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General Certificate of Education (A-level)
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Mathematics MS/SS1B

(Specification 6360)

Statistics 1B

Mark Scheme

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Key to mark scheme abbreviations

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
CAO	correct answer only
CSO	correct solution only
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
A2,1	2 or 1 (or 0) accuracy marks
–*x* EE	deduct *x* marks for each error
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
c	candidate
sf	significant figure(s)
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.

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)(i)	$r = 0.6$ to 0.98	B1		AWFW (≈ 0.8) If answers are not labelled, assume order is (a)(i) then (a)(ii)
(ii)	$r = -0.5$ to -0.02 Accept answers as ranges if and only if contained entirely within given ranges	B1	2	AWFW (≈ -0.3) Eg: (a)(i) 0.7 to $0.9 \Rightarrow$ B1 (a)(ii) -0.6 to $-0.4 \Rightarrow$ B0
(b)(i)	$r = 0.757$ $r = 0.75$ to 0.77 $r = 0.65$ to 0.85 **or** Attempt at $\sum x$ $\sum x^2$ $\sum y$ $\sum y^2$ and $\sum xy$ **or** Attempt at S_{xx} S_{yy} and S_{xy} Attempt at substitution into correct corresponding formula for r $r = 0.757$	B3 (B2) (B1) (M1) (m1) (A1)	3	AWRT (0.75708) AWFW AWFW 271.5 6142.97 1911.9 304650.01 and 43259.17 (all 5 attempted) 0.2825 36.5425 and 2.4325 (all 3 attempted) AWRT
(ii)	Strong/fairly strong/moderate positive (linear) correlation/relationship/ association/link (but not 'trend') between Circumference/size and weight of (cricket) balls	Bdep1 B1	2	Dependent on $0.65 < r < 0.85$ Or equivalent; must qualify strength and indicate positive Bdep0 for very strong/high/average/ medium/some etc. Context; providing $0 < r < 1$
	Total		**7**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
2(a)(i)	$P(M \cap C) = \frac{175}{645} = \frac{35}{129} = 0.271$	B1	1	AWRT; accept either correct fraction
(ii)	$P(M) = \frac{519}{645} = \frac{173}{215} = 0.804$ to 0.805	B1	1	AWFW; accept either correct fraction
(iii)	$P(LD) = \frac{63}{645} = \frac{21}{215} = 0.097$ to 0.098	B1	1	AWFW; accept either correct fraction
(iv)	$P(L\|F) = \frac{94}{126} = \frac{47}{63}$	M1		Accept $\frac{94}{645} \div \frac{126}{645}$
	$= 0.746$	A1	2	AWRT
(v)	$P(M\|L') = \frac{519-255}{645-349} = \frac{175+54+35}{193+63+40}$	M1 M1		Allow one arithmetic slip Allow one arithmetic slip
	$= \frac{264}{296} = \frac{132}{148} = \frac{66}{74} = \frac{33}{37}$			Any of these implies M1 M1
	$= 0.891$ to 0.893	A1	3	AWFW
(b)	$P(L \cap L\|F) = \left(\frac{94}{126} \times \frac{93}{125}\right)$ or $\frac{8742}{15750}$	B1		Or $\left(\frac{47}{63} \times \frac{93}{125}\right)$ or $\frac{4371}{7875}$ or $\frac{1457}{2625}$
	$= 0.555$	B1	2	AWRT
(c)	$P(L \cap C \cap (LD + O))$			
	$= \frac{349}{645} \times \frac{193}{644} \times \frac{63+40}{643}$	M1 M1		Correct numerator Correct denominator
	SC The three correct fractions identified but not multiplied $\Rightarrow$ M1 M0 M0 A0			
	$\times 6$ or 3	M1		Note that a denominator of $\binom{645}{3}$ $\Rightarrow$ M2 (second and third M1 marks)
	$= 0.155$ to 0.157	A1	4	AWFW
	NB: 0.026 with no working $\Rightarrow$ M1 only $0.026 \times 6 = 0.156$ with no working $\Rightarrow$ 4 marks			
	Total		**14**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
3(a)(i)	$\frac{0.98+1.00}{2}$ or $\frac{0.975+1.005}{2}$ or $0.98+\frac{0.02}{2}$ or $0.975+\frac{0.03}{2}$ $=0.99$	B1		AG (At least) one correct expression seen Ignore contradictions Accept any valid equivalent
(ii)	$\frac{0.97+0.98}{2}=0.975$ and $\frac{1.00+1.01}{2}=1.005$	B1	2	Both CAO Can not be implied from (a)(i)
	SC In (a)(i) and (a)(ii) allow $1.004\dot{9}$ or 1.0049… etc			Similar forms for lower boundary
(b)	Mean, $\bar{x}=1.062$	B1		CAO $\sum fx=106.2$ Ignore notation
	Standard deviation, s or $\sigma=0.043$	B2	3	AWRT $\sum fx^2=112.9662$ If B0 B0, M1 can be awarded for attempt at $\frac{\sum fx}{100}$
(c)(i)	$99\%(0.99)\Rightarrow z=2.57$ to 2.58	B1 (B1)		AWFW (2.5758) $t_{99}(0.995)=2.626$ AWRT
	CI for μ is $\bar{x}\pm(z \text{ or } t)\times\frac{(s \text{ or } \sigma)}{\sqrt{n}}$	M1		Used Must have $\sqrt{n}$ with $n > 1$
	Thus $1.062\pm2.5758\times\frac{0.043}{\sqrt{100 \text{ or } 99}}$	A1F		F on $\bar{x}$, s/σ and z/t
	Hence 1.06 ± 0.01 or (1.05, 1.07)	A1	4	AWRT; award even if previous inaccuracies in $\bar{x}$, s/σ or z/t Dependent on A1F
(ii)	Volumes/ X / (parent) population may be modelled by a normal distribution / is normally distributed (Ignore contradictions)	B1	1	Or equivalent; not distribution, data, values (in table), sample, n large, nor simply 'It is stated in question'
(iii)	Sample data grouped Exact sample values unknown / mid-points used $\bar{x}$ and s calculated from grouped data	B1	1	σ unknown s calculated from a sample $\bar{x}$ (not μ) and s are estimates NOT data values rounded
(d)(i)	CI for μ or CI in (c)(i) > 1 LCL of CI for μ or LCL of CI in (c)(i) > 1	B1		Or equivalent; must compare CI to 1 Dependent on CI in (c)(i) > 1
(ii)	99 or 100 or all sample/ table/ data volumes/ values/ x-values/ cartons are within this range (or none/0 or 1 volumes outside)	B1	2	
	Total		**13**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
4(a)	$R \sim B(15, 0.45)$			
(i)	$P(R \leq 5) = 0.26(0)$ to 0.261	B1	1	AWFW (0.2608)
(ii)	$P(R > 10) = 1 - P(R \leq 10)$			Requires '1 –' Accept 3dp rounding or truncation
	$= 1 - (0.9745 \text{ or } 0.9231)$	M1		Can be implied by 0.025 to 0.026 but not by 0.0769 to 0.077
	= 0.025 to 0.026	A1	2	AWFW (0.0255)
(iii)	$P(R = 6) = 0.4522 - $ (a)(i)			
	or $= \binom{15}{6}(0.45)^6(0.55)^9$	M1		Can be implied by a correct answer
	= 0.191 to 0.192	A1	2	AWFW (0.1914)
(iv)	$P(5 \leq R \leq 10) = 0.9745 \text{ or } 0.9231 \quad (p_1)$	M1		Accept 3dp rounding or truncation $p_2 - p_1 \Rightarrow$ M0 M0 A0 $(1 - p_2) - p_1 \Rightarrow$ M0 M0 A0 $p_1 - (1 - p_2) \Rightarrow$ M1 M0 A0 only providing result > 0
	Minus 0.1204 or 0.2608 (p_2)	M1		Accept 3dp rounding or truncation
	= 0.853 to 0.855	A1	3	AWFW (0.8541)
	Or			
	B (15, 0.45) terms stated for at least 3 values within $4 \leq R \leq 11$ gives probability	(M1)		Can be implied by a correct answer
	= 0.853 to 0.855	(A2)		AWFW (0.8541)
(b)(i)	$P(S) = 0.85$ plus 1 minus	B1		CAO; requires 'plus' or 'minus'
	(0.15×0.80) (0.15×0.20)	B1	2	CAO; not simply 0.12 or 0.03
	= 0.97			AG
	NB: $(0.85 \times 0.20) + 0.80 \Rightarrow$ B0 B0 $(0.85 \times 0.20) + (0.85 \times 0.80)$ $+ (0.15 \times 0.80) \Rightarrow$ B0 B1			
(ii)	$P(S \geq 48) = 0.81$ to 0.82 or 0.5553 or 0.9372	M2		Accept 3dp rounding or truncation M2 for the three correctly expressed terms for B (50, 0.03) or B (50, 0.97) added
	=0.81(0) to 0.811	A1	3	AWFW (0.8108)
	NB: Answer = 0.4447 or 0.1892 or 0.0628 $\Rightarrow$ M1 only			
(iii)	$p = 1 - 0.85 = 0.15$	B1		CAO; may be implied by correct answer or correct expression for mean
	Mean, $\mu = 80 \times 0.15 = 12$	B1	2	CAO
	SC Mean = 9.6 $\Rightarrow$ B1 only			
	Total		**15**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
5(a)	Time taken is dependent upon leaving time	B1	1	Or equivalent
(b)	b (gradient) = 1.28 (or 141/110)	B2		AWRT; (CAO or equivalent) (1.28182)
	b (gradient) = 1.25 to 1.35	(B1)		AWFW Treat rounding of correct answers as ISW
	a (intercept) = 29.95 to 30 (or 659/22)	B2		AWFW; (CAO or equivalent) (29.95455)
	a (intercept) = 29 to 31	(B1)		AWFW
	Thus $y = 30 + 1.28x$	B1F	5	F on a and b
	or			
	Attempt at Σx Σx^2 Σy and Σxy $\left(\Sigma y^2\right)$			275 9625 682 and 20575 (47494) (All four attempted)
	or	(M1)		
	Attempt at S_{xx} and S_{xy} $\left(S_{yy}\right)$			2750 and 3525 (5210) (Both attempted)
	Attempt at correct formula for b gradient	(m1)		
	b (gradient) = 1.28 (or 141/110)	(A1)		AWRT; (CAO or equivalent)
	a (intercept) = 29.95 to 30 (or 659/22)	(A1)		AWFW; (CAO or equivalent)
	Thus $y = 30 + 1.28x$	(B1F)		F on a and b
	Accept a and b interchanged only if identified correctly by a clearly shown equation			If a and b are not identified anywhere in the question, then: 1.25 to 1.35 $\Rightarrow$ B1 29 to 30 $\Rightarrow$ B1
(c)	7.45 am $\Rightarrow x = 15$	B1		CAO; stated, used or implied
	$\Rightarrow y_{15} = 30 + 1.28 \times 15$	M1		Use of $10 < x < 20$
	= 47 to 52	A1		AWFW (49.2)
	Time before 9.00 am = 9.00 – (7.45 + c's y_{15})	M1		May be implied
	= 23 to 28	A1	5	AWFW (25.8)
	SC Answer of 17 CAO (use of c's y_{15} = 58) gains 2 marks			**NB:** An answer of 8.32 to 8.37 gains B1 M1 A1 M0 A0
(d)(i)	$y_{85} = 30 + 1.28 \times 85 = 135$ to 146	B1	1	AWFW (138.9)
(ii)	Extrapolation/ outside/ above range of x-values	B1		Or equivalent
	Implies leaves home at 8.55 so different traffic conditions	B1	2	Or equivalent; 8.55 may be implied by 5 minutes
	Total		**14**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
6(a)	Volume, $V \sim N\left(412, 8^2\right)$			
(i)	$\mathrm{P}\left(V < 400\right) = \mathrm{P}\left(Z < \dfrac{400-412}{8}\right)$	M1		Standardising 400 with 412 and 8 and/or $\left(412 - x\right)$
	$= \mathrm{P}\left(Z < -1.5\right) = 1 - \mathrm{P}\left(Z < 1.5\right)$	M1		Area change May be implied by a correct answer or an answer < 0.5
	$= 1 - 0.93319 = 0.066$ to 0.067	A1	3	AWFW (0.06681)
(ii)	$\mathrm{P}\left(V > 420\right) = \mathrm{P}\left(Z > 1\right)$	B1		CAO but ignore inequality and sign May be implied by a correct answer
	$= 1 - P\left(Z < 1\right) = 1 - 0.84134$ $= 0.158$ to 0.159	B1	2	AWFW (0.15866)
(iii)	$\mathrm{P}\left(V = 410\right) = 0$ or zero or impossible	B1	1	Ignore any working B0 for 'impossible to calculate' or 'no answer'
(b)(i)	A statement/indication that (–) 1.6449 and/or 2.3263 are *z*-values Do **not** allow $\Phi\left(0.99\right) = 2.3263$, etc but **allow** $\Phi^{-1}\left(0.99\right) = 2.3263$ Do **not** award for *z*-value(s) simply embedded in standardisation statement(s)	B1		Simple statement that $z = \pm 1.6449$ and/or $z = \pm 2.3263$ **or** sketch of normal curve with at least one *z*-value marked
	A clear use of $z = \dfrac{v-\mu}{\sigma}$ or $v = \mu + 2\sigma$ with 400 and/or 420 (condone sign errors)	M1		**SC** Immediate algebraic use of $v - \mu = z\sigma \Rightarrow$ B1 M1 A0
	The two given equations correctly derived	A1	3	AG; watch for sign inconsistencies
(ii)	Thus $20 = \left(2.3263 + 1.6449\right)\sigma$	M1		A sensible (one that would lead to values required if completed correctly) attempt at solving the two given equations by eliminating μ or σ Do **NOT** allow MC or MR
	$\sigma = 5.04$	A1		AWRT (5.03626)
	$\mu = 408$	A1	3	AWRT (408.284)
	Total		**12**	
	TOTAL		**75**	