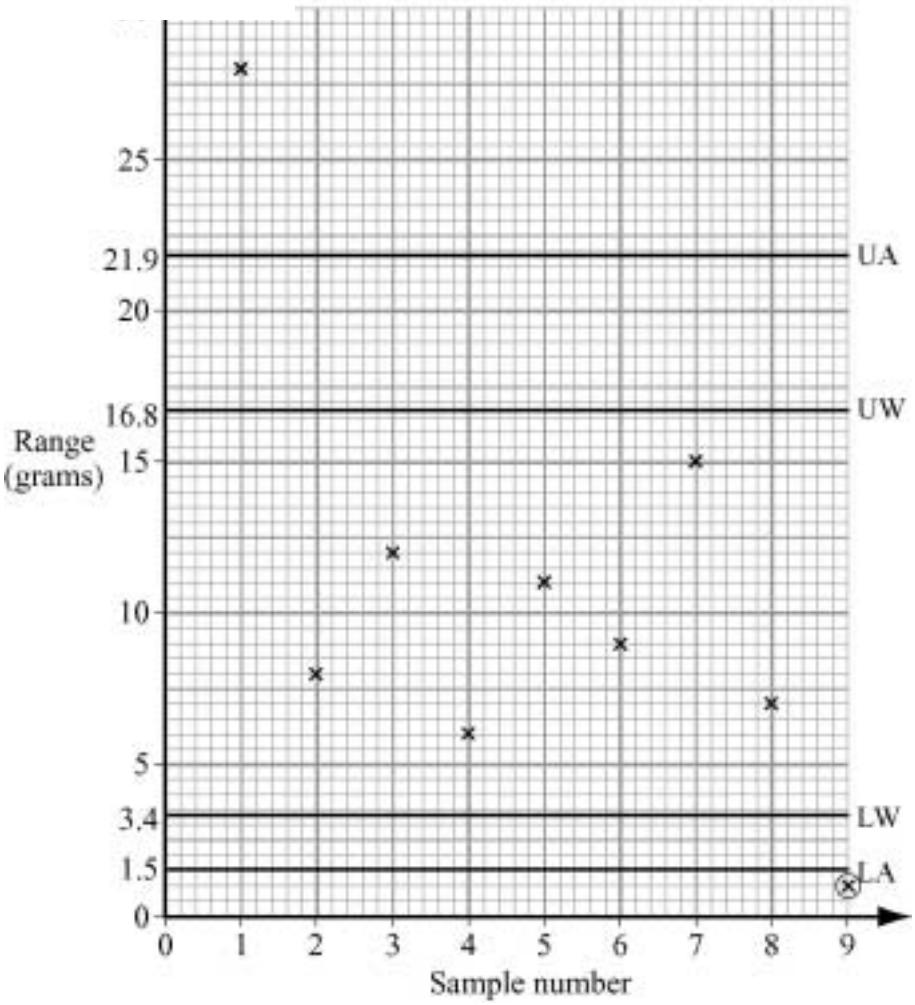
SS06

Q	Solution	Marks	Total	Comments
1(a)(i)	Group treated with new ointment	B1		CAO
(ii)	Group treated with well established ointment	B1	2	CAO
(b)	Neither patient nor medical staff administering the ointment know which is new and which is well established ointment. This is to ensure that any differences observed are due to the ointments and not due to expectations that the new ointment will be better.	E1 E1 E1	3	patients don't know administrators of treatment don't know to ensure differences are due to ointments - allow to eliminate bias
	Total		**5**	
2(a)(i)	Chart for means Warning limits $210 \pm 1.96 \times 4/\sqrt{5}$ 210 ± 3.51 $206.5 \sim 213.5$ Action limits $210 \pm 3.09 \times 4/\sqrt{5}$ 210 ± 5.53 $204.5 \sim 215.5$ + limits on chart	B1 M1 m1 A1 B1	5	1.96 (1.96~2) and 3.09 (3~3.1) use of their $z \times 4/\sqrt{5}$ method - their z - for all limits 206.5 (206~207), 213.5 (213 ~214) 204.5 (204~205) and 215.5 (215~216) limits correctly plotted - disallow 206,214 etc allow omission of target line
(ii)	Chart for ranges Lower Action $0.367 \times 4 = 1.5$ Lower Warning $0.850 \times 4 = 3.4$ Upper Warning $4.197 \times 4 = 16.8$ Upper Action $5.484 \times 4 = 21.9$ + limits on chart	B1 M1 A1 B1	4	4.197 (or 4.20), and 5.484 (or 5.48) their factors $\times 4$ - allow wrong sample size, use of E and/or upper limits only all four limits ± 0.1 limits correctly plotted
(b)(i)	on graph	B1 B1	2	means correct - by eye ranges correct - by eye
(ii)	First sample out of control on both mean and range chart. Action appears to have been taken successfully as all other points within warning limits. Mean appears to be drifting upwards	E1√ E1 E1	3	first sample outside action limits other points within warning limits mean appears to be increasing

2(a)(i), b(i), (c)(i)



2(a)(ii), b(i), (c)(i)



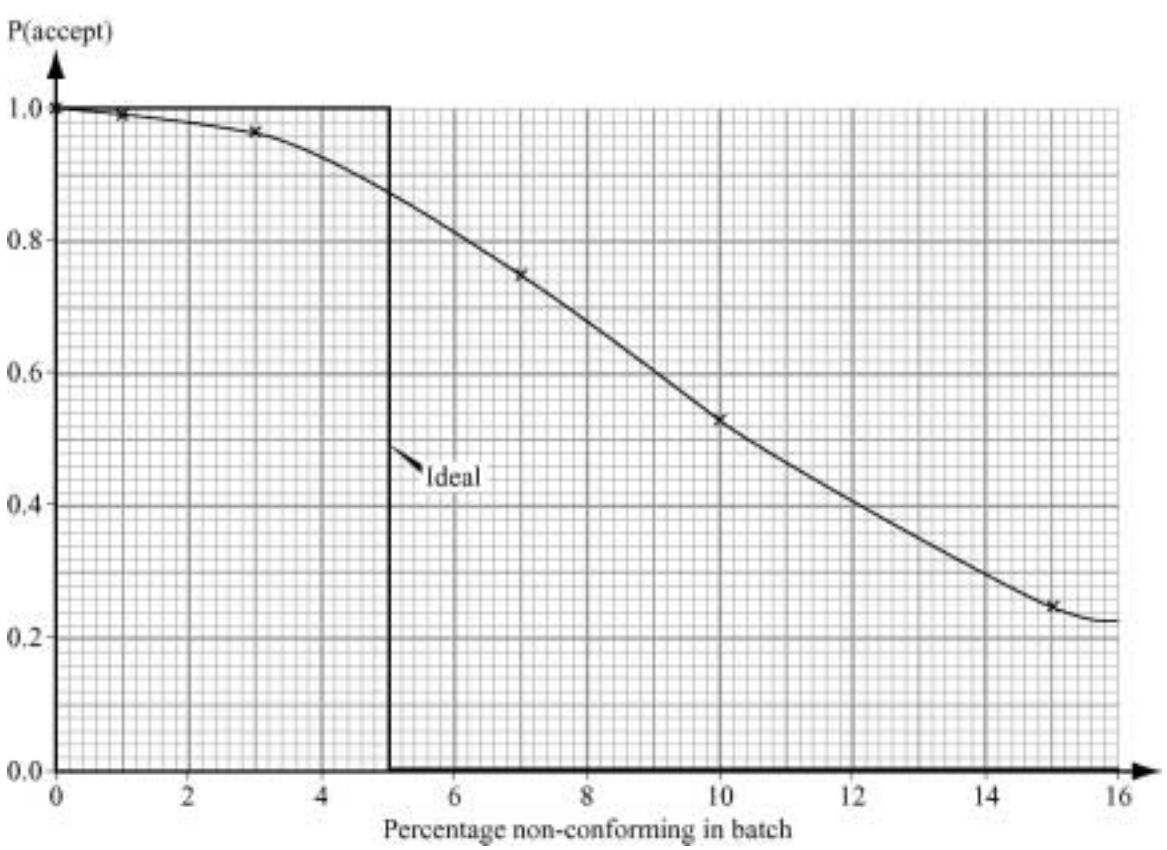
SS06 (cont)

Q	Solution	Marks	Total	Comments
2(c)(i)	mean 211.6	M1		method for calc and plot mean
	range 1	M1		method for calc and plot range
	+ points on graph	A1	3	both points correct
(ii)	Mean between warning limits, range below lower action limit. No action/ investigate apparent improvement in order to maintain/ check readings are correct	E1√		recommended action consistent with their points and limits
		E1	2	correct action based on correct points and limits
			19	
3(a)	H_0: $\mu_{diff} = 0$	B1		both hypotheses - must use μ or population - allow $\mu_A = \mu_B$ H_1: must be consistent with differences
	H_1: $\mu_{diff} > 0$			
	Pair 1 2 3 4 5 6	M1		method for differences
	B - A 7 35 9 -12 12 22			
		M1		use of their s.d./√6
	$\bar{x} = 12.167$ $s = 15.741$	m1		method for *t* - ignore sign
	$t = (12.167 - 0)/(15.741/\sqrt{6}) = 1.89$	A1		1.89 (1.89 to 1.9) or − 1.89 if A-B used
		B1		5df
	cv t_5 is 1.476	B1		1.476 or 1.48 - ignore sign
	reject H_0: significant evidence that older girls score more points on average.	A1		reject H_0 - must be compared with correct tail of t
		A1√	9	conclusion in context - requires previous A1
	Alternative			
	s.c. confidence interval			
	$12.167 \pm 1.476 \times 15.741/\sqrt{6}$			
	$2.68 \sim 21.65$			
	$2.68 > 0$			2.68 (2.65 to 2.7)
	s.c critical value			
	$1.476 \times 15.741/\sqrt{6} = 9.49$			
	$9.49 < 12.167$			9.49 (9.48 to9.5)
	s.c unpaired t used			
	allow maximum			B1 hypotheses
	B1 M0M0m0A0 B1B1 A0A0			B1 10df
				B1 1.372 or 1.37
	s.c. all differences same sign			
	allow maximum			
	B1 M0M1m0A0B1B1A1A1√			

SS06 (cont)

Q	Solution	Marks	Total	Comments
3(b)	Differences may be regarded as a random sample from the population and	E1		random
	are normally distributed	E1	2	normal
(c)	Boys would introduce an additional source of experimental error and make			
	any effect of age more difficult to detect.	E1	1	explanation
(d)(i)	ranks also unreliable - Wilcoxon signed-rank test unsuitable.	E1 E1		ranks unreliable Wilcoxon unsuitable
(ii)	sign test valid but unlikely to detect a difference with such a small sample.	E1	3	sign test valid sample too small for sign test to be effective. maximum 3
			15	
4(a)(i)	% non-conf 1 3 5 7 10 15 P(Accept) 0.998 0.962 0.873 0.747 0.537 0.254	B1 M1 A1	3	Use of Binomial n = 25 method for P(Accept) at least two points all correct 3dp -allow one small slip
(ii)	on graph below	M1 A1	2	points plotted accurate plot - points joined - passes through (0,1)
(iii)	on graph below	M1 A1	2	shape of ideal OC accurate plot - line above 5% not necessarily visible

4(a)(i) and (ii)



SS06 (cont)

Q	Solution	Marks	Total	Comments
4(b)	% non-conforming 3 15 P(Accept) 0.983 0.112	B1	1	0.983 (0.9825 to 0.9835) and 0.112 (0.1115 to 0.1125)
(c)(i)	More chance of accepting batch with low % non-conforming	E1		advantage (b) compared to (a)
	Less chance of accepting batch with high % non-conforming	E1		advantage (b) compared to (a)
(ii)	Requires more components to be tested	E1	3	disadvantage (b) compared to (a)
	Total		**11**	
5(a)(i)	O M R Tot A 42 29 19 90 B 37 33 24 94 C 24 29 18 71 D 25 22 13 60 Tot 128 113 74 315			
	$\Sigma x^2 = 9019$			
	Between Models SS $\left(\frac{90^2+94^2+71^2+60^2}{3}\right)-\frac{315^2}{12}=256.92$	M1		method between models SS
	Between Campers SS $\left(\frac{128^2+113^2+74^2}{4}\right)-\frac{315^2}{12}=388.5$	M1		method between campers SS
	Total SS = $9019-\frac{315^2}{12}=750.25$	M1		method total SS
	Source **SS** **DF** **MS** **Models** 256.92 3 85.64 **Campers** 388.50 2 194.25 **Error** 104.83 6 17.47 **Total** 750.25 11	M1 B1 m1		method Error SS df 3,2,6 MS - their df
	H_0: no difference between models F = 85.64/17.47 = 4.90	M1		method for F - their positive SS and df
	cv $F_{[3,6]}$ is 4.757 reject H_0 - not all models take same time to pitch on average	B1		4.757 and 5.143 (2dp)
	H_0: no difference between campers F = 194.25/17.47 = 11.1	A1√		conclusion - must be compared with upper tail of F
	cv $F_{[2,6]}$ is 5.143 reject H_0 - not all campers take same time to pitch a tent on average	M1		method for F - their positive SS and df
		A1		4.90 (4.85 - 4.95) and 11.1(11.0 to 11.2)
		A1√		conclusion- must be compared with upper
		A1√		with upper tail of F both conclusions in context – needs both previous A1√ marks

SS06 (cont)

Q	Solution	Marks	Total	Comments
5(a)(ii)	D appears to take least time to pitch but this could be because it is always pitched last after practice on other models.	B1 E1		D CAO because always pitched last
(b)(i)	**Source** | **SS** | **DF** **Order** | 577.5 | 3 **Camper** | 198.5 | 3 **Model** | 611.5 | 3 **Error** | 134.5 | 6 **Total** | 1522.0 | 15	 B1 B1	 2	 df correct - allow omission of total df 134.5 (134 to 135)
(ii)	H_0: no difference between models F = (611.5/3)/(134.5/6) = 203.83/22.417 = 9.09 cv $F_{[3,6]}$ 4.757 Reject H_0 - there is evidence of a difference between models.	 M1 A1 B1 A1√	 4	 method for F - their df and SS 9.09 (9 ~ 9.15) 4.757 (4.75 ~ 4.76) conclusion - requires cv from F tables
(iii)	Totals A - 128 B - 93 C - 137 D - 162 model B appears to take the least time to pitch.	 B1 E1	 2	 B comparison of totals or means
(iv)	Latin Square enables 3-factors at n levels to be examined using only n^2 trials. If a Latin Square is to be used and there are only 4 models to be compared then only 4 campers can be included.	 E1 E1	 2	 cannot be more campers than models comment on advantages of Latin Squares
	Total		**25**	
	TOTAL		**75**	