



## General Certificate of Education

# Mathematics/Statistics 6360/6380

*MS/SS1B Statistics 1B*

## Mark Scheme

*2005 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.

## 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	OE	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)

### Application of Mark Scheme

#### **No method shown:**

Correct answer without working  
Incorrect answer without working

mark as in scheme  
zero marks unless specified otherwise

#### **More than one method / choice of solution:**

2 or more complete attempts, neither/none crossed out

mark both/all fully and award the mean  
mark rounded down

1 complete and 1 partial attempt, neither crossed out

award credit for the complete solution only

#### **Crossed out work**

do not mark unless it has not been replaced

**Alternative solution** using a correct or partially correct method

award method and accuracy marks as  
appropriate

## MS/SS1B

Q	Solution	Marks	Total	Comments	
<b>1</b>	<b>(a)(i)</b> $r = 0.797$ or $r = 0.79$ to $0.81$  or $r = 0.8$  Attempt at $\Sigma x \Sigma x^2 \Sigma y \Sigma y^2 \Sigma xy$ or Attempt at $S_{xx} S_{yy} S_{xy}$  Attempt at a correct formula for $r$  $r = 0.797$	B3	3	AWRT	
		(B2)		AWFW; accept 0.80 but not 0.8	
		(B1)			
		(M1)		115, 1725; 130, 2076.36; 1809.3 402.5; 386.36; 314.3	
		(m1)			
	<b>(ii)</b>	<b>Strong</b> (fairly strong) evidence of a <b>positive</b> (direct) linear <b>correlation</b> (association/relationship) between <b>time in store</b> and <b>value of items purchased</b>		(A1)	AWRT
				B1	Not 'some' or 'weak' or 'good' Must use 'positive' or equivalent and 'correlation' or equivalent Accept 'high' as alternative to 'strong'
	<b>(b)</b>	$r =$ Answer to (a)(i) or $0.797$		B1 $\checkmark$	1
	<b>Total</b>		<b>6</b>		

## MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
<b>2</b>	<b>(a)(i)</b> Weight, $X \sim N(205, 25^2)$ $P(X < 250) = P\left(Z < \frac{250 - 205}{25}\right)$ $= P(Z < 1.8)$ $= 0.964$	M1	3	Standardising (249.5, 250 or 250.5) with 205 and ( $\sqrt{25}$ , 25 or $25^2$ ) and/or (205 - x) CAO; ignore sign
		A1		
		A1		
	<b>(ii)</b> $P(200 < X < 250) = (i) - P(X < 200)$ $= (i) - P(Z < -0.2) = (i) - [1 - \Phi(0.2)]$ $= 0.96407 - (1 - 0.57926) = 0.543$	M1	3	Or equivalent Area change AWRT (0.54333)
		M1		
		A1		
	<b>(b)(i)</b> $(100 - 30)\% = 70\% \Rightarrow z = 0.524$ to 0.525  Thus $\frac{s - 205}{25} = -0.5244$  Thus $s = 191.9$	B1	5	AWFW; ignore sign (- 0.5244) Equating z-term, involving 205 and 25, to z value Not using 0.3, 0.7 or $ 1 - z $ Allow (205 - s) AWRT
		M1		
		A1		
	<b>(ii)</b> $(100 - 20)\% = 80\% \Rightarrow z = 0.841$ to 0.842  Thus $\frac{m - 205}{25} = 0.8416$  $m = 226.0$	B1	5	AWFW; ignore sign (0.8416) Only if not awarded in (i) Not using 0.2 or 0.8 Allow (205 - m) AWRT; accept 226
		(M1)		
		A1		
<b>(c)</b> $90\% \Rightarrow z = 1.28$  $z = \frac{200 - 175}{\sigma}$ Thus $\frac{25}{\sigma} = 1.2816$ Thus $\sigma = 19.5$	B1	4	AWRT; ignore sign (1.2816) Standardising 200 with 175 & $\sigma$ Do not allow 175 - 200 Equating z-term to z-value Not using 0.9 or 0.1 AWRT	
	M1			
	m1			
	A1			
	<b>Total</b>		<b>15</b>	

## MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
<b>3</b>	$P(F) = 0.8 \quad P(D F) = 0.9 \quad P(D F') = 0.4$			
<b>(a)(i)</b>	$P(F \cap D)$ $= P(F) \times P(D F) = 0.8 \times 0.9$ $= 0.72$	M1  A1	2	CAO (18/25)
<b>(ii)</b>	$P(F' \cap D')$ $= P(F') \times P(D' F') = (1 - 0.8) \times (1 - 0.4)$ $= 0.2 \times 0.6 = 0.12$	M1  A1	2	CAO (3/25)
<b>(b)</b>	$P(M) = 0.7$			
<b>(i)</b>	$P(F \cap D \cap M) = P(F) \times P(D F) \times P(M)$ $= (a)(i) \times P(M) = 0.72 \times 0.7$ $= 0.504$	M1  A1 <sup>√</sup>  A1	3	(a) (i) x P (M), ignore multipliers  Or equivalent; <sup>√</sup> on (a)(i) < 1  CAO (63/125)
<b>(ii)</b>	$P(2 \text{ in } 3)$ $= P(F \cap D \cap M')$ $+ P(F \cap D' \cap M)$ $+ P(F' \cap D \cap M)$ $= 0.8 \times 0.9 \times 0.3$ $+ 0.8 \times 0.1 \times 0.7$ $+ 0.2 \times 0.4 \times 0.7$ $= 0.216 + 0.056 + 0.056$ $= 0.328$	M1    A2 (A1)   A1	4	At least 2 permutations of 3 events seen, or implied by multiplication of 3 correct probabilities at least twice  Ignore multipliers e.g. x3  At least 2 correct expressions (Exactly 1 correct expression)  CAO (41/125)
	<b>Total</b>		<b>11</b>	

## MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
4(a)	Gradient, $b = 0.0848$ or $b = 0.084$ to $0.085$	B2 (B1)	4	AWRT AWFW
	Intercept, $a = 1.72$ to $1.73$ or $a = 1.7$	B2 (B1)		AWFW CAO
	Attempt at $\Sigma x$ $\Sigma x^2$ $\Sigma y$ $\Sigma xy$ or Attempt at $S_{xx}$ $S_{xy}$ Attempt at a correct formula for $b$ $b = 0.0848$ $a = 1.72$ to $1.73$	(M1) (m1) (A1) (A1)		224, 7180; 32.8; 995.4 908; 77 AWRT AWFW
	Accept $a$ & $b$ interchanged only if $y = ax + b$ stated or subsequently used correctly in either (b) or (c)			
(b)(i)	Residual = $y - a - bx$	M1	3	Res =  (Obs $y$ ) - (Pred $y$ )  & used Allow use of $x = 3$ and/or $x = 7$
	(Residual) <sub>3</sub> = $-0.465$ to $-0.485$	A1 (A1)		AWFW Both correct magnitude
	(Residual) <sub>7</sub> = $-0.335$ to $-0.365$	A1		AWFW
(ii)	Residuals are small (relative to $y$ -values) No pattern to residuals	B1	2	Except for (Residual) <sub>6</sub> <i>Any sensible comment</i> Residuals random
	Fitted equation is appropriate/suitable	B1		Or equivalent Do <b>not</b> allow "equation is good", "equation is accurate". Allow "equation is suitable".
(c)	Total = Scan + Transmit = $y + z$	M1		Use of; or equivalent
(i)	$T_{15} = 4.45$ to $4.6$	A1		AWFW
	Reliable as interpolation or small residuals	B1		Or equivalent
(ii)	$T_{75} = 12.5$ to $12.7$	A1	5	AWFW
	Unreliable as extrapolation Cannot get 75 lines of print on A4 page	B1		Or equivalent
<b>Total</b>			<b>14</b>	

## MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
5	(a)(i) $B(n, 0.07)$  $P(X=2) = \binom{17}{2}(0.07)^2(0.93)^{15}$  $= 136 \times 0.0049 \times 0.33670$  $= 0.224$ to $0.225$	M1		Use of in (a)
		A1		Fully correct expression May be implied
		A1	3	AWFW (0.22438)
	(ii) $P(X \leq 5 \mid B(50, 0.07))$  $= 0.865$	M1		Attempted; tables or formula ( $\geq 3$ terms stated) May be implied
		A1	2	AWRT (0.8650)
	(b) $B(50, 0.55)$  $P(Y \geq 30) = P(Y' \leq 20)$  with $p = 0.45$  $= 0.286$	M1		Change from $Y$ to $Y'$ Must be clear evidence
		A1		Stated or implied
		A1	3	AWRT (0.2862)
	(c)(i) Estimate of $p = \frac{10}{50} = 0.2$	B1	1	CAO
		(ii) Estimate of $SD(X) = \sqrt{np(1-p)}$  $= \sqrt{50 \times 0.2 \times 0.8} = \sqrt{8}$ $= 2.82$ to $2.83$	M1	
	A1		2	AWFW; accept $\sqrt{8}$
	(iii) $SD(X)$ less than 6.8 or $V(X)$ less than 46.24  <b>Not</b> a reasonable assumption	M1 $\checkmark$		Comparison $\checkmark$ on (c)(ii) Must be like with like
		A1 $\checkmark$	2	$\checkmark$ on (c)(ii) and like with like comparison
	<b>Total</b>		<b>13</b>	

## MS/SS1B (cont)

Q	Solution	Mark	Total	Comments
<b>6</b>				
<b>(a)(i)</b>	Mean ( $\bar{x}$ ) = 24.7 to 25.7	B2		AWFW (25.2)
	Standard Deviation ( $s_n, s_{n-1}$ ) = 16.7 to 17.7	B2		AWFW (17.1474 or 17.2338)
	MPs ( $x$ ): 5.5, 15.5, 23, 28, 33, 38, 45.5, 75.5	(B1)		At least 4 correct
	Mean ( $\bar{x}$ ) = $\frac{\sum fx}{100}$	(M1)	4	Use of
<b>(b)</b>	Data is skewed or not symmetric Discrete data or counts (Mean – 2 × SD) < 0 ⇒ negative counts	B1	1	One valid reason
<b>(c)(i)</b>	Since sample size large ( $n > 30$ ) can use Central Limit Theorem	B1	1	Either point
<b>(ii)</b>	Mean = $\mu$	B1		CAO; not $\bar{x}$ or its value
	Variance = $\frac{\sigma^2}{100}$	B1	2	Accept $\frac{\sigma^2}{n}$ or $\frac{(\text{their SD})^2}{100}$ , etc
<b>(d)</b>	99% ⇒ $z = 2.57$ to 2.58	B1		AWFW (2.5758)
	CI for $\mu$ is $\bar{x} \pm z \times \frac{(\sigma \text{ or } s)}{\sqrt{n}}$	M1		Use of Must have $(\pm\sqrt{n})$ with $n > 1$
	Thus $25.2 \pm 2.5758 \times \frac{17.1 \text{ or } 17.2}{\sqrt{100}}$	A1✓		✓ on $\bar{x}$ , $z$ and $s > 0$ ; not on $n$
	(20.8, 29.6)	A1	4	AWRT
<b>(e)</b>	UCL < 30 so Reject claim that $\mu > 30$	B1✓ ↑dep B1✓		✓ on CI ✓ on CI
	7/100 or 7% of $X > 50$ (from table) so Reject claim that often $X > 50$	B1 ↑dep B1	4	CAO CAO
	<b>Total</b>		<b>16</b>	
	<b>Total</b>		<b>75</b>	