Version : 1.0 0707

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Statistics 6380

SS06 Statistics unit 6

Mark Scheme

2007 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.

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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.

June 07

SS06

Q	Solution	Marks	Total	Comments
1(a)	mean range $=\frac{0.84}{8}=0.105$	M1		attempt to find mean range
	estimated s.d. $=0.4299\times0.105$	B1		0.4299
	$= 0.045$	A1	3	0.045 ag by any correct method $(0.045\sim0.05)$
(b)(i)	chart for means			
	warning limits	B1		1.96 and 3.09 – allow 2 and 3
	$6.00\pm1.96\times\frac{0.045}{\sqrt{5}}$	M1		use of $\frac{0.045}{\sqrt{5}}$
	$5.961\sim6.039$	M1		method – both limits, allow incorrect z-value, use of $\sqrt{8}$, disallow if not centred on 6.00
	action limits			
	$6.00\pm3.09\times\frac{0.045}{\sqrt{5}}$			
	$5.938\sim6.062$	A1	4	$5.96(5.959\sim5.961)$ $6.04(6.039\sim6.041)$ $5.94(5.937\sim5.94)$ $6.06(6.06\sim6.063)$
(ii)	chart for ranges			
	LA $0.367\times0.045=0.017$ LW $0.850\times0.045=0.038$ UW $4.197\times0.045=0.189$	M1		$D\times0.045$ allow upper limits only allow any D
	UA $5.484\times0.045=0.247$	A1	2	$0.017(0.016\sim0.017)$ $0.038(0.038\sim0.039)$ $0.189(0.1885\sim0.1895)$ $0.247(0.246\sim0.247)$ } allow one small slip
(c)	mean 6.056 range 0.20	B1		$6.056(6.05\sim6.06)$ and 0.2 CAO
	both between warning and action limits	E1√		correct conclusion – their figures
	take another sample immediately – if mean or range on new sample outside warning limits take action	E1	3	take another sample immediately - based on all correct working
(d)	$z_1=\frac{(6.15-6.06)}{0.045}=2$	M1		method – allow z_1 only, allow proportion inside tolerances
	$z_2=\frac{(5.85-6.06)}{0.045}=-4.67$			
	proportion outside tolerances $= 1 - 0.97725$			
	$= 0.02275$	A1	2	$0.02275(0.022\sim0.023)$
	Total		**14**	

SS06 (cont)

Q	Solution	Marks	Total	Comments
2(a)	In a blind trial the subject does not know whether they are being treated with an active ingredient or a placebo – which looks similar but contains no active ingredient. Purpose is to prevent outcome of the trial being affected by subjects' expectations.	E1 E1 E1	3	subject does not know purpose complete answer
(b)	If any measurable benefit is claimed for a product it can be tested using a placebo. The reason for the product's effectiveness is irrelevant Statement nonsense.	E1 E1	2	nonsense explanation
	Total		**5**	
3(a)	vol 1 2 3 4 5 6 7 W – G 32 102 7 54 –4 44 91 8 9 10 11 12 6 47 48 18 –41			
		M1		method for differences – disallow all same sign (W – G or G – W)
	$\bar{d}=33.6667$ $s=39.97575$	B1		$33.67\,(33.6\sim33.7)$ and $39.98\,(39.9\sim40.0)$
	$H_0: \mu_d = 0$ $H_1: \mu_d > 0$ allow $H_0: \mu_G = \mu_w$ $H_1: \mu_G < \mu_w$	B1		both hypothesis consistent with their differences – needs population or μ
	$t = \dfrac{(33.6667-0)}{\frac{(39.97575)}{\sqrt{12}}} = 2.92$	M1 m1 A1		use of $\dfrac{\text{their s.d.}}{\sqrt{12}}$ method for t – ignore sign – needs both previous M marks $2.92\,(2.91\sim2.92)$ or –2.92 if G–W used
	c.v. $t_{11} = 1.1796$	B1 B1√		11 df $1.796\,(1.79\sim1.8)$ ignore sign
	reject H_0, significant evidence that items can be collected more quickly, on average, at Guildford than at Woking	A1√ A1√	10	conclusion – must be compared with correct tail of t conclusion in context – needs previous A mark **For sign test/Wilcoxon** allow maximum M1 B0 B1
(b)	All volunteers collected from Woking first then Guildford – possible learning effect. Could have 6 collect at Guildford first and the other 6 collect at Woking first.	E1 E1	2	source of possible bias – allow familiarity with store / particular items included in lists etc. method of removal
	Total		**12**	

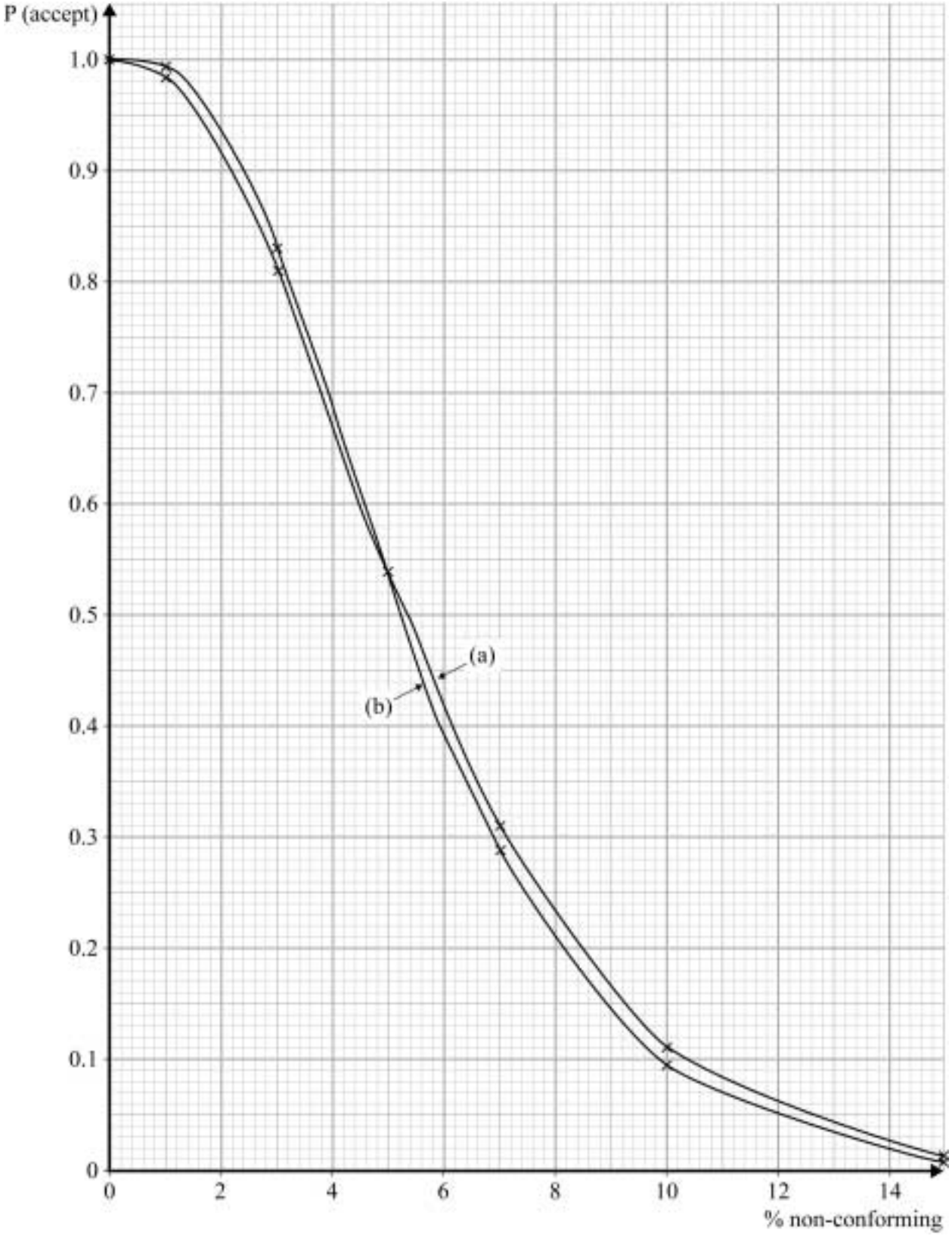
SS06 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$z = \dfrac{(25.2-24.6)}{\left(\dfrac{0.65}{\sqrt{10}}\right)}$	M1		method for z – ignore sign
	$= 2.919$			
		m1		method for P(reject) – both method marks may be earned in (a)(ii)
	P (reject) = 0.998	A1		$0.998(0.998\sim0.9985)$
	>0.9			
	or $2.92 > 1.2816$			
	condition met	A1√	4	condition met
(ii)	$z=\dfrac{(25.2-25.7)}{\left(\dfrac{0.65}{\sqrt{10}}\right)}$			
	$= -2.433$			
	P (accept) = 0.993	A1		$0.993(0.992\sim0.993)$
	> 0.95			
	or $-2.433 < -1.6449$			
	condition met	A1√	2	condition met
(b)	Since both conditions are easily met,			
	it is likely that the sample size could	E1		likely sample size could be reduced
	be reduced and the conditions still met.	E1	2	because conditions easily met allow
	can imply A1√ A1√ in (a)			answers based on further calculation
	Total		**8**	

SS06 (cont)

Q	Solution	Marks	Total	Comments
5(a)(i)	% n-c 1 3 5 7 10 15 P(accept) 0.986 0.811 0.541 0.311 0.112 0.014	B1 M1 A1	3	use of binomial n = 50 method all values ±0.001
(ii)	on next page	M1 A1	2	method – points must be joined accurate plot – allow 1 small slip – must go through (0,1)
(b)(i)	accept 1st 0 1 2 2 3 2nd 0 1 0	M1 m1		reasonable attempt to enumerate ways of accepting or rejecting correct enumeration
	B (40,0.05)	B1		use of B (40,0.05)
	P(accept) = P(0 or 1)+P(2)×P(0 or 1)+P(3) × P(0) =0.3991+0.2776×0.3991+0.1852×0.1285	m1		correct method
	= 0.534	A1	5	0.534(0.533~0.534)
(ii)	on next page	M1 A1	2	method for given data – points must be joined accurate plot – allow one small slip – don't penalise omission of (0,1) twice
(c)	Double sampling plans more likely to accept good (low % n–c) batches and to reject bad (high % n–c) batches.	E1		double sampling plan 'better'
	More complicated to operate.	E1		double sampling plan more complicated
	All acceptance sampling plans will reject some good batches and accept some bad batches.	E1	3	all acceptance sampling plans will reject some good batches
	Total		**15**	

SS06 (cont)


P (accept)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
2
4
6
8
10
12
14
% non-conforming
(a)
(b)

SS06 (cont)

Q	Solution	Marks	Total	Comments
6(a)	group 1 2 3 total 622 660 860 $\sum x = 2142 \quad \sum x^2 = 411620$			
	total SS $= 411620 - \frac{2142^2}{12} = 29273$	M1		method for total SS disallow negative SS
	between groups SS = $\frac{622^2}{4} + \frac{660^2}{4} + \frac{860^2}{4} - \frac{2142^2}{12} = 8174$	M1		method for between groups SS
	source / SS / DF / MS between groups / 8174 / 2 / 4087 residual / 21099 / 9 / 2344.3 total / 29273 / 11 /	B1 M1 m1		df 2, 9 method for residual SS $MS = \frac{SS}{\text{their df}}$
	H_0: no difference between groups H_1: not all group means equal	B1		hypotheses – population not essential
	$F = \frac{4087}{2344.3} = 1.74$	M1 A1		method for F – their figures $1.74(1.73\sim1.75)$
	c.v. $F_{[2,9]} = 4.256$	B1		$4.256(4.25\sim4.26)$
	accept H_0: no significant evidence of differences in mean times to complete Sudoku for groups drinking different quantities of alcohol	A1√ A1√	11	their figures – must be compared with upper tail of F – needs previous M only in context – requires previous A mark
(b)	source / SS / DF / MS alcohol / 9348 / 2 / 4674 weights / 7980 / 3 / 2660 residual / 3214 / 6 / 535.67 total / 20542 / 11 /	B1 M1		2, 3, 6 df method for all MS (including method for residual SS), their df
	H_0: no difference between amounts of alcohol			
	$F = \frac{4674}{535.67} = 8.73$	m1		method for F (either) – their figures
	reject H_0: significant evidence differences in mean times to do Sudoku between groups drinking different amounts of alcohol			
	H_0: no difference between weights			
	$F = \frac{2660}{535.67} = 4.97$	A1		$8.73(8.72\sim8.73)$ and $4.97(4.96\sim4.97)$
	c.v. $F_{[3,6]} = 4.757$	B1		$5.143(5.14\sim5.15)$ and $4.757(4.75\sim4.76)$
	reject H_0: significant evidence differences in mean times to do Sudoku between groups of different weights	A1√	6	both conclusions – their figures – must be compared with upper tail of F

SS06 (cont)

Q	Solution	Marks	Total	Comments
6(c)	The design in (b) has greatly reduced the residual MS, thus making it more likely to detect a difference if one exists. Design successful.	E1 E1	2	design effective reason
(d)	No interaction means that drinking alcohol has the same effect (in terms of time to do Sudoku) on a light person as on a heavy person.	E1 E1	2	meaning of interaction in context
	Total		**21**	
	TOTAL		**75**	