General Certificate of Education (A-level)
June 2013

Mathematics MS2B

(Specification 6360)

Statistics 2B

Final

Mark Scheme

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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.

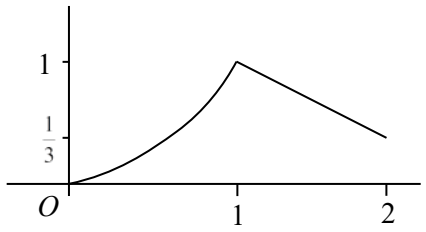
Q	Solution	Marks	Total	Comments
1(a)	$\bar{x} = 948$ and $s^2 = 4817.25$	B1		Both; AWRT 4820 ($s = 69.406$)
	$t_8 = 2.896$	B1		AWRT 2.90
	C.I. $= 948 \pm 2.896 \times \sqrt{\frac{4817.25}{9}}$	M1		For division by $\sqrt{9}$
		m1		For rest of expression, must be t_8 or t_9 (= 2.821)
	$= 948 \pm 67.0 = (881, 1015)$	A1	5	Either form AWRT ± 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)				
	O_i | E_i | $(\lvert O_i - E_i\rvert - 0.5)^2/E_i$ 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.)
		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	B1		At least one correct
	H_1: Association between method of receiving information and outcome			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			
	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 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**	

Q	Solution	Marks	Total	Comments
3(a)(i)	Just catches a tram	E1		Must refer to the 0 in some way to score the E1
	= 2 (+ 0) + 20 + 5 = 27	B1		but can score B1 for 2 + 20 + 5 = 27
(ii)	$b = 37$	B1	3	
(b)	E(T) = 32	B1		
	Var(T) = $10^2/12$			
	= 100/12 = 25/3 = $8^1/_3$ = 8.33	B1	2	Any form
(c)	(35 – 27) = 8	M1		Or by integration from 27 to 35
	× 0.1 = 0.8	A1	2	
	Total		**7**	
4(a)(i)	$\frac{e^{-3.5} \times 3.5^4}{4!}$	M1		
	= 0.189	A1	2	AWRT 0.189 Answer only gets B2
(ii)	Using or stating Po(0.5)	B1		An answer of 0.0144, 0.3935, 0.6065, 0.9098 or 0.9856 implies award of B1 but no further marks
	P(≥ 2) = 1 – P(≤ 1)	M1		
	or = 1 – 0.9098			
	= 0.0902	A1	3	Accept 0.09
(iii)	Using Po(14)	B1		Sight of 0.1094, 0.1757, 0.9235, 0.9521
	P(≤ 19) – P(≤ 10) = 0.9235 – 0.1757	M1		Allow 0.8752 – 0.1185
				or 0.9573 – 0.2517 for M1
	= 0.7478	A1	3	AWFW 0.747 to 0.748
(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)	$1 - ({}^1/_3 + {}^1/_4 + {}^1/_5 + {}^1/_6)$	M1		OE
	$= {}^1/_{20} = 0.05$	A1	2	AG
(ii)	$E(X) =$			
	$1\times{}^1/_3 + 2\times{}^1/_4 + 3\times{}^1/_5 + 4\times{}^1/_6 + 5\times{}^1/_{20}$	M1		At least 2 terms
	$= 2.35$	A1	2	OE: give B2 for only 2.35 seen
(iii)	$E(X^2) =$			
	$1\times{}^1/_3 + 4\times{}^1/_4 + 9\times{}^1/_5 + 16\times{}^1/_6 + 25\times{}^1/_{20}$	M1		All 5 terms
	$(= 7.05)$			$E(X^2) = 7.05$ with no working scores M0 Correct working but labelled $\text{Var}(X)$ and then no more done also scores M0
	$\text{Var}(X) = E(X^2) - E(X)^2$	m1		Applied to this problem
	$= 1.5275$	A1	3	AG
(iv)	$1 - ({}^1/_3 + {}^1/_4)$ **or** $({}^1/_5 + {}^1/_6 + {}^1/_{20})$	M1		
	$= {}^5/_{12}$ or 0.417	A1	2	AWRT Accept answer only for B2
(b)	'2.35' × 100 – 50	M1		Their value of mean
	= 185	A1F		FT from **(a)(ii)** Give B2 for only 185 seen
	$100^2 \times 1.5275$ **or** $100 \times \sqrt{1.5275}$	M1		
	$SD = \sqrt{15275} = 5\sqrt{611} = 124$	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		
	$z = \dfrac{\text{'168.1'} - 175}{9.4/\sqrt{6}}$	M1		For use of $9.4/\sqrt{6}$
		m1		For rest of formula (ignore sign)
	$= -1.798$	A1		Must be negative AWRT –1.80
	CV = –1.6449	B1		AWFW –1.64 to –1.65
	–1.6449 > –1.798 so test statistic in critical region Reject H_0, significant evidence that batch **mean** is less than 175grams	A1	7	Comparison of correct test statistic with correct CV **must be seen** (diagram or words) OE; suspicion supported Must be in context AG
(b)	H_0: $\mu = 175$ H_1: $\mu < 175$			Award B1 for both correct if not scored in **(a)**
	$t = \dfrac{169.4 - 175}{11.2/\sqrt{20}}$	M1		For use of $11.2/\sqrt{20}$
		m1		For rest of formula (ignore sign)
	$= -2.236$	A1		Must be negative AWRT –2.24
	CV(t_{19}) = –2.539	B1		AWRT –2.54
	–2.236 > –2.539 so test statistic not in critical region			Comparison of correct test statistic with correct CV (need not be seen)
	Accept H_0, no significant evidence that batch mean/weight is less than 175grams	A1	5	OE; suspicion not supported
(c)	Because the significance level is 1% instead of 5%	E1	1	OE; eg SL is different Reference to sample size $\Rightarrow$ E0
	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**	