

GCE 2004  
*June Series*



# Mark Scheme

## Mathematics and Statistics B *MBS6*

---

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.

Further copies of this Mark Scheme are available from:

Publications Department, Aldon House, 39, Heald Grove, Rusholme, Manchester, M14 4NA  
Tel: 0161 953 1170

or

download from the AQA website: [www.aqa.org.uk](http://www.aqa.org.uk)

Copyright © 2004 AQA and its licensors

#### COPYRIGHT

AQA retains the copyright on all its publications. However, registered centres for AQA are permitted to copy material from this booklet for their own internal use, with the following important exception: AQA cannot give permission to centres to photocopy any material that is acknowledged to a third party even for internal use within the centre.

Set and published by the Assessment and Qualifications Alliance.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales 3644723 and a registered charity number 1073334. Registered address AQA, Devas Street, Manchester. M15 6EX.

*Dr Michael Cresswell Director General*

**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	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>cso</b>		correct solution only
<b>awfw</b>		anything which falls within
<b>awrt</b>		anything which rounds to
<b>acf</b>		any correct form
<b>ag</b>		answer given
<b>sc</b>		special case
<b>oe</b>		or equivalent
<b>sf</b>		significant figure(s)
<b>dp</b>		decimal place(s)
<b>A2,1</b>		2 or 1 (or 0) accuracy marks
<b>-x ee</b>		deduct x marks for each error
<b>pi</b>		possibly implied
<b>sca</b>		substantially correct approach

**Abbreviations used in Marking**

<b>MC – x</b>	deducted x marks for mis-copy
<b>MR – x</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 book

**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 6 MBS6 June 2004

Question Number And Part	Solution	Marks	Total	Comments
1(a)	$r = 0.846$ (calculator) <b>Or</b> $r = \frac{\frac{150605}{15} - \left(\frac{2169 \times 1004}{15}\right)}{\left(\sqrt{318889 - \frac{2169^2}{15}}\right) \times \left(\sqrt{75030 - \frac{1004^2}{15}}\right)}$	B4	4	sc 2 marks for awrt 0.85 $\sum x = 2169 \quad \sum x^2 = 318889$ $\sum y = 1004 \quad \sum y^2 = 75030$ $\sum xy = 150605 \quad \text{B1}$ Numerator = 5426.6 M1 Denominator = 72.468 × 88.481 M1 A1
1(b)	$H_0 \rho = 0$ $H_1 \rho > 0$ 1 tail 1% sig level  $cv = 0.5923$  $ts = r = 0.846$ since $ts > 0.5923$ Reject $H_0$  Significant evidence to suggest that there is a positive correlation between height and pulmonary anatomical dead space as the paediatric doctor believed.	B1  B1  M1  A1	4	For cv  For comparison $ts / cv$  Conclusion in context
	<b>Total</b>		<b>8</b>	

## MBS6 (cont)

Question Number And Part	Solution	Marks	Total	Comments
2(a)	<p><math>H_0</math> Populations of catalytic/non-catalytic systems are distributed identically</p> <p><math>H_1</math> Populations of catalytic/non-catalytic systems are not distributed identically – non-catalytic systems contain less carbon monoxide on average</p> <p>1 tail 5% sig level</p> <p>ranks    1   2   8   5   3   6 catalytic</p> <p>ranks    7   9   10   12   13   4   11 non-catalytic</p> <p><math>T_{\text{catalytic}} = 25</math> <math>T_{\text{non-catalytic}} = 66</math></p> <p><math>U = 25 - \frac{6 \times 7}{2} = 4</math></p> <p>test stat = 4</p> <p>cv = 9 (lower tail)</p> <p>Since <math>4 &lt; 9</math>, reject <math>H_0</math></p> <p>Significant evidence to suggest that populations are not identical and that exhausts with a catalytic system contain less carbon monoxide on average</p>	<p>B1</p> <p>B1</p> <p>M1 A1</p> <p>A1</p> <p>m1</p> <p>m1</p> <p>A1 B1</p> <p>M1</p> <p>A1</p>	<p>12</p> <p>4</p>	<p>Or <math>H_0</math>: Pop average CO emissions for catalytic/non-catalytic systems are the same</p> <p><math>H_1</math>: Pop average CO emissions are less for catalytic systems</p> <p>NB Many other methods acceptable</p> <p>For ranks as one group (can be reversed) For catalytic correct</p> <p>For non-catalytic correct</p> <p>Totals</p> <p>Method consistent for test stat</p> <p>Or <math>U = 66 - \frac{7 \times 8}{2} = 38</math> upper tail</p> <p>Either test stat OK, upper or lower For either tail cv, consistent with test stat Allow B1 ft provided sensible/correct method</p> <p>For comparison t.s./critical value (ft if cv sensible, cv = 7 allowed M1)</p> <p>Or equivalent</p> <p>Or equivalent</p>
(b)	<p>Minimum value for <math>T</math> is <math>1 + 2 + 3 + 4 + 5 + 6 = 21</math></p> <p>Minimum value for <math>U = 21 - \frac{6 \times 7}{2}</math> <math>= 0</math></p> <p>Maximum value for <math>T</math> is <math>7 + 8 + 9 + 10 + 11 + 12 + 13 = 70</math></p> <p>Maximum value for <math>U = 70 - \frac{7 \times 8}{2}</math> <math>= 42</math></p>	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p>	<p>4</p>	<p>Or equivalent</p> <p>Or equivalent</p>
	<b>Total</b>		<b>16</b>	

## MBS6 (cont)

Question Number And Part	Solution	Marks	Total	Comments
3 (a)(i)	$P(B \cup C) = P(B) + P(C) - P(B \cap C)$ $= P(B) + P(C) - P(B) \times P(C)$ <p>Let <math>x = P(C)</math></p> $0.28 = 0.1 + x - (0.1x)$ $\text{so } 0.18 = 0.9x \quad x = 0.2$	M1 M1	4	For attempt at formula For independent events <b>sc</b> M2 if $P(C) = 0.28 - 0.1 + 0.02$
(ii)	$P(C' \cup B') = P(C') + P(B') - P(C' \cap B')$ $= 0.8 + 0.9 - (0.8 \times 0.9)$ $= 0.98$	M1 A1		2
(b)(i)	$0.1 \times 0.7 \times 0.8 = 0.056$	M1 A1	2	
(ii)	$(i) + (0.9 \times 0.7 \times 0.2)$ $+ (0.9 \times 0.3 \times 0.8)$ $= 0.056 + 0.126 + 0.216 = 0.398$	M1 M1 A1	3	
(iii)	$\frac{0.216}{0.398} = 0.543$	M1 $\checkmark$ M1 $\checkmark$	3	For 0.216 ft For 0.398 ft
	<b>Total</b>	A1		<b>14</b>
4 (a)	$H_0$ Population median = 6.6 hours $H_1$ Population median $\neq$ 6.6 hours 2 tail test 10% sig level Signs - + + + + + + + . + + + - - + + t.s. 12+ or 3 - B(15,0.5) model  $P(12 \text{ or more } +) = P(3 \text{ or less } -)$ $= 0.0176 < 0.05$  Reject $H_0$ Significant evidence to suggest patients taking new tablet have a different median number of hours sleep	B1  M1 A1  M1 M1 M1  A1	7	Signs If Wilcoxon allow M1 A1  Model used Correct prob Compare probability and 5%

## MBS6 (cont)

Question Number And Part	Solution	Marks	Total	Comments
4(b)(i)	<p><math>H_0</math> Population average hours sleep same for new and existing tablet  <math>H_1</math> Population average hours sleep greater for new tablet.            1 tail test            5% sig level            Differences            8, .1, -.1, -.4, .7, 1.0, .3, .9, -.5, .2            Ranks            8, 1½, -1½, -5, 7, 10, 4, 9, -6, 3</p> <p><math>T_+ = 12\frac{1}{2}</math>  <math>T_- = 42\frac{1}{2}</math>            critical value = 11            test statistic = <math>12\frac{1}{2}</math>            test statistic &gt; 11            No significant evidence to reject <math>H_0</math>            Conclude that the average number of hours slept is not greater with the new tablet</p>	<p>B1</p> <p>M1</p> <p>m1 A1</p> <p>m1 A1 B1</p> <p>M1</p> <p>A1</p>	<p>9</p>	<p>For differences</p> <p>For ranks Ranks correct</p> <p>For attempting totals - either</p> <p>For comparison ts/cv</p>
(ii)	So that any effect of taking one of the tablets before or after the other is fairly dealt with and the effect the tablets taken can be detected.	B1	1	Order effect noted Concept of 'fair' order enabling any difference to be detected
(iii)	<p>A paired design is preferred because it ensures that any differences between individual patients are eliminated so that a difference in tablets taken can be detected.</p> <p>Results are contradictory –more powerful Wilcoxon test would be expected to detect a difference and yet it did not, when the single sample sign test in (a) did detect a difference</p>	<p>B1 B1</p> <p>B1 E1 E1</p>	<p>2</p> <p>3</p>	<p>Generous Well explained Or, it is a more powerful test</p> <p>Contradictory Allow Type 1 or Type II error in context Unexpected that paired test did not detect difference when single sample test did - with valid reason</p>
	<b>Total</b>		<b>22</b>	
	<b>TOTAL</b>		<b>60</b>	