



General Certificate of Education (A-level)
January 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.

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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.

MS2B

Q	Solution	Marks	Total	Comments
1(a)	<p>Sample mean = 53.06, $s = 1.140$ $t_5 = 2.571$ Sample mean $\pm t \times s/\sqrt{6}$</p> <p>$(53.06 \pm 1.20) = (51.86, 54.26)$</p>	<p>B1 B1 M1 m1</p> <p>A1</p>	5	<p>Both. For s AWR 1.14 AWRT 2.57 For $\sqrt{6}$ Rest of formula. Allow $t_5 = 2.01$ to 2.02, or $t_6 = 2.45$ Either form ± 0.01 in total.</p>
(b)	<p>Sample mean is lower than last year's mean so claim may be true. 53.41 lies within c.i. so not certain that mean time is better. Performance in competition does not depend on mean time. Times seem to be improving.</p>	E2	2	<p>E1 each for sensible comments either supporting or against statement up to a maximum of 2. Comment must be uncertain.</p>
		Total	7	

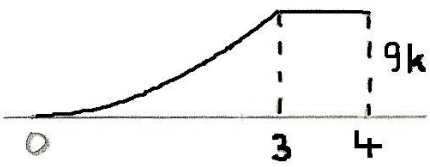
Q	Solution	Marks	Total	Comments																							
2 (a)	<table><tr><th colspan="5">Expected values</th></tr><tr><th>F</th><th>T</th><th>S</th><th>D</th></tr><tr><td><3</td><td>8.736</td><td>34.944</td><td>24.192</td><td>16.128</td></tr><tr><td>>3</td><td>4.264</td><td>17.056</td><td>11.808</td><td>7.872</td></tr></table>	Expected values					F	T	S	D	<3	8.736	34.944	24.192	16.128	>3	4.264	17.056	11.808	7.872	M1		Any two correct to 2 d.p.				
	Expected values																										
	F	T	S	D																							
	<3	8.736	34.944	24.192	16.128																						
	>3	4.264	17.056	11.808	7.872																						
		A1		All correct, here or below, to 2 d.p.																							
	One expected value for Flat < 5 So combine first two columns to give	E1		Must be expected value, applied to this case, not just general statement																							
	<table><tr><th colspan="4">Expected values</th></tr><tr><th>F+T</th><th>S</th><th>D</th></tr><tr><td><3</td><td>43.68</td><td>24.192</td><td>16.128</td></tr><tr><td>>3</td><td>21.32</td><td>11.808</td><td>7.872</td></tr></table>	Expected values				F+T	S	D	<3	43.68	24.192	16.128	>3	21.32	11.808	7.872	B1		For combining first two E columns, at least 1 correct. H ₀ seen somewhere in solution								
	Expected values																										
	F+T	S	D																								
	<3	43.68	24.192	16.128																							
	>3	21.32	11.808	7.872																							
	H ₀ : No association between property type and time to sell. H ₁ : Association between property type and time to sell.	B1		If “independent” used then must be correct way round																							
<table><tr><th>O_i</th><th>E_i</th><th>(O_i−E_i)²/E_i</th></tr><tr><td>38</td><td>43.68</td><td>0.7386</td></tr><tr><td>27</td><td>21.32</td><td>1.5132</td></tr><tr><td>28</td><td>24.192</td><td>0.5994</td></tr><tr><td>8</td><td>11.808</td><td>1.2281</td></tr><tr><td>18</td><td>16.128</td><td>0.2173</td></tr><tr><td>6</td><td>7.872</td><td>0.4452</td></tr><tr><td></td><td>X²</td><td>4.7418</td></tr></table>	O _i	E _i	(O _i −E _i) ² /E _i	38	43.68	0.7386	27	21.32	1.5132	28	24.192	0.5994	8	11.808	1.2281	18	16.128	0.2173	6	7.872	0.4452		X ²	4.7418	M1		For attempt at (O _i −E _i) ² /E _i
O _i	E _i	(O _i −E _i) ² /E _i																									
38	43.68	0.7386																									
27	21.32	1.5132																									
28	24.192	0.5994																									
8	11.808	1.2281																									
18	16.128	0.2173																									
6	7.872	0.4452																									
	X ²	4.7418																									
2 degrees of freedom	A1		4.7 < X ² < 4.8																								
C.V. of χ ² for 2 d.f. = 4.605	B1		PI by 4.605, 5.991, 7.378, 9.210 or 10.597 seen AWFW 4.60 to 4.61																								
4.74 > 4.605 so reject H ₀ significant evidence of an association between property type and time to sell.	A1		Context conclusion. Dep. on B1 for H ₀ , A1 for χ ² and B1 for c.v.																								
(b)(i) More in total than any other type so likely to have biggest effect	E1	10	Or similar referring to large number																								
(ii) Far away from expected values	E1		Or opposite pattern to other three																								
		2																									
		Total	12																								

	If Flats and Detached combined:	Expected values		
		F+D	T	S
	<3	24.864	34.944	24.192
	>3	12.136	17.056	11.808
	O_i	E_i	$(O_i - E_i)^2/E_i$	
	22	24.864	0.3299	
	34	34.944	0.0255	
	28	24.192	0.5994	
	15	12.136	0.6759	
18	17.056	0.0522		
8	11.808	1.2281		
	X^2	2.9110		
Accept H_0				

MS2B (cont)

Q	Solution	Marks	Total	Comments
3 (a)(i)	$e^{-1.5} \times 1.5^3 / 3!$ $= 0.126$	M1 A1	2	0.125 to 0.126
(ii)	Using Po(1), $P(X > 1) = 1 - P(X \leq 1)$ $= 1 - 0.7358 = 0.264$	M1 A1	2	SC Award M1 only if obtain 0.0902 using Po(0.5)
(iii)	Weekdays Po(7.5) weekend Po(1) Total Po(8.5) $P(\text{Total} < 10) = P(\text{Total} \leq 9)$ $= 0.653$	M1 A1 m1 A1	4	Weekdays = 7.5 Applied (0.7764, 0.7166, 0.6530 are evidence)
(b)	Using Total Po from (a)(iii) $P(>15) = 0.0138$, $P(>16) = 0.0066$ So needs 16 tubes	M1 A1	2	M1 using their total providing supporting probabilities seen OE use of $P(\text{Total} \leq 15 \text{ \& } 16)$ CAO Answer alone scores B2
(c)	Average rate of failure unlikely to be constant over the course of a day. Very little use of lights over this period.	E1	1	One mark for any sensible comment
		Total	11	

MS2B (cont)

Q	Solution	Marks	Total	Comments
4(a)		B1 B1 B1	3	Curve + rectangle Some indication of x values $9k$ or 0.5 indicated for vertical height
(b)	Attempt to integrate kx^2 between 0 & 3 Obtain $9k$ Area under rectangle = $9k$ $9k + 9k = 1$ so $k = \frac{1}{18}$	M1 A1 B1 B1		
(c)(i)	3	B1	4	For $9k + 9k = 1$. AG
(ii)	Attempt to integrate kx^2 between 0 & Q_1 put = 0.25 $\frac{(Q_1)^3}{54} = 0.25$ $Q_1 = 2.38$	M1 A1 A1		
			4	AWRT or any equivalent exact form $\sqrt[3]{13.5} = \sqrt[3]{\frac{27}{2}} = \frac{3}{\sqrt[3]{2}} = \frac{3}{2}(\sqrt[3]{4})$
		Total	11	

MS2B (cont)

Q	Solution	Marks	Total	Comments
5(a)	Mean = $0 \times 0.1 + 1 \times 0.35 \dots\dots$ $= 1.85$	M1	4	AG
	$E(X^2) = 0^2 \times 0.1 + 1^2 \times 0.35 \dots$ $= 4.75$	M1		Full method including -1.85^2
	$\text{Var}(X) = 4.75 - 1.85^2$	A1		For $E(X^2) = 4.75$
	$= 1.3275$	A1		For final answer AWRT 1.33
(b)(i)	$T = c + nX$	B1	1	
(ii)	$E(c + nX) = c + nE(X)$ $= c + 1.85n$	M1	4	Getting at least as far as $c + E(nX)$
		A1		CAO
	$\text{Var}(c + nX) = \text{Var}(c) + \text{Var}(nX)$	M1		Getting at least as far as (0 +) $\text{Var}(nx)$
	$= 0 + n^2 \text{var}(X) = 1.3275n^2$	A1F		FT their $\text{Var}(X)$ if $0 < \text{Var}(X) < 4$
		Total	9	

MS2B (cont)

Q	Solution	Marks	Total	Comments
6(a)	Putting $\frac{t^3}{216} = 0.9$	M1	3	5.79 to 5.80 Accept 40 days in this context
	$t = 5.793$	A1		
	41 days.	A1		
(b)	Attempt to differentiate $F(t)$	M1	3	ct^2 seen Condone domain missing here For complete function
	$f(t) = \frac{1}{72}t^2 \quad 0 \leq t \leq 6$	A1		
	$= 0$ otherwise	A1		
(c)	Attempt to integrate $tf(t)$ from 0 to 6	M1	6	Using their $f(t)$ from (b) ct^4 seen Using their $f(t)$ from (b) ct^5 seen Applied in this case. Dependent on both M1
	$E(T) = 4.5$	A1		
	Attempt to integrate $t^2f(t)$ from 0 to 6	M1		
	$E(T^2) = 21.6$	A1		
	$\text{Var}(T) = E(T^2) - E(T)^2$	m1		
	$= 21.6 - 4.5^2 = 1.35$	A1		
(d)	S.d. $= \sqrt{1.35} = 1.162$	M1	4	For $\sqrt{\text{Var}}$ (their Var) $0 < \text{Var}(T) < 9$ For $F(\text{their s.d.} + \text{their } E(T))$ provided $0 < \text{Total} < 6$ AWFW 0.159 to 0.161
	Use of $F(5.662)$	m1		
	$1 - \frac{5.662^3}{216}$	m1		
	$= 0.160$	A1		
		Total	16	

MS2B (cont)

Q	Solution	Marks	Total	Comments
7(a)	$H_0: \mu_y = 20$ $\mu_x = 3020$	B1	8	Both
	$H_1: \mu_y \neq 20$ $\mu_x \neq 3020$			
	$\bar{y} = 18.47$ $\bar{x} = 3018.47$	B1		x or y .
	$s = 8.00$	B1		
	$z = (18.47 - 20) / (\frac{8}{\sqrt{100}})$ o.e. for x	M1 m1		$\sqrt{100}$ rest of formula for z (either way round in numerator)
	$= -1.9125$	A1		AWFW -1.93 to -1.91 .
	c.v. = ± 1.96 (or ± 1.98 from t_{99})	B1		Sign consistent with z value.
(b)	So test statistic not in critical region. Accept H_0 , no significant evidence that mean has changed.	A1	1	Comparison not just with opposite C.V. Mention of water not necessary. Dep on B1 for H_0 & H_1 , A1 and B1 for c.v.
	No error if (a) is "Accept H_0 " Type I if (a) is "Reject H_0 "	B1F		MUST FOLLOW THROUGH
	Alternatives:			
	$(3018.47 - 3020) / (\frac{8}{\sqrt{100}})$ for z			
	p value is 0.0558 and must be compared with 0.05			
	Critical values for \bar{y} are 18.43 or 18.44 and 21.56 or 21.57			
		Total	9	
	TOTAL		75	