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General Certificate of Education
June 2010

Mathematics MS1B
Statistics SS1B

Statistics 1B

Mark Scheme

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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)	r = **0.915**	B3		AWRT (0.91504)
	r = **0.91 to 0.92**	(B2)		AWFW
	r = **0.88 to 0.95**	(B1)		AWFW
	OR			
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ $\sum y^2$ and $\sum xy$			12510 15835890 1180 146616 and **1510062** (all 5 attempted)
	or			
	Attempt at S_{xx} S_{yy} and S_{xy}	(M1)		185880 7376 and **33882** (all 3 attempted)
	Attempt at substitution into **correct** corresponding formula for r	(m1)		
	r = **0.915**	(A1)	3	AWRT
(b)	**Very strong / strong / fairly strong positive** (linear) **correlation** / relationship / association / link (*but not ' trend*')	B1dep		Dependent on **0.88 < *r* < 0.95** Or equivalent; must qualify strength and indicate positive B0dep for (almost) perfect / high / average / medium / some / etc
	between			
	weight and **(**engine) **power/bhp** of (hatchback) cars	B1	2	Context; providing **0 < *r* < 1**
	Examples:			
	The more weight/heavier the more/greater power ⇒ B0dep B1			No mention of strength
	Strong correlation and as weight/kg increases so does engine power / bhp ⇒ B0dep B1			Mention of strength but implied suggestion of positive not sufficient
	Total		**5**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
2	–18 –11 1 15 7 –1 17 –16 18 –3 0 9			
(a)(i)	Mean, $\bar{d}$ = **1.5**	B1		CAO $\sum d = 18$ Ignore notation and units
	Standard deviation, σ_d or s_d = **11.7 to 12.3**	B1	2	(11.737 or 12.259) AWFW $\sum d^2 = 1680$
(ii)	Mean, $\bar{x} = 50 + \bar{d}$ = **51.5**	B1F		F on (a)(i) or correct
	x: 32 39 51 65 57 49 67 4 68 47 50 59			$\sum x = 618$ $\sum x^2 = 33480$ Ignore notation and units
	Standard deviation, σ_x or s_x = **11.7 to 12.3**	B1F	2	F on (a)(i) providing > 0 or correct
(b)	[Values, mean or sd in (a)(i) or (a)(ii)] $\times \frac{1.22}{100}$ or 1.22	M1		Award if use seen or implied by ≥ 1 Subsequent correct or (correct × 100) answer
	Mean = **0.628 to 0.63**	A1		AWFW (0.6283)
	Standard deviation = **0.14 to 0.151**	A1	3	AWFW (0.1432 or 0.1496)
	Special Cases: **At least one** answer correct with no stated units or incorrect stated units ⇒ M1 A1 A1 max			
	At least one answer × 100 with its units stated as 'cents' ⇒ M1 A1 A1 max			'cents' attached to **≥ 1** answer × 100
	At least one answer × 100 with no units stated or units stated as euros / pence / £ ⇒ M1 only			
	Total		**7**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
3	Time, $X \sim N(65, 20^2)$			
(a)				
(i)	$P(X < 90) = P\left(Z < \frac{90-65}{20}\right) -$			
	$\left[P\left(Z < \frac{0-65}{20}\right) = P(Z < -3.25) = 0.00058\right]$	M1		Standardising (89.5, 90 or 90.5 or 59.5, 60 or 60.5) with 65 and ($\sqrt{20}$, 20 or 20^2) and/or $(65 - x)$ **May be gained in (a)(i) or (a)(ii)**
	$= P(Z <$ **1.25**$)$	A1		CAO; ignore inequality and sign May be implied by a correct answer
	= **0.893 to 0.895**	A1		AWFW (0.89435)
(ii)	$P(X > 60) = P(Z > -0.25)$			
	$= P(Z < 0.25)$	M1		Area change May be implied by a correct answer or answer > 0.5
	= **0.598 to 0.599**	A1	5	AWFW (0.59871)
(b)				
(i)	P(1 in 6 = 60) = **0 or zero or impossible**	B1	1	Ignore any working B0 for 'impossible to calculate'
(ii)	$P(X < 60) = 1 -$ [(a)(ii)] **or** (0.401 to 0.402)	M1		May be implied
	P(6 in 6 < 60) = p^6 with $0 < p < 1$	M1		Any probability to power 6; do **not** allow multiplying factors
	$= (0.40129)^6 =$ **0.004 to 0.00425**	A1dep	3	Dependent on M1 M1 (0.0041759)
(iii)	Variance of $\bar{X}_6$ = **$20^2/6$ = 66.6 to 66.7**			CAO/AWFW
	or	B1		Stated or used **anywhere in (b)**
	Sd of $\bar{X}_6$ = **$20/\sqrt{6}$ = 8.16 to 8.17**			CAO/AWFW
	$P(\bar{X}_6 < 60) = P\left(Z < \frac{60-65}{20/\sqrt{6}}\right) =$	M1		Standardising 60 with 65 and **$20/\sqrt{6}$ or equivalent** allow (65 – 60)
	$P(Z < -0.61) = 1 - P(Z < 0.61)$	m1		Area change May be implied by a correct answer or answer < 0.5
	= 1 – 0.72907 = = **0.27(0) to 0.271**	A1	4	AWFW (0.27093) (1 – answer) ⇒ B1 M1 max
	Note: Watch for answers to (ii) and (iii) interchanged			
	Total		**13**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
4(a)	$\underline{M \sim B(50,\ 0.15)}$	M1		Used somewhere in (a); may be implied
(i)	$P(M \leq 10) = \mathbf{0.88(0)}$	A1	2	AWRT (0.8801)
(ii)	$P(M \geq 5) = 1 - P(M \leq 4)$			
	$= \mathbf{1 - (0.1121 \text{ or } 0.2194)}$	M1		Requires '1 –'; accept 3 dp accuracy Implied by 0.888 but **not** by 0.781
	$= \mathbf{0.888}$	A1	2	AWRT (0.8879)
(iii)	$P(6 < R < 12) = \mathbf{0.9372 \text{ or } 0.9699}$ (p_1)	M1		Accept 3 dp accuracy 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 0.3613 or 0.2194 (p_2)	M1		Accept 3 dp accuracy
	$= \mathbf{0.576}$	A1		AWRT (0.5759)
	OR			
	B(50, 0.15) expressions stated for **at least 3** terms within $5 \leq R \leq 12$ gives probability $= \mathbf{0.576}$	(M1) (A2)	3	Can be implied by correct answer AWFW (0.5759)
(b)	$\underline{F \sim B(35,\ 0.11)}$	M1		Implied from correct stated formula; do not accept misreads
	$P(F = 4) = \binom{35}{4}(0.11)^4(0.89)^{31}$	A1		Can be implied by a correct answer Ignore any additional terms
	$= \mathbf{0.206 \text{ to } 0.208}$	A1	3	AWFW (0.20685)
(c)	$P(M \text{ and } LH) = 0.52 \times 0.15 = \mathbf{0.078}$)			
	or $N(M) = 2000 \times 0.52 = \mathbf{1040}$)	M1		**≥1** of these 2 probabilities or **≥1** of these 2 numbers attempted; may be implied
	$P(F \text{ and } LH) = 0.48 \times 0.1 = \mathbf{0.0528}$)			
	or $N(F) = 2000 \times 0.48 = \mathbf{960}$)	A1		**2** probabilities or **2** numbers evaluated correctly
	$N(M \text{ and } LH) =$			
	$2000 \times 0.078 = 1040 \times 0.15 = \mathbf{156}$)			
	$N(F \text{ and } LH) =$			Evaluation of **≥1** of these 2 numbers
	$2000 \times 0.0528 = 960 \times 0.11 = \mathbf{105.6}$)			
	or	A1		**or**
	$P(LH) = 0.078 + 0.0528 = \mathbf{0.1308}$)			Addition of these 2 probabilities
	$N(LH) = 156 + 105.6 = 2000 \times 0.1308$			262/2000 $\Rightarrow$ A0
	$= \mathbf{261 \text{ to } 262}$	A1	4	AWFW (261.6)
	Total		**14**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
5				*Ratios (eg 63:100) are only penalised by1 mark at first correct answer F marks can only be awarded if $0 < p < 1$*
(a)	$P(J) = 0.9 \quad P(R \mid J) = 0.7 \quad P(R \mid J') = 0.2$			
(i)	P(both at trough) $= 0.9 \times 0.7$	M1		Can be implied by **correct** answer
	$= 0.63 = 63/100$	A1	2	CAO
(ii)	P(neither at trough) $= (1 - 0.9) \times (1 - 0.2)$ $= 0.1 \times 0.8$	M1		Can be implied by **correct** answer
	$= 0.08 = 8/100 = 4/50 = 2/25$	A1	2	CAO
(iii)	P(at least one at trough) $= (1 - $ (ii))			
	$= 0.92 = 92/100 = 46/50 = 23/25$	B1F	1	F on (ii) or **correct** answer
(b)(i)		B1		**Both** row and column totals ie 0.25 and 0.40; CAO
		B1	2	**Three** table values ie 0.35 and 0.20 and 0.05; CAO
	Notes: Use of Venn or tree diagrams **without** table completion $\Rightarrow$ B0 B0. Table not completed on page 13 but completed on page 10 $\Rightarrow$ max of B1 B1			
(ii)	**Accept answers ÷ 1.00**			
(A)	P(neither at gate) $=$ **0.05**	B1F	1	F on table or **correct** answer by 'otherwise'
(B)	P(only Daisy at gate) $=$ **0.35**	B1F	1	F on table or **correct** answer by 'otherwise'
(C)	P(exactly one at gate) $= \mathrm{P}(D \cap M') + \mathrm{P}(D' \cap M)$	M1		Only **correct two** values from c's table **shown and added**. Can be implied by **correct** answer
	$0.35 + 0.20 =$ **0.55**	A1F	2	F on table or **correct** answer by 'otherwise'
	Total		**11**	

	M	***M′***	**Total**
D	0.40	**0.35**	0.75
D′	**0.20**	**0.05**	**0.25**
Total	0.60	**0.40**	1.00

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
6				
(a)	b (gradient) = **3.25 to 3.26**	B2		AWFW (3.25472)
	b (gradient) = **3.2 to 3.3**	(B1)		AWFW Treat rounding of correct answers as ISW
	a (intercept) = **509 to 510**	B2		AWFW (509.71698)
	a (intercept) = **507 to 513**	(B1)		AWFW
	OR			
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ and $\sum xy$ $\left(\sum y^2\right)$			720 44472 8460 and **511740** (6399400) (all 4 attempted)
	or	(M1)		
	Attempt at S_{xx} and S_{xy} $\left(S_{yy}\right)$			1272 and **4140** (435100) (both attempted)
	Attempt at **correct** formula for b (gradient)	(m1)		
	b (gradient) = **3.25 to 3.26**	(A1)		AWFW
	a (intercept) = **509 to 510**	(A1)	4	AWFW
	Accept a and b interchanged only if identified correctly by a **clearly shown or drawn equation**			If a and b are not identified anywhere in question, then: 3.25 to 3.26 $\Rightarrow$ B1 509 to 510 $\Rightarrow$ B1
(b)				
(i)	**Correct line drawn on graph** (40, 630 to 650) (80, 750 to 790)	B2dep		Dep on $\geq$ B1 B1 or $\geq$ A1 A0 in (a) From $x \approx 40$ to 80
	If B0 but evidence of use of line for ≥ 2 points within range $0 \leq x \leq 80$ **or** 'intercept' and means	(M1)	2	Calc^n or points shown on graph Allow point ('0', 500 to 520)
				Graph
(ii)	Outliers / at least E and H identified / wide scatter (of points) / large residuals	B1		Or equivalent words
	Evidence of a (+ ve) relationship or correlation /model is not appropriate	B1	2	Or equivalent words; none of strong/ negative/trend/etc or unreliable/invalid
(c)				
(i)	**Correct two points marked on graph**	B1	1	Labels are **not** required; nor is ⊙ **Graph**
(ii)	b (gradient) = **11.6**	B1		AWRT (11.60377)
	a (intercept) = **23 to 24**	B1		AWFW (23.77358)
	Correct line on graph (40, 480 to 500) (80, 930 to 970)	B1dep	3	**Graph** Dependent on B1 B1
(iii)	No outliers / less scatter / small residuals	B1		Or equivalent words
	Strong(er)/more evidence of a **positive** link/ relationship or **more rapid increase** (of reaction time with age) or model is more appropriate	B1	2	Or equivalent words; **must indicate change** from (b)(ii) in context; not some/weak/etc or reliable/valid References to correlation alone $\Rightarrow$ B0
	Total		**14**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
7(a)(i)	$\bar{t} - 2s = 6.31 - 2\sqrt{19.3} =$ **–2.48 to –2.47**	B1		AWRT (–2.4764)
	Negative value is **impossible** for a measurement of **time**	B1	2	Or equivalent; allow if negative value incorrect or not stated
(ii)	Sample size, $n = 80$ is large / > 25	B1		Indication that **given** sample is 'large'
	Thus sample **mean** $(\bar{T})$ ~ approximately **normal** due to **CLT**	B1dep	2	Dependent on previous B1 Requires 'mean' and 'normal' and 'CLT'
(b)	98% (0.98) $\Rightarrow z =$ **2.32 to 2.33**	B1 (B1)		AWFW (2.3263) $t_{79}(0.99) = 2.37$ AWRT
	CI for μ is $\bar{t} \pm z/t \times \frac{s}{\sqrt{n}}$	M1		Used Must have $\sqrt{n}$ with $n > 1$
	Thus $6.31 \pm 2.3263 \times \frac{\sqrt{19.3}}{\sqrt{80}}$	A1F		F on z/t only
	Hence **6.31 ± (1.13 to 1.15)** or **(5.16 to 5.18, 7.44 to 7.46)**	A1		CAO and AWFW AWFW (5.17, 7.45)
	Note: Use of t gives 6.31 ± (1.17) or (5.14, 7.48)	(A1)	4	AWRT
(c)	$\mu_T < 8$			
	Since **CI / UCL < 8** $\Rightarrow$ **Yes**	B1F		F on (b); must clearly compare 8 with CI/UCL and state a correct follow-through conclusion
	P($T \leq 20$) > 95%			
	P($T > 20$) = **1/80 = 0.01 to 0.013** **or** P($T \leq 20$) = **79/80 = 0.987 to 0.99**	B1		CAO/AWFW; accept eg '1 in 80' B0 for use of normal distribution CAO/AWFW; accept eg '79 in 80'
	P($T > 20$) **< 0.05 or 5%** **or** $\Rightarrow$ **Yes** P($T \leq 20$) **> 0.95 or 95%**	B1dep	3	Dependent on previous B1 A **correct** comparison must be **clearly** stated together with **clear** conclusion Do **not** accept use of 2% or 98% OE
	Total		**11**	
	TOTAL		**75**	