



## **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.**

SS06

Q	Solution	Marks	Total	Comments
1(a)	$\text{mean range} = \frac{0.84}{8} = 0.105$ estimated s.d. $= 0.4299 \times 0.105$ $= 0.045$	M1 B1 A1	3	attempt to find mean range 0.4299 0.045 ag by any correct method (0.045~0.05)
(b)(i)	chart for means warning limits $6.00 \pm 1.96 \times \frac{0.045}{\sqrt{5}}$ $5.961 \sim 6.039$ action limits $6.00 \pm 3.09 \times \frac{0.045}{\sqrt{5}}$ $5.938 \sim 6.062$	B1 M1 M1  A1	4	1.96 and 3.09 – allow 2 and 3 use of $\frac{0.045}{\sqrt{5}}$ method – both limits, allow incorrect z-value, use of $\sqrt{8}$ , disallow if not centred on 6.00  5.96 (5.959~5.961) 6.04 (6.039~6.041) 5.94 (5.937~5.94) 6.06 (6.06~6.063)
(ii)	chart for ranges LA $0.367 \times 0.045 = 0.017$ LW $0.850 \times 0.045 = 0.038$ UW $4.197 \times 0.045 = 0.189$ UA $5.484 \times 0.045 = 0.247$	M1  A1	2	D $\times$ 0.045 allow upper limits only allow any D  $\left. \begin{array}{l} 0.017 (0.016 \sim 0.017) \\ 0.038 (0.038 \sim 0.039) \\ 0.189 (0.1885 \sim 0.1895) \\ 0.247 (0.246 \sim 0.247) \end{array} \right\} \begin{array}{l} \text{allow one} \\ \text{small slip} \end{array}$
(c)	mean 6.056 range 0.20 both between warning and action limits take another sample immediately – if mean or range on new sample outside warning limits take action	B1 E1✓ E1	3	6.056 (6.05~6.06) and 0.2 CAO correct conclusion – their figures take another sample immediately - based on all correct working
(d)	$z_1 = \frac{(6.15 - 6.06)}{0.045} = 2$ $z_2 = \frac{(5.85 - 6.06)}{0.045} = -4.67$ proportion outside tolerances $= 1 - 0.97725$ $= 0.02275$	M1  A1	2	method – allow $z_1$ only, allow proportion inside tolerances  0.02275 (0.022~0.023)
<b>Total</b>			<b>14</b>	

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	3	subject does not know																																
		E1		purpose																																
		E1		complete answer																																
		E1		nonsense																																
(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	2	explanation																																
		E1																																		
<b>Total</b>			<b>5</b>																																	
3(a)	<table style="margin-left: 20px;"> <tr> <td>vol</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> <td>6</td> <td>7</td> </tr> <tr> <td>W – G</td> <td>32</td> <td>102</td> <td>7</td> <td>54</td> <td>–4</td> <td>44</td> <td>91</td> </tr> <tr> <td></td> <td>8</td> <td>9</td> <td>10</td> <td>11</td> <td>12</td> <td></td> <td></td> </tr> <tr> <td></td> <td>6</td> <td>47</td> <td>48</td> <td>18</td> <td>–41</td> <td></td> <td></td> </tr> </table> <p><math>\bar{d}=33.6667</math> <math>s=39.97575</math></p> <p><math>H_0: \mu_d = 0</math> <math>H_1: \mu_d &gt; 0</math></p> <p>allow <math>H_0: \mu_G = \mu_w</math> <math>H_1: \mu_G &lt; \mu_w</math></p> $t = \frac{(33.6667-0)}{\frac{(39.97575)}{\sqrt{12}}} = 2.92$ <p>c.v. <math>t_{11} = 1.1796</math></p> <p>reject <math>H_0</math>, significant evidence that items can be collected more quickly, on average, at Guildford than at Woking</p>	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	10	method for differences – disallow all same sign (W – G or G – W) 33.67(33.6~33.7) and 39.98(39.9~40.0)
		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																													
		B1	both hypothesis consistent with their differences – needs population or $\mu$																																	
		B1	use of $\frac{\text{their s.d.}}{\sqrt{12}}$																																	
		M1	method for t – ignore sign – needs both previous M marks																																	
		m1	2.92(2.91~2.92) or –2.92 if G–W used																																	
		A1	11 df																																	
B1	1.796(1.79~1.8) ignore sign																																			
B1✓	conclusion – must be compared with correct tail of t																																			
A1✓	conclusion in context – needs previous A mark																																			
A1✓	<b>For sign test/Wilcoxon</b> 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	2	source of possible bias – allow familiarity with store / particular items included in lists etc.																																
		E1		method of removal																																
<b>Total</b>			<b>12</b>																																	

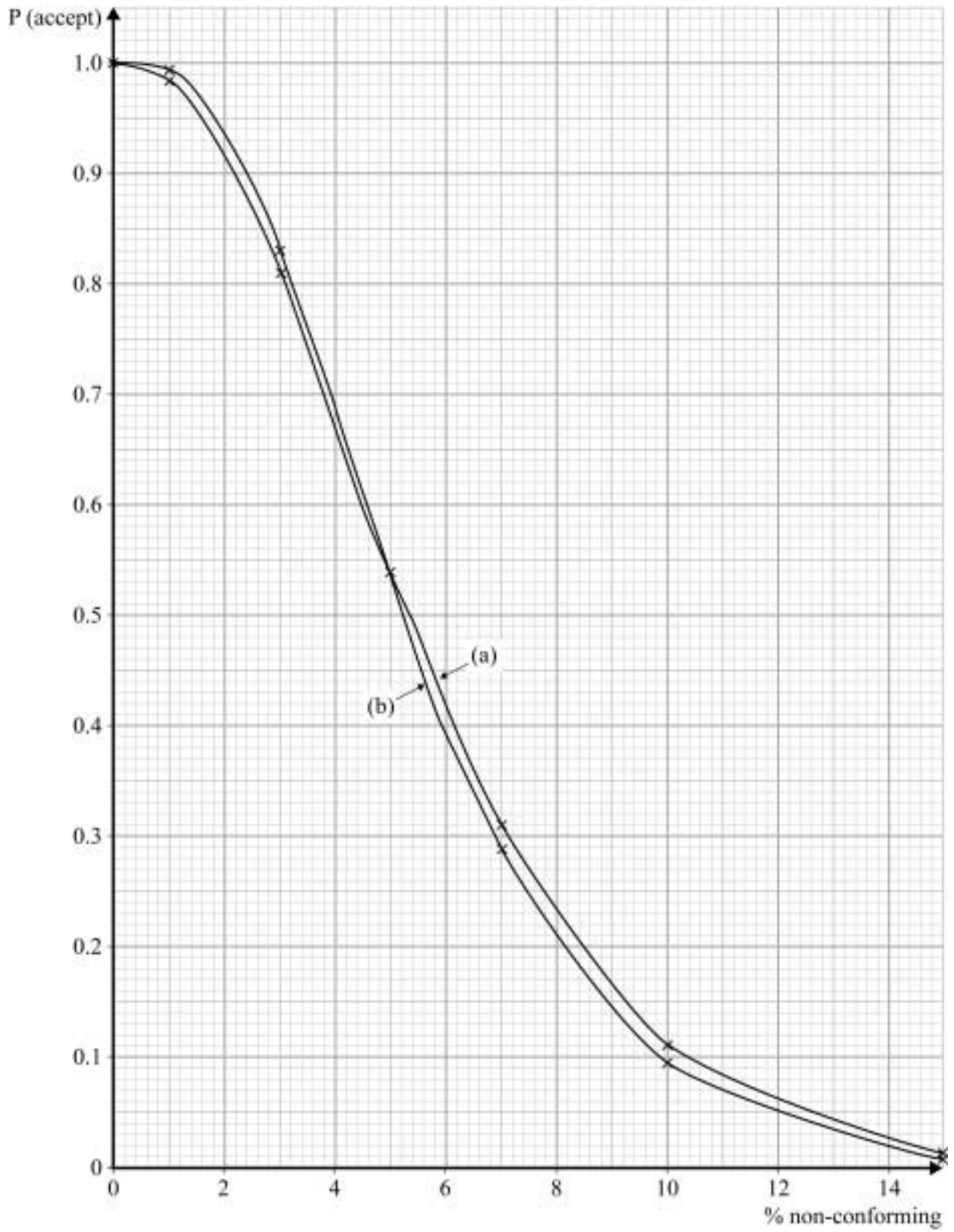
SS06 (cont)

Q	Solution	Marks	Total	Comments
4(a)(i)	$z = \frac{(25.2-24.6)}{\left(\frac{0.65}{\sqrt{10}}\right)}$ $= 2.919$ <p>P (reject) = 0.998 &gt;0.9 <b>or</b> 2.92 &gt; 1.2816 condition met</p>	M1	4	method for z – ignore sign
		m1		method for P(reject) – both method marks may be earned in (a)(ii)
		A1		0.998(0.998~0.9985)
(ii)	$z = \frac{(25.2-25.7)}{\left(\frac{0.65}{\sqrt{10}}\right)}$ $= - 2.433$ <p>P (accept) = 0.993 &gt; 0.95 <b>or</b> - 2.433 &lt; - 1.6449 condition met</p>	A1	2	0.993(0.992~0.993)
		A1✓		condition met
(b)	<p>Since both conditions are easily met, it is likely that the sample size could be reduced and the conditions still met. <b>can imply A1✓ A1✓ in (a)</b></p>	E1 E1	2	likely sample size could be reduced because conditions easily met allow answers based on further calculation
<b>Total</b>				<b>8</b>

**SS06 (cont)**

Q	Solution	Marks	Total	Comments
<b>5(a)(i)</b>	% 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 $\pm 0.001$
	<b>(ii)</b> on next page	M1 A1	2	method – points must be joined accurate plot – allow 1 small slip – must go through (0,1)
<b>(b)(i)</b>	accept            1st    0    1    2    2    3 2nd            0    1    0  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 = 0.534	M1 m1 B1		reasonable attempt to enumerate ways of accepting or rejecting correct enumeration use of B (40,0.05)
	<b>(ii)</b> on next page	m1 A1	5	correct method 0.534(0.533~0.534)
<b>(c)</b>	Double sampling plans more likely to accept good (low % n-c) batches and to reject bad (high % n-c) batches. More complicated to operate. All acceptance sampling plans will reject some good batches and accept some bad batches.	M1		method for given data – points must be joined
		A1	2	accurate plot – allow one small slip – don't penalise omission of (0,1) twice
		E1		double sampling plan ‘better’
		E1		double sampling plan more complicated
		E1	3	all acceptance sampling plans will reject some good batches
	<b>Total</b>		<b>15</b>	

SS06 (cont)





SS06 (cont)

Q	Solution	Marks	Total	Comments																								
6(a)	<table border="1"> <tr> <td>group</td> <td>1</td> <td>2</td> <td>3</td> </tr> <tr> <td>total</td> <td>622</td> <td>660</td> <td>860</td> </tr> </table> <p><math>\Sigma x=2142</math> <math>\Sigma x^2=411620</math></p> <p>total SS = <math>411620 - \frac{2142^2}{12} = 29273</math></p> <p>between groups SS =</p> <p><math>\frac{622^2}{4} + \frac{660^2}{4} + \frac{860^2}{4} - \frac{2142^2}{12} = 8174</math></p> <table border="1"> <tr> <td>source</td> <td>SS</td> <td>DF</td> <td>MS</td> </tr> <tr> <td>between groups</td> <td>8174</td> <td>2</td> <td>4087</td> </tr> <tr> <td>residual</td> <td>21099</td> <td>9</td> <td>2344.3</td> </tr> <tr> <td>total</td> <td>29273</td> <td>11</td> <td></td> </tr> </table> <p><math>H_0</math>: no difference between groups  <math>H_1</math>: not all group means equal</p> <p><math>F = \frac{4087}{2344.3} = 1.74</math></p> <p>c.v. <math>F_{[2,9]} = 4.256</math></p> <p>accept <math>H_0</math>: no significant evidence of differences in mean times to complete Sudoku for groups drinking different quantities of alcohol</p>	group	1	2	3	total	622	660	860	source	SS	DF	MS	between groups	8174	2	4087	residual	21099	9	2344.3	total	29273	11		M1		method for total SS disallow negative SS
	group	1	2	3																								
	total	622	660	860																								
	source	SS	DF	MS																								
	between groups	8174	2	4087																								
	residual	21099	9	2344.3																								
	total	29273	11																									
	M1		method for between groups SS																									
	B1		df 2, 9																									
	M1		method for residual SS																									
m1		$MS = \frac{SS}{\text{their df}}$																										
B1		hypotheses – population not essential																										
M1		method for F – their figures																										
A1		1.74(1.73~1.75)																										
B1		4.256(4.25~4.26)																										
A1✓		their figures – must be compared with upper tail of F – needs previous M only																										
A1✓	11	in context – requires previous A mark																										
6(b)	<table border="1"> <tr> <td>source</td> <td>SS</td> <td>DF</td> <td>MS</td> </tr> <tr> <td>alcohol</td> <td>9348</td> <td>2</td> <td>4674</td> </tr> <tr> <td>weights</td> <td>7980</td> <td>3</td> <td>2660</td> </tr> <tr> <td>residual</td> <td>3214</td> <td>6</td> <td>535.67</td> </tr> <tr> <td>total</td> <td>20542</td> <td>11</td> <td></td> </tr> </table> <p><math>H_0</math>: no difference between amounts of alcohol</p> <p><math>F = \frac{4674}{535.67} = 8.73</math></p> <p>reject <math>H_0</math>: significant evidence differences in mean times to do Sudoku between groups drinking different amounts of alcohol</p> <p><math>H_0</math>: no difference between weights</p> <p><math>F = \frac{2660}{535.67} = 4.97</math></p> <p>c.v. <math>F_{[3,6]} = 4.757</math></p> <p>reject <math>H_0</math>: significant evidence differences in mean times to do Sudoku between groups of different weights</p>	source	SS	DF	MS	alcohol	9348	2	4674	weights	7980	3	2660	residual	3214	6	535.67	total	20542	11		B1		2, 3, 6 df				
	source	SS	DF	MS																								
	alcohol	9348	2	4674																								
	weights	7980	3	2660																								
	residual	3214	6	535.67																								
	total	20542	11																									
	M1		method for all MS (including method for residual SS), their df																									
	m1		method for F (either) – their figures																									
	A1		8.73(8.72~8.73) and 4.97(4.96~4.97)																									
	B1		5.143(5.14~5.15) and 4.757(4.75~4.76)																									
A1✓	6	both conclusions – their figures – must be compared with upper tail of F																										

**SS06 (cont)**

<b>Q</b>	<b>Solution</b>	<b>Marks</b>	<b>Total</b>	<b>Comments</b>
<b>6(c)</b>	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	2	design effective
		E1		reason
<b>(d)</b>	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	2	meaning of interaction
		E1		in context
	<b>Total</b>		<b>21</b>	
	<b>TOTAL</b>		<b>75</b>	