



## **General Certificate of Education**

# **Mathematics 6360**

# **Statistics 6380**

## **MS/SS1B Statistics 1B**

# **Mark Scheme**

*2008 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

Q	Solution	Marks	Total	Comments	
1(a)	$b$ (gradient) = $-1.01$ to $-1(.00)$ $(b$ (gradient) = $-1.05$ to $-0.95)$	B2 (B1)	4	AWFW ( $-1.00337$ )	
	$a$ (intercept) = $53(.0)$ to $53.2$ $(a$ (intercept) = $52(.0)$ to $54(.0))$	B2 (B1)		AWFW ( $53.06736$ )	
	<b>OR</b>				
	Attempt at $\sum x$ , $\sum x^2$ , $\sum y$ and $\sum xy$			180, 3986, 297 and 5552.7	
	<b>or</b> Attempt at $S_{xx}$ and $S_{xy}$	(M1)		386 and $-387.3$	
	Attempt at <b>correct</b> formula for $b$ (gradient)	(m1)			
	$b$ (gradient) = $-1.01$ to $-1(.00)$	(A1)		AWFW	
	$a$ (intercept) = $53(.0)$ to $53.2$	(A1)		AWFW	
	Accept $a$ and $b$ interchanged only if then identified correctly in part (b), but B2 in (b) does <b>not</b> necessarily imply 4 marks in (a)				
(b)	When $x = 21$ ,		2	AWFW AWFW  AWFW; or equivalent	
	$y = 31.7$ to $32.2$ $(y = 29.9$ to $34.1)$	B2 (B1)			(32.0)
	Evidence of use of 21 in c's equation	(M1)			
	<i>Special Cases (if seen):</i> $y = \frac{33.0+30.7}{2} = 31.8$ to $31.9$	(B1)			
	$y = 31.85$ without working	(B1)			
	<b>Total</b>		<b>6</b>		

## MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
2(a)	$P(\text{Blue}) = \frac{160}{400} = 0.4 \text{ or } \frac{2}{5} \text{ or } \frac{160}{400}$ <p><i>In (b) to (e), method marks are for single fractions, or equivalents, only</i></p>	B1	1	CAO; or equivalent
(b)	$P(\text{Marker}) = \frac{280}{400}$ $= 0.7 \text{ or } \frac{7}{10} \text{ or } \frac{280}{400}$	M1 A1	2	270 ≤ Numerator ≤ 290 and Numerator < Denominator ≤ 400 CAO; or equivalent
(c)	$P(B \text{ or } M) = P(B \cup M) =$ $\frac{160 + 280 - 119}{400} = \frac{280 + 41}{400} = \frac{321}{400}$ $= 0.802 \text{ to } 0.803 \text{ or } \frac{321}{400}$	M1 A1	2	290 ≤ Numerator ≤ 321 and Numerator < Denominator ≤ 400 AWFW/CAO (0.8025)
(d)	$P(\text{Green}   \text{Highlighter}) = P(G   H) = \frac{42}{120}$ $= 0.35 \text{ or } \frac{7}{20} \text{ or } \frac{42}{120}$	M1 A1	2	Numerator = 42 and 110 ≤ Denominator ≤ 120 CAO; or equivalent
(e)	$P(\text{Non-Permanent}   \text{Red}) = P(P'   R) = \frac{21}{90}$ $= 0.233 \text{ to } 0.234 \text{ or } \frac{7}{30} \text{ or } \frac{21}{90}$	M1 A1	2	Numerator = 21 and 80 ≤ Denominator ≤ 90 AWFW/CAO (0.2333)
	<b>Total</b>		<b>9</b>	

## MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
3(a)	$r = 0.806$ to $0.807$ ( $r = 0.8(0)$ to $0.81$ ) ( $r = 0.7$ to $0.9$ )	B3 (B2) (B1)	3	AWFW (0.80656) AWFW AWFW
	<b>OR</b>  Attempt at $\sum x$ , $\sum x^2$ , $\sum y$ , $\sum y^2$ and $\sum xy$ <b>or</b> Attempt at $S_{xx}$ , $S_{yy}$ and $S_{xy}$ Attempt at <b>correct</b> formula for $r$ $r = 0.806$ to $0.807$	(M1)  (m1) (A1)		2859, 681575, 1428, 170342 and 340555 418.25, 410 and 334 AWFW
(b)	<b>Moderate/fairly strong/strong positive correlation</b> (relationship/association)  between <b>length and width</b> of plaques	B1  B1	2	Or equivalent; must qualify strength and indicate positive B0 for some/average/medium/very strong/etc Context; providing $0 < r < 1$
(c)	<b>Figure 1:</b> 6 correct labelled points (5 correct labelled points) (4 correct labelled points)	B3 (B2) (B1)	3	Deduct 1 mark if not labelled
(d)	A to F: $r = -0.2$ to $+0.2$	B1		AWFW (-0.0275) No penalties for calculations Statements must include a <b>single value</b> within range
	Accept 'Zero' but not 'No' correlation			
	G to L: $r = -0.2$ to $+0.2$	B1	2	AWFW (-0.0196)
	<i>Special Cases:</i>  $r = -0.2$ to $+0.2$ with <b>no</b> sources $r = -0.2$ to $+0.2$ for <b>each/both</b> source(s)	(B1) (B2)		AWFW AWFW; or equivalent identification
	If B0 B0 but both values of $r = -0.4$ to $+0.4$	(B1)		AWFW
	<b>Total</b>		<b>10</b>	

## MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
4(a)	Ordering: 0 0 13 28 35 40 47 51 63 77 $a$	M1	4	May be implied by 40 and/or 63 and 13
	Median (6 <sup>th</sup> ) = 40	B1		CAO
	IQR = $Q_3(9^{\text{th}}) - Q_1(3^{\text{rd}})$  = 63 - 13 = 50	(B1) B2		Identification of 63 and 13 CAO
(b)(i)	<i>Mode:</i> Zero is not representative / sensible reason Wide range of (known) values Small number of values mostly different	B1		Or equivalent
(ii)	<i>Range:</i> Largest value, $a$ , is unknown Cannot be calculated	B1	2	Or equivalent
	<b>Total</b>		<b>6</b>	

## MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
5	Height $X \sim N(140, 2.5^2)$			
(a)(i)	$P(X < 145) = P\left(Z < \frac{145-140}{2.5}\right) =$ $P(Z < 2) =$ $0.977 \text{ to } 0.98(0)$	M1 A1 A1	3	Standardising (144.5, 145 or 145.5) with 140 and ( $\sqrt{2.5}$ , 2.5 or $2.5^2$ ) and/or (140 - x) 2 CAO; ignore sign AWFW (0.97725)
(ii)	$P(138 < X < 142) =$ $P(X < 142) - P(X < 138) =$ $P(Z < 0.8) - P(Z < -0.8) =$ $P(Z < 0.8) - \{1 - P(Z < 0.8)\} =$ $(0.78814) - (1 - 0.78814) =$ $0.576 \text{ to } 0.58(0)$	M1 B1 m1 A1	4	Difference (142 - 138) 0.8 CAO Correct area change AWFW (0.57628)
(b)	$0.85 \text{ (85\%)} \Rightarrow z = -1.03 \text{ to } -1.04$ $z = \frac{x-140}{2.5}$ $= \pm 1.03 \text{ to } \pm 1.04$ <p>Hence <math>x = 137.3 \text{ to } 137.5</math></p>	B1 M1 A1 A1	4	AWFW; ignore sign (-1.0364) Standardising $x$ with 140 and 2.5; allow (140 - x) Equating $z$ -term to the $z$ -value AWFW; CSO (137.41)
(c)	<p>Variance of <math>\bar{X}_4 = \frac{2.5^2}{4} = 1.56(25)</math></p> <p>SD of <math>\bar{X}_4 = \frac{2.5}{2} = 1.25</math></p> $P(\bar{X}_4 > 139) = P\left(Z > \frac{139-140}{\sqrt{2.5^2/4}}\right) =$ $P(Z > -0.8) = P(Z < 0.8) =$ $0.788 \text{ to } 0.79(0)$	B1 M1 m1 A1	4	CAO; stated or used Standardising 139 with 140 and 1.25; allow (140 - 139) Correct area change AWFW (0.78814)
	<b>Total</b>		<b>15</b>	



## MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
6	Binomial distribution	M1		Used somewhere in question
(a)(i)	$M \sim B(40, 0.35)$	A1		Used; may be implied
	$P(M \leq 15) = 0.69(0) \text{ to } 0.696$	A1	3	AWFW (0.6946)
(ii)	$P(10 < M < 20) =$ 0.9637 or 0.9827	M1		Accept 3 dp accuracy
	minus 0.1215 or 0.0644	M1		Accept 3 dp accuracy
	$= 0.84(0) \text{ to } 0.843$	A1	3	AWFW (0.8422)
	<b>OR</b>			
	B(40, 0.35) expressions stated for <b>at least 3</b> terms within $10 \leq M \leq 20$	(M1)		Or implied by a correct answer
	Answer = 0.84(0) to 0.843	(A2)		AWFW
(b)	$W \sim B(10, 0.29)$	B1		Used; may be implied
	$P(W = 3) = \binom{10}{3}(0.29)^3(0.71)^7$	M1		Stated; may be implied
	$= 0.266 \text{ to } 0.2665$	A1	3	AWFW (0.2662) <b>Note:</b> $B(10, 0.3) \Rightarrow 0.2668$
(c)(i)	$n = 20 \quad p = 0.71$	B1		Stated or used; may be implied by 14.2
	Mean, $\mu = np = 14.2$	B1		CAO
	Variance, $\sigma^2 = np(1-p) = 4.11 \text{ to } 4.12$	B1	3	AWFW (4.118)
(ii)	Mean of 16.5 is greater/different <b>or</b> $16.5/20 = 0.825$ is greater/different to 0.71	B1dep		Dependent on $\mu = 14.2$
	<i>Means and variances are different</i>	(B2,1 dep)		
	Variance of 2.50 is smaller/different	B1dep		Dependent on $\sigma^2 = 4.11 \text{ to } 4.12$
	Suggests <b>claim</b> that groups are not random samples <b>is justified</b>	B1dep	3	Dependent on previous 2 marks Or equivalent
	<b>Total</b>		<b>15</b>	

## MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
7(a)(i)	$x:$ -5 -3 -1 1 3 5 7 9 $f:$ 4 9 13 27 21 15 7 4			
	Mean ( $\bar{x}$ ) = 1.9 (0.9 to 2.9)	B2 (B1)		CAO AWFW (190)
	Standard deviation ( $s_{n-1}$ or $\sigma_n$ ) = 3.3(0) to 3.32 (3(0.0) to 3.5(0))	B2 (B1)	4	(1452) AWFW (3.31967) AWFW (3.30303)
	If no marks scored but $\sum fx$ attempted and result divided by 100	(M1)		
(ii)	Mean = $60 + \bar{x}$ = 61.9	M1 A1✓	3	✓ on (a)(i) ✓ on (a)(i); accept 'same as' only providing answer in (a)(i)
	Standard deviation = 3.3(0) to 3.32	B1✓		
(b)(i)	98% $\Rightarrow z = 2.32$ to 2.33 ( $\Rightarrow t = 2.36$ to 2.37)	B1		AWFW (2.3263) AWFW (2.364)
	CI for $\mu$ is $\bar{x} \pm z/t \times \frac{s_{n-1} \text{ or } \sigma_n}{\sqrt{n \text{ or } n-1}}$	M1		Used; must have $\sqrt{n}$ with $n > 1$
	Thus $61.9 \pm 2.3263 \times \frac{3.3 \text{ to } 3.32}{\sqrt{100 \text{ or } 99}}$	A1✓		✓ on (a)(ii) and $z/t$ only
	Hence $61.9 \pm (0.7 \text{ to } 0.8)$ <b>or</b> (61.1 to 61.2, 62.6 to 62.7)	A1	4	Accept $1.03 \pm (0.012 \text{ to } 0.013)$ AWFW Accept (1.01 to 1.02, 1.04 to 1.05)
(ii)	Mean and SD based upon grouped data SD ( <b>not mean</b> ) calculated from a sample CLT used / Times (may) not (be) normal	B1	1	Actual times/values unknown Or equivalent
(c)	$S > 1 \text{ hour or } 60 \text{ minutes:}$ <b>Valid</b> as $74/100$ or $0.74$ or $74\% > 50\%$	B1		Must use 74 etc Or equivalent
	$\bar{S} \gg 1 \text{ hour or } 60 \text{ minutes:}$ <b>Not valid</b> as $UCL \approx 1 \text{ hour}$ (Accept Both limits $\approx 1 \text{ hour}$ )	B1dep	2	Dependent on $UCL = 62.6 \text{ to } 62.7$ or $UCL = 1.04 \text{ to } 1.05$
	<b>Total</b>		<b>14</b>	
	<b>TOTAL</b>		<b>75</b>	