

# GCE 2005

## *January Series*



## Mark Scheme

### Mathematics and Statistics B

*(MBS3)*

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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

<b>M</b> .....	mark is for .....	method
<b>m</b> .....	mark is dependent on one or more M marks and is for .....	method
<b>A</b> .....	mark is dependent on M or m marks and is for .....	accuracy
<b>B</b> .....	mark is independent of M or m marks and is for .....	method and accuracy
<b>E</b> .....	mark is for .....	explanation
<b>✓ or ft or F</b> .....	follow through from previous	incorrect result
<b>CAO</b> .....	correct answer only	
<b>AWFW</b> .....	anything which falls within	
<b>AWRT</b> .....	anything which rounds to	
<b>AG</b> .....	answer given	
<b>SC</b> .....	special case	
<b>OE</b> .....	or equivalent	
<b>A2,1</b> .....	2 or 1 (or 0) accuracy marks	
<b>-x EE</b> .....	deduct $x$ marks for each error	
<b>NMS</b> .....	no method shown	
<b>PI</b> .....	possibly implied	
<b>SCA</b> .....	substantially correct approach	
<b>c</b> .....	candidate	
<b>SF</b> .....	significant figure(s)	
<b>DP</b> .....	decimal place(s)	

## Abbreviations used in Marking

<b>MC – <math>x</math></b> .....	deducted $x$ marks for mis-copy
<b>MR – <math>x</math></b> .....	deducted $x$ marks for mis-read
<b>ISW</b> .....	ignored subsequent working
<b>BOD</b> .....	given benefit of doubt
<b>WR</b> .....	work replaced by candidate
<b>FB</b> .....	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

**Mathematics and Statistics B Statistics 3 MBS3 January 2005**

<b>Question Number and Part</b>	<b>Solution</b>	<b>Marks</b>	<b>Total</b>	<b>Comments</b>
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 $0.3 \times 0.4$ or $0.2 \times 0.1$ 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)
	<b>Total</b>		<b>11</b>	

**MBS3 (cont)**

Question Number and Part	Solution	Marks	Total	Comments
2(a)	<p><math>H_0</math> Population median assessment mark same for both diets  <math>H_1</math> 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 <b>Or</b> If data is non numeric then sign test can be used but Wilcoxon cannot	B1	1	
	<b>Total</b>		<b>15</b>	

**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 <b>alternatively</b> 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 fit
(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	
<b>Total</b>			<b>14</b>	

**MBS3 (cont)**

Question Number and Part	Solution	Marks	Total	Comments
4(a)	<p><math>H_0</math> samples from identical pops  <math>H_1</math> 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><math>T_{\text{thinking}} = 40\frac{1}{2}</math>  <math>T_{\text{feeling}} = 79\frac{1}{2}</math></p> <p><math>U_p = 40\frac{1}{2} - \frac{1}{2}(7 \times 8) = 12\frac{1}{2}</math>  <math>U_c = 79\frac{1}{2} - \frac{1}{2}(8 \times 9) = 43\frac{1}{2}</math></p> <p>test stat <math>U = 12\frac{1}{2}</math>                      critical value = 11 (<math>m = 7, n = 8</math>)</p> <p>test stat &gt; 11 Accept <math>H_0</math>                      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 <math>H_0</math> blood pressures the same  <math>H_1</math> 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 <math>U</math> values, either                      either <math>U</math> value correct</p> <p>either tail cv                      for use of correct cv consistent with <math>U</math>                      for comparison of ts/cv</p> <p>allow ft for small slip</p>
(b)	<p><math>H_0</math> Managers have no specific preference                      (<math>\pi = \frac{1}{2}</math>)  <math>H_1</math> Managers prefer new pay structure                      (<math>\pi &gt; \frac{1}{2}</math>)</p> <p>1 tail test 1% sig level                      test stat = 35 + or 15 –</p> <p>B(50, 0.5) model  <math>P(\text{at most } 15 -) = (\text{at least } 35 +) = 0.0033</math>  <math>0.0033 &lt; 0.01</math> for 1 tail test</p> <p>Reject <math>H_0</math>                      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 <math>n = 50</math> <math>p = 0.5</math> with seen probability                      comparison with 0.01                      or use of critical region  <math>\{0, 1 \dots 16 -\}</math> or <math>\{33, 34 \dots 50 +\}</math> with prob 0.0077</p>
	<b>Total</b>		<b>20</b>	
	<b>TOTAL</b>		<b>60</b>	