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

MS/SS1B/W (cont)

Q	Solution	Marks	Total	Comments
2(a)	$r = 0.893$ to 0.8933	B3	3	AWFW (0.89319)
	$r = 0.89$ to 0.896	(B2)		AWFW
	$r = 0.8$ to 0.95	(B1)		AWFW
	or			
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ $\sum y^2$ & $\sum xy$	(M1)		561 30667 671 42613 & 35882 (all 5 attempted)
	Attempt at S_{xx} S_{yy} & S_{xy}	(m1)		2056 1682 & 1661 (all 3 attempted)
	Attempt at correct corresponding formula for r	(A1)		AWFW
(b)	Fairly strong / strong / very strong positive (linear) correlation / relationship / association / link (but not trend) between length and weight 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
(c)	Figure 1: 5 correct labelled points 4 or 3 correct labelled points	B2 (B1)	2	Deduct 1 mark if points not labelled
(d)(i)	D and G	B1	1	Both CAO
(ii)	$r = 0.25$ 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 Do not accept comparison with value in (a) or statement in (b)	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
		Total	10	

MS/SS1B/W (cont)

Q	Solution	Marks	Total	Comments
3(a)	$X \sim N(253, 5^2)$			
(i)	$P(X < 250) = P\left(Z < \frac{250 - 253}{5}\right) =$ $P(Z < -0.6) = 1 - P(Z < 0.6)$ $= 1 - 0.72575$ $= 0.274 \text{ to } 0.275$	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
(ii)	$P(245 < X < 250) = [C's(a)(i)] - P(X < 245)$ $= (i) - P(Z < -1.6) = 0.27425 - 0.0548$ $= 0.219 \text{ to } 0.22(0)$	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
(iii)	$P(X = 245) = 0$ or zero or impossible	B1	1	Ignore any working B0 for 'for impossible to calculate'
(b)	$98\% (0.98) \Rightarrow z = -2.05 \text{ to } -2.06$ $z = \frac{245 - 253}{\sigma}$ $= -2.0537$ $\sigma = 3.88 \text{ to } 3.9(0)$	B1 M1 A1 A1		AWFW; ignore sign (-2.0537) Standardising 245 with 253 and σ ; allow (253 - 245) Only allow: ± 2.05 to ± 2.06 ± 2.32 to ± 2.33 AWFW (3.8954)
	<p>Note:</p> $\frac{245 - 253}{\sigma} = 2.0537 \Rightarrow \sigma = 3.8954$ $\Rightarrow \text{B1 M1 A1 A0}$		4	Or equivalent inconsistent signs
		Total	10	

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	
	or				
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$ ($\sum y^2$)			305 14975 281 & 6980 (10173) (all 4 attempted)	
	or	(M1)			
	Attempt at s_{xx} & s_{xy}			4638.89 & -2542.78 (both attempted)	
	Attempt at correct 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 clearly shown equation (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)	
or	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			
	or				
	$y = 0 \Rightarrow x = 89$ to 93	(B1)			AWFW (90.84942) Accept a descriptive answer that includes a value in range and 13
	\Rightarrow 13 weeks (approximately)	(B1)			Stated
	Note: B1 B1 or (B1) (B1) are available even if (a) not attempted				
or	Thus claim appears justified	B1 dep		Or equivalent; ignore reasoning unless contradictory Dependent upon 2 nd B1 in (c) or 2 nd (B1) in (c)	
or	Thus tablet likely to have dissolved				
or	Extrapolation required so cannot comment	(B1)		Not dependent	
Note:	If (B1) for extrapolation maximum mark is 2; other mark available is for 91		3		

		Total	8	
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MS/SS1B/W (cont)

Q	Solution	Marks	Total	Comments
5(a) (i)	Median (50) = 3	B1	3	CAO
	If not identified, then assume order is median then IQR			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
	$IQR (75 - 25) = 4 - 2 = 2$	B2		CAO; but 25 th value $\Rightarrow IQR = 2 \Rightarrow B0$
	Special Cases: Identification that LQ = 2 and UQ = 4	(B1)		Both CAO
	Statement of ≥ 4 cumulative frequencies F: 14 49 74 87 96 98 99	(M1)		Can award if no marks scored in (i) even if then applied to continuous data
(ii)	$Mean = \frac{\sum fx}{\sum f} = \frac{275}{99} = 2.77 \text{ to } 2.78$	B1	3	AWFW (2.778)
	If not identified, assume order is \bar{x} then s $SD (\sum fx^2 = 933) = 1.3(0) \text{ to } 1.32$	B2		Treat rounding to integers as ISW AWFW (1.307 & 1.314)
	Special Case: Evidence of $\frac{\sum fx}{99}$	(M1)		Can award if no marks scored in (ii)
(b)(i)	$Mean_{163} = \frac{99 \times Mean_{99}}{163} \text{ or } \frac{\sum fx \text{ from (a)(ii)}}{163}$	M1	2	Or equivalent; may be implied by an answer within range
	$= 1.68 \text{ to } 1.69$	A1		AWFW (1.687)
(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 not valid	B1		Or equivalent (-1.75 to -0.90)
	Total		11	

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 μ 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 ± 11.0 to 11.1	A1	5	CAO & AWRT (accept 11)
Or	(35.9 to 36.0, 58.0 to 58.1)			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 Teleair times	B1		Or equivalent; ignore reasoning
	Distribution of Y not known	B1		Or equivalent; must be clear reference to Y or population B0 for $n > 30$
	Note: To score B1 B1 there must be both a clear indication of where in question and a valid reason			Any reference to part (a) \Rightarrow B0 B0
		Total	11	

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)
	or			
	B(50, 0.15) expressions stated for at least 3 terms within $4 \leq R \leq 10$ gives probability $= 0.768$	(M1) (A2)	4	Can be implied by correct answer AWRT
(b)	Confusion of 22, 35, 120 and/or 0.15, 0.06			Do not 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 μ then σ^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)	Means are (approximately) the same stated or Variiances are (very) different stated	B1		Must have scored 1 st B1 in (iii) Must have scored 2 nd B1 in (iii)
	Agree with $P(\text{sorts letter incorrectly}) = 0.06$	B1 dep		Dependent on 'means same' stated
	Disagree with independent from letter to letter	B1 dep	3	Dependent on 'variances different' stated
		Total	14	
		Paper	75	

