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General Certificate of Education

Mathematics 6360
Statistics 6380

MS/SS1B/W Statistics 1B

Mark Scheme

2010 examination - January series

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.

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Key to mark scheme and abbreviations used in marking

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	MC	mis-copy
CAO	correct answer only	MR	mis-read
CSO	correct solution only	RA	required accuracy
AWFW	anything which falls within	FW	further work
AWRT	anything which rounds to	ISW	ignore subsequent work
ACF	any correct form	FIW	from incorrect work
AG	answer given	BOD	given benefit of doubt
SC	special case	WR	work replaced by candidate
OE	or equivalent	FB	formulae book
A2,1	2 or 1 (or 0) accuracy marks	NOS	not on scheme
–*x* EE	deduct *x* marks for each error	G	graph
NMS	no method shown	c	candidate
PI	possibly implied	sf	significant figure(s)
SCA	substantially correct approach	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. However, there are situations in some units where part marks would be appropriate, particularly when similar techniques are involved. Your Principal Examiner will alert you to these and details will be provided on the mark scheme.

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.

MS/SS1B

Q	Solution	Marks	Total	Comments
1(a)(i)	$X \sim N(10.2,\ 0.15^2)$			
	$P(X < 10.5) = P\left(Z < \frac{10.5-10.2}{0.15}\right)$	M1		Standardising (10.45, 10.5 or 10.55) with 10.2 and ($\sqrt{0.15}$, 0.15 or 0.15^2) and/or $(10.2 - x)$
	$= P(Z < 2)$	A1		CAO; ignore inequality and sign May be implied by a correct answer
	$= 0.977$	A1	3	AWRT (0.97725)
(ii)	$P(10.0 < X < 10.5)$ $=$ [C's (a)(i)] $-$ $P(X < 10.0)$	M1		Or equivalent; must be clear correct method if answer incorrect and answer > 0
	$=$ (a)(i) $-$ $P(Z < -1.33)$			Method correct using -1.3 gives 0.88 to 0.881 $\Rightarrow$ M1 m1 A0
	$=$ (a)(i) $-$ $(1 - p)$			
	$= 0.97725 - (1 - 0.90824)$	m1		Area change May be implied by a correct answer or answer > 0.5
	$= 0.885$ to 0.887	A1	3	AWFW (0.88604) M1 m1 A1 for $0.90824 - [1 - (a)(i)]$ $= 0.886$ M1 m0 A0 for (a)(i) $- 0.90824$ $= 0.0685$ M0 mo A0 for answer < 0
(b)	$P(X > 10) = p$[from (a)(ii)] $= 0.908$ to 0.909	B1F		Correct value **or** F on value used or implied in (a)(ii) providing > 0.5 Use of -1.3 gives 0.9032
	$P(6 \text{ rolls} > 10) = 0.90824^6$	M1		Accept any probability to power 6
	0.56 to 0.565	A1	3	AWFW
	Note: B0F M1 A0 is possible			
		Total	**9**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
2(a)	Ordering values gives: (*a*) 14 15 18 20 25 25 26 27 29 32 34 37 37 (*b*)	M1		May be implied by correct median or correct IQR Ignore any reference to *a* and *b*
	Median = 26	A1		CAO
	IQR = 34 – 18 = 16	A2		CAO
	Special Case: Identification that LQ = 18 and UQ = 34	(A1)	4	Both CAO
(b)(i)	Two values (25 and 37) of mode No unique value Sparse data Many different values	B1		Or equivalent
(ii)	*a* **and** *b* (two values) unknown Impossible to calculate Cannot be calculated	B1	2	Or equivalent
(c)	Mean = $\frac{\sum x}{n} = \frac{390}{15} = 26$	B1		CAO
	If not identified, assume order is $\bar{x}$ then *s*			
	SD $\left(\sum x^2 = 11472\right)$ = 9.4 to 9.8	B1	2	AWFW (9.423 & 9.754) Treat rounding of a correct stated answer to an integer as ISW
	Special Case: Evidence of $\frac{\sum x}{15}$	(M1)		Can only be awarded if no marks scored elsewhere in (c)
		Total	**8**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
3(a)	b (gradient) = 7.05 b (gradient) = 7(.00) to 7.1(0)	B2 (B1)		AWRT (7.05134) AWFW Treat rounding of correct stated answers as ISW
	a (intercept) = 2500 to 2502 a (intercept) = 2490 to 2510	B2 (B1)	4	AWFW (2501.091) AWFW
	or Attempt at $\sum x \ \ \sum x^2 \ \ \sum y \ \ \& \sum xy \ \ \left(\sum y^2\right)$ **or** Attempt at S_{xx} & S_{xy} $\left(S_{yy}\right)$	(M1)		1351 268047 27034 & 5269065 (105653202) (all 4 attempted) 7304 & 51503 (1247894) (both attempted)
	Attempt at **correct** formula for b (gradient) b (gradient) = 7.05 a (intercept) = 2500 to 2502	(m1) (A1) (A1)		 AWRT AWFW
	Accept a & b interchanged only if identified correctly by a **clearly shown equation** (stated answers are not sufficient) in (b)			If a and b are not identified anywhere in solution, then: 7.05 $\Rightarrow$ B1 2500 to 2502 $\Rightarrow$ B1
(b)	$y_{200} = a + b \times 200$	M1		Used May be implied by correct answer
	= 3890 to 3930	A1	2	AWFW (3911.36)
(c)	Large residuals / residual range suggest estimate may be unreliable **or** Largest residuals only small in relation to y-values (10%) so estimate may be reliable (unreliable) **Special Case:** If B0 B0dep then: Involves interpolation Does not involve extrapolation Within observed range	B1 B1dep B1 B1dep (B1)	2	 (unreliable) requires (10% or equivalent) Any one; or equivalent
		Total	**8**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
				Ratios (eg 65:1000) are only penalised by 1 mark at first correct answer
4(a)(i)	P(all 3 walk) = 0.65 × 0.40 × 0.25	M1		Can be implied by **correct** answer
	= 65/1000 = 13/200 = 0.065	A1	2	CAO; do not confuse with 0.65
(ii)	P(Rita by bus) = 0.25×(1– 0.15)×(1– 0.20)	M1		Can be implied by **correct** answer
	= 17/100 = 0.17	A1	2	CAO
(iii)	P(2 cycle) = 0.10 × 0.45 × (0.25 + 0.20) = 0.02025 + 0.10 × (0.40 + 0.15) × 0.55 = 0.03025 + (0.65 + 0.25) × 0.45 × 0.55 = 0.22275 (0.27325)	B1		CAO at least 1 of these 3 terms or equivalent but allow a '× 3'
	P(3 cycle) = 0.10 × 0.45× 0.55 = 0.02475	B1		CAO
	P(≥ 2 cycle) = P(2 cycle) + P(3 cycle)	M1		Sum of 4 or 7 terms each a product of 3 probabilities but not '× 3'
	= 0.298	A1	4	CAO
	or P(0 cycle) = 0.90 × 0.55 × 0.45 = 0.22275	(B1)		CAO
	P(1 cycles) = 0.10 × 0.55 × 0.45 = 0.02475 + 0.90 × 0.45 × 0.45 = 0.18225 (0.47925) + 0.90 × 0.55 × 0.55 = 0.27225	(B1)		CAO at least 1 of these 3 terms but allow a '× 3'
	P(≥ 2 cycle) = 1 – [P(0 cycle) + P(1 cycles)]	(M1)		1 – [sum of 4 terms each a product of 3 probabilities but not '× 3']
	1 – 0.702 = 0.298	(A1)		CAO
(b)(i)	P(WW) = (0.65 × 0.90) = 0.585 P(CC) = (0.10 × 0.70) = 0.070	B1		CAO either
	P(WW or CC) = 0.585 + 0.070	M1		Sum of 2 terms each a product of 2 probabilities
	= 0.655	A1	3	CAO; or equivalent
(ii)	P(different) = 1 – (b)(i) = 0.345	B1F	1	F on (b)(i) providing $0 < p < 1$
		Total	**12**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
5(a)(i)	Mean = $\frac{12120}{12}$ = 1010	B1		CAO
	98% (0.98) $\Rightarrow$ z = 2.32 to 2.33	B1		AWFW (2.3263)
	CI for μ is $\bar{x} \pm z \times \frac{\sigma}{\sqrt{n}}$	M1		Used Must have $\sqrt{n}$ with $n > 1$
	Thus $1010 \pm 2.3263 \times \frac{10.5}{\sqrt{12}}$	A1F		F on $\bar{x}$ and z only
	Hence 1010 ± (7(.0) to 7.1) **or** (1003, 1017)	A1dep	5	CAO & AWFW (accept 7) Dependent on A1F AWRT
	Notes: Use of $t_{11}(0.99) = 2.718$ $\Rightarrow$ maximum of B1 B0 M1 A0F A0 Use of a 'corrected' 10.5 $\Rightarrow$ maximum of B1 B1 M1 A0F A0			
(ii)	**Weight** of flour in a bag (may be assumed to be) is **normally distributed**	B1	1	Or equivalent; must refer to **weight**
(iii)	Any number such that 20 ≤ number ≤ 50	B1	1	Must be **a single integer value** Ignore any reasoning
(b)	1 kg or 1000 grams is outside / below CI **or** From CI, (population) mean weight is **greater than** 1kg or 1000 grams	B1F		Or equivalent F on (a)(i) Any reference to 1010 $\Rightarrow$ B0F
	3 or 3/12 or 25% of bags in sample weigh **less than** 1kg or 1000 grams	B1		Or equivalent; but not 'some'
	Statement appears dubious/incorrect/invalid	B1dep	3	Dependent on both B1F and B1
(c)	2/100 or 1/50 or 0.02 or 2%	B1	1	CAO; not 0.02%
		Total	**11**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
6(a)(i)	$R \sim$ B(14, 0.35)	M1		Used somewhere in (a); may be implied
	$P(R \leq 7) = 0.924$ to 0.925	A1	2	AWFW (0.92466)
(ii)	$P(R \geq 11) = 1 - P(R \leq 10)$			
	$= 1 -$ (0.9989 or 0.9999)	M1		Requires '1 –'and ≥ 4 dp accuracy
	$= 0.0011$	A1	2	AWRT (0.001106)
(iii)	$P(5 < R < 10) = 0.9940$ or 0.9989 (p_1)	M1		Accept 3 dp accuracy $p_2 - p_1 \Rightarrow$ M0 M0 A0 $(1 - p_2) - p_1 \Rightarrow$ M0 M0 A0 $p_1 - (1 - p_2) \Rightarrow$ M1 M0 A0 only providing result > 0
	minus 0.6405 or 0.4227 (p_2)	M1		Accept 3 dp accuracy
	$= 0.353$ to 0.354	A1	3	AWFW (0.35346)
	or			
	B(14, 0.35) expressions stated for **at least 3** terms within $4 \leq R \leq 11$ gives probability	(M1)		Can be implied by correct answer
	$= 0.353$ to 0.354	(A2)		AWFW (0.35346)
(b)	$R \sim$ B(21, 0.35)	M1		Implied from correct stated formula; do not accept misreads
	$P(R = 4) = \binom{21}{4}(0.35)^4(0.65)^{17}$	A1		Can be implied by a correct answer Ignore any additional terms
	$= 0.059$ to 0.0595	A1	3	AWFW (0.059274)
(c)(i)	$S \sim$ B(7, 5/7)			
	Mean $= np = 7 \times 5/7 = 5$	B1		CAO
	If not identified, assume order is μ then σ^2			
	Variance $= np(1-p)$			Must clearly state variance value if standard deviation (also) stated
	$= 7 \times 5/7 \times 2/7 = 10/7$ or 1.42 to 1.43	B1	2	CAO / AWFW
(ii)	**Means** are the **same** **and (both comparisons clearly stated)** **Variances**/standard deviations are **similar** Do not accept statements involving correct/incorrect/exact/etc	B1dep		Must have scored B1 B1 in (i) or B1 B0 plus 10/7 v 1.5 or $\sqrt{10/7}$ v $\sqrt{1.5}$ **stated**
	Barry's claim appears/is **sound/valid/correct/likely**	B1dep	2	Must have scored previous B1dep
		Total	**14**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
7(a)	$r = -0.0355$ to -0.035	B3	3	AWFW (– 0.03546)
	$r = -0.036$ to -0.034	(B2)		AWFW
	$r = -0.04$ to $+0.04$	(B1)		AWFW
	or			
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ $\sum y^2$ & $\sum xy$			636 42702 738 68294 &38605 (all 5 attempted)
	or			
	Attempt at S_{xx} S_{yy} & S_{xy}	(M1)		8994 22907 & –509 (all 3 attempted)
	Attempt at substitution into **correct** corresponding formula for r	(m1)		
	$r = -0.0355$ to -0.035	(A1)		AWFW
(b)	Almost/virtually/practically **no / zero** (linear) **correlation** / relationship / association / link (**but not 'no trend'**)	B1dep		Dependent on $-0.1 < r < 0.1$ Or equivalent; must qualify strength as 'zero'; B0dep for very weak/weak/etc unless then qualified correctly
	between **purchase and auction prices** of antiques	B1	2	Context; providing $-1 < r < 1$
(c)(i)	Figure 1: **6** correct labelled points	B3	3	Deduct 1 mark if > **1 point** not labelled or labelled incorrectly
	5 or 4 correct labelled points	(B2)		
	3 correct labelled points	(B1)		
(ii)	**(Two) outlier/anomaly/unusual** or identification of **J and L**	B1		Or equivalent
	(Otherwise) a **positive/linear correlation**	B1	2	Or equivalent; ignore any qualification of 'strength'
(d)(i)	$r = \frac{4268.8}{\sqrt{4854.4 \times 4216.1}}$	M1		Used Award B2 for a **correct** answer without/with different method
	$r = 0.943$ to 0.944	A1	2	AWFW (0.94359)
(ii)	**Very strong/strong positive** (linear) **correlation**/relationship/association/link	B1dep	1	Dependent on $0.9 < r < 1$ Or equivalent; must qualify strength and indicate positive; B0dep for high/etc
	Previous calculation of r was not appropriate (due to outliers)	(B1)		
		Total	**13**	
		TOTAL	**75**	