

Version 1.0



**General Certificate of Education (A-level)
June 2013**

Mathematics

MS2B

(Specification 6360)

Statistics 2B

Final

Mark Scheme

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 events which all examiners participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for standardisation each examiner analyses a number of students' scripts: alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, examiners encounter unusual answers which have not been raised 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 students' 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: aqa.org.uk

Copyright © 2013 AQA and its licensors. All rights reserved.

Copyright

AQA retains the copyright on all its publications. However, registered schools/colleges 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 schools/colleges 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.

Key to mark scheme abbreviations

M	mark is for method
m or dM	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
CSO	correct solution only
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
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)

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

Q	Solution	Marks	Total	Comments
1(a)	$\bar{x} = 948$ and $s^2 = 4817.25$ $t_8 = 2.896$	B1 B1		Both; AWR T 4820 ($s = 69.406$) AWRT 2.90
	$\text{C.I.} = 948 \pm 2.896 \times \sqrt{\frac{4817.25}{9}}$	M1		For division by $\sqrt{9}$
	$= 948 \pm 67.0 = (881, 1015)$	m1 A1	5	For rest of expression, must be t_8 or $t_9 (= 2.821)$ Either form AWR T ± 67 Accept 1010 or 1020 as upper limit
(b)(i)	$(927 + 1063) \div 2 = 995$	B1	1	CAO
(ii)	Dependent on partial overlap			
	Because of the overlap by the confidence intervals ...	E1		
	... no definite conclusion is possible	Edep1	2	Accept "No evidence"
SC	Reference to evidence provided by the mean or the limits being lower 'suggesting' or 'providing evidence' or 'supporting' weight reduction scores 1	(E1)		The statement must be not definite. Anything definite, eg. 'proves that' or 'shows that' scores 0
	Total		8	

Q	Solution	Marks	Total	Comments																		
2(a)	<table border="1"> <thead> <tr> <th>O_i</th> <th>E_i</th> <th>$(O_i - E_i - 0.5)^2 / E_i$</th> </tr> </thead> <tbody> <tr> <td>30</td> <td>35.2</td> <td>0.6276</td> </tr> <tr> <td>14</td> <td>8.8</td> <td>2.5102</td> </tr> <tr> <td>130</td> <td>124.8</td> <td>0.1770</td> </tr> <tr> <td>26</td> <td>31.2</td> <td>0.7080</td> </tr> <tr> <td></td> <td>χ^2</td> <td>4.0228</td> </tr> </tbody> </table>	O_i	E_i	$(O_i - E_i - 0.5)^2 / E_i$	30	35.2	0.6276	14	8.8	2.5102	130	124.8	0.1770	26	31.2	0.7080		χ^2	4.0228	M1		E attempted (at least two correct to 1 d.p.)
	O_i	E_i	$(O_i - E_i - 0.5)^2 / E_i$																			
	30	35.2	0.6276																			
	14	8.8	2.5102																			
	130	124.8	0.1770																			
	26	31.2	0.7080																			
		χ^2	4.0228																			
			M1		Yates' correction attempted; at least one correct value in final column																	
			M1		χ^2 attempted																	
			A1		AWFW 4.02 to 4.03																	
	H_0 : No association between method of receiving information and outcome			At least one correct																		
	H_1 : Association between method of receiving information and outcome	B1		If "independent" used, it must be the right way round																		
	CV of χ^2 for 1 df = 3.84(1)	B1																				
	4.02 > 3.841 so reject H_0 There is significant evidence of an association between method of receiving information and outcome	A1		Dep on A1 and B1 for CV																		
	Applications higher than expected for telephone calls, so council's belief seems to be true	Adep1	8	Dep on previous A1 Context conclusion about council's belief, referring to higher than expected for telephone																		
	Alternative if Yates' not used																					
	<table border="1"> <thead> <tr> <th>O_i</th> <th>E_i</th> <th>$(O_i - E_i)^2 / E_i$</th> </tr> </thead> <tbody> <tr> <td>30</td> <td>35.2</td> <td>0.7682</td> </tr> <tr> <td>14</td> <td>8.8</td> <td>3.0727</td> </tr> <tr> <td>130</td> <td>124.8</td> <td>0.2167</td> </tr> <tr> <td>26</td> <td>31.2</td> <td>0.8667</td> </tr> <tr> <td></td> <td>χ^2</td> <td>4.9243</td> </tr> </tbody> </table>	O_i	E_i	$(O_i - E_i)^2 / E_i$	30	35.2	0.7682	14	8.8	3.0727	130	124.8	0.2167	26	31.2	0.8667		χ^2	4.9243			Loses M1 for Yates' and A1 for final χ^2 value but can score all the other 6 marks
O_i	E_i	$(O_i - E_i)^2 / E_i$																				
30	35.2	0.7682																				
14	8.8	3.0727																				
130	124.8	0.2167																				
26	31.2	0.8667																				
	χ^2	4.9243																				
				Final 2 A1 marks dep on 4.92 to 4.93 and B1 for CV																		
(b)	Type I error was made because H_0 has been rejected (when it was true)	E1 Edep		Dep on previous E1																		
SC	If 'H_0 accepted' when their χ^2 less than their CV No error was made because H_0 has been accepted (when it was true)	(E1) (Edep1)	2	Dep on previous (E1)																		
	Total		10																			

Mark Scheme – General Certificate of Education (A-level) Mathematics – MS2B – June 2013

Q	Solution	Marks	Total	Comments
3(a)(i)	Just catches a tram	E1	3	Must refer to the 0 in some way to score the E1 but can score B1 for $2 + 20 + 5 = 27$
	$= 2(+0) + 20 + 5 = 27$	B1		
	(ii) $b = 37$	B1		
(b)	$E(T) = 32$	B1	2	Any form
	$\text{Var}(T) = 10^2/12$ $= 100/12 = 25/3 = 8\frac{1}{3} = 8.33$	B1		
(c)	$(35 - 27) = 8$ $\times 0.1 = 0.8$	M1 A1		
Total			7	
4(a)(i)	$\frac{e^{-3.5} \times 3.5^4}{4!}$	M1	2	AWRT 0.189 Answer only gets B2
	$= 0.189$	A1		
(ii)	Using or stating Po(0.5)	B1	3	An answer of 0.0144, 0.3935, 0.6065, 0.9098 or 0.9856 implies award of B1 but no further marks
	$P(\geq 2) = 1 - P(\leq 1)$ or $\quad = 1 - 0.9098$	M1		
	$= 0.0902$	A1		
(iii)	Using Po(14)	B1	3	Sight of 0.1094, 0.1757, 0.9235, 0.9521
	$P(\leq 19) - P(\leq 10) = 0.9235 - 0.1757$	M1		
	$= 0.7478$	A1		
(b)	GRBs/explosions/events/etc will be random and/or independent	E1	1	For any valid point
	GRBs/etc short in comparison to observation period (non-overlapping)			
Total			9	

Q	Solution	Marks	Total	Comments
5(a)(i)	$1 - (\frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \frac{1}{6})$ $= \frac{1}{20} = 0.05$	M1 A1	2	OE AG
(ii)	$E(X) =$ $1 \times \frac{1}{3} + 2 \times \frac{1}{4} + 3 \times \frac{1}{5} + 4 \times \frac{1}{6} + 5 \times \frac{1}{20}$ $= 2.35$	M1 A1	2	At least 2 terms OE: give B2 for only 2.35 seen
(iii)	$E(X^2) =$ $1 \times \frac{1}{3} + 4 \times \frac{1}{4} + 9 \times \frac{1}{5} + 16 \times \frac{1}{6} + 25 \times \frac{1}{20}$ $(= 7.05)$	M1		All 5 terms $E(X^2) = 7.05$ with no working scores M0 Correct working but labelled $\text{Var}(X)$ and then no more done also scores M0
	$\text{Var}(X) = E(X^2) - E(X)^2$ $= 1.5275$	m1 A1	3	Applied to this problem AG
(iv)	$1 - (\frac{1}{3} + \frac{1}{4})$ or $(\frac{1}{5} + \frac{1}{6} + \frac{1}{20})$ $= \frac{5}{12}$ or 0.417	M1 A1	2	AWRT Accept answer only for B2
(b)	$'2.35' \times 100 - 50$ $= 185$	M1 A1F		Their value of mean FT from (a)(ii) Give B2 for only 185 seen
	$100^2 \times 1.5275$ or $100 \times \sqrt{1.5275}$	M1		
	$\text{SD} = \sqrt{15275} = 5\sqrt{611} = 124$	A1	4	AWFW 123.5 to 124 or $5\sqrt{611}$ Give B2 for only 123.5 to 124 or $5\sqrt{611}$ seen
	Total		13	

Q	Solution	Marks	Total	Comments
6(a)	$H_0: \mu = 175$ $H_1: \mu < 175$	B1		Both; accept $H_0: \mu \geq 175$ Do not accept mean or \bar{x} but accept population mean
	$\bar{x} = 168.1$	B1		
	$z = \frac{168.1 - 175}{\frac{9.4}{\sqrt{6}}}$	M1		For use of $9.4/\sqrt{6}$
	$= -1.798$	m1		
	$CV = -1.6449$	A1	7	Comparison of correct test statistic with correct CV must be seen (diagram or words) OE; suspicion supported Must be in context AG
	$-1.6449 > -1.798$ so test statistic in critical region Reject H_0 , significant evidence that batch mean is less than 175grams	B1		
(b)	$H_0: \mu = 175$ $H_1: \mu < 175$			Award B1 for both correct if not scored in (a)
	$t = \frac{169.4 - 175}{\frac{11.2}{\sqrt{20}}}$	M1		
	$= -2.236$	m1	5	Comparison of correct test statistic with correct CV (need not be seen) OE; suspicion not supported
	$CV(t_{19}) = -2.539$	A1		
	$-2.236 > -2.539$ so test statistic not in critical region Accept H_0 , no significant evidence that batch mean/weight is less than 175grams	B1		Reference to sample size \Rightarrow E0
		A1		
(c)	Because the significance level is 1% instead of 5%	E1	1	
Total			13	

Q	Solution	Marks	Total	Comments
7(a)		B1 B1 B1	3	Curve concave upwards between (0, 0) and (1, y_1) Negative gradient line between (1, y_1) and (2, y_2) with $y_2 > 0$ (and not beyond 2) $y_1 = 1$ and $y_2 = \frac{1}{3}$ shown
(b)(i)	Attempt to integrate t^2 between 0 and x $F(x) = \frac{1}{3}x^3$	M1 A1	2	Accept integral of x^2
(ii)	Their $F(x) = 0.25$ $x = 0.909$	M1 A1	2	AWRT; accept $\sqrt[3]{0.75}$ OE
(c)(i)	$F(1) = \frac{1}{3}$ $\int_1^x \frac{1}{3}(5-2t) dt = \left[\frac{1}{3}(5t-t^2) \right]_1^x$ $= \frac{1}{3}(5x-x^2) - \frac{4}{3}$ $F(x) = \frac{1}{3}(5x-x^2) - \frac{4}{3} + \frac{1}{3}$ $= \frac{1}{3}(5x-x^2-3)$	B1 M1 A1 A1	4	For integral attempted with correct limits For limits substituted in correct expression F(1) added to give complete F(x) AG
(ii)	$\frac{1}{3}(5q-q^2-3) = 0.75$ or integral of f(x) from q to 2 = 0.25 $4q^2 - 20q + 21 = 0$ or $q^2 - 5q + 5.25 = 0$ $(2q-3)(2q-7) = 0$ or $q = 2.5 \pm 1$ $q = 1.5$	M1 A1 m1 A1	4	Setting up equation Reaching correct simplified quadratic Factorising for two solutions or using formula or calculator Selecting only this one
	Total		15	
	TOTAL		75	