



General Certificate of Education

Statistics 6380

SS03 Statistics 3

Mark Scheme

2008 examination - January 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.

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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.

SS03

Q	Solution	Marks	Total	Comments
1	H_0 pop median = £5.60 H_1 pop median $\neq$ £5.60 2 tail 10% Signs - + + + + + + + + - + test statistic $2^- / 10^+ \quad n = 12$ $P(\leq 2^-) = 0.0193$ or $P(\geq 10^+) = 0.0193$ $0.0193 < 0.05$ for 2 tailed test at 10% Significant evidence at 10% level to reject H_0 There is significant evidence to suggest that the median weekly amount of pocket money given to 14 year-old children living in Brighton has changed (increased) since 2003	B1 M1 A1 M1 m1 A1 E1	 7	 ts correct Bin model seen to be used Comparison of correct B(12, 0.5) prob with 0.05 or use of identified cv
	Total		7	

SS03 (cont)

Q	Solution	Marks	Total	Comments																		
2	H₀ Samples are taken from identical populations H₁ Samples are not taken from identical populations (rugby players have higher average scores) 1 tail 5% <table><tr><th>Golfers ranks</th><th>Rugby players ranks</th></tr><tr><td>1</td><td>4</td></tr><tr><td>2</td><td>6</td></tr><tr><td>3</td><td>7 ¹/₂</td></tr><tr><td>5</td><td>10</td></tr><tr><td>7 ¹/₂</td><td>13</td></tr><tr><td>9</td><td>14</td></tr><tr><td>11</td><td>15</td></tr><tr><td>12</td><td></td></tr></table> T_G = 1 + 2 + ... + 12 = 50.5 T_R = 4 + 6 + ... + 15 = 69.5 U_G = 50.5 - $\frac{8 \times 9}{2}$ = 14.5 U_R = 69.5 - $\frac{7 \times 8}{2}$ = 41.5 Test statistic U = 14.5 n = 8 , m = 7 , cv = 13 U = 14.5 > 13 Accept H₀ No significant evidence at the 5% level to suggest that the average test score is higher for rugby players	Golfers ranks	Rugby players ranks	1	4	2	6	3	7 ¹ / ₂	5	10	7 ¹ / ₂	13	9	14	11	15	12		B1 B1 M1 m1 M1 M1 B1 M1 A1 E1	10	Hypotheses referring to population averages also acceptable Attempt at Mann-Whitney; ranks as one group For ties For total attempt For U formula correct Correct/relevant cv used In context
Golfers ranks	Rugby players ranks																					
1	4																					
2	6																					
3	7 ¹ / ₂																					
5	10																					
7 ¹ / ₂	13																					
9	14																					
11	15																					
12																						
	Total		10																			

SS03 (cont)

Q	Solution	Marks	Total	Comments
3(a)	H_0 No association between type of victim and type of offence H_1 Association exists between type of victim and type of offence 1 tail 5% Expected frequencies:	B1		Independent / not independent: allow B1 once only
		M1		E method (1dp allowed)
		m1		for 3 correct
		m1		for all E correct (SC2 if integers)
	</			

SS03 (cont)

Q	Solution	Marks	Total	Comments												
3(b)(i)	<table><tr><td></td><td>Under 25 years</td><td>25 years and over</td></tr><tr><td>Aggravated</td><td>3.375</td><td>5.625</td></tr><tr><td>Simple</td><td>11.625</td><td>19.375</td></tr><tr><td>Intimidation</td><td>18</td><td>30</td></tr></table>		Under 25 years	25 years and over	Aggravated	3.375	5.625	Simple	11.625	19.375	Intimidation	18	30	M1		E method
			Under 25 years	25 years and over												
		Aggravated	3.375	5.625												
		Simple	11.625	19.375												
	Intimidation	18	30													
	m1		for 3 correct													
	m1	3	for all E correct (SC2 if integers)													
	(ii)	Pooling necessary because the expected frequency (3.375) for ‘Under 25 years’ ‘Aggravated’ assault is below 5	E1	1												
	(iii)	2 assault categories should be pooled – both the same ‘type’ of offence: assault	E1	1												
(iv)	<table><tr><td></td><td>Under 25 years</td><td>25 years and over</td></tr><tr><td>Assaults – simple/aggravated</td><td>15</td><td>25</td></tr><tr><td>Intimidation</td><td>18</td><td>30</td></tr></table>		Under 25 years	25 years and over	Assaults – simple/aggravated	15	25	Intimidation	18	30						
			Under 25 years	25 years and over												
		Assaults – simple/aggravated	15	25												
	Intimidation	18	30													
	H ₀ No association between age of offender and type of offence H ₁ Association exists between age of offender and type of offence 1 tail 5% $ts = \sum \frac{(O - E - 0.5)^2}{E} =$ $\frac{1.5^2}{15} + \frac{1.5^2}{25} + \frac{1.5^2}{18} + \frac{1.5^2}{30}$ = 0.44 df = 1 5% cv = 3.841 ts < 3.841 Accept H ₀ No significant evidence to suggest an association between age of offender and type of offence	B1														
		M1 M1		For ts correct denominators For Yates’ correction												
		A1		For ts 0.2 – 0.50 (SC2 ts = 0.782)												
		B1		For cv												
		M1		For comparison ts/cv												
		A1	7	In context												
	Total		22													

SS03 (cont)

Q	Solution	Marks	Total	Comments													
4(a)	H ₀ pop median/mean diff $\eta_d = 0$	B1	9	Consistent with differences													
	H ₁ pop median/mean diff $\eta_d < 0$	B1															
	1 tail 5% (d is 2003 – 1999)																
	<table><tr><td>diff</td><td>-5.4</td><td>-3.2</td><td>-3.8</td><td>-4.2</td><td>-2.4</td></tr><tr><td>rank</td><td>10</td><td>6</td><td>8</td><td>9</td><td>3</td></tr></table>	diff			-5.4	-3.2	-3.8	-4.2	-2.4	rank	10	6	8	9	3	M1	For differences
	diff	-5.4			-3.2	-3.8	-4.2	-2.4									
	rank	10			6	8	9	3									
	<table><tr><td>-2.1</td><td>-3.1</td><td>+0.3</td><td>-2.8</td><td>+3.4</td></tr><tr><td>2</td><td>5</td><td>1</td><td>4</td><td>7</td></tr></table>	-2.1			-3.1	+0.3	-2.8	+3.4	2	5	1	4	7	M1	For ranks		
	-2.1	-3.1			+0.3	-2.8	+3.4										
	2	5			1	4	7										
	T ₊ = 1 + 7 = 8	m1			For total												
T ₋ = 10 + 6 ++ 4 = 47	A1	For one correct total															
ts T = 8 n = 10 cv = 11	B1	For cv															
T < 11	M1	Comparison cv/ts															
Significant evidence at 5% level to reject H ₀ and conclude that average teenage conception rate has decreased between 1999 and 2003	E1																
(b)	A matched pairs design eliminates individual differences by comparing conception rates in the same regions for the two years. This means that any particular regional differences will not affect the comparisons and so a difference is more likely to be detected if one exists	B1	2	General idea of matched pairs reducing experimental error													
		E1		In context													
(c)	A Type I error is when a correct H ₀ is rejected. In this case it would mean that we conclude that the average conception rate has decreased when, in fact, it has not	B1	2														
		E1															
	Total		13														

SS03 (cont)

Q	Solution	Marks	Total	Comments																					
5(a)	<table><tr><td>Team</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr><tr><td>x rank</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>y rank</td><td>2</td><td>5</td><td>4</td><td>6</td><td>7</td></tr></table>	Team	A	B	C	D	E	x rank	1	2	3	4	5	y rank	2	5	4	6	7	M1		Attempt at ranks (can be reversed)			
	Team	A	B	C	D	E																			
	x rank	1	2	3	4	5																			
	y rank	2	5	4	6	7																			
		M1		For 8 correct																					
	<table><tr><td>Team</td><td>F</td><td>G</td><td>H</td><td>I</td><td>J</td><td>K</td></tr><tr><td>x rank</td><td>6</td><td>7</td><td>8</td><td>9½</td><td>9½</td><td>11</td></tr><tr><td>y rank</td><td>10</td><td>3</td><td>11</td><td>9</td><td>1</td><td>8</td></tr></table>	Team	F	G	H	I	J	K	x rank	6	7	8	9½	9½	11	y rank	10	3	11	9	1	8	A1		
	Team	F	G	H	I	J	K																		
	x rank	6	7	8	9½	9½	11																		
	y rank	10	3	11	9	1	8																		
	$r_s = 0.355$ (3sf from calc)	B3	6	Or $d = 1, 3, 1, 2, 2, 4, 4, 3, \frac{1}{2}, 8\frac{1}{2}, 3$ $\sum d^2 = 141\frac{1}{2}$ B1 $r_s = 1 - \frac{6 \times 141\frac{1}{2}}{11 \times 120} = 0.357$ M1A1 SC4 0.36 SC4 0.318																					
(b)	H_0 Rank orders of gate receipts and player costs are independent	B1																							
	H_1 Rank orders of gate receipts and player costs are not independent – there is a positive association																								
	1 tail 10%																								
	cv = 0.4182	B1		For cv																					
	ts $r_s = 0.355$	M1		For comparison ts/cv																					
	$r_s < 0.4182$	A1		$r_s = 0.355$ or 0.357																					
	Accept H_0 No significant evidence at 10% level to suggest a positive association between rank orders of gate receipts and player costs	E1	5	In context																					
	Total		11																						

SS03 (cont)

Q	Solution	Marks	Total	Comments																								
6	H_0 Samples are taken from identical populations	B1		or $H_0 \quad \eta_{Normal} = \eta_{Depres} = \eta_{MildAlz}$																								
	H_1 Samples are not taken from identical populations – population average recall scores differ	B1		H_1 at least two of $\eta_{Normal}, \eta_{Depres}, \eta_{MildAlz}$ differ																								
	1% 1 tail																											
	Ranks																											
	<table><tr><th>Normal</th><th>Depression</th><th>Mild Alzheimer's</th></tr><tr><td>8</td><td>5</td><td>1</td></tr><tr><td>14</td><td>9</td><td>2</td></tr><tr><td>15</td><td>10</td><td>3</td></tr><tr><td>16</td><td>11</td><td>4</td></tr><tr><td>17</td><td>12</td><td>6</td></tr><tr><td>18</td><td>13</td><td>7</td></tr><tr><td>19</td><td></td><td></td></tr></table>	Normal	Depression	Mild Alzheimer's	8	5	1	14	9	2	15	10	3	16	11	4	17	12	6	18	13	7	19			M1		Ranks
	Normal	Depression	Mild Alzheimer's																									
	8	5	1																									
	14	9	2																									
	15	10	3																									
	16	11	4																									
	17	12	6																									
	18	13	7																									
	19																											
	m1		At least 12 correct																									
$T_{Normal} = 107 \quad T_{Depres} = 60 \quad T_{MildAlz} = 23$	m1		Totals																									
$n_{Normal} = 7 \quad n_{Depres} = 6 \quad n_{MildAlz} = 6$	A1		Any one correct																									
$\sum_{i=1}^m \frac{T_i^2}{n_i} = \frac{107^2}{7} + \frac{60^2}{6} + \frac{23^2}{6} = 2323.74$	m1																											
$H = \frac{12}{19 \times 20} \times 2323.74 - (3 \times 20) = 13.38$	A1		ts correct 13.0 – 13.8																									
Critical value from $\chi^2_2 = 9.210$	B1																											
$H > 9.210$	M1																											
Sig evidence to reject H_0 and conclude that samples are not from identical populations	A1																											
Significant evidence at the 1% level to suggest that the population average recall scores differs for the three categories of adults: at least two of the averages differ. It appears that those adults with Mild Alzheimer's disease have a significantly lower average recall score than those who have normal memory function	E1	12	Difference in context Mention of 'at least two' or a significant difference between scores for Mild Alzheimer's and those with normal memory function																									
	Total	12																										
	TOTAL	75																										