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.

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

$\sqrt{}$ 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*′) = $1 - \dfrac{32}{160}$ **or** P(*S*) = $\dfrac{32}{160}$ = 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* or *H*) = P(*S* ∪ *H*) = $\dfrac{60+32-18}{160}$ **or** $\dfrac{60+14}{160}$ **or** $\dfrac{32+8+16+18}{160}$ = 74/160 = 37/80 = 0.462 to 0.463	M1 A1	 2	Or equivalent Can be implied by **correct** answer CAO/AWFW (0.4625)
(iv)	P(*T* | *P*) = $\dfrac{{}^{30}\!/_{160}}{\text{(i)}}$ = 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(1*C* & 1*R* & 1*S*) = $\dfrac{24}{160} \times \dfrac{56}{159} \times \dfrac{32}{158}$ (0.15 × 0.35220 × 0.20253) × 6 = 0.064 to 0.0644	M1 M1 M1 A1		Multiplication of any 3 different given subject totals Multiplication of 160, 159 & 158 Accept 3dp accuracy Award for 3 ≤ multiplier ≤ 6 AWFW (0.0642) Do not accept a fraction as answer A **correct** answer can imply 4 marks
	Special Case: (Any given subject total) ÷ 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		AWFW (0.89319)
	$r = 0.89$ to 0.896	(B2)		AWFW
	$r = 0.8$ to 0.95	(B1)		AWFW
	or			
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ $\sum y^2$ & $\quad\sum xy$			561 30667 671 42613 & **35882** (all 5 attempted)
	or	(M1)		
	Attempt at S_{xx} S_{yy} & S_{xy}			2056 1682 & **1661** (all 3 attempted)
	Attempt at **correct** corresponding formula for r	(m1)		
	$r = 0.893$ to 0.8933	(A1)	3	AWFW
(b)	Fairly strong / strong / very strong positive (linear) correlation / relationship / association / link (but not trend)	B1dep		Or equivalent; must qualify strength and indicate positive Dependant on $0.8 \le r \le 0.95$ B0 for some/average/medium/etc
	between			
	length and weight of adult snakes	B1	2	Context; providing $0 < r < 1$
(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	B1dep	2	Or equivalent; must qualify strength and indicate positive Dependant on $0.25 \le r \le 0.75$ 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)			
		Total	**10**	

MS/SS1B/W (cont)

Q	Solution	Marks	Total	Comments
3(a)	$X \sim N(253, \ 5^2)$			
(i)	$P(X < 250) = P\left(Z < \dfrac{250-253}{5}\right) =$	M1		Standardising (249.5, 250 or 250.5) with 253 and ($\sqrt{5}$, 5 or 5^2) and/or $(253-x)$
	$P(Z < -0.6) = 1 - P(Z < 0.6)$			
	$= 1 - 0.72575$	m1		Area change; may be implied
	$= 0.274 \text{ to } 0.275$	A1	3	AWFW $\qquad$ (0.27425) $(1 - \text{answer}) \Rightarrow$ M1 max
(ii)	$P(245 < X < 250) = \left[C's(a)(i)\right] - P(X < 245)$	M1		Or equivalent; must be clear correct method if answer incorrect and answer > 0
	$= \text{(i)} - P(Z < -1.6) = 0.27425 - 0.0548$			
	$= 0.219 \text{ to } 0.22(0)$	A1	2	AWFW $\qquad$ (0.21945) M1 A0 for $[1 - \text{(i)}] - 0.0548 = 0.67095$ M0 A0 for $0.9452 - [\text{(i)}] = 0.67095$ M1 A1 for $0.9452 - [1 - \text{(i)}] = 0.21945$
(iii)	$P(X = 245) = 0$ or zero or impossible	B1	1	Ignore any working B0 for 'for impossible to calculate'
(b)	$98\% \ (0.98) \Rightarrow z = -2.05 \text{ to } -2.06$	B1		AWFW; ignore sign $\qquad$ (–2.0537)
	$z = \dfrac{245-253}{\sigma}$	M1		Standardising 245 with 253 and σ; allow $(253-245)$
	$= -2.0537$	A1		Only allow: $\quad \pm 2.05 \text{ to } \pm 2.06$ $\qquad\qquad\qquad \pm 2.32 \text{ to } \pm 2.33$
	$\sigma = 3.88 \text{ to } 3.9(0)$	A1		AWFW $\qquad$ (3.8954)
	Note: $\dfrac{245-253}{\sigma} = 2.0537 \Rightarrow \sigma = 3.8954$			
	$\Rightarrow$ 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		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 $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$ $\left(\sum y^2\right)$			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)	4	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 **or** Value 50 stated even if (a) incorrect or not attempted	B1F	1	Accept value rounded to nearest integer (50)
(c)	13 weeks $\Rightarrow$ 91 days	B1		Stated or used Accept a descriptive answer that includes 91 and a value in range
	y = –1.1 to + 1.1	B1		AWFW (–0.08254)
	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			
	Thus claim appears **justified** **or** Thus tablet likely to have **dissolved** **or**	B1 dep		Or equivalent; ignore reasoning unless contradictory Dependent upon 2nd B1 in (c) or 2nd (B1) in (c)
	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	

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
	If not identified, then assume order is median then IQR IQR (75 – 25) = 4 – 2 = **2**	B2		CAO; but 25th 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)	3	Can award if no marks scored in (i) even if then applied to continuous data
(ii)	Mean $= \dfrac{\sum fx}{\sum f} = \dfrac{275}{99} = 2.77$ to 2.78	B1		AWFW (2.778)
	If not identified, assume order is $\bar{x}$ then s SD $\left(\sum fx^2 = 933\right) = 1.3(0)$ to 1.32	B2		Treat rounding to integers as ISW AWFW (1.307 & 1.314)
	Special Case: Evidence of $\dfrac{\sum fx}{99}$	(M1)	3	Can award if no marks scored in (ii)
(b)(i)	$\text{Mean}_{163} = \dfrac{99 \times \text{Mean}_{99}}{163}$ or $\dfrac{\sum fx \text{ from(a)(ii)}}{163}$	M1		Or equivalent; may be implied by an answer within range
	$= 1.68$ to 1.69	A1	2	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)] $- 2 \times$ [C's SD in (a)(ii)] < 0 or [C's mean in (b)(i)] $- 2 \times$ [1.69 to 1.71] < 0	B1		Or equivalent (–1.75 to –0.90)
	Thus claim appears **not valid**	B1 dep	2	Or equivalent Dependent upon previous B1
	Total		**11**	

MS/SS1B/W (cont)

Q	Solution	Marks	Total	Comments
6(a)	Mean $=\dfrac{470}{10}=$ **47**	B1		CAO
	98% (0.98) $\Rightarrow$ $z=2.32$ to 2.33	B1		AWFW (2.3263)
	CI for μ is $\quad \overline{x} \pm z \times \dfrac{\sigma}{\sqrt{n}}$	M1		Used Must have $\sqrt{n}$ with $n>1$
	Thus $\quad 47 \pm 2.3263 \times \dfrac{15}{\sqrt{10}}$	A1F		F on $\overline{x}$ and z only
	Hence $\quad 47 \pm 11.0$ to 11.1 **Or** $\quad(35.9$ to $36.0,\; 58.0$ to $58.1)$	A1	5	CAO & AWRT (accept 11) AWRT (accept 36 & 58)
(b)	$Y \sim \text{N}(108,\; 28^2)$			
	Variance of $\overline{Y}_{40}=28^2/40=19.6$ $\surd$SD of $\overline{Y}_{40}=28\surd40=4.425$ to 4.43	B1		CAO Stated or used AWFW
	$\text{P}\left(\overline{Y}_{40}>120\right)=\text{P}\left(Z>\dfrac{120-108}{28/\sqrt{40}}\right)$	M1		Standardising 120 with 108 and $\sqrt{19.6}$ or $(4.425$ to $4.43)$ or equivalent; allow $(108-120)$
	$=\text{P}(Z>2.71)=1-\text{P}(Z<2.71)$	m1		Area change; may be implied
	$=1-0.99664=0.0033$ to 0.0034	A1	4	AWFW (0.00336) $(1-\text{answer}) \Rightarrow$ 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
			2	
		Total	**11**	

MS/SS1B/W - AQA GCE Mark Scheme 2009 June series

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	(M1)		Can be implied by correct answer
	= 0.768	(A2)	4	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 = 120×0.94 = 112.8 or 113	B1		Either
	If not identified, assume order is μ then σ^2 Variance = $np(1 - p)$			Must clearly state variance value
	$= 120 \times 0.94 \times 0.06$ = 6.76 to 6.78	B1	2	AWFW (6.768)
(iv)	**Means** are (approximately) the **same** stated or **Variances** are (very) **different** stated	B1		Must have scored 1st B1 in (iii) Must have scored 2nd B1 in (iii)
	Agree with P(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**	