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General Certificate of Education (A-level)
June 2011

Mathematics MS/SS1B

(Specification 6360)

Statistics 1B

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 candidates' 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 candidates' 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.

MS/SS1B

Q	Solution	Marks	Total	Comments
1 (a)(i)	Mode = **253**	B1	1	CAO
(ii)	Median = **252**	B1		CAO
	Upper quartile = **253** Lower quartile = **250**	B1		CAO; either May be implied by IQR = 3
	Interquartile range = **3**	B1	3	CAO; do not award if **seen** to be not based on 253 and 250
(b)(i)	Range = 271 – 227 = **44**	B1	1	CAO; do not award if **seen** to be not based on 271 and 227
(ii)	Mean, $\bar{x}$ = **251 to 251.4** *Award B1 if divisor **seen** not to be 85 but answer in range*	B2		AWFW $\sum fx$ = 21352 $\bar{x}$ = 251.2
	Note: If B0 then can award M1 for attempt at $\sum fx \div 85$ **seen**			*Ignore notation and condone incorrect midpoints (eg upper or lower limits used)*
	Standard deviation, s or σ = **4.21 to 4.28** *Award B1 if divisor **seen** not to be 84 or 85 but answer in range*	B2	4	AWFW $\sum fx^2$ = 5365134 σ = 4.217 s = 4.242
(c)	Interquartile range (IQR)	B1		Named
	Not affected by unknown/large/small/extreme/ outlying/227 & 271 values	Bdep1	2	Or equivalent Dependent on previous B1 Only negative comments on other measures ⇒ Bdep0
	OR			*More than one named ⇒ B0 Bdep0* *Range ⇒ B0 Bdep0*
	Standard deviation (s or σ)	(B1)		Named
	Uses all data values	(Bdep1)		Or equivalent Dependent on previous (B1) Only negative comments on other measures ⇒ Bdep0
	Total		**11**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
2				
(a)(i)	Diameter, $D \sim N(57.15,\ 0.04^2)$			
	$P(D < 57.2) = P\left(Z < \frac{57.2-57.15}{0.04}\right)$	M1		Standardising 57.2 with 57.15 and 0.04; allow $(57.15 - 57.2)$
	$= P(Z < \mathbf{1.25})$	A1		CAO; ignore inequality and sign May be implied by a **correct** answer
	$=$ **0.894 to 0.895**	A1	3	AWFW (0.89435)
(ii)	$P(57.1 < D < 57.2)$			
	$= p - (1 - p)$	M1		Allow even if incorrect standardising providing $p - (1 - p)$ **seen** May be implied by a correct answer
	$= 2 \times 0.89435 - 1 =$ **0.788 to 0.79(0)**	A1	2	AWFW (0.78870)
(b)(i)				
	P(16 balls < 57.2) $= p^{16}$ with $0 < p < 1$	M1		Any probability to power 16 or $1 - p^{16}$; do **not** allow multiplying factors *If only seen in (b)(ii), allow just M1*
	$= [(a)(i)]^{16} = (0.89435)^{16} =$ **0.166 to 0.17(0)**	A1	2	AWFW (0.16754)
(ii)	Variance of $\bar{D}_{16}$ $=$ **$0.04^2/16 = 0.0001$**			CAO
	or			
	Sd of $\bar{D}_{16}$ $=$ **$0.04/\sqrt{16} = 0.01$**	B1		Stated or used (*see* **Notes** *below*) CAO *If only seen in (b)(i), allow just B1*
	$P(\bar{D}_{16} > 57.16) = P\left(Z > \frac{57.16-57.15}{0.01}\right)$	M1		Standardising 57.16 with 57.15 and **0.01 or equivalent**; allow $(57.15 - 57.16)$
	$= P(Z > 1) = 1 - P(Z < 1)$	m1		Area change May be implied by a correct answer or answer < 0.5
	$=$ 1 – 0.84134 = = **0.158 to 0.159**	A1	4	AWFW (0.15866) (1 – answer) $\Rightarrow$ B1 M1 max
	Notes: Ignore partial/incomplete attempts at (ii) in (i) if followed by correct method			Mark two complete answers in (i) as two attempts so $(0 + 2)/2 \Rightarrow$ 1max
	Answer to (i) or (ii) repeated			Mark as per scheme; thus (2 max, 0) or (0, 4 max)
	Total		**11**	

Q	Solution	Marks	Total	Comments
3				
(a)	b (gradient) = **191**	B2		CAO
	b (gradient) = **190 to 192**	(B1)		AWFW
				Treat rounding of correct answers as ISW
	a (intercept) = **115**	B2	4	CAO
	a (intercept) = **93 to 137**	(B1)		AWFW
	OR			
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$ $\left(\sum y^2\right)$			154 3452 30219 & **677042** (133170091) (all 4 attempted)
	or	(M1)		
	Attempt at S_{xx} & S_{xy} $\left(S_{yy}\right)$			12224 & **64** (2714668) (both attempted)
	Attempt at **correct** formula for b (gradient)	(m1)		
	b (gradient) = **191**	(A1)		CAO
	a (intercept) = **115**	(A1)		CAO
	Accept a & b interchanged only if identified and used correctly in (ii)			If a and b are not identified anywhere in question, then: 190 to 192 ⇒ B1 93 to 137 ⇒ B1
(ii)	$y_{24} = 115 + 191 \times 24$			
	= **£4699 or £4700**	B2	2	Either; ignore units (£4699)
	= **£4650 to £4750**	(B1)		AWFW
	SC: (4290 + 5057)/2 = 4673 to 4674 ⇒ B1			
	If B0 but **clear evidence** of correct use of c's equation with $x = 24$	(M1)		
(iii)	(Maximum) **temperature** (in February) is likely to be/will be lower/different	B1	1	Or equivalent; must be **clear indication** that (max) **temperature** is less than/different
	Must imply a temperature comparison with July			Extrapolation/not July/not summer/winter/etc ⇒ B0
(iv)	Rainfall amount/wind strength/sunshine hours/ daylight hours/opening times/day of week/ visitor numbers/public holidays/school holidays/ local attractions/etc	B1	1	Or equivalent Accept any sensible reason; do **not** penalise for dubious 'variable name' so, for example, accept 'rainfall' Minimum/average temp/etc ⇒ B0 Quality or price of food/ staff/etc ⇒ B0
	Allow if at least 1 variable correctly identified			
	Total		**8**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
3				
(b)	Any line (straight, freehand, curve) from (0, –1) on Figure 1 **or** from (0, 5) on Figure 2	B1		Accept **clear marking** of (0, –1) **or** (0, 5) with no line
(i)	**Straight,** not freehand, line from **(0, –1) to (40, 5)** on F1 only; allow line extensions and only **very** minor inaccuracies in points plotted	B1		(10, 0.5) (20, 2) (30, 3.5)
(ii)	**Straight ,** not freehand, line from **(0, 5) to (10, 1)** on F2 only; allow line extensions and only **very** minor inaccuracies in points plotted **Notes:** Both lines on F1 ⇒ B1 B1 B0 max Both lines on F2 ⇒ B1 B0 B1 max >1 undeleted line on either F1 or F2 ⇒ 2 max	B1	3	(2, 4.2) (4, 3.4) (6, 2.6) (8, 1.8)
	Total		**3**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
4				
(a)	$\sqrt{\frac{184.5}{49}}$ **or** $1.92 \times \sqrt{\frac{50}{49}}$ $= 1.94$	B1	1	**Fully correct** expression or equivalent must be **seen** **Note:** $s = \sqrt{184.5/50} = 1.939 \Rightarrow$ B0 AG
(b)				
(i)	96% (0.96) $\Rightarrow$ z = **2.05 to 2.06**	B1		AWFW (2.0537)
	CI for μ is $\bar{x} \pm z \times \frac{s}{\sqrt{n}}$	M1		Used with 251.1 and 1.94 correctly Must have $\sqrt{n}$ with $n > 1$
	Thus $251.1 \pm 2.0537 \times \frac{1.94}{\sqrt{50 \text{ or } 49}}$	AF1		F on z only
	Hence **251.1 ± 0.6** **or** **(250.5, 251.7)**	Adep1	4	CAO/AWRT Dependent on AF1 but not on z so can be gained using an incorrect z AWRT
(ii)	Claim is $\mu > 250$			
	Clear correct comparison of **250** with **LCL or CI**	BF1		F on CI (250 < LCL or CI)
	so Claim is supported/reasonable/correct/true/etc Must be consistent with c's comparison	Bdep1	2	Dependent on BF1
(c)	$\bar{x} - ns = 251.1 - n \times 1.94 < 250$ **SC:** Quoted values of 249.2, 247.2 or 245.3 (AWRT) $\Rightarrow$ M1	M1		Allow any multiple of 1.94 Must **clearly indicate** the value of a numerical expression giving a result less than 250
	so Some individual packets are likely to/will contain less than 250 grams	A1	2	Or equivalent
	Total		**9**	

Q	Solution	Marks	Total	Comments
5				
(a)(i)				
		B1		**0.35 and 0.7**; CAO
		B1		**0.55**; CAO
		B1	3	**0.1 and 0.2**; CAO
	Notes: Use of Venn or tree diagrams **without** table completion ⇒ B0 B0 B0 Printed table not completed but constructed and completed on Page 12/13 ⇒ B1 B1 B1 max			Accept fractional answers Do not accept percentages
(ii)	P(purchases exactly one) $= P(W \cap J') + 0.15$ $= 0.10 + 0.15$ $=$ **0.25 or 25/100 or 5/20 or 1/4**	M1 A1	2	Only c's equivalent to 0.10 **shown and added to** 0.15 Can be implied by **correct** answer CAO
(iii)				
(A)	$P(W \cup J) =$ **0.8** **&/≠** $P(W) + P(J) =$ **1.35** **or** $P(W \cap J) =$ **0.55** (>0); accept if indicated in a Venn diagram **or** $P(W) + P(J) =$ **1.35 >0 or impossible**	B1		Any one of these three **seen** *Ignore contradictions, explanations & justifications* *Do **not** accept use of W' and/or J'*
(B)	$P(W \mid J) = 0.55/0.70 =$ **0.79** **&/≠** $P(W) =$ **0.65** **or** $P(J \mid W) = 0.55/0.65 =$ **0.85** **&/≠** $P(J) =$ **0.70** **or** $P(W) \times P(J) =$ **0.45 to 0.46** **&/≠** $P(W \cap J) =$ **0.55**	B1 Bdep1	3	AWRT Any one of these three **seen** *Ignore contradictions, explanations & justifications* AWFW
(b)	**Do not allow multiplying factors in (b)**			
(i)	P(0) = 0.15 × 0.40 × 0.45 $=$ **0.027 or 27/1000**	B1 B1	2	Can be implied by **correct** answer or 1 – (0.2265 + 0.466 + 0.2805) CAO
(ii)	P(2) = **0.85 × 0.60 × 0.45** = 0.2295 + **0.85 × 0.40 × 0.55** = 0.1870 + **0.15 × 0.60 × 0.55** = 0.0495 **or** = 1 – (**0.027** + **0.2265** + **0.2805**) $=$ **0.466 or 466/1000 or 233/500**	M2 (M1) A1	3	*For either method:* **At least two bold** expressions correct **Only one bold** expression correct Can be implied by **correct** answer *For second method:* Must have '1 –' for any marks CAO; **do not** imply this from (i)
	Total		**13**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
6				
(a)	$\underline{X \sim B(10,\ 0.15)}$			
(i)	$P(X \leq 2) =$ **0.82(0)**	B1	1	AWRT (0.8202)
(ii)	$P(X \geq 2) = 1 - P(X \leq 1)$			Requires '1 –'
	= **1 – (0.5443 or 0.8202)**	M1		Accept 3/2 dp rounding or truncation Can be implied by 0.455 to 0.456 but **not** by 0.179 to 0.18(0)
	= **0.455 to 0.456**	A1	2	AWFW (0.4557)
(iii)	$P(1 < X < 5) =$ **0.9901 or 0.9986** (p_1)	M1		Accept 3 dp rounding or truncation $p_2 - p_1 \Rightarrow$ 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 0.5443 or 0.1969 (p_2)	M1		Accept 3 dp rounding or truncation
	= **0.445 to 0.446**	A1	3	AWFW (0.4458)
	OR			
	B(10, 0.15) expressions stated for **at least 3** terms within $1 \leq X \leq 5$ gives probability	(M1)		Can be implied by a correct answer
	= **0.445 to 0.446**	(A2)		AWFW (0.4458)
(b)	$\underline{Y \sim B(50,\ 0.15)}$			Normal approximation $\Rightarrow$ 0 marks
(i)	$P(Y > 5) = 1 - P(Y \leq 5)$			Requires '1 –'
	= **1 – (0.2194 or 0.1121)**	M1		Accept 3 dp rounding or truncation Can be implied by 0.78(0) to 0.781 but **not** by 0.888 to 0.89
	= **0.78(0) to 0.781**	A1	2	AWFW (0.7806)
(ii)	$P(5 \leq Y \leq 10) =$ **0.8801 or 0.7911** (p_1)	M1		Accept 2/3 dp rounding or truncation $p_2 - p_1 \Rightarrow$ 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 0.1121 or 0.2194 (p_2)	M1		Accept 3 dp rounding or truncation
	= **0.768**	A1	3	AWRT (0.7680)
	OR			
	B(50, 0.15) expressions stated for **at least 3** terms within $4 \leq Y \leq 10$ gives probability	(M1)		Can be implied by a correct answer
	= **0.768**	(A2)		AWRT (0.7680)
	Total		**11**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
7				
(a)	**Ryan:** Value indicates that as **volume increases** then **weight decreases**	B1		Or equivalent in context
	Sunil: Value indicates **no correlation/relationship/ association/link** between **volume and weight**	B1	2	Or equivalent in context
	SC: If B0 B0: Would expect **weight** to **increase** with **volume** **or** Would expect **strong**(er) **positive** correlation between **weight** and **volume**	(B1)		Or equivalent in context
(b)	**Ryan & Sunil:** r is not affected by units/(linear) scaling	B1		Or equivalent
	Tim: r is not affected by sample size **or** $2 \times 0.612 > 1 \Rightarrow$ impossibility	B1	2	Either; or equivalent
(c) **(i)**	r = **0.541 to 0.543** r = **0.54 to 0.55** r = **0.5 to 0.6**	B3 (B2) (B1)	3	AWFW (0.54186) AWFW AWFW
	OR			
	Attempt at $\sum v$ $\sum v^2$ $\sum w$ $\sum w^2$ & $\sum vw$ **or** Attempt at S_{vv} S_{ww} & S_{vw}	(M1)		216 6633.16 136 2376.84 & **3795.5** (all 5 attempted) Accept notation of x and y 801.16 64.84 & **123.5** (all 3 attempted)
	Attempt at substitution into **correct** corresponding formula for r	(m1)		
	r = **0.541 to 0.543**	(A1)		AWFW
(ii)	(Quite or fairly) **weak/some/moderate** **positive** (linear) **correlation**/relationship/ association/link (*but not ' trend'*)	Bdep1		Dependent on **$0.5 \leq r \leq 0.6$** Or equivalent; must **qualify strength** and **state positive** Bdep0 for very strong/strong/high/ good/average/medium/reasonable/ poor/very weak/little/etc
	between **volumes** and **weights** of suitcases	B1	2	Context; providing **$0 < r < 1$**
	Total		**9**	
	TOTAL		**75**	