



**General Certificate of Education
June 2010**

**Mathematics
Statistics**

**MS1B
SS1B**

Statistics 1B

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 meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting 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 the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

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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
1(b)	OR Attempt at $\sum x$ $\sum x^2$ $\sum y$ $\sum y^2$ and $\sum xy$ or Attempt at S_{xx} S_{yy} and S_{xy}	(M1)		12510 15835890 1180 146616 and 1510062 (all 5 attempted)
	Attempt at substitution into correct corresponding formula for r	(m1)		185880 7376 and 33882 (all 3 attempted)
	$r = 0.915$	(A1)	3	AWRT
	Very strong / strong / fairly strong positive (linear) correlation / relationship / association / link (but not 'trend') between weight and (engine) power/bhp of (hatchback) cars Examples: The more weight/heavier the more/greater power \Rightarrow B0dep B1 Strong correlation and as weight/kg increases so does engine power / bhp \Rightarrow B0dep B1	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
	B1	2	Context; providing $0 < r < 1$ No mention of strength 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 $\times 100$) 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 \Rightarrow M1 A1 A1 max At least one answer $\times 100$ with its units stated as 'cents' \Rightarrow M1 A1 A1 max At least one answer $\times 100$ with no units stated or units stated as euros / pence / £ \Rightarrow M1 only			'cents' attached to ≥ 1 answer $\times 100$
	Total		7	

MS/SS1B (cont)

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

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
4(a)	$M \sim B(50, 0.15)$	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)	$F \sim B(35, 0.11)$	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
	$N(M \text{ and } LH) =$ $2000 \times 0.078 = 1040 \times 0.15 = \mathbf{156}$			
	$N(F \text{ and } LH) =$ $2000 \times 0.0528 = 960 \times 0.11 = \mathbf{105.6}$			
or	$P(LH) = 0.078 + 0.0528 = \mathbf{0.1308}$	A1		or Addition of these 2 probabilities
	$N(LH) = 156 + 105.6 = 2000 \times 0.1308$ $= \mathbf{261 \text{ to } 262}$	A1	4	$262/2000 \Rightarrow A0$ AWFW (261.6)
	Total		14	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments																
5				<i>Ratios (eg 63:100) are only penalised by 1 mark at first correct answer F marks can only be awarded if $0 < p < 1$</i>																
(a)	$P(J) = 0.9 \quad P(R J) = 0.7 \quad P(R J') = 0.2$																			
(i)	$P(\text{both at trough}) = 0.9 \times 0.7$ $= \mathbf{0.63} = \mathbf{63/100}$	M1 A1	2	Can be implied by correct answer CAO																
(ii)	$P(\text{neither at trough}) = (1 - 0.9) \times (1 - 0.2)$ $= 0.1 \times 0.8$ $= \mathbf{0.08} = \mathbf{8/100} = \mathbf{4/50} = \mathbf{2/25}$	M1 A1	 2	 Can be implied by correct answer CAO																
(iii)	$P(\text{at least one at trough}) = (1 - (\text{ii}))$ $= \mathbf{0.92} = \mathbf{92/100} = \mathbf{46/50} = \mathbf{23/25}$	B1F	1	F on (ii) or correct answer																
(b)(i)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th><i>M</i></th> <th><i>M'</i></th> <th>Total</th> </tr> </thead> <tbody> <tr> <th><i>D</i></th> <td>0.40</td> <td>0.35</td> <td>0.75</td> </tr> <tr> <th><i>D'</i></th> <td>0.20</td> <td>0.05</td> <td>0.25</td> </tr> <tr> <th>Total</th> <td>0.60</td> <td>0.40</td> <td>1.00</td> </tr> </tbody> </table> <p>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</p>		<i>M</i>	<i>M'</i>	Total	<i>D</i>	0.40	0.35	0.75	<i>D'</i>	0.20	0.05	0.25	Total	0.60	0.40	1.00	B1 B1	 2	Both row and column totals ie 0.25 and 0.40; CAO Three table values ie 0.35 and 0.20 and 0.05; CAO
	<i>M</i>	<i>M'</i>	Total																	
<i>D</i>	0.40	0.35	0.75																	
<i>D'</i>	0.20	0.05	0.25																	
Total	0.60	0.40	1.00																	
(ii)	Accept answers + 1.00																			
(A)	$P(\text{neither at gate}) = \mathbf{0.05}$	B1F	1	F on table or correct answer by 'otherwise'																
(B)	$P(\text{only Daisy at gate}) = \mathbf{0.35}$	B1F	1	F on table or correct answer by 'otherwise'																
(C)	$P(\text{exactly one at gate}) =$ $P(D \cap M') + P(D' \cap M)$ $0.35 + 0.20 = \mathbf{0.55}$	M1 A1F	 2	Only correct two values from c's table shown and added Can be implied by correct answer F on table or correct answer by 'otherwise'																
	Total		11																	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
6				
(a)	b (gradient) = 3.25 to 3.26 b (gradient) = 3.2 to 3.3 a (intercept) = 509 to 510 a (intercept) = 507 to 513 OR Attempt at $\sum x$ $\sum x^2$ $\sum y$ and $\sum xy$ $(\sum y^2)$ or Attempt at S_{xx} and S_{xy} (S_{yy}) Attempt at correct formula for b (gradient) b (gradient) = 3.25 to 3.26 a (intercept) = 509 to 510 Accept a and b interchanged only if identified correctly by a clearly shown or drawn equation	B2 (B1) B2 (B1) (M1) (m1) (A1) (A1)	4	AFWW (3.25472) AFWW Treat rounding of correct answers as ISW AFWW (509.71698) AFWW 720 44472 8460 and 511740 (6399400) (all 4 attempted) 1272 and 4140 (435100) (both attempted) AFWW AFWW 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) If B0 but evidence of use of line for ≥ 2 points within range $0 \leq x \leq 80$ or 'intercept' and means	B2dep (M1)	2	Dep on \geq B1 B1 or \geq A1 A0 in (a) From $x \approx 40$ to 80 Calc ⁿ or points shown on graph Allow point ('0', 500 to 520)
(ii)	Outliers / at least E and H identified / wide scatter (of points) / large residuals Evidence of a (+ ve) relationship or correlation /model is not appropriate	B1 B1	2	Graph Or equivalent words 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 \odot Graph
(ii)	b (gradient) = 11.6 a (intercept) = 23 to 24 Correct line on graph (40, 480 to 500) (80, 930 to 970)	B1 B1 B1dep	3	AWRT (11.60377) AFWW (23.77358) Graph Dependent on B1 B1
(iii)	No outliers / less scatter / small residuals Strong(er)/more evidence of a positive link/ relationship or more rapid increase (of reaction time with age) or model is more appropriate	B1 B1	2	Or equivalent words 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)	$\bar{t} - 2s = 6.31 - 2\sqrt{19.3} = -2.48 \text{ to } -2.47$	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}) \sim approximately normal due to CLT	B1dep	2	Dependent on previous B1 Requires 'mean' and 'normal' and 'CLT'
(b)	98% (0.98) $\Rightarrow z = 2.32 \text{ to } 2.33$	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 \pm (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 $6.31 \pm (1.17)$ 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
	$P(T \leq 20) > 95\%$			
	$P(T > 20) = 1/80 = 0.01 \text{ to } 0.013$ or $P(T \leq 20) = 79/80 = 0.987 \text{ to } 0.99$	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 $P(T \leq 20) > 0.95$ or 95% \Rightarrow Yes	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	