



**General Certificate of Education**

**Mathematics 6360**  
**Statistics 6380**

**MS/SS1B/W Statistics 1B**

**Mark Scheme**

*2009 examination - June series*

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.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' 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.

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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/W

Q	Solution	Marks	Total	Comments
<b>1(a)</b>				<b>In (a), ratios (eg 100:160) are only penalised by 1 mark at first correct answer</b>
<b>(i)</b>	$P(P) = 100/160 = 50/80 = 25/40 = 10/16$ $= 5/8 = 0.625$	B1	1	CAO
<b>(ii)</b>	$P(S') = 1 - \frac{32}{160} \quad \text{or} \quad P(S) = \frac{32}{160}$ $= 128/160 = 64/80 = 32/40 = 16/20 = 8/10$ $= 4/5 = 0.8$	M1  A1	  2	Or equivalent Ignore labels of $S'$ & $S$ Can be implied by <b>correct</b> answer  CAO
<b>(iii)</b>	$P(S \text{ or } H) = P(S \cup H) =$ $\frac{60+32-18}{160} \quad \text{or} \quad \frac{60+14}{160} \quad \text{or} \quad \frac{32+8+16+18}{160}$ $= 74/160 = 37/80 = 0.462 \text{ to } 0.463$	M1  A1	  2	Or equivalent Can be implied by <b>correct</b> answer  CAO/AFWW (0.4625)
<b>(iv)</b>	$P(T P) = \frac{30/160}{(i)}$ $= 3/100 = 3/10 = 0.3$	M1  A1	  2	Or equivalent Can be implied by <b>correct</b> answer But watch for $18/160$ or $48/160$  CAO
<b>(b)</b>	$P(1C \text{ \& } 1R \text{ \& } 1S) =$ $\frac{24}{160} \times \frac{56}{159} \times \frac{32}{158}$ $(0.15 \times 0.35220 \times 0.20253)$ $\times 6$ $= 0.064 \text{ to } 0.0644$	M1 M1  M1  A1	       4	Multiplication of any 3 different given subject totals Multiplication of 160, 159 & 158  Accept 3dp accuracy Award for $3 \leq \text{multiplier} \leq 6$  AWFW (0.0642) Do not accept a fraction as answer A <b>correct</b> answer can imply 4 marks
	<b>Special Case:</b> (Any given subject total) $\div$ 160 seen anywhere in (b)	(M1)	4	Can award if no marks scored in (b) Accept a decimal equivalent
		<b>Total</b>	<b>11</b>	

## MS/SS1B/W (cont)

Q	Solution	Marks	Total	Comments
<b>2(a)</b>	$r = 0.893$ to 0.8933	B3		AWFW (0.89319)
	$r = 0.89$ to 0.896	(B2)		AWFW
	$r = 0.8$ to 0.95	(B1)		AWFW
	<b>or</b>			
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ $\sum y^2$ & $\sum xy$			561 30667 671 42613 & <b>35882</b> (all 5 attempted)
<b>or</b>		(M1)		2056 1682 & <b>1661</b> (all 3 attempted)
	Attempt at $S_{xx}$ $S_{yy}$ & $S_{xy}$			
	Attempt at <b>correct</b> corresponding formula for $r$	(m1)		
	$r = 0.893$ to 0.8933	(A1)	3	AWFW
<b>(b)</b>	Fairly strong / strong / very strong positive (linear) correlation / relationship / association / link (but not trend) between <b>length and weight</b> of adult snakes	B1dep		Or equivalent; must qualify strength and indicate positive Dependant on $0.8 \leq r \leq 0.95$ B0 for some/average/medium/etc
<b>(c)</b>	Figure 1: 5 correct labelled points 4 or 3 correct labelled points	B2 (B1)	2	Deduct 1 mark if points not labelled
<b>(d)(i)</b>	D and G	B1	1	Both CAO
<b>(ii)</b>	$r = 0.25$ to 0.75	B1		AWFW (0.48790) No penalty for calculation Accept a range only if whole of it falls within 0.25 to 0.75
	Fairly weak / weak / some / moderate positive (linear) correlation / relationship / association / link	B1dep	2	Or equivalent; must qualify strength and indicate positive Dependant on $0.25 \leq r \leq 0.75$ B0 for very weak/little/slight/hardly any/fair/average/medium/anything involving strong/etc
	Do not accept comparison with value in (a) or statement in (b)			
		<b>Total</b>	<b>10</b>	

## MS/SS1B/W (cont)

Q	Solution	Marks	Total	Comments
<b>3(a)</b>	$X \sim N(253, 5^2)$			
<b>(i)</b>	$P(X < 250) = P\left(Z < \frac{250 - 253}{5}\right) =$ $P(Z < -0.6) = 1 - P(Z < 0.6)$ $= 1 - 0.72575$ $= 0.274 \text{ to } 0.275$	M1 m1 A1	3	Standardising (249.5, 250 or 250.5) with 253 and ( $\sqrt{5}$ , 5 or $5^2$ ) and/or (253 - x)  Area change; may be implied  AWFW (0.27425) (1 - answer) $\Rightarrow$ M1 max
<b>(ii)</b>	$P(245 < X < 250) = [C's(a)(i)] - P(X < 245)$ $= (i) - P(Z < -1.6) = 0.27425 - 0.0548$ $= 0.219 \text{ to } 0.22(0)$	M1  A1	2	Or equivalent; must be clear correct method if answer incorrect and answer > 0  AWFW (0.21945) M1 A0 for [1 - (i)] - 0.0548 = 0.67095 M0 A0 for 0.9452 - [(i)] = 0.67095 M1 A1 for 0.9452 - [1 - (i)] = 0.21945
<b>(iii)</b>	$P(X = 245) = 0$ or zero or impossible	B1	1	Ignore any working B0 for 'for impossible to calculate'
<b>(b)</b>	$98\% (0.98) \Rightarrow z = -2.05 \text{ to } -2.06$ $z = \frac{245 - 253}{\sigma}$ $= -2.0537$ $\sigma = 3.88 \text{ to } 3.9(0)$ <p><b>Note:</b>  <math display="block">\frac{245 - 253}{\sigma} = 2.0537 \Rightarrow \sigma = 3.8954</math> <math display="block">\Rightarrow \text{B1 M1 A1 A0}</math></p>	B1 M1 A1 A1	4	AWFW; ignore sign (-2.0537)  Standardising 245 with 253 and $\sigma$ ; allow (253 - 245)  Only allow: $\pm 2.05$ to $\pm 2.06$ $\pm 2.32$ to $\pm 2.33$  AWFW (3.8954)
		<b>Total</b>	<b>10</b>	Or equivalent inconsistent signs

## MS/SS1B/W (cont)

Q	Solution	Marks	Total	Comments	
4(a)	$b$ (gradient) = $-0.5485$ to $-0.5475$	B2	4	AWFW ( $-0.54814$ )	
	$b$ (gradient) = $-0.55$ to $-0.54$	(B1)		AWFW	
	Omission of $-ve$ sign	(B0)			
	$a$ (intercept) = $49.7$ to $49.9$	B2		AWFW ( $49.7982$ )	
	$a$ (intercept) = $49$ to $50$	(B1)		AWFW	
	<b>or</b>				
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$ ( $\sum y^2$ )			305 14975 281 & <b>6980</b> ( $10173$ ) (all 4 attempted)	
	<b>or</b>	(M1)			
	Attempt at $S_{xx}$ & $S_{xy}$			4638.89 & <b>-2542.78</b> (both attempted)	
	Attempt at <b>correct</b> formula for $b$ (gradient)	(m1)			
$b$ (gradient) = $-0.5485$ to $-0.5475$	(A1)	AWFW			
$a$ (intercept) = $49.7$ to $49.9$	(A1)	AWFW			
	Accept $a$ & $b$ interchanged only if identified correctly by a <b>clearly shown equation</b> (stated answers are not sufficient) in (b) or (c)		If $a$ and $b$ not identified anywhere in question, then: $-0.5485$ to $-0.5475 \Rightarrow$ B1 $49.7$ to $49.9 \Rightarrow$ B1		
(b)	C's value of intercept from (a) providing $> 47$	B1F	1	Accept value rounded to nearest integer ( $50$ )	
<b>or</b>	Value $50$ stated even if (a) incorrect or not attempted				
(c)	$13$ weeks $\Rightarrow 91$ days	B1		Stated or used Accept a descriptive answer that includes $91$ and a value in range AWFW ( $-0.08254$ )	
	$y = -1.1$ to $+ 1.1$	B1			
	<b>or</b>				
	$y = 0 \Rightarrow x = 89$ to $93$	(B1)			AWFW ( $90.84942$ ) Accept a descriptive answer that includes a value in range and $13$
	$\Rightarrow 13$ weeks (approximately)	(B1)			Stated
<b>Note:</b> B1 B1 or (B1) (B1) are available even if (a) not attempted					
<b>or</b>	Thus claim appears <b>justified</b>	B1 dep		Or equivalent; ignore reasoning unless contradictory Dependent upon 2 <sup>nd</sup> B1 in (c) or 2 <sup>nd</sup> (B1) in (c)	
<b>or</b>	Thus tablet likely to have <b>dissolved</b>				
<b>or</b>	Extrapolation required so cannot comment	(B1)		Not dependent	
<b>Note:</b> If (B1) for extrapolation maximum mark is 2; other mark available is for $91$			<b>3</b>		

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		<b>Total</b>	<b>8</b>	
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## MS/SS1B/W (cont)

Q	Solution	Marks	Total	Comments
5(a) (i)	Median (50) = 3	B1		CAO Do not award marks if correct answers are based on shown incorrect method; eg accept use of 99/2, etc but not 276/2, etc CAO; but 25 <sup>th</sup> value $\Rightarrow$ IQR = 2 $\Rightarrow$ B0
	If not identified, then assume order is median then IQR  IQR (75 – 25) = 4 – 2 = 2	B2		
(ii)	<b>Special Cases:</b> Identification that LQ = 2 and UQ = 4	(B1)	3	Both CAO  Can award if no marks scored in (i) even if then applied to continuous data
	Statement of $\geq 4$ cumulative frequencies F: 14 49 74 87 96 98 99	(M1)		
	Mean = $\frac{\sum fx}{\sum f} = \frac{275}{99} = 2.77$ to 2.78	B1		
(b)(i)	If not identified, assume order is $\bar{x}$ then s SD ( $\sum fx^2 = 933$ ) = 1.3(0) to 1.32	B2	3	Treat rounding to integers as ISW AWFW (1.307 & 1.314)  Can award if no marks scored in (ii)
	<b>Special Case:</b> Evidence of $\frac{\sum fx}{99}$	(M1)		
	Mean <sub>163</sub> = $\frac{99 \times \text{Mean}_{99}}{163}$ or $\frac{\sum fx \text{ from (a)(ii)}}{163}$  = 1.68 to 1.69	M1 A1		
(ii)	Increase	B1	1	CAO; or equivalent (1.696) Ignore any working (1.702)
(iii)	Data is (positively/negatively) skewed / not symmetric / bimodal / not bell-shaped from frequency distribution / given table or [C's mean in (b)(i)] – 2 × [C's SD in (a)(ii)] < 0 or [C's mean in (b)(i)] – 2 × [1.69 to 1.71] < 0  Thus claim appears <b>not valid</b>	B1 B1 dep	2	Or equivalent  (–1.75 to –0.90)  Or equivalent Dependent upon previous B1
<b>Total</b>			<b>11</b>	

## MS/SS1B/W (cont)

Q	Solution	Marks	Total	Comments
6(a)	Mean = $\frac{470}{10} = 47$	B1		CAO
	98% (0.98) $\Rightarrow z = 2.32$ to 2.33	B1		AWFW (2.3263)
	CI for $\mu$ is $\bar{x} \pm z \times \frac{\sigma}{\sqrt{n}}$	M1		Used Must have $\sqrt{n}$ with $n > 1$
	Thus $47 \pm 2.3263 \times \frac{15}{\sqrt{10}}$	A1F		F on $\bar{x}$ and $z$ only
	Hence $47 \pm 11.0$ to 11.1			CAO & AWRT (accept 11)
	<b>Or</b> (35.9 to 36.0, 58.0 to 58.1)	A1	5	AWRT (accept 36 & 58)
	(b) $Y \sim N(108, 28^2)$			
	Variance of $\bar{Y}_{40} = 28^2/40 = 19.6$	B1		CAO Stated or used AWFW
	$\sqrt{\text{SD of } \bar{Y}_{40}} = 28/\sqrt{40} = 4.425$ to 4.43			
	$P(\bar{Y}_{40} > 120) = P\left(Z > \frac{120-108}{28/\sqrt{40}}\right)$	M1		Standardising 120 with 108 and $\sqrt{19.6}$ or (4.425 to 4.43) or equivalent; allow (108 – 120)
$= P(Z > 2.71) = 1 - P(Z < 2.71)$	m1		Area change; may be implied	
$= 1 - 0.99664 = 0.0033$ to 0.0034	A1	4	AWFW (0.00336) (1 – answer) $\Rightarrow$ B1 M1 max	
(c) Part (b) or Telear times	B1		Or equivalent; ignore reasoning	
Distribution of Y not known	B1		Or equivalent; must be clear reference to $Y$ or population B0 for $n > 30$	
<b>Note:</b> To score B1 B1 there must be <b>both</b> a clear indication of where in question <b>and</b> a valid reason			Any reference to part (a) $\Rightarrow$ B0 B0	
			2	
		<b>Total</b>	<b>11</b>	

## MS/SS1B/W (cont)

Q	Solution	Marks	Total	Comments
7(a)	$R \sim B(50, 0.15)$			
(i)	$P(R < 10) = 0.791$	B1		AWRT (0.7911)
(ii)	$P(5 \leq R \leq 10) = 0.8801$ or $0.7911$ ( $p_1$ )	M1		Accept 3 dp accuracy $(1 - p_2) - p_1 \Rightarrow$ M0 M0 A0 $p_1 - (1 - p_2) \Rightarrow$ M1 M0 A0 only providing result $> 0$
	minus $0.1121$ or $0.2194$ ( $p_2$ )	M1		Accept 3 dp accuracy
	$= 0.768$	A1		AWRT (0.7680)
	<b>or</b>			
	B(50, 0.15) expressions stated for <b>at least 3</b> terms within $4 \leq R \leq 10$ gives probability $= 0.768$	(M1) (A2)	4	Can be implied by correct answer AWRT
(b)	<b>Confusion of</b> 22, 35, 120 and/or 0.15, 0.06			Do <b>not</b> treat as misreads
(i)	$S \sim B(22, 0.06)$	M1		Used in (b)(i) as evidenced by any correct binominal term for $S > 0$
	$P(S = 2) = \binom{22}{2}(0.06)^2(0.94)^{20}$	A1		Can be implied by correct answer Ignore any additional terms
	$= 0.24$ to $0.242$	A1	3	AWFW (0.24125)
(ii)	$P(S \geq 1) = 1 - q^{35}$ where $0.84 \leq q \leq 0.96$	M1 (B1)		Can be implied by correct answer Award for $(0.94)^{35}$ seen in an expression but not if accompanied by a multiplier $\neq 1$
	$= 0.885$ to $0.89$	A1	2	AWFW (0.88532)
(iii)	Mean = $np = 120 \times 0.94 = 112.8$ or $113$ If not identified, assume order is $\mu$ then $\sigma^2$ Variance = $np(1 - p)$ $= 120 \times 0.94 \times 0.06 = 6.76$ to $6.78$	B1  B1	2	Either  Must clearly state variance value AWFW (6.768)
(iv)	<b>Means</b> are (approximately) the <b>same</b> stated or <b>Variiances</b> are (very) <b>different</b> stated	B1		Must have scored 1 <sup>st</sup> B1 in (iii) Must have scored 2 <sup>nd</sup> B1 in (iii)
	<b>Agree</b> with $P(\text{sorts letter incorrectly}) = 0.06$	B1 dep		Dependent on 'means same' stated
	<b>Disagree</b> with independent from letter to letter	B1 dep	3	Dependent on 'variances different' stated
		<b>Total</b>	<b>14</b>	
		<b>Paper</b>	<b>75</b>	

