

GCE 2005
January Series



Mark Scheme

Mathematics and Statistics B (MBS3)

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

M	mark is for	method
m	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
CAO	correct answer only	
AWFW	anything which falls within	
AWRT	anything which rounds to	
AG	answer given	
SC	special case	
OE	or equivalent	
A2,1	2 or 1 (or 0) accuracy marks	
-x EE	deduct x marks for each error	
NMS	no method shown	
PI	possibly implied	
SCA	substantially correct approach	
c	candidate	
SF	significant figure(s)	
DP	decimal place(s)	

Abbreviations used in Marking

MC – x	deducted x marks for mis-copy
MR – x	deducted x marks for mis-read
ISW	ignored subsequent working
BOD	given benefit of doubt
WR	work replaced by candidate
FB	formulae booklet

Application of Mark Scheme

No method shown:

Correct answer without working	mark as in scheme
Incorrect answer without working.....	zero marks unless specified otherwise

More than one method/choice of solution:

2 or more complete attempts, neither/none crossed out	mark both/all fully and award the mean mark rounded down
1 complete and 1 partial attempt, neither crossed out	award credit for the complete solution only

Crossed out work

do not mark unless it has not been replaced

Alternative solution using a correct or partially
correct method

award method and accuracy marks as
appropriate

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Question Number and Part	Solution	Marks	Total	Comments
1(a)	$0.5 \times 0.2 = 0.1$ (or 10%)	M1 A1	2	
(b)	$0.1 + (0.3 \times 0.4) + (0.2 \times 0.1) =$ $0.1 + 0.12 + 0.02 = 0.24$ (or 24%)	M1 M1 A1	3	for 'their' 0.1 + considering other two for 0.3×0.4 or 0.2×0.1 effort
(c)	$\frac{0.1}{0.24} = 0.417$ (or 41.7%)	M1 M1 A1	3	for numerator for denominator ft
(d)	$\frac{(0.5 \times 0.8)}{(1 - 0.24)} = 0.526$ (or 52.6%) or $\frac{40}{76}$ or $\frac{10}{19}$	M1 M1 A1	3	for numerator (B1 for $0.8 \times 0.5 = 0.4$) for denominator ft part(b)
	Total		11	

MBS3 (cont)

Question Number and Part	Solution	Marks	Total	Comments
2(a)	<p>H_0 Population median assessment mark same for both diets H_1 Population median assessment mark higher for diet A 1 tail test 1 % level differences 1 2 3 4 5 6 7 8 9 10 12 10 -5 15 -1 7 13 7 9 4 ranks 8 7 -3 10 -1 4½ 9 4½ 6 2</p> $T_+ = 8 + 7 + 10 + 4 \frac{1}{2} + 9 + 4 \frac{1}{2} + 6 + 2 = 51$ $T_- = 1 + 3 = 4$ test stat $T = 4$ critical value = 5 test stat < 5 so Reject H_0 There is significant evidence that the median assessment mark is higher for diet A	<p>B1 M1 m1 m1 A1 m1 A1 B1 M1 A1</p>	<p>10</p>	<p>for differences for ranks (1 = lowest) ties for totals correct test stat for cv for comparison ts/cv (can be wrong cv but WS-R tables)</p>
(b)(i)	$T = 0$	B1		
(ii)	$T = 55$	M1 A1	3	effort to total $\sum_{n=1}^{n=10} n$ or $\frac{1}{2}n(n+1) - (i)$
(c)(i)	Wilcoxon signed-rank test considers the rank order of their difference, not just their signs	B1	1	Sensible comment
(ii)	If data is not symmetrical – then sign test can be used but Wilcoxon cannot			
	Or If data is non numeric then sign test can be used but Wilcoxon cannot	B1	1	
	Total		15	

MBS3 (cont)

Question Number and Part	Solution	Marks	Total	Comments
3(a)	Scatter diagram	B1 M1A1	3	For axes labelled
(b)	Ranks miles 10, 7, 4, 3, 1, 9, 6, 8, 5, 2 score $9\frac{1}{2}$, 8, 3, 4, 1, $9\frac{1}{2}$, 6, 7, 5, 2 r_s (from calculator) = 0.973	M1 M1 A1 B3	6	for ranks (can be reversed) ties allow small error alternatively differences, d $\frac{1}{2}, 1, 1, 1, 0, \frac{1}{2}, 0, 1, 0, 0$ $\sum d^2 = 4\frac{1}{2}$ B1 $r_s = 1 - \frac{6 \times 4\frac{1}{2}}{10 \times 99} = 0.973$ M1, A1 can ft
(c)	$H_0 \rho_s = 0$ $H_1 \rho_s > 0$ 1 tail 1% test stat $r_s = 0.973$ critical value = 0.7333 tests stat > 0.7333 so significant evidence exists to reject H_0 and conclude that a positive association exists. This suggests that salespeople who travel more miles for work tend to have a higher stress score	B1 B1 M1 A1	4	Or 2 tail test $H_1 \rho_s \neq 0$ B0 if inconsistent H_0 / H_1 and cv for cv 2 tail cv = 0.7818 comparison ts/cv not pmcc cv unless ts is pmcc also explanation in context – allow conclusion that association exists in context if 2 tail test carried out.
(d)	The scatter diagram indicates a non linear relationship (or a J shaped curve) and PMCC is appropriate for linear relationships only	B1	1	
Total			14	

MBS3 (cont)

Question Number and Part	Solution	Marks	Total	Comments
4(a)	<p>H_0 samples from identical pops H_1 samples not from identical pops</p> <p>2 tail 5% significance level</p> <p>Ranks ‘Thinking’ 7 5 4 8½ 12 1 3 ‘Feeling’ 10 8½ 11 6 14 15 2 13</p> <p>$T_{\text{thinking}} = 40\frac{1}{2}$ $T_{\text{feeling}} = 79\frac{1}{2}$</p> <p>$U_p = 40\frac{1}{2} - \frac{1}{2}(7 \times 8) = 12\frac{1}{2}$ $U_c = 79\frac{1}{2} - \frac{1}{2}(8 \times 9) = 43\frac{1}{2}$</p> <p>test stat $U = 12\frac{1}{2}$ critical value = 11 ($m = 7, n = 8$)</p> <p>test stat > 11 Accept H_0 No significant evidence to doubt that samples are from identical populations (or no evidence to suggest that there is a difference in average diastolic blood pressure for the two personality groups)</p>	<p>B1 B1</p> <p>M1 M1 A1 A1</p> <p>M1</p> <p>M1 M1 A1</p> <p>B1 B1 M1</p> <p>A1✓</p>	<p>14</p>	<p>or H_0 blood pressures the same H_1 blood pressures differ allow B1 only</p> <p>NB Many other methods acceptable</p> <p>for ranks as one group (can be reversed) for ties T 71.5, 48.5 all ok except ties correct</p> <p>for totals</p> <p>for U values, either either U value correct</p> <p>either tail cv for use of correct cv consistent with U for comparison of ts/cv</p> <p>allow ft for small slip</p>
(b)	<p>H_0 Managers have no specific preference ($\pi = \frac{1}{2}$) H_1 Managers prefer new pay structure ($\pi > \frac{1}{2}$)</p> <p>1 tail test 1% sig level test stat = 35 + or 15 –</p> <p>B(50, 0.5) model $P(\text{at most } 15 -) = (\text{at least } 35 +) = 0.0033$ $0.0033 < 0.01$ for 1 tail test</p> <p>Reject H_0 There is sig evidence to suggest that managers prefer new pay structure</p>	<p>B1</p> <p>M1 A1 M1</p> <p>m1</p> <p>A1</p>	<p>6</p>	<p>for signs for correct test stat for Bin model $n = 50$ $p = 0.5$ with seen probability comparison with 0.01 or use of critical region $\{0, 1 \dots 16 -\}$ or $\{33, 34 \dots 50 +\}$ with prob 0.0077</p>
	Total		20	
	TOTAL		60	