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General Certificate of Education

Mathematics 6360
Statistics 6380

MS/SS1B Statistics 1B

Mark Scheme

2009 examination - January 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)	Mean = $\frac{\sum fx}{\sum x} = \frac{247}{52} = 4.75$ or $4\frac{3}{4}$	B2		$\frac{247}{52} \Rightarrow$ B1 CAO ($4.75 = 5 \Rightarrow$ ISW) $4\frac{39}{52} \Rightarrow$ B2
	If B0 but evidence of $\frac{\sum fx}{52}$	(M1)		
	Median (26, 26½) = 5	B2		CAO
		(B1)		Stated identification of 26 or 26½
	If B0 but evidence of cumulative frequencies *F*: (0) 1 3 12 25 32 45 51 52			Need to see attempt at ≥ 4 *F*–values
	or If data assumed continuous so use of $4+\frac{x}{7}$ where $0 < x < 2$	(M1)		(4 < median < 4.29)
	Mode(s) = 4 and 6	B1	5	CAO both (so mode = 5 $\Rightarrow$ B0)
(b)	Mode(s)	B1		CAO
	More than one mode/value Two modes/values No unique mode/value	B1dep		Or equivalent; eg not unique Dep only on previous B1 scored
	Notes: If data treated as two separate sets, then only marks available are B1 B1dep in (b)			Modes = 1 and 13 $\Rightarrow$ B0 in (a) but B1 B1dep available in (b)
	If averages confused then mark (a) as stated eg median = 4 and 6 $\Rightarrow$ B0 in (a) and in (b) "median, as two values" $\Rightarrow$ B0 B0		2	
		Total	**7**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
2 (a)(i)	r = 0.022 to 0.023	B3		AWFW (0.022557)
	r = 0.02 to 0.03	(B2)		AWFW
	r = –0.1 to 0.1	(B1)		AWFW
	OR			
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ $\sum y^2$ & $\sum xy$			118.8 1619.36 31.5 114.43 & 416.13 (all 5 attempted)
	or	(M1)		
	Attempt at S_{xx} S_{yy} & S_{xy}			51.2 4.18 & 0.33 (all 3 attempted)
	Attempt at **correct** formula for r	(m1)		
	r = 0.022 to 0.023	(A1)	3	AWFW
(ii)	(Almost/virtually) **no/zero** (linear) **correlation** (relationship/association/link) between **length** and (maximum) **diameter** of carrots	B1	2	Or equivalent qualification of **NO** strength; do not follow-through from (i) B0 for very weak/weak/some/ little/slight/positive/hardly any/etc unless correct qualification also stated Context; providing $-1 < r < 1$
(b)	**Unlikely**/wrong/incorrect/invalid	B1		Or equivalent
	Would expect a **positive value** **or** Would expect **weight to increase with length** **or** Would imply **shorter carrots are heavier**	B1	2	Or equivalent reason
		Total	**7**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
3	$X \sim \text{N}(5.08, 0.05^2)$			
(a)(i)	$\text{P}(X < 5) = \text{P}\left(Z < \frac{5-5.08}{0.05}\right) =$ $\text{P}(Z < -1.6)$	M1		Standardising (4.5, 4.95, 5, 5.05 or 5.5) with 5.08 and ($\sqrt{0.05}$, 0.05 or 0.05^2) and/or $(5.08 - x)$
	$= 1 - \text{P}(Z < 1.6) = 1 - 0.9452$	m1		Area change; may be implied
	$= 0.0545$ to 0.055	A1	3	AWFW (0.0548) (1 – answer) ⇒ M1 max
(ii)	$P(5 < X < 5.10) = \text{P}(X < 5.10) -$ (i)	M1		Or equivalent; must be clear correct method if answer incorrect and answer > 0
	$= \text{P}(Z < 0.4) -$ (i) $= 0.65542 - 0.0548$			
	$= 0.6$ to 0.601	A1	2	AWFW (0.60062)
(b)(i)	Variance of $\bar{X}_4 = 0.05^2/4 = 0.000625$ SD of $\bar{X}_4 = 0.05/2 = 0.025$	B1		CAO; stated or used
	$\text{P}(\bar{X}_4 > 5.05) = \text{P}\left(Z > \frac{5.05-5.08}{0.025}\right)$	M1		Standardising 5.05 with 5.08 and 0.025; allow $(5.08 - 5.05)$
	$= \text{P}(Z > -1.2) = \text{P}(Z < 1.2)$	m1		Area change; may be implied
	$= 0.884$ to 0.886	A1	4	AWFW (0.88493) (1 – answer) ⇒ B1 M1 max
(ii)	Zero	B1	1	CAO; or equivalent (ignore any working)
(c)	1% (0.01) ⇒ $z = -2.33$ to -2.32	B1		AWFW; ignore sign (–2.3263)
	$z = \frac{5-\mu}{0.05}$	M1		Standardising 5 with μ and 0.05 or 0.025; allow $(\mu - 5)$
	$= -2.3263$	A1		Only allow: ±2.05 to ±2.06 ±2.32 to ±2.33 ±2.57 to ±2.58
	$\mu = 5.11$ to 5.12	A1		AWFW (5.1163)
	Note: $\frac{5-\mu}{0.05} = 2.3263 \Rightarrow 5.116$ ⇒ B1 M1 A1 A0			Or equivalent inconsistent signs
			4	
		Total	**14**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
4	$P(C) = 0.6 \quad P(C \cap B) = 0.25$ $\{P(C \text{ only}) = 0.35 \quad P(B \text{ only}) = 0.4\}$			*In (a), ratios (eg 4 : 10) are only penalised by 1 mark at first correct answer*
(a) (i)	$P(C') = 1 - P(C) = 1 - 0.6 = 0.4$	B1	1	CAO; or equivalent
(ii)	$P(C \cap B') = 0.6 - 0.25$ $= 1 - (0.4 + 0.25)$ $= 0.35$	M1 A1	2	Can be implied by correct answer CAO; or equivalent
(iii)	$P(B) = \text{(i)} + p$ with $p < 0.6$ $= \text{(i)} + 0.25$ $= 0.65$ **OR** $P(B) = 1 - \text{(ii)}$ $= 0.65$ **OR** $1 = P(C) + P(B) - P(C \cap B)$ Thus $P(B) = 1 - (0.6 - 0.25)$ $= 0.65$	M1 A1 A1 (M2) (A1) (M1) (A1) (A1)	 3	Can be implied by correct answer Can be implied by correct answer CAO; or equivalent Can be implied by correct answer Can be implied by correct answer Can be implied by correct answer CAO; or equivalent
(b)	$P(L \mid G_C) = 0.9 \quad P(L \mid G_{CB}) = 0.7$ $P(L \mid G_B) = 0.3$			
(i)	$P(G \cap L) \Rightarrow$ (a)(ii) $\times$ 0.9 (0.315) 0.25×0.7 (0.175) $[\text{(a)(iii)} - 0.25] \times 0.3$ (0.12) Note: Each pair of multiplied probabilities must be > 0 to score the corresponding method mark $\Rightarrow 0.315 + 0.175 + 0.12 = 0.61$	M1 M1 M1 A1	 4	Follow through or correct Follow through or correct Ignore any multiplying factors Ignore any additional terms CAO
(ii)	Probability $= \{1 - \text{(b)(i)}\}^5$ $= 0.39^5 = 0.009$	M1 A1	 2	Allow $5 \times \{1 - \text{(b)(i)}\}^5$ AWRT (0.00902)
		Total	**12**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
5 (a)	Mean = $\frac{1620}{30}$ = 54	B1	1	CAO; cannot be gained in (b)
(b)	98% (0.98) $\Rightarrow$ z = 2.32 to 2.33	B1		AWFW (2.3263)
	CI for μ is $\bar{x} \pm z \times \frac{\sigma}{\sqrt{n}}$	M1		Used Must have $\sqrt{n}$ with $n > 1$
	Thus $54 \pm 2.3263 \times \frac{8}{\sqrt{30}}$	A1F		F on $\bar{x}$ (but not 1620) and z only Allow $\bar{x}$ = 54 even if B0 in (a)
	Hence 54 ± (3.38 to 3.42)			CAO & AWFW (54 & 3.4)
	or	A1	4	
	(50.58 to 50.62, 57.38 to 57.42)			AWFW (50.6, 57.4)
	Notes: Use of n = 1 in (b) must not be deemed as answer to (c) Use of n = 1 in (b) followed by use of n = 1 in (c) $\Rightarrow$ (b) B1, (c) M1 A1 max Use of n = 1 with (b) or (c) not identified $\Rightarrow$ (b) B1, (c) 0 max			
(c)	Repeat of structure in (b) but with n = 1 and $1.96 \leq z \leq 3.03$	M1		Or equivalent
	Thus 54 ± (18.56 to 18.64)			CAO & AWFW (54 & 18.6)
	or	A1F		If z-value incorrect, then must use $54 \pm 8 \times [z \text{ from (b)}]$
	(35.36 to 35.44, 72.56 to 72.64)		2	AWFW (35.4, 72.6)
	Note: Accept sensible non-symmetric intervals such as: (0, 54 + 2.0537 × 8) = (0, 70.4 to 70.5)			
(d)	Nowhere **or** No	B1	1	CAO; or equivalent (ignore any reasoning)
		Total	**8**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
6(a)	Figure 1: **3** correct labelled points **2** correct labelled points	B2 (B1)	2	Deduct 1 mark if not labelled
(b)				
	b (gradient) = 0.685	B2		AWRT (0.68502)
	b (gradient) = 0.68 to 0.69	(B1)		AWFW
	a (intercept) = 0.344	B2		AWRT (0.34404)
	a (intercept) = 0.34 to 0.35	(B1)		AWFW
	OR			
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$			630 40344 435 & 27853 (all 4 attempted)
	or	(M1)		
	Attempt at S_{xx} & S_{xy}			654 & 448 (both attempted)
	Attempt at correct formula for b (gradient)	(m1)		
	b (gradient) = 0.685	(A1)		AWRT
	a (intercept) = 0.344	(A1)		AWRT
	Accept a & b interchanged only if then identified correctly by a stated or used equation in (c) or (d)		4	
(c)	Figure 1: Correct line (50, 34 to 35) (60, 40½ to 42) (70, 47¼ to 49) (80, 54 to 56)	B2dep		Dep on ≥ B1 B1 or ≥A1 A0 in (b) At least from $x \approx 55$ to 70 Any two
	If B0 but evidence of use of line for ≥ 2 points within range $50 \leq x \leq 80$	(M1)	**2**	Calc^n or points shown on graph
(d)(i)	Residual = $y - (a + bx)$ [**or** $(a + bx) - y$]	M1		Used or implied; or equivalent (using graph); ≥ 1 residual correct (2.98)
	H I J 2.5 to 4(.0) 2.5 to 4(.0) 2(.0) to 4(.0)	A2,1 (–1 EE)		AWFW; ignore signs only (3.19) providing all the same (2.70)
	Mean = 2.3 to 4(.0)	A1dep	4	AWFW; do not ignore sign (2.96) Dep on previous A2 scored
(ii)	$y_{65} = a + b \times 65$	M1		Use shown or AWFW (44.9)
	or y_{65} = 44 to 45.5			
	+ [(d)(i)] **or** [2.95 to 2.97]	m1		Use shown or AWFW; ignore sign of mean residual
	= 46 to 50	A1		AWFW (47.8)
	Special Cases: Line drawn/calc^d on H, I & J **or** linear interp^n using I & J = 47 to 49	(B2)		$y_M = 4.51 + 0.666x \Rightarrow 47.8$ **OR** no evidence of method {from (d)(i) and/or (d)(ii)} Evidence of incorrect method ⇒ B0
	44 to 45.5 seen with no evidence ⇒ B1		3	
		Total	**15**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
7 (a)(i)	B(16 or 25 or 40, 0.45)	M1		Used at least once in (a)(i) to (iii)
	$P(S = 3) = \binom{16}{3}(0.45)^3(0.55)^{13}$	A1		May be implied by correct answer Ignore any additional terms
	$= 0.021$ to 0.022	A1	3	AWFW (0.0215)
(ii)	$P(S < 10) = 0.3843$ or 0.2424	B1		Accept 3 dp accuracy from tables or calculation
	$= 0.242$ to 0.243	B1	2	AWFW (0.2424)
(iii)	$P(15 \leq S \leq 20)$	M1		Accept 3 dp accuracy
	$= 0.7870$ or 0.6844 (p_1)			$p_2 - p_1 \Rightarrow$ M0 M0 A0 $p_1 - (1 - p_2) \Rightarrow$ M1 M0 A0
	minus 0.1326 or 0.2142 (p_2)	M1		Accept 3 dp accuracy / truncation
	$= 0.654$ to 0.655	A1		AWFW (0.6544)
	OR			
	B(40, 0.45) expressions stated for at least 3 terms within $14 \leq S \leq 20$ gives probability	(M1)		Or implied by a correct answer
	$= 0.654$ to 0.655	(A2)	3	AWFW
(iv)	Mean, $\mu = np = 50 \times 0.45$	B1		CAO ($22.5 = 22$ or $23 \Rightarrow$ ISW)
	$= 22.5$ or $22\frac{1}{2}$			
	Variance, $\sigma^2 = np(1-p)$			Accept $12\frac{3}{8}$ or $\frac{99}{8}$
	$= 50 \times 0.45 \times 0.55$			
	$= 12.3$ to 12.4	B1	2	AWFW (12.375)
(b)(i)	**Non-independence** of senior citizens travel Senior citizens tend to **travel in pairs/groups**	B1	1	Or equivalent; but must be a clear indication of non-independent events
(ii)	7.15 am is outside 9.30 am to 11.30 am Cannot use SCPs before 9.30 am Cannot use SCPs @ 7.15 am Cannot use SCPs during morning 'rush hour'			
	Value of p likely to be smaller/different/zero Data not available Senior citizens not out at this time Passengers likely to be workers/school children	B1	1	Or equivalent Accept other **sensible** reasons Distribution of **types of** passenger different
		Total	**12**	
		Paper	**75**	