

GCE 2005  
*January Series*



# Mark Scheme

## Mathematics and Statistics B (MBS4)

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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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*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 .....	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 – 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 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	$\bar{x} = 344.75 \quad s = 1.8323$  90% confidence interval $344.75 \pm 1.895 \times \frac{1.8323}{\sqrt{8}}$  $344.75 \pm 1.23$ (343.52 , 345.98)	B1 B1  B1 B1✓  M1  m1 A1  B1	8	344.75 (344.7 ~ 345) 1.8323 (1.83 ~ 1.835)  7df 1.895 ( allow 1.89 or 1.9) their df  Use of their $\frac{sd}{\sqrt{8}}$  Completely correct method 343.52 (343.5 ~343.55) and 346.0 ( 345.9 ~ 346) allow 344 and 346 or 344.75 ( 344.7 ~344.8) $\pm 1.23$ (1.225 ~1.23) Allow $345 \pm 1$ 4,5 or 6sf given in final answer																
<b>Total</b>			<b>8</b>																	
2(a) (b)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th>Won</th> <th>Lost</th> <th></th> </tr> </thead> <tbody> <tr> <td>&lt; 2 hours</td> <td>28 22.63</td> <td>15 20.37</td> <td>43</td> </tr> <tr> <td>≥ 2 hours</td> <td>22 27.37</td> <td>30 24.63</td> <td>52</td> </tr> <tr> <td></td> <td>50</td> <td>45</td> <td>95</td> </tr> </tbody> </table> <p> <math>H_0</math> No association between length of match and chance of Boris winning  <math>H_1</math> Association between length of match and chance of Boris winning  <math>\sum \frac{( O - E  - 0.5)^2}{E} = 4.04</math>                       c.v. <math>\chi_1^2</math> is 3.841                       Reject <math>H_0</math>, evidence of association between result and length of game.                 </p>		Won	Lost		< 2 hours	28 22.63	15 20.37	43	≥ 2 hours	22 27.37	30 24.63	52		50	45	95	M1 A1 A1 M1  B1  M1 m1 m1 A1 B1✓ B1✓  A1✓	3	Method for table Labeled correctly, allow >2 Numerically correct Method for E's - their table  Null hypothesis - may be implied by clearly stated conclusion-generous, allow 1-sided etc  Attempt at $\Sigma(O - E)^2/E$ Attempt at Yates' correction Correct application of Yates' Correction 4.04 ( 4 ~ 4.10) 1 df 3.841 or 3.84, their df
	Won	Lost																		
< 2 hours	28 22.63	15 20.37	43																	
≥ 2 hours	22 27.37	30 24.63	52																	
	50	45	95																	
(c)	There is evidence of association between result and length of game but contrary to Boris's belief he appears to be less likely to win longer games.	A1✓  E1 E1	9	ft their figures - needs all M Marks and must be compared with upper tail of $\chi^2$ (maximum 8 out of 9 if method of constructing table is incorrect) – Needs clearly stated correct conclusion or hypothesis  evidence of association Boris less likely to win long games (2 marks for this point if evidence of association clearly stated in (b)) Needs proportion probably implied for both marks																
<b>Total</b>			<b>14</b>																	

## MBS4 (cont)

Question Number and Part	Solution	Marks	Total	Comments
3(a)	$c/2$	B1	1	$c/2$ cao
(b)	$E(X^2) = \int_{-c}^{2c} \frac{1}{3c} x^2 dx = \left[ \frac{1}{3c} \frac{x^3}{3} \right]_{-c}^{2c}$ $= \frac{1}{9c} [8c^3 - -c^3] = c^2$	M1 M1 m1 A1	4	Any correct expression - ignore limits Any correct integration Correct method apart from numerical/algebraic slips Completely correct method <b>ag</b>
(c)	Variance = $c^2 - (c/2)^2 = 3c^2/4$ standard deviation = $c\sqrt{3/4} = 0.866c$	M1 m1 A1	3	Correct method their answer to (a) - allow variance if called variance Allow any correct method - allow variance if called variance $c\sqrt{3/4}$ acf or $0.866c$ ( $0.866c \sim 0.867c$ )
(d)(i)	22 is estimate of $c/2$ . Estimated value of $c$ is 44 Estimated standard deviation of $X$ is $44 \times \sqrt{3/4} = 38.1$	M1 A1 m1 A1	4	Method for $c$ - their answer to (a) 44 cao - may be implied later Method for s.d. their answer to (c) $38.1$ ( $38 \sim 38.2$ ) allow $22\sqrt{3}$
(ii)	Minimum weight is $2000 - c$ grams estimated by 1956 grams.	M1 A1	2	Method their $c$ 1956grams or 1.956 kg - allow 1960 or 1.96 units required
<b>Total</b>			<b>14</b>	
4(a)	$H_0 \mu = 18$ $H_1 \mu \neq 18$ $\bar{x} = 32.11 \quad s = 18.71$  $t = \frac{32.11 - 18}{\frac{18.71}{\sqrt{11}}} = 2.50$ critical values $t_{10}$ are $\pm 2.228$  reject $H_0$ significant evidence mean not equal to (greater than) 18	B1 B1 B1 B1 M1 m1 A1 B1 B1✓ A1✓	10	One correct hypothesis - generous Both correct - ungenerous $32.1$ ( $32.05 \sim 32.15$ ) $18.7$ ( $18.65 \sim 18.75$ ) Use of their s.d./ $\sqrt{11}$ Correct method for $t$ ignore sign $2.50$ ( $2.495 \sim 2.505$ )  10df $\pm 2.228$ their df, ignore sign, allow 2.23 Reject $H_0$ , must be compared with correct tail of $t$ .
(b)(i)	$H_0 \mu = 18$ - no change	B1	4	No change
(ii)	$H_1 \mu < 18$	B1		$\mu < 18$ - generous
(iii)	$-1.812$	B1		$-1.812$ cao
(iv)	Accept $H_0$ mean equals 18	B1		Correct conclusion based on correct answers to (i),(ii) and (iii)
(c)(i)	$H_0 \mu = 18$ - no change	B1	4	no change – allow $\mu <$
(ii)	$H_1 \mu > 18$	B1		$\mu > 18$ generous
(iii)	$1.812$	B1		$1.812$ cao
(iv)	Reject $H_0$ significant evidence mean greater than 18	B1		Correct conclusion based on correct answers to (i),(ii) and (iii)
<b>Total</b>			<b>18</b>	

## MBS4 (cont)

Question Number and Part	Solution	Marks	Total	Comments
5(a)	$\bar{x} = 4256/400 = 10.64$ 95% confidence interval for mean $10.64 \pm 1.96 \times \frac{3.68}{\sqrt{400}}$ $10.64 \pm 0.361$ (10.28, 11.00)	B1 B1 M1 m1 A1	5	10.64 allow 10.6 1.96 Use of $\frac{3.68}{\sqrt{400}}$ , allow use of $3.68 \sqrt{\frac{400}{399}}$ Correct method for interval, their mean-allow incorrect z-value 10.28 (10.275 ~ 10.3) and 11.00 (10.995 ~ 11.005) or $10.64_{\text{cao}} \pm 0.361$ (0.36 ~ 0.361)
(b)(i)	$E(X) = 5 \times 0.15 + 10 \times 0.63 + 15 \times 0.15 + 20 \times 0.07 = \text{£}10.7$	M1 A1		Method for $E(X)$ 10.7 cao – ignore units
(ii)	$E(X^2) = 25 \times 0.15 + 100 \times 0.63 + 225 \times 0.15 + 400 \times 0.07 = 128.5$	M1		Method for $E(X^2)$ may be implied
(iii)	s.d. of $X = \sqrt{128.5 - 10.7^2} = \text{£}3.74$	M1 m1 A1	6	Method for s.d., their answers to (i) and (ii) -allow variance if called variance Completely correct method for s.d. - Allow variance if called variance 3.74 (3.74 ~ 3.745)
(c)	mean within confidence interval calculated in (a), standard deviation close to observed standard deviation. Model appears plausible.	E1✓ E1✓ E1✓	3	ft Mean within confidence interval – allow similar ft s.d. similar to observed Correct conclusion based on correct calculations
(d)(i)	$\bar{x} = 2342/200 = 11.71$ $H_0 \mu = 11.00$ $H_1 \mu > 11.00$ $z = \frac{11.71 - 11.00}{\frac{3.42}{\sqrt{200}}} = 2.94$ critical value 1.6449 Reject $H_0$ significant evidence mean exceeds	B1 B1 B1 M1 m1 A1 B1 A1✓	8	11.71 or 11.7 One correct hypothesis - generous Both correct - ungenerous Use of $\frac{3.42}{\sqrt{200}}$ , allow use of $3.42 \sqrt{\frac{200}{199}}$ Correct method for z, ignore sign 2.94 (2.93 ~ 2.94) 1.6449 oe 1.645 or 1.64 or 1.65 allow $t = 1.652$ on 1.653 Correct conclusion, their figures, must be compared with appropriate tail of z. needs previous M1
(ii)	Since £11 was upper limit of confidence interval for mean, there is strong evidence that the mean has increased	E1 E1	2	Evidence sales have increased Since £11 upper limit of confidence interval
(iii)	Have total sales of petrol increased? How much does the scheme cost? Have other sales increased? Etc	E1 E1	2	Any sensible point A second sensible point
	<b>Total</b>		<b>26</b>	
	<b>TOTAL</b>		<b>80</b>	