Version

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

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 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.

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)**	$a = \underline{\textbf{30}}$	B1	1	CAO
(b)(i)	b (gradient) = $\underline{\textbf{–0.64}}$ b (gradient) = $\underline{\textbf{–0.6 to –0.7}}$ a (intercept) = $\underline{\textbf{31}}$ a (intercept) = $\underline{\textbf{30 to 32}}$	B2 (B1) B2 (B1)		CAO (-0.64) AWFW *Treat rounding of correct answers as ISW* *Written form of equation is **not** required* CAO (31) AWFW
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$ $\left(\sum y^2\right)$ **or** Attempt at S_{xx} & S_{xy} $\left(S_{yy}\right)$ Attempt at **correct** formula for b (gradient) b (gradient) = $\underline{\textbf{–0.64}}$ $\quad$ a (intercept) = $\underline{\textbf{31}}$	(M1) (m1) (A1 A1)	4	225 7125 135 & **2415** (2643) (all 4 attempted) 1500 & **–960** (618) (both attempted) CAO both
(ii)	Candle **length reduces** by **0.64 (**cm**) per hour** Candle **burns 0.64 (**cm**) each/per hour** Candle **reduces** by **–0.64 (**cm**) each/per hour** (Length, y, cm) **decreases** with (time, x, hours) **or** As (time, x, hours) **increases** then (length, y, cm) **decreases**	B1 BF1 (BF2) (BF1) (B1)	2	OE; must be in context OE; must be in context OE; must be in context OE; must be in context (double –ve) F on $-0.6 \le b \le -0.7$ from (i) OE; context **not** required B0 for reference only to correlation
(iii)	When $x = 50$, $y = (31$ or $30) - 0.64 \times 50$ $\qquad\qquad\qquad\qquad = \underline{\textbf{–1 or –2}}$ **or** When $y = 0$, $x = 31 \div 0.64 = \underline{\textbf{48 to 48.5}}$ **or** $30 \div 0.64 = \underline{\textbf{46.8 to 47}}$	B1		CAO; accept **correct** comparison of 32 with either 30 or 31 AWFW AWFW
	Claim **not** justified **or** –1 is impossible **or** value < 50 Claim cannot be answered due to uneven burning **or** unlikely to burn completely	Bdep1 (B1)	2	OE; dependent on previous B1 Extrapolation required
			9	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
2				**In (a), ignore the inclusion of a lower limit of 0; it has no effect on the answer**
(a)	Volume, $V \sim N(106, 2.5^2)$ $$P(V < 110) = P\left(Z < \frac{110-106}{2.5}\right)$$	M1		Standardising 110 with 106 and 2.5; allow $(106 - 110)$
	$= P(Z < \underline{\mathbf{1.6}})$	A1		CAO; ignore inequality and sign May be implied by a **correct** answer
	$= \underline{\mathbf{0.945}}$	A1	3	AWRT (0.94520)
(b)	$P(V > 100) = P(Z > -2.4) = P(Z < +2.4)$	M1		**Correct** area change May be implied by a **correct** answer **or** by an answer **> 0.5**
	$= \underline{\mathbf{0.991\ to\ 0.992}}$	A1	2	AWFW (0.99180)
(c)	$P(104 < V < 108) = P(-a < Z < a) =$ $P(Z < a) - (1 - P(Z < a))$ **or** $2 \times P(Z < a) - 1$	M1		OE; $a = 0.8$ is **not** a requirement May be implied by **0.788 seen** **or** by a **correct** answer
	$= 0.788 - (1 - 0.788) = 0.788 - 0.212$ **or** $= 2 \times 0.788 - 1$	A1		AWRT (0.78814/0.21186) Condone 0.211 May be implied by a **correct** answer
	$= \underline{\mathbf{0.576}}$	A1	3	AWRT (0.57628)
(d)	$P(V \neq 106) = \underline{\mathbf{1\ or\ one\ or\ unity\ or\ 100\%}}$	B1	1	CAO; accept nothing else but ignore additional words providing they are not contradictory (eg certain so = 1)
		Total	**9**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
3 **(a)** **(i)**	$\underline{E \sim \text{B}(40,\ 0.30)}$ P$(E \le 10) = \underline{\textbf{0.308 to 0.309}}$	M1 A1	 **(2)**	Used anywhere in (a) even only by implication from a **correct** value AWFW $\qquad$ (0.3087)
SC	For calcⁿ of individual terms: award B2 for answer within above range; award B1 for answer within range 0.3 to 0.32			
(ii)	P$(E \ge 15) = \underline{\textbf{1 – (0.8074 or 0.8849)}}$ $= \underline{\textbf{0.192 to 0.193}}$	M1 A1	 **(2)**	Requires '1 –' Accept 3 dp rounding or truncation Can be implied by 0.192 to 0.193 but **not** by 0.115 to 0.116 AWFW $\qquad$ (0.1926)
SC	For calcⁿ of individual terms: award B2 for answer within above range; award B1 for answer within range 0.18 to 0.2			
(iii)	P$(E \le 12) = \underline{\textbf{0.5772 – 0.4406}}$ **or** P$(E \le 12) = \dbinom{40}{12}0.3^{12}0.7^{28}$ $= \underline{\textbf{0.136 to 0.138}}$	 M1 A1	 **(2)**	Accept 3 dp rounding or truncation Correct expression; may be implied by a **correct** answer AWFW $\qquad$ (0.1366)
			6	
(b)	Means = $\underline{\textbf{3.2 and 2}}$ Variances = $\underline{\textbf{2.56 and 1.75}}$	B1 B1 B1	 **3**	CAO both **values**; ignore notation *If not labelled, assume order in question* CAO each **value**; ignore notation ISW all subsequent working
(c)(i)	Mean = $\underline{\textbf{2}}$ Variance = $\underline{\textbf{2.54 to 2.55 or 2.33 to 2.34}}$ (SD = 1.59 to 1.6 or 1.52 to 1.53)	B1 B1	 **2**	CAO **value**; ignore notation Any **value** within either range; ignore notation ISW all subsequent working
(ii)	B(16, 0.20) **or** eg "One distⁿ" **Different/larger** mean **Similar/same** variance or standard deviation B(16, 0.125) **or** eg "Other distⁿ" **Equal/same** mean **Different/smaller** variance or standard deviation **Neither** likely to provide satisfactory model	Bdep1 Bdep1 Bdep1	 **3**	Identification of distribution **not** required Both; dep on 3.2, 2.56 /1.6 & (c)(i) Identification of distribution **not** required Both; dep on 2, 1.75/1.3 & (c)(i) Dep on Bdep1 and on Bdep1
SC	Award Bdep1 Bdep0 Bdep0 for comparison of 3 correct means only **or** for comparison of 3 correct variances/SDs only Award up to Bdep1 Bdep1 Bdep1 for comparison of 3 correct means **and** for comparison of 3 correct variances/SDs			
		Total	**14**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
4(a) **(i)**	$r = $ **–0.326 to –0.325** $r = $ **–0.33 to –0.32** $r = $ **–0.4 to –0.2** $r = $ **0.2 to 0.4**	B3 (B2) (B1) (B1)		AWFW (–0.32569) AWFW AWFW AWFW
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ $\sum y^2$ & $\sum xy$ **or** Attempt at S_{xx} S_{yy} & S_{xy} Attempt at substitution into **correct** corresponding formula for r $r = $ **–0.326 to –0.325**	(M1) (m1) (A1)	3	756 50004 738 48200 & **45652** (all 5 attempted) 2376 2813 & **–842** (all 3 attempted) AWFW
(ii)	**Some/little/slight/(fairly/quite) weak/ (fairly/quite) moderate** **negative** (linear) **correlation**/relationship/ association/link (*but not 'trend'*) between **marks/percentages** in the two examination papers	Bdep1 B1	2	Dependent on $-0.4 \le r \le -0.2$ OE; must **qualify strength** and **state negative** Ignore extra words unless contradict Bdep0 for 'low', 'small', 'poor', 'unlikely', 'medium', 'average', or adjective 'very' Context; providing $-1 < r < 1$
(b)(i)	Identifying linear patterns/non-linear patterns/ multiple patterns/no pattern (*allow 'trend'*) Identifying outliers/anomalies Estimating/gives idea of value of r/sign of r	B2,1	2	OE; only one mark from each set B0 for reference to **checking** calculated value
(ii)	**Graph** (**6** labelled points correct) (**5 or 4** labelled points correct)	B2 (B1)	2	Correct $\Rightarrow$ within a circle of radius equal to distance between 2 grid lines Deduct 1 mark for any unlabelled or incorrectly labelled point
(iii)	**Two** separate correlations/relationships/lines/ associations/links/sets of data (*but not 'trends'*)	B1	1	OE; eg A to F and G to L
(c)	A to F: **(+)0.7 to (+)0.99** G to L: **–0.9 to –0.5**	B1 B1	2	AWFW; allow calculation (0.937) *If not labelled, assume order A to F then G to L* AWFW; allow calculation (–0.757)
		Total	**12**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
5 **(a)(i)**	P(F & C) = **0.3 or 3/10 or 30%**	B1 **(1)**		Ratios (eg 3:10) are only penalised by 1 accuracy mark at first correct answer CAO (0.3)
(ii)	P(G or S) = **0.45 or 45/100 or 45%**	B1 **(1)**		CAO (0.45)
(iii)	$P(C \mid F) = \dfrac{0.3 \text{ or } (i)}{0.55} =$ **or** $\quad\quad\quad\quad\dfrac{\mathbf{30/55 \ or \ 6/11}}{}$ **(0.54 to 0.55) or (54% to 55%)**	M1 A1 **(2)**		 CAO (6/11) AWFW (0.54545)
(iv)	$P(R' \mid D) = \dfrac{0.25 \text{ or } (0.30 - 0.05)}{0.30}$ **or** $\quad\quad\quad\quad \mathbf{25/30 \ or \ 5/6}$ **(0.83 to 0.834) or (83% to 83.4%)**	M1 M1 A1 **(3)**		Correct numerator Correct denominator CAO (5/6) AWFW (0.83333)
(v)	$P(F \mid C') = \dfrac{0.25 \text{ or } (0.60 - 0.35)}{0.60}$ **or** $\quad\quad\quad\quad \mathbf{25/60 \ or \ 5/12}$ **(0.416 to 0.42) or (41.6% to 42%)**	M1 A1 **(2, 3)**		Correct expression CAO (5/12) AWRT (0.41667)
			9	
(b)	$P = [P(F \& C)]^2 + [P(F \& G)]^2$ $0.30^2 + 0.25^2$ **or** $0.09 + 0.0625 =$ **or** $\quad\quad \dfrac{\mathbf{1525/10000 \ or \ 305/2000 \ or \ 61/400}}{}$ **(0.152 to 0.153) or (15.2% to 15.3%)**	M1 A1 A1 **3**		Attempt at **sum of at least 2 squared terms; 0 < term < 1**; not $(a+b)^2$ May be implied by a **correct** expression or a **correct** answer OE Ignore additional terms or integer multipliers May be implied by a **correct** answer CAO (0.1525) AWFW
		Total	**12**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
6 **(a)**	$L \sim \text{N}(1005, 15^2)$ V(pack) = **$15^2/12$ or 225/12 or 75/4** **or** **18.7 to 18.8** **OR** SD (pack) = **$15/\sqrt{12}$ or $15/2\sqrt{3}$ or $5\sqrt{3}/2$** **or** **4.3 to 4.4**	B1		CAO AWFW (18.75) CAO; OE AWFW (4.33013)
	$P(L < 1000) = P\left(\dfrac{1000 - 1005}{15/\sqrt{12}}\right) =$	M1		Standardising 1000 using 1005 and **$15/\sqrt{12}$ OE**; allow (1005 – 1000)
	$P(Z < -1.1547) = 1 - P(Z < 1.1547) =$	m1		**Correct** area change May be implied by a correct answer **or** an answer **< 0.5**
	$1 - (0.87698 \text{ to } 0.87493) = \underline{\textbf{0.123 to 0.126}}$	A1	**4**	AWFW (0.12411) (1 – answer) $\Rightarrow$ B1 M1 max
(b)(i)	$99\% (0.99) \Rightarrow z = \underline{\textbf{2.57 to 2.58}}$	B1		AWFW (2.5758)
	CI for μ is $\bar{x} \pm z \times \dfrac{\sigma}{\sqrt{n}}$	M1		Used with z (2.05 to 2.58), $\bar{x}$ (4.65) & σ(0.15) and $\div\sqrt{n}$ with $n > 1$
	Thus $4.65 \pm 2.5758 \times \dfrac{0.15}{\sqrt{24}}$	A1		z (2.05 to 2.06 or 2.32 to 2.33 or 2.57 to 2.58), $\bar{x}$ (4.65) & σ(0.15) and $\div\sqrt{24 \text{ or } 23 \text{ or } 12 \text{ or } 11}$
	Hence **4.65 ± 0.08** **OR** **(4.57, 4.73)**	A1	**4**	CAO/AWRT AWRT
(b)(ii)	**Clear correct comparison** of **4.5** with **LCL or CI** (eg 4.5 < LCL or its value or 4.5 < CI or its limits so **Agree** with manufacturer's specification	BF1 Bdep1	**2**	F on CI only providing LCL > 4.5 (ie whole of CI > 4.5) Quoting values for LCL or for CI is **not** required BF0 for '4.5 is outside CI'; OE OE; dependent on previous BF1
		Total	**10**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
7 **(a)**	$\sigma \approx \dfrac{10}{a}$ **or** $\dfrac{20}{b}$ **or** $\dfrac{\text{range}}{b}$ **or** $10c$ **or** $20d$	M1		OE; with $2 \le a \le 4$ $4 \le b \le 8$ **or** with c or d in equiv percentages **Cannot** be implied from a **correct** answer (justification required)
	2.5 or 3.3(OE) or 5	A1	**2**	
SC	Award **B1** for only **2.5 or 3.3(OE) or 5** with no justification Award **B0** for any other answer with no justification or with incorrect justification (eg $\sqrt{10} = 3.16$)			
(b)	**Valid statement** involving: 391 and 405 **OR** 401 and 415 **OR** 24 and 10 **OR** 391 and 415 and 10/24 with linking statement	B1		Allow 'set weight' to imply 415 and/or 'mean' to imply 391 B0 for 10 linked to σ
	$95.5 >$ (**value** of σ of **2.5 or 3.3(OE) or 5**)	B1		Accept $\ne$ rather than $>$ **Clear correct numerical** comparison
	Neither (likely to be) **correct**	Bdep1	**3**	Dependent on B1 B1
(c)	Mean **or** $\bar{y} = \dfrac{8210.0}{10} = \underline{\textbf{821}}$ **OR** $\sum y = \underline{\textbf{8200}}$	B1		CAO;
	Variance $\dfrac{110.00}{9} = \underline{\textbf{12.2}}$ **or** $\dfrac{110.00}{10} = \underline{\textbf{11}}$ **OR** SD $\underline{\textbf{3.5}}$ **or** $\underline{3.3}$	B1		AWRT CAO Award on **value**; ignore notation AWRT
	821 **is similar to/within 10 of** 820 **OR** 8210 **is within 100 of** 8200	B1		OE; **clear correct numerical** comparison of **821** with **820** Allow 'set weight' to imply 820 **Or** OE; **clear correct numerical** comparison of **8210** with **8200** but do **not** accept 'within 10' here
	3.5 **or** 3.3 is **similar to** a **value** of σ of **3.3(OE) or 2.5**	B1	**4**	**Clear correct numerical** comparison
		Total	**9**	
	TOTAL		**75**	