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General Certificate of Education (A-level)
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Mathematics MS/SS1B

(Specification 6360)

Statistics 1B

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.

MS/SS1B

Q	Solution	Marks	Total	Comments
1 (a)	a = **30**	B1	**1**	CAO
(b)(i)	b (gradient) = **–0.64** b (gradient) = **–0.6 to –0.7**	B2 (B1)		CAO (–0.64) AWFW *Treat rounding of correct answers as ISW* *Written form of equation is **not** required*
	a (intercept) = **31** a (intercept) = **30 to 32**	B2 (B1)		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) = **–0.64** a (intercept) = **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**	B1 BF1 (BF2) (BF1)		OE; must be in context OE; must be in context OE; must be in context OE; must be in context (double –ve) F on $-0.6 \leq b \leq -0.7$ from (i)
	(Length, y, cm) **decreases** with (time, x, hours) **or** As (time, x, hours) **increases** then (length, y, cm) **decreases**	 (B1)	**2**	 OE; context **not** required B0 for reference only to correlation
(iii)	When x = 50, y = (31 or 30) – 0.64 × 50 = **–1 or –2** **or** When y = 0, x = 31 ÷ 0.64 = **48 to 48.5** **or** 30 ÷ 0.64 = **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**
	Volume, $V \sim N(106, 2.5^2)$			
(a)	$P(V < 110) = P\left(Z < \frac{110-106}{2.5}\right)$	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**
	$= \underline{\mathbf{0.991 \text{ to } 0.992}}$	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)	$P(V \neq 106) = \underline{\mathbf{1 \text{ or one or unity or } 100\%}}$	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)	$E \sim B(40, 0.30)$	M1		Used anywhere in (a) even only by implication from a **correct** value
(i)	$P(E \leq 10) =$ **0.308 to 0.309**	A1	**(2)**	AWFW (0.3087)
SC	For calc^{n} of individual terms: award B2 for answer within above range; award B1 for answer within range 0.3 to 0.32			
(ii)	$P(E \geq 15) =$ **1 – (0.8074 or 0.8849)**	M1		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
	$=$ **0.192 to 0.193**	A1	**(2)**	AWFW (0.1926)
SC	For calc^{n} of individual terms: award B2 for answer within above range; award B1 for answer within range 0.18 to 0.2			
(iii)	$P(E \leq 12) =$ **0.5772 – 0.4406** **or** $P(E \leq 12) = \binom{40}{12}0.3^{12}0.7^{28}$	M1		Accept 3 dp rounding or truncation Correct expression; may be implied by a **correct** answer
	$=$ **0.136 to 0.138**	A1	**(2)**	AWFW (0.1366)
			6	
(b)	Means = **3.2 and 2**	B1		CAO both **values**; ignore notation *If not labelled, assume order in question*
	Variances = **2.56 and 1.75**	B1 B1	**3**	CAO each **value**; ignore notation ISW all subsequent working
(c)(i)	Mean = **2**	B1		CAO **value**; ignore notation
	Variance = **2.54 to 2.55 or 2.33 to 2.34**	B1		Any **value** within either range; ignore notation
	(SD = 1.59 to 1.6 or 1.52 to 1.53)		**2**	ISW all subsequent working
(ii)	B(16, 0.20) **or** eg "One dist^{n}" **Different/larger** mean **Similar/same** variance or standard deviation	Bdep1		Identification of distribution **not** required Both; dep on 3.2, 2.56 /1.6 & (c)(i)
	B(16, 0.125) **or** eg "Other dist^{n}" **Equal/same** mean **Different/smaller** variance or standard deviation	Bdep1		Identification of distribution **not** required Both; dep on 2, 1.75/1.3 & (c)(i)
	Neither likely to provide satisfactory model	Bdep1	**3**	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**	B3		AWFW (–0.32569)
	r = **–0.33 to –0.32**	(B2)		AWFW
	r = **–0.4 to –0.2**	(B1)		AWFW
	r = **0.2 to 0.4**	(B1)		AWFW
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ $\sum y^2$ & $\sum xy$			756 50004 738 48200 & **45652** (all 5 attempted)
	or	(M1)		
	Attempt at S_{xx} S_{yy} & S_{xy}			2376 2813 & **–842** (all 3 attempted)
	Attempt at substitution into **correct** corresponding formula for r	(m1)		
	r = **–0.326 to –0.325**	(A1)	**3**	AWFW
(ii)	**Some/little/slight/(fairly/quite) weak/ (fairly/quite) moderate**	Bdep1		Dependent on **–0.4 ≤ *r* ≤ –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'
	negative (linear) **correlation/**relationship/ association/link (*but not 'trend'*) between			
	marks/percentages in the two examination papers	B1	**2**	Context; providing **–1 < *r* < 1**
(b)(i)	Identifying linear patterns/non-linear patterns/ multiple patterns/no pattern (*allow 'trend'*)			
	Identifying outliers/anomalies	B2,1		OE; only one mark from each set
	Estimating/gives idea of value of *r*/sign of *r*		**2**	B0 for reference to **checking** calculated value
(ii)	**Graph** (**6** labelled points correct)	B2		Correct ⇒ within a circle of radius equal to distance between 2 grid lines Deduct 1 mark for any unlabelled or incorrectly labelled point
	(**5 or 4** labelled points correct)	(B1)	**2**	
(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**	B1		AWFW; allow calculation (0.937) *If not labelled, assume order A to F then G to L*
	G to L: **–0.9 to –0.5**	B1	**2**	AWFW; allow calculation (–0.757)
		Total	**12**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
5				**Ratios (eg 3:10) are only penalised by 1 accuracy mark at first correct answer**
(a)(i)	P(F & C) = **0.3 or 3/10 or 30%**	B1	**(1)**	CAO (0.3)
(ii)	P(G or S) = **0.45 or 45/100 or 45%**	B1	**(1)**	CAO (0.45)
(iii)	$P(C \mid F) = \frac{0.3 \text{ or } (i)}{0.55} =$	M1		
	30/55 or 6/11	A1	**(2)**	CAO (6/11)
	or			
	(0.54 to 0.55) or (54% to 55%)			AWFW (0.54545)
(iv)	$P(R' \mid D) = \frac{0.25 \text{ or } (0.30-0.05)}{0.30}$	M1 M1		Correct numerator Correct denominator
	25/30 or 5/6	A1	**(3)**	CAO (5/6)
	or			
	(0.83 to 0.834) or (83% to 83.4%)			AWFW (0.83333)
(v)	$P(F \mid C') = \frac{0.25 \text{ or } (0.60-0.35)}{0.60}$	M1		Correct expression
	25/60 or 5/12	A1	**(2, 3)**	CAO (5/12)
	or			
	(0.416 to 0.42) or (41.6% to 42%)			AWRT (0.41667)
			9	
(b)	$P = [P(F \& C)]^2 + [P(F \& G)]^2$	M1		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
	$0.30^2 + 0.25^2$ **or** $0.09 + 0.0625 =$	A1		OE Ignore additional terms or integer multipliers May be implied by a **correct** answer
	1525/10000 or 305/2000 or 61/400	A1	**3**	CAO (0.1525)
	or			
	(0.152 to 0.153) or (15.2% to 15.3%)			AWFW
		Total	**12**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
6 **(a)**	$L \sim N(1005, 15^2)$			
	V(pack) = **$15^2/12$ or 225/12 or 75/4**	B1		CAO
	or **18.7 to 18.8**			AWFW (18.75)
	OR SD (pack) = **$15/\sqrt{12}$ or $15/2\sqrt{3}$ or $5\sqrt{3}/2$**			CAO; OE
	or **4.3 to 4.4**			AWFW (4.33013)
	$P(L < 1000) = P\left(\frac{1000-1005}{15/\sqrt{12}}\right) =$	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 to 0.87493) = **0.123 to 0.126**	A1	**4**	AWFW (0.12411) (1 – answer) ⇒ B1 M1 max
(b)(i)	99% (0.99) ⇒ z = **2.57 to 2.58**	B1		AWFW (2.5758)
	CI for μ is $\bar{x} \pm z \times \frac{\sigma}{\sqrt{n}}$	M1		Used with z (2.05 to 2.58), $\bar{x}$ (4.65) & σ (0.15) and $\div\sqrt{n}$ with $n > 1$
	Thus $4.65 \pm 2.5758 \times \frac{0.15}{\sqrt{24}}$	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**			CAO/AWRT
	OR	A1		
	(4.57, 4.73)		**4**	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	BF1		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
	so **Agree** with manufacturer's specification	Bdep1	**2**	OE; dependent on previous BF1
		Total	**10**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
7 **(a)**	$\sigma \approx \frac{10}{a}$ **or** $\frac{20}{b}$ **or** $\frac{\text{range}}{b}$ **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 $\neq$ rather than > **Clear correct numerical** comparison
	Neither (likely to be) **correct**	Bdep1	**3**	Dependent on B1 B1
(c)	Mean **or** $\bar{y} = \frac{8210.0}{10}$ = **821** **OR** $\sum y$ = **8200**	B1		CAO;
	Variance $\frac{110.00}{9}$ = **12.2** **or** $\frac{110.00}{10}$ = **11** **OR** SD **3.5 or 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**	