GCE 2005
January Series

AQA

A S S E S S M E N T and
Q U A L I F I C A T I O N S
A L L I A N C E

Mark Scheme

Mathematics and Statistics B
(MBS4)

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 to download from the AQA Website:
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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

Mathematics and Statistics B Statistics 4 MBS4 January 2005

Question Number and Part	Solution	Marks	Total	Comments
1	$\bar{x} = 344.75 \quad s = 1.8323$	B1		344.75 (344.7 ~ 345)
		B1		1.8323 (1.83 ~ 1.835)
	90% confidence interval			
		B1		7df
	$344.75 \pm 1.895 \times \dfrac{1.8323}{\sqrt{8}}$	B1√		1.895 (allow 1.89 or 1.9) their df
		M1		Use of their $\dfrac{\text{sd}}{\sqrt{8}}$
	344.75 ± 1.23	m1		Completely correct method
	$(343.52 , 345.98)$	A1		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
		B1	8	4,5 or 6sf given in final answer
	Total		**8**	
2(a) (b)		M1		Method for table
		A1		Labeled correctly, allow >2
		A1	3	Numerically correct
		M1		Method for E's - their table
	H_0 No association between length of match and chance of Boris winning	B1		Null hypothesis - may be implied by clearly stated conclusion-generous, allow 1-sided etc
	H_1 Association between length of match and chance of Boris winning			
	$\sum \dfrac{\left(\left\| O - E \right\| - 0.5\right)^2}{E} = 4.04$	M1		Attempt at $\Sigma(O-E)^2/E$
		m1		Attempt at Yates' correction
		m1		Correct application of Yates' Correction
	c.v. χ_1^2 is 3.841	A1		4.04 (4 ~ 4.10)
		B1√		1 df
		B1√		3.841 or 3.84, their df
	Reject H_0, evidence of association between result and length of game.	A1√	9	ft their figures - needs all M Marks and must be compared with upper tail of χ^2 (maximum 8 out of 9 if method of constructing table is incorrect) – Needs clearly stated correct conclusion or hypothesis
(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.	E1		evidence of association
		E1	2	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
	Total		**14**	

Table in 2(a):

	Won	Lost	
< 2 hours	28 22.63	15 20.37	43
$\geq$ 2 hours	22 27.37	30 24.63	52
	50	45	95

MBS4 (cont)

Question Number and Part	Solution	Marks	Total	Comments
3(a)	$c/2$	B1	1	$c/2$ cao
(b)	$E(X^2) = \int_{-c}^{2c} \frac{1}{3c} x^2 \, dx = \left[\frac{1}{3c} \frac{x^3}{3} \right]_{-c}^{2c}$ $= \frac{1}{9c}\left[8c^3 - -c^3 \right] = c^2$	M1 M1 m1 A1	4	Any correct expression - ignore limits Any correct integration Correct method apart from numerical/algebraic slips Completely correct method **ag**
(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 - allow1960 or 1.96 units required
	Total		**14**	
4(a)	$H_0 \ \mu = 18$ $H_1 \ \mu \neq 18$ $\bar{x} = 32.11 \qquad s = 18.71$ $t = \dfrac{32.11 - 18}{\dfrac{18.71}{\sqrt{11}}} = 2.50$ critical values t_{10} are ± 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 ± 2.228 their df, ignore sign, allow 2.23 Reject H_0, must be compared with correct tail of t.
(b)(i) (ii) (iii) (iv)	$H_0 \ \mu = 18$ - no change $H_1 \ \mu < 18$ -1.812 Accept H_0 mean equals 18	B1 B1 B1 B1	4	No change $\mu < 18$ - generous -1.812 cao Correct conclusion based on correct answers to (i),(ii) and (iii)
(c)(i) (ii) (iii) (iv)	$H_0 \ \mu = 18$ - no change $H_1 \ \mu > 18$ 1.812 Reject H_0 significant evidence mean greater than 18	B1 B1 B1 B1	4	no change – allow $\mu <$ $\mu > 18$ generous 1.812 cao Correct conclusion based on correct answers to (i),(ii) and (iii)
	Total		**18**	

MBS4 (cont)

Question Number and Part	Solution	Marks	Total	Comments
5(a)	$\bar{x}$ = 4256/400 = 10.64	B1		10.64 allow 10.6
	95% confidence interval for mean	B1		1.96
	$10.64 \pm 1.96 \times \dfrac{3.68}{\sqrt{400}}$	M1		Use of $\dfrac{3.68}{\sqrt{400}}$, allow use of $3.68\sqrt{\dfrac{400}{399}}$
	10.64 ± 0.361	m1		Correct method for interval, their mean- allow incorrect *z*-value
	(10.28 , 11.00)	A1	5	10.28 (10.275 ~ 10.3) and 11.00 (10.995 ~ 11.005) or 10.64cao $\pm$ 0.361 (0.36 ~ 0.361)
(b)(i)	E(X)=5×0.15+10×0.63+15×0.15+20×0.07	M1		Method for E(X)
	= £10.7	A1		10.7 cao – ignore units
(ii)	E(X^2)=25×0.15×100×0.63+225×0.15+ 400×0.07 = 128.5	M1		Method for E(X^2) may be implied
		M1		Method for s.d., their answers to (i) and (ii) -allow variance if called variance
(iii)	s.d. of X = $\sqrt{128.5 - 10.7^2}$ = £3.74	m1		Completely correct method for s.d. - Allow variance if called variance
		A1	6	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$\checkmark$		ft Mean within confidence interval – allow similar
		E1$\checkmark$		ft s.d. similar to observed
		E1$\checkmark$	3	Correct conclusion based on correct calculations
(d)(i)	$\bar{x}$ = 2342/200 = 11.71	B1		11.71 or 11.7
	H$_0$ μ = 11.00	B1		One correct hypothesis - generous
	H$_1$ μ > 11.00	B1		Both correct - ungenerous
	$z = \dfrac{11.71-11.00}{\dfrac{3.42}{\sqrt{200}}} = 2.94$	M1		Use of $\dfrac{3.42}{\sqrt{200}}$, allow use of $3.42\sqrt{\dfrac{200}{199}}$
		m1		Correct method for *z*, ignore sign
		A1		2.94 (2.93 ~ 2.94)
	critical value 1.6449	B1		1.6449 oe 1.645 or 1.64 or 1.65 allow *t* = 1.652 on 1.653
	Reject H$_0$ significant evidence mean exceeds	A1$\checkmark$	8	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		Evidence sales have increased
		E1	2	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		Any sensible point
		E1	2	A second sensible point
	Total		**26**	
	TOTAL		**80**	