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General Certificate of Education (A-level)
June 2012

Mathematics MS/SS1B

(Specification 6360)

Statistics 1B

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)	$r = \frac{S_{xy}}{\sqrt{S_{xx} \times S_{yy}}} = \frac{-0.410}{\sqrt{2.030 \times 1.498}} =$ **<u>–0.235</u>**	M1		Correct substitution into **correct** formula May be implied by a **correct** answer
		A1	2	AWRT (–0.235115)
(b)				Dependent on **–0.235 or –0.24**
	Some / (very) weak / (very) little / (very)slight negative correlation/relationship/association/link	Adep1		OE; must qualify strength **and** state negative Ignore extra words unless contradict Not 'no', 'low', 'small', 'unlikely' or 'trend'
	between **width and thickness** of lengths of steel	B1	2	Context; do **not** allow 'cms' or 'mms'
SC	r = (+)0.235 ⇒ M1 A0 Adep0 B1 max			
	Total		**4**	

Q	Solution	Marks	Total	Comments
2				
(a)(i)	Mode = **<u>23</u>**	B1	1	CAO
(ii)	Median (88^{th} value) = **<u>22</u>**	B1		CAO
	Upper quartile (132^{nd} value) = **<u>23</u>**	B1		CAO; either May be implied by IQR = 3
	Lower quartile (44^{th} value) = **<u>20</u>**			
	Interquartile range = **<u>3</u>**	B1	3	CAO; do **not** award if **seen** to be not based on 23 and 20
(b)	Mean = **<u>22.3</u>**	B2		CAO; but only award B1 (22.3) if incorrect mid-points or Σfx **seen**
	Mean = **<u>21 to 23</u>**	(B1)		AWFW (Σfx = 3902.5)
	Standard deviation = **<u>6.37 or 6.39</u>**	B2		AWRT (s = 6.391 σ = 6.372)
	Standard deviation = **<u>5 to 7</u>**	(B1)	4	AWFW (Σfx^2 = 94132.25)
SC	Only if B0 B0 or B1 B0 then award as follows but only up to a **maximum total part mark of 2** **1** At least 2 correct mid-points 4.5, 14.5, 27, 32, 37, 44.5, 54 seen ⇒ M1 **2** Clear use of Σfx/(175 or 174) ⇒ M1			
(c)	Mean = (c's mean from (b)) + $\frac{280}{175}$ = 22.3 + 1.6	M1		Adding (1.6 or equivalent) CAO to (c's mean from (b)) **or** to (c's new mean)
	Mean = **<u>23.9</u>**	AF1	2	F on (c's mean from (b)) **or** on (c's new mean)
	Total		**10**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
3				
(a)	b (gradient) = **2.27**	B2		AWRT (2.27075)
	b (gradient) = **2.2 to 2.3**	(B1)		AWFW *Treat rounding of correct answers as ISW*
	a (intercept) = **4.16 to 4.2**	B2		AWFW (4.16981)
	a (intercept) = **3 to 7**	(B1)		AWFW
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$ $\left(\sum y^2\right)$			480 24500 1140 & **57635** (135908) (all 4 attempted)
	or	(M1)		
	Attempt at S_{xx} & S_{xy} $\left(S_{yy}\right)$			5300 & **12035** (27608) (both attempted)
	Attempt at **correct** formula for b (gradient)	(m1)		
	b (gradient) = **2.27**	(A1)		AWRT
	a (intercept) = **4.16 to 4.2**	(A1)	4	AWFW
Notes	**1** Values of a and b interchanged and equation $y = ax + b$ stated in (a) ⇒ max of 4 marks **2** Values of a and b interchanged and equation $y = a + bx$ stated in (a) ⇒ 0 marks **3** Values are **not** identified or simply a = # and b = #, then 2.2 to 2.3 ⇒ B1 and 3 to 7 ⇒ B1 but accept, for example, as identification, [a = #, b = # with $y = a + bx$ but no substitution for a & b] **or** [intercept(a) = #, gradient(b) = #] **4** b = **2407/1060** CAO ⇒ B2, otherwise B1 if fraction equates to 2.2 to 2.3 (Notes 1, 2 & 3 also apply) a = **221/53** CAO ⇒ B2, otherwise B1 if fraction equates to 3 to 7 (Notes 1, 2 & 3 also apply) **5** Some/all of marks can be scored in (b), and in c(ii) & (iii), even if some/all of marks are lost in (a) but marks lost in (a) **cannot** be recouped by subsequent working in (b)			
(b)	Correct **straight** line drawn on scatter diagram	B2		Line must go from $x \leq 20$ to $x \geq 70$ and fall between the following 2 lines: Lower: (10, 25) (80, 180) Upper: (10, 30) (80, 190)
	Correct shortened and/or freehand line drawn on scatter diagram	(B1)	2	
Notes	**1** If B0 but **seen** correct attempt at ≥2 points even if incorrectly evaluated ⇒ M1 **2** If B0 but **no seen** evidence to support ≥2 points (correct or incorrect) marked on scatter diagram ⇒ M0			
(c)(i)	Correct **straight** line drawn on scatter diagram	B2		Line must go from $x \leq 20$ to $x \geq 70$ and fall between the following 2 lines: Lower: (10, 60) (80, 75) Upper: (10, 65) (80, 85)
	Correct shortened and/or freehand line drawn on scatter diagram	(B1)	2	
Notes	**1** If B0 but **seen** correct attempt at ≥2 points even if incorrectly evaluated ⇒ M1 **2** If B0 but **no seen** evidence to support ≥2 points (correct or incorrect) marked on scatter diagram ⇒ M0			
(ii)	**27 to 29**	B1	1	AWFW (calculation ⇒ 27.75) Must clearly identify x-value Thus (27 to 29, y-value) ⇒ B0
(iii)	At low temperatures more B (than A) dissolves At high temperatures more A (than B) dissolves	B1		Either; OE (eg a comparison using lines and/or data at a specific temperature but **not** at 0°C)
	Amount increases more rapidly for A (than B) Amount increases more slowly for B (than A)	B1	2	Either; OE Any comments about b or a ⇒ B0 Comment about 'rate' must relate to temp
	Total		**11**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
4				**Ratios (eg 194:640) are only penalised by 1 accuracy mark at first correct answer**
(a)(i)	P(B = 3) = **$\underline{194/640 \text{ or } 97/320 \text{ or } 0.303 \text{ or } 30.3\%}$**	B1	1	CAO or AWRT (0.303125)
(ii)	P(T ≥ 2) = $\frac{172+256+135}{640}$ **or** $1-\frac{77}{640}$ **or** $\frac{563}{640}$	M1		
	= **$\underline{563/640}$**	A1	2	CAO
	$\underline{\text{or (0.879 to 0.88) or (87.9\% to 88\%)}}$			AWFW (0.879688)
(iii)	P(B = 3 & T ≥ 2) = $\frac{72+99+16}{640}$ **or** $\frac{194-7}{640}$ **or** $\frac{187}{640}$	M1		
	= **$\underline{187/640 \text{ or } 0.292 \text{ or } 29.2\%}$**	A1	2	CAO or AWRT (0.292188)
(iv)	P(B ≤ 3 | T = 2) = $\frac{(14+67+72)}{172}$ **or** $\frac{172-19}{172}$ **or** $\frac{153}{172}$	M1 M1		Correct numerator (accept both ÷ 640) Correct denominator
	= **$\underline{153/172}$**	A1	3	CAO
	$\underline{\text{or (0.888 to 0.89) or (88.8\% to 89\%)}}$			AWFW (0.889535)
				Answers as fractions, percentages or ratios lose accuracy (A & B) marks in (b) & (c)
(b)	(a)(i) × (a)(ii) ≠ (a)(iii) since	M1		Attempted
	0.303 × 0.88 = **$\underline{0.265 \text{ to } 0.27 \neq 0.292}$**	A1	2	AWFW & AWRT
SC	Any **correct fully-explained** reasoning, using other than answers from part (a), which results in an inequality (≠) **with both sides as numerically correct decimals** (to 3 dp) ⇒ B1 (eg P(B = 3) = 0.303 ≠ P(B = 3| T = 2) = 72/172 = 0.419) but no/unclear/incomplete reasoning or no/incorrect/incomplete numerical work ⇒ B0			
(c)	P(2T ∩ 3T ∩ ≥4T | B = 3) = $\frac{72}{194}\times\frac{99}{193}\times\frac{16}{192}$	M1 M1		Correct 3 values multiplied in numerator Correct 3 values multiplied in denominator 0.371 × 0.513 × 0.083 (all AWRT) ⇒ M1 M1 (OE products)
	abc multiplied by 6 or 3	M1		0 < (*a*, *b* & *c*) < 1
	= **$\underline{0.095 \text{ to } 0.0952}$**	A1	4	AWFW (0.095187)
Notes	**1** Incorrect answer with no working ⇒ 0 marks **2** The **3 correct fractions/decimals** identified but not multiplied (eg added) ⇒ M1 M0 M0 A0 **3** The **3 correct fractions/decimals** identified together with 0.016 (AWRT) ⇒ M1 M1 M0 A0 **4** A denominator of $^{194}C_3$ = 1198144 ⇒ M2 (2nd & 3rd M1 marks)			
	Total		**14**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
5				**In (a)(i) & (c), ignore the inclusion of a lower limit of 0; it has no effect on either answer**
(a)	Weight, $W \sim N(2.75, 0.15^2)$			
(i)	$P(W < 2.8) = P\left(Z < \frac{2.8 - 2.75}{0.15}\right)$	M1		Standardising 2.8 with 2.75 and 0.15; allow $(2.75 - 2.8)$
	$= P(Z <$ **0.33 or 1/3**$)$	A1		AWRT/CAO; ignore inequality and sign May be implied by a **correct** answer
	= **0.629 to 0.633**	A1		AWFW (0.63056)
(ii)	$P(W > 2.5) = P(Z > -1.67) = P(Z < +1.67)$	M1		**Correct** area change May be implied by a **correct** answer **or** an answer > **0.5**
	= **0.951 to 0.953**	A1	5	AWFW (0.95221)
(b)	Weight, $X \sim N(5.25, 0.20^2)$			
(i)	$P(5.1 < X < 5.3) = P(Z < 0.25) - P(Z < -0.75)$ = **0.59871**	B1		Must have diff of 2 probs for each B1 Accept 0.599
	MINUS [(1 – 0.77337) or 0.22663] = **0.372(08)**	B1	2	Accept 0.773 or 0.227 AG; do **not** mark simply on answer
(ii)	$P(0 \text{ in } 4) = [1 - 0.372]^4$	M1		Accept $[1 -$ c's (b)(i)$]^4$
	$= 0.628^4 =$ **0.155 to 0.156**	A1	2	AWFW (0.15554)
(c)	Weight, $Y \sim N(10.75, 0.50^2)$			
	Variance of $\bar{Y}_6$ = **$0.5^2/6$ = 0.0416 to 0.0417** **or** Sd of $\bar{Y}_6$ = **$0.5/\sqrt{6}$ = 0.204**	B1		CAO or AWFW Stated or used CAO or AWRT
	$P(\bar{Y}_6 < 10.5) = P\left(Z < \frac{10.5 - 10.75}{\sqrt{0.041\dot{6}}}\right) =$	M1		Standardising 10.5 with 10.75 and $\sqrt{0.041\dot{6}}$ OE; allow $(10.75 - 10.5)$
	$P(Z < -1.22) = 1 - P(Z < 1.22) =$	m1		**Correct** area change May be implied by a correct answer **or** an answer < **0.5**; but do **not** award for use of $z = \pm 0.22$
	$1 -$ (0.88877 to 0.89065) = **0.109 to 0.112**	A1	4	AWFW (0.11034) (1 – answer) $\Rightarrow$ B1 M1 max
	Total		**13**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
6				
(a)(i)	$\underline{U \sim B(30,\ 0.13, 0.35 \text{ or } 0.20)}$	M1		Used correctly anywhere in (a)
	$P(P = 2) = \binom{30}{2}(0.13)^2(0.87)^{28}$	A1		Can be implied by a **correct** answer
	$= \underline{\mathbf{0.148 \text{ to } 0.15}}$	A1	3	AWFW (0.1489)
(ii)	$p = \underline{\mathbf{0.35}}$	B1		CAO
	$P(R \cup P > 10) = \underline{\mathbf{1 - (0.5078 \text{ or } 0.3575)}}$	M1		Requires '1 –' Accept 3 dp rounding or truncation Can be implied by 0.49 to 0.493 but **not** by 0.642 to 0.643
	$= \underline{\mathbf{0.49 \text{ to } 0.493}}$	A1	3	AWFW (0.4922)
(iii)	$P(5 \le G \le 10) =$ **0.9744 or 0.9389** (p_1)	M1		Accept 3 dp rounding or truncation
	MINUS 0.2552 or 0.4275 (p_2)	M1		Accept 3 dp rounding or truncation
	$= \underline{\mathbf{0.719 \text{ to } 0.72}}$ (p_3)	A1	3	AWFW (0.7192)
Notes	**1** $p_3 \le 0$ or $p_3 \ge 1 \Rightarrow$ M0 M0 A0 **2** $p_2 - p_1 \Rightarrow$ M0 M0 A0 **3** $(1 - p_2) - p_1 \Rightarrow$ M0 M0 A0			**4** $p_1 - (1 - p_2) \Rightarrow$ M1 M0 A0 **5** $p_1 \times p_2 \Rightarrow$ M1 M0 A0 **6** $(1 - p_2) - (1 - p_1) \Rightarrow$ M1 M1 (A1)
(b)(i)	Mean or $\mu = 100 \times 0.22 = \underline{\mathbf{22}}$	B1		CAO
	Variance or $\sigma^2 = 100 \times 0.22 \times 0.78$ $= \underline{\mathbf{17.1 \text{ to } 17.2}}$	B1	2	AWFW (ignore notation) (17.16) ISW all subsequent working
(ii)	22.1 ≈/= 22 or means similar/equal **or** 0.221 ≈/= 0.22 or proportions similar/equal so **reject claim** (that $p > 0.22$) **or** **accept that p = 0.22**	B1		Dependent on 22 seen in (b)(i) or (ii) Accept diff = 0.1 CAO **Correct** (numerical) comparison with **correct** conclusion (even if at end and stated as 'reject (both) claims')
	$\sqrt{17.1 \text{ to } 17.2} = \underline{\mathbf{4.13 \text{ to } 4.15 \approx/= 4.17}}$ **or** $\underline{\mathbf{17.1 \text{ to } 17.2 \approx/= 17.3 \text{ to } 17.4}}$ so **reject claim that not random samples** **or** **accept that are random samples**	B1 Bdep1	3	Comparison using two values **or** one value + diff (0.02 to 0.04 AWFW) Comparison using two values **or** one value + diff (0.1 to 0.3 AWFW) Dependent on previous B1 **Correct** conclusion regarding randomness of sample
	Total		**14**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
7				
(a)	$\bar{x} = \frac{181.8}{36}$ = **5.05 or 5050**	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 with z (2.05 to 2.58), $\bar{x}$ (5.05, 5050 or 181.8), σ (0.0075, 0.075, 0.75, 7.5 or 75) and $\div\sqrt{n}$ with $n > 1$
	Thus $5.05 \pm 2.3263 \times \frac{0.075}{\sqrt{36}}$	A1		z (2.05 to 2.06 or 2.32 to 2.33 or 2.57 to 2.58), $\bar{x}$ (5.05) & σ (0.075) or $\bar{x}$ (5050) & σ (75) and $\div\sqrt{36 \text{ or } 35}$
	Hence **5.05 ± 0.03 or 5050 ± 30**			CAO/AWRT
	OR	Adep1	5	Dependent on previous A1 so can be scored with $z \neq$ 2.32 to 2.33
	(5.02, 5.08) or (5020, 5080)			Ignore (absence of) quoted units AWRT to 3sf accuracy
Note	Use of t(2.43 to 2.72) $\Rightarrow$ B1 B0 M1 A0 A0 max			
(b)	**Clear correct comparison** of **5 or 5000** with **LCL or CI** so **agree** with (first) claim (about mean)	Adep1		Dependent on Adep1 in (a) Must use consistent units
	(8/36 **or** 0.22 **or** 22%) v (1/10 **or** 0.10 **or** 10%) **or** 8 v 3.6 (3 to 4) so	B1		Mention of a value on LHS **and** a value on RHS
	8/36 OE >/≠ 1/10 OE so **disagree** with (second) claim (about individuals)	Bdep1	3	Dependent on B1 Explicit comparison of values and correct conclusion
Notes	**1** It/(claimed) mean/(claimed) value < LCL/CI $\Rightarrow$ Adep0 Must indicate 5 or 5000 **2** 98% have (mean) weights between CLs so ... $\Rightarrow$ Adep0 **3** Any reference to CI for second claim $\Rightarrow$ B0 Bdep0 Claim refers to individual bottles			
(c)	**Yes** because **volumes/bleach/litres/bottles/** (parent) **population** are **not (stated as) normally distributed**	B1	1	OE; but do **not** accept 'data' or 'sample' or 'it' Reference to sample size only $\Rightarrow$ B0 (eg $n > 25$ or $n > 30$)
	Total		**9**	
	TOTAL		**75**	