

A-LEVEL STATISTICS

Statistics 6 – SS06
Mark scheme

6380
June 2014

Version 1.0 Final

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

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' 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.

Further copies of this Mark Scheme are available from aqa.org.uk

Q	Solution	Marks	Total	Comments																																																						
1(a)	16 birds/feathers can be regarded as a random sample. Differences in yellowness index can be assumed to be normally distributed.	E1 E1	2	At least one in context for E2 sc B1 for both reasons, no context																																																						
1(b)	<p>H₀ pop mean diff $\mu_d = 0$ H₁ pop mean diff $\mu_d > 0$ 1 tail 1%</p> <p>$d = \text{Typical} - \text{Odd}$</p> <table border="1" data-bbox="191 705 794 884"> <thead> <tr> <th></th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> <th>6</th> <th>7</th> <th>8</th> </tr> </thead> <tbody> <tr> <td>d</td> <td>+</td> <td>-</td> <td>+</td> <td>-</td> <td>-</td> <td>+</td> <td>+</td> <td>+</td> </tr> <tr> <td></td> <td>.069</td> <td>.028</td> <td>.109</td> <td>.041</td> <td>.018</td> <td>.014</td> <td>.249</td> <td>.08</td> </tr> <tr> <td></td> <td>9</td> <td>10</td> <td>11</td> <td>12</td> <td>13</td> <td>14</td> <td>15</td> <td>16</td> </tr> <tr> <td>d</td> <td>+</td> <td>+</td> <td>+</td> <td>+</td> <td>+</td> <td>+</td> <td>+</td> <td>+</td> </tr> <tr> <td></td> <td>.032</td> <td>.189</td> <td>.119</td> <td>.37</td> <td>.386</td> <td>.241</td> <td>.183</td> <td>.238</td> </tr> </tbody> </table> <p>$\bar{d} = 0.137$ $s = 0.135$ $n = 16$</p> <p>$t = \frac{0.137 - 0}{\frac{0.135}{\sqrt{16}}} = 4.05 \text{ to } 4.07$</p> <p>df = 15 cv =2.602</p> <p>Reject H₀ Significant evidence to suggest that odd tail feathers are less yellow than typical feathers.</p>		1	2	3	4	5	6	7	8	d	+	-	+	-	-	+	+	+		.069	.028	.109	.041	.018	.014	.249	.08		9	10	11	12	13	14	15	16	d	+	+	+	+	+	+	+	+		.032	.189	.119	.37	.386	.241	.183	.238	<p>B1</p> <p>M1 A1</p> <p>m1dep</p> <p>M1 m1ft</p> <p>A1</p> <p>B1</p> <p>A1dep E1dep</p>	<p>10</p>	<p>Consistent with differences Odd – Typical H₁ $\mu_d < 0$</p> <p>Differences ignore sign At least 3 correct</p> <p>attempt to find \bar{d}, s</p> <p>Use of $\frac{s}{\sqrt{16}}$ ft</p> <p>(±) 4.06</p> <p>cao cv p=0.00051 comp 1%</p> <p>dep correct ts and cv(both + or both -) In context dep A1</p>
	1	2	3	4	5	6	7	8																																																		
d	+	-	+	-	-	+	+	+																																																		
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Q	Solution	Marks	Total	Comments																
2(a) (i)	<table border="1"> <tr> <td>Mean</td> <td>19.2</td> <td>19.4</td> <td>19.6</td> <td>19.8</td> <td>20.0</td> <td>20.2</td> <td>20.4</td> </tr> <tr> <td>Prob</td> <td>.068</td> <td>.228</td> <td>.5</td> <td>.772</td> <td>.932</td> <td>.987</td> <td>.999</td> </tr> </table>	Mean	19.2	19.4	19.6	19.8	20.0	20.2	20.4	Prob	.068	.228	.5	.772	.932	.987	.999	B1m1	3	B1 for 0.5 m1 for $z = \frac{19.6 - \mu}{\frac{0.6}{\sqrt{5}}}$ or 1 prob correct
	Mean	19.2	19.4	19.6	19.8	20.0	20.2	20.4												
Prob	.068	.228	.5	.772	.932	.987	.999													
(ii)	On graph	A1	3 others correct																	
(iii)	Quite high chance of acceptance at mean 19.8/20 kg when some bags may well have contents below 20kg Low chance of batch acceptance at low mean and high chance at high mean so plan seems OK	M1 A1	2	M1 effort and at least 3 points joined A1 all correct																
(b) (i)	$\frac{w - 19.4}{\frac{0.6}{\sqrt{4}}} \geq 1.645$ $w \geq 19.4 + 1.645 \times \frac{0.6}{\sqrt{4}}$ $w \geq 19.893$ Weight to be exceeded is 19.9 kg	E1	1	Relevant comment																
(ii)	$\frac{19.6 - 20}{\frac{0.6}{\sqrt{n}}} \leq -1.75$ $-0.4 \leq -1.75 \times \frac{0.6}{\sqrt{n}}$ $0.4\sqrt{n} \geq 1.05$ $n \geq 6.89$ Minimum number is 7	B1	4	For 1.645																
		M1		For z formula 19.4 and $\frac{0.6}{\sqrt{4}}$ seen																
		m1		Condone 19.4 - w Rearrangement of inequality																
		A1		19.89 or 19.9 only																
		B1		For - 1.75																
		M1		For z formula (19.6 - 20) in numerator																
		m1		Rearrangement of inequality or equality																
		A1		n = 7 only Condone confused signs																
	sc Trial and improvement M1 probs seen <u>any 2</u> for <u>M1A1</u> if correct 19.7 .158 19.8 .091 19.9 .048 20.0 .023 If answer correct then B4																			

Q	Solution	Marks	Total	Comments																				
3(a)	$\hat{p} = \frac{4+7+5+\dots\dots\dots+7}{80+110+90+\dots\dots+95} = 0.06$	M1A1	3	M1 Sum of non-conf components / n A1 cao																				
	$\hat{n} = \frac{80+110+90+\dots\dots\dots+95}{10} = 100$	A1		(M1) Sum of numbers inspected /10 A1 cao																				
3(b)	Warning Limits		4	+ only necessary. Need 1.96 and any effort For upper																				
	$0.06 \pm 1.96 \times \sqrt{\frac{0.06 \times 0.94}{100}}$	M1ft																						
	(0.0134/5 , 0.106/7)	A1																						
	Action Limits																							
$0.06 \pm 3.09 \times \sqrt{\frac{0.06 \times 0.94}{100}}$	M1ft		+ only necessary Need 3.09 and any effort For upper																					
(-0.0133/4 or 0 , 0.133)	A1																							
3(c)	Proportion for each sample		4	Effort at finding proportions as decimals At least 4 correct																				
	$\frac{4}{80}, \frac{7}{110}, \dots\dots\dots, \frac{7}{95}$	M1ftA1																						
	<table border="1"> <thead> <tr> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> </tr> </thead> <tbody> <tr> <td>0.05</td> <td>0.064</td> <td>0.056</td> <td>0.093</td> <td>0.054</td> </tr> <tr> <td>6</td> <td>7</td> <td>8</td> <td>9</td> <td>10</td> </tr> <tr> <td>0.05</td> <td>0.057</td> <td>0.04</td> <td>0.076</td> <td>0.074</td> </tr> </tbody> </table>	1			2	3	4	5	0.05	0.064	0.056	0.093	0.054	6	7	8	9	10	0.05	0.057	0.04	0.076	0.074	A1
	1	2			3	4	5																	
	0.05	0.064			0.056	0.093	0.054																	
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0.05	0.057	0.04	0.076	0.074																				
All proportions lie below upper warning limit (0.106/7) therefore production is fine	M1 E1		All values below 0.106/7 correct Production fine sc B1 Clear comparison 'their' UWL and 'their' proportions.																					
(d)(i)	$\frac{3}{85} = 0.035$ Proportion below upper warning limit so OK. No action needed	M1 E1dep	4	M1 for finding proportion																				
(ii)	$\frac{12}{85} = 0.141$ Proportion above upper action limit so stop production immediately.	M1 E1dep	4	M1 for finding proportion																				

Q	Solution			Marks	Total	Comments	
4a(i)	Treatment			E1		Does not have to be 10/10 but 2 allocated numbers of volunteers must sum to 20	
	Placebo		New vaccine				
	10		10				
	Explanation: volunteers allocated a number. Numbers randomly selected and allocated to placebo or new vaccine.						
(ii)	Treatment			B1		Blocking used – age/sex	
	Placebo		New vaccine				
	Sex	Male	5				5
		Female	5				5
Explanation: volunteers allocated to subgroups or blocks by sex/age and then randomly assigned to either placebo or new vaccine.			E1		Blocking explained + table		
(iii)	Treatment			B1 E1		Pairing for age and/or sex idea Explanation of pairing	
	Placebo		New vaccine				
	Pair	1	1				1
		2	1				1
						
	10	1	1				
Volunteers are placed into pairs based on sex and age. Within each pair, volunteers are randomly allocated to receive the placebo or the new vaccine.			E1		Table and explanation with consideration of sex and age.		
b(i)	No bias in allocation of adults to placebo or vaccine treatment. or Simple to set up.			E1		Removal of any bias in allocation or simple to organise	
(ii)	Use of a blocking factor (for sex or age) removes effect of this factor on experimental outcome so that observed differences can be attributed only to treatment (placebo or vaccine) used.			E1		Removal of effect of one blocking factor	
(iii)	Experimental error reduced as the adults can be paired as closely as possible so that any difference in outcome can be attributed only to treatment (placebo or vaccine) used.			E1	3	Reduction in expt error as differences between outcome for paired adults should be due to treatment only. eg could consider age, sex health and whether a smoker or not or whether an asthma sufferer or not.	
(c)	Matched pairs as more likely to detect whether vaccine is effective or not since other factors controlled by pairing.			B1E1	2	B1 matched pairs E1 detect difference better	

Q	Solution	Marks	Total	Comments																			
5(a)(i)	<p>A B C D E F G</p> <p>$T_A=13$ $T_B=33$ $T_C=45$ $T_D=16$ $T_E=18$ $T_F=21$ $T_G=17$</p> <p>$n_A=3$ $n_B=3$ $n_G=3$</p> <p>$T = 163$</p> <p>$\sum \sum x_{ij}^2 = 1705$ $N = 21$</p> <p>Making</p> $\sum \frac{T_j^2}{n_j} = \frac{73^2}{7} + \frac{54^2}{7} + \frac{36^2}{7} = 1363$ <p>Tea Brands</p> $\sum \frac{T_i^2}{n_i} = \frac{13^2}{3} + \frac{33^2}{3} + \dots + \frac{17^2}{3} = 1531$ <p>SS_{makings} = 1363 - $\frac{163^2}{21}$</p> <p>= 97.81</p> <p>SS_{teas} = 1531 - $\frac{163^2}{21}$</p> <p>= 265.81</p> <p>SS_{Total} = 1705 - $\frac{163^2}{21}$</p> <p>= 439.81</p> <table border="1"> <thead> <tr> <th></th> <th>SS</th> <th>df</th> <th>ms</th> </tr> </thead> <tbody> <tr> <td>Makings</td> <td>97.81</td> <td>2</td> <td>48.91</td> </tr> <tr> <td>Tea Brands</td> <td>265.81</td> <td>6</td> <td>44.30</td> </tr> <tr> <td>Error</td> <td>76.19</td> <td>12</td> <td>6.35</td> </tr> <tr> <td>Total</td> <td>439.81</td> <td>20</td> <td></td> </tr> </tbody> </table>		SS	df	ms	Makings	97.81	2	48.91	Tea Brands	265.81	6	44.30	Error	76.19	12	6.35	Total	439.81	20		<p>M1ft</p> <p>M1ft</p> <p>M1ft</p> <p>M1ft</p> <p>M1ft</p>	<p>SS for makings attempt</p> <p>SS for teas attempt</p> <p>SS for total attempt</p> <p>Error SS ft (not -ve)</p> <p>Method for ms (not -ve)</p> <p>Condone only one correct or clear method seen ft</p>
	SS	df	ms																				
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Total	439.81	20																					
	<p>$H_0 \mu_{first} = \mu_{second} = \mu_{Third}$</p> <p>$H_1$ at least 2 of the means differ</p> <p>$T_s = \frac{48.91}{6.35} = 7.70$ $F_{12}^2 = 3.885 < 7.70$</p> <p>Reject H_0.</p> <p>$H_0 \mu_A = \mu_B = \dots = \mu_G$</p> <p>$H_1$ at least 2 of the means differ</p> <p>$= \frac{44.30}{6.35} = 6.98$ $F_{12}^6 = 2.996 < 6.98$</p> <p>Reject H_0.</p>	<p>B1</p> <p>m1ft</p> <p>B1</p> <p>A1dep</p> <p>m1ft</p> <p>B1</p> <p>(A1)</p>	<p>Correct hypotheses seen once</p> <p>Method for F for makings</p> <p>cv correct 3.885</p> <p>or p = 0.007</p> <p>A1 dep ts/cv or p correct</p> <p>Method for F for teas</p> <p>cv correct 2.996</p> <p>or p = 0.0022</p>																				

<p>(ii) First making is significantly preferred to the third making.</p> <p>Don't use a tea bag more than twice, preferably only once</p> <p>Brand C seems to be the favourite tea brand and Brand A the least favourite</p> <p>(b)(i) There is no interaction [between tea brand and making order.]</p> <p>One brand is not better/worse at particular making.</p> <p>(ii) The population of ratings is normal and the ratings have a common variance</p> <p>(c) H_0 pop mean/median diff = 0 H_1 pop mean/median diff \neq 0</p>	<p>There is a significant difference between at least two of the making orders and between at least two of the brands</p> <p>Ranks</p> <table border="1" data-bbox="188 1249 798 1406"> <tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th></tr> <tr><td>9</td><td>2</td><td>5</td><td>.</td><td>1</td><td>3½</td><td>7</td><td>6</td><td>8</td><td>3½</td></tr> <tr><td>1</td><td>8</td><td>5</td><td></td><td>9</td><td>6½</td><td>3</td><td>4</td><td>2</td><td>6½</td></tr> <tr><td>-</td><td>+</td><td>-</td><td></td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>+</td></tr> </table> <p>$T_- = 9 + 5 + 1 + 3\frac{1}{2} + 7 + 6 + 8 = 39\frac{1}{2}$ $T_+ = 2 + 3\frac{1}{2} = 5\frac{1}{2}$</p> <p>ts $T_+ = 5\frac{1}{2}$ cv = 6 $T_+ < 6$ Reject H_0 There is a significant difference the brands – C preferred</p>	1	2	3	4	5	6	7	8	9	10	9	2	5	.	1	3½	7	6	8	3½	1	8	5		9	6½	3	4	2	6½	-	+	-		-	-	-	-	-	+	<p>E1dep</p> <p>E1 or E1 or E1</p> <p>B1</p> <p>E1</p> <p>B1 E1</p> <p>M1</p> <p>m1 A1</p> <p>B1 E1dep</p>	<p>12</p> <p>2</p> <p>4</p> <p>5</p>	<p>A1 for Reject for both E1 In context for both dep A1 Might see in earlier conclusions</p> <p>For any two relevant comments</p> <p>Normal and common variance Reference to context/ratings somewhere or μ_d, η_d used</p> <p>ranks – any effort</p> <p>totals of ranks +/- correct</p> <p>cv correct and correct comparison with lower ts in context ts and cv correct and hypotheses effort</p>
1	2	3	4	5	6	7	8	9	10																																			
9	2	5	.	1	3½	7	6	8	3½																																			
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-	+	-		-	-	-	-	-	+																																			