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General Certificate of Education
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Mathematics MS1A/W
Statistics SS1A/W

Statistics 1A/W

Mark Scheme

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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/SS1A/W

Q	Solution	Marks	Total	Comments
1	$\underline{M \sim B(40,\ 0.35)}$	M1		**Used in question; may be implied**
(a)	$P(M \leq 12) =$ **<u>0.314</u>**	A1	2	AWRT (0.31431)
(b)	$P(10 \leq M \leq 15) =$ **0.6946 or 0.5721** (p_1)	M1		Accept 3 dp 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 0.0644 or 0.1215 (p_2)	M1		Accept 3 dp rounding or truncation
	= **0.63(0)**	A1		AWRT (0.63021)
	OR			
	B(40, 0.35) expressions stated for **at least 3** terms within $9 \leq M \leq 15$ gives probability	(M1)		Can be implied by correct answer
	= **0.63(0)**	(A2)	3	AWRT (0.6302)
(c)	$P(M = 15) = 0.6946 -$ **0.5721**			Accept 3 dp accuracy Allow F from (b)
	OR	M1		Can be implied by correct answer
	$P(M = 15) = \binom{40}{15}(0.35)^{15}(0.65)^{25}$			Ignore any additional terms
	= **0.122 to 0.123**	A1	2	AWFW (0.12256)
	Total		**7**	

MS/SS1A/W (cont)

Q	Solution	Marks	Total	Comments
2				
	–18 –11 1 15 7 –1 17 –16 18 –3 0 9			
(a)				
(i)	Mean, $\bar{d}$ = **1.5**	B1		CAO $\sum d = 18$
				Ignore notation and units
	Standard deviation, σ_d or s_d = **11.7 to 12.3**	B1	2	(11.737 or 12.259) AWFW $\sum d^2 = 1680$
(ii)	Mean, $\bar{x} = 50 + \bar{d}$ = **51.5**	B1F		F on (a)(i) or correct
	x: 32 39 51 65 57 49 67 34 68 47 50 59			$\sum x = 618$ $\sum x^2 = 33480$
				Ignore notation and units
	Standard deviation, σ_x or s_x = **11.7 to 12.3**	B1F	2	F on (a)(i) providing > 0 or correct
(b)	[Values, mean or sd in (a)(i) or (a)(ii)] $\times \frac{1.22}{100}$ or 1.22	M1		Award if use seen or implied by **≥ 1** subsequent correct or (correct × 100) answer
	Mean = **0.628 to 0.63**	A1		AWFW (0.6283)
	Standard deviation = **0.14 to 0.151**	A1	3	AWFW (0.1432 or 0.1496)
	Special Cases:			
	At least one answer correct with no stated units or incorrect stated units ⇒ M1 A1 A1 max			
	At least one answer × 100 with its units stated as 'cents' ⇒ M1 A1 A1 max			'cents' attached to **≥ 1** answer × 100
	At least one answer × 100 with no units stated or units stated as euros / pence / £ ⇒ M1 only			
	Total		**7**	

MS/SS1A/W (cont)

Q	Solution	Marks	Total	Comments
3	Volume, $X \sim N(153,\ 1.6^2)$			
(a)(i)	P(not overflow) = P($X < 155$)	B1		May be implied
	$= P\left(Z < \frac{155-153}{1.6}\right)$	M1		Standardising (154.5, 155 or 155.5 or 149.5, 150 or 150.5) with 153 and ($\sqrt{1.6}$, 1.6 or 1.6^2) and/or $(153 - x)$ **May be gained in (a)(i) or (a)(ii)**
	= P($Z <$ **1.25**)	A1		CAO; ignore inequality and sign May be implied by a correct answer
	= **0.894 to 0.895**	A1		AWFW (0.89435)
(ii)	P(less than printed) = P($X < 150$)	(B1)		Only if B1 not awarded in (a)(i)
	= P($Z < -1.875$)			
	1 – P($Z < 1.875$)	M1		Area change May be implied by a correct answer or answer < 0.5
	= **0.03 to 0.031**	A1	6	AWFW (0.03040)
(b)	Volume, $Y \sim N(152,\ 0.8^2)$			
	Variance of $\overline{Y}_{12}$ = **$0.8^2/12$ = 0.053**	B1		CAO/AWRT
	Sd of $\overline{Y}_{12}$ = **$0.8/\sqrt{12}$ = 0.23 to 0.231**			Stated or used CAO/AWFW
	$P\left(\overline{Y}_{12} > 152.5\right) = P\left(Z > \frac{152.5-152}{0.8/\sqrt{12}}\right)$	M1		Standardising 152.5 with 152 or 153 and $0.8/\sqrt{12}$ or $1.6/\sqrt{12}$ or equivalent; allow $(152 - \bar{y})$
	= P($Z >$ 2.165)			
	= 1 – P($Z <$ 2.165)	m1		Area change May be implied by a correct answer or answer < 0.5
	= **0.015 to 0.0153**	A1	4	AWFW (0.01519) (1 – answer) ⇒ B1 M1 max
	Total		**10**	

MS/SS1A/W (cont)

Q	Solution	Marks	Total	Comments
4				*Ratios (eg 63:100) are only penalised by 1 mark at first correct answer* *F marks can only be awarded if $0 < p < 1$*
(a)	$P(J) = 0.9$ $P(R \mid J) = 0.7$ $P(R \mid J') = 0.2$			
(i)	P(both at trough) $= 0.9 \times 0.7$	M1		Can be implied by **correct** answer Ignore additional terms
	$=$ **0.63 = 63/100**	A1	2	CAO
(ii)	P(neither at trough) $= (1 - 0.9) \times (1 - 0.2)$ $= 0.1 \times 0.8$	M1		Can be implied by **correct** answer
	$=$ **0.08 = 8/100 = 4/50 = 2/25**	A1	2	CAO
(iii)	P(at least one at trough) = (1 – (ii))			
	= **0.92 = 92/100 = 46/50 = 23/25**	B1F	1	F on (ii) or **correct** answer
(b)				
(i)		B1		**Both** row and column totals ie 0.25 and 0.40; CAO
		B1	2	**Three** table values ie 0.35 and 0.20 and 0.05; CAO
	Notes: Use of Venn or tree diagrams **without** table completion ⇒ B0 B0 Table not completed on page 13 but completed on page 10 ⇒ max of B1 B1			
(ii)	**Accept answers .÷1.00**			
(A)	P(neither at gate) = **0.05**	B1F	1	F on table or **correct** answer by 'otherwise'
(B)	P(only Daisy at gate) = **0.35**	B1F	1	F on table or **correct** answer by 'otherwise'
(C)	P(exactly one at gate) $P(D \cap M') + P(D \cap M)$	M1		Only **correct two** values from C's table **shown and added** Can be implied by **correct** answer
	0.35 +0.20 = **0.55**	A1F	2	F on table or **correct** answer by 'otherwise'
	Total		**11**	

	M	***M′***	**Total**
D	0.40	**0.35**	0.75
D′	**0.20**	**0.05**	**0.25**
Total	0.60	**0.40**	1.00

MS/SS1A/W (cont)

Q	Solution	Marks	Total	Comments
5(a)	b (gradient) = **3.25 to 3.26**	B2		AWFW (3.25472)
	b (gradient) = **3.2 to 3.3**	(B1)		AWFW
				Treat rounding of correct answers as ISW
	a (intercept) = **509 to 510**	B2		AWFW (509.71698)
	a (intercept) = **507 to 513**	(B1)		AWFW
	OR			
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ and $\sum xy$ $\left(\sum y^2\right)$			720 44472 8460 and **511740** (6399400) (all 4 attempted)
	or	(M1)		
	Attempt at S_{xx} and S_{xy} $\left(S_{yy}\right)$			1272 and **4140** (435100) (both attempted)
	Attempt at **correct** formula for b (gradient)	(m1)		
	b (gradient) = **3.25 to 3.26**	(A1)		AWFW
	a (intercept) = **509 to 510**	(A1)	4	AWFW
	Accept a and b interchanged only if identified correctly by a **clearly shown or drawn equation**			If a and b are not identified anywhere in question, then: 3.25 to 3.26 ⇒ B1 509 to 510 ⇒ B1
(b)(i)	**Correct line on graph** (40, 630 to 650) (80, 750 to 790)	B2dep		Dep on ≥ B1 B1 or ≥ A1 A0 in (a) From $x \approx 40$ to 80
	If B0 but evidence of use of line for ≥ 2 points within range $0 \leq x \leq 80$ **or** 'intercept' and means	(M1)	2	Calc^n or points shown on graph Allow point ('0', 500 to 520) **Graph**
(ii)	Outlier(s) / at least E and H identified / wide scatter (of points) large residuals	B1		Or equivalent words
	Evidence of a (+ ve) relationship or correlation/model is not appropriate	B1	2	Or equivalent words; none of strong/ negative/trend/etc or unreliable/invalid
(c)(i)	**Correct two points marked on graph**	B1	1	Labels are **not** required nor is ⊙ **Graph**
(ii)	b (gradient) = **11.6**	B1		AWRT (11.60377)
	a (intercept) = **23 to 24**	B1		AWFW (23.77358)
	Correct line on graph (40, 480 to 500) (80, 930 to 970)	B1dep	3	**Graph** dependent on B1 B1
(iii)	No outliers/less scatter/small residuals	B1		Or equivalent words
	Strong(er)/more evidence of a **positive** link/ relationship or **more rapid increase** (of reaction time with age) or model is more appropriate	B1	2	Or equivalent words; **must indicate change** from (b)(ii) in context; not some/weak/etc or reliable/valid. References to correlation alone ⇒ B0
	Total		**14**	

MS/SS1A/W (cont)

Q	Solution	Marks	Total	Comments
6(a)				
(i)	$\bar{t} - 2s = 6.31 - 2\sqrt{19.3} =$ **–2.48 to –2.47**	B1		AWRT (–2.4764)
	Negative value is **impossible** for a measurement of **time**	B1	2	Or equivalent; allow if negative value incorrect or not stated
(ii)	Sample size, $n = 80$ is large / > 25	B1		Indication that **given** sample is 'large'
	Thus sample **mean** $\left(\bar{T}\right)$ ~ approximately **normal** due to **CLT**	B1dep	2	Dependent on previous B1 Requires 'mean' and 'normal' and 'CLT'
(b)	98% (0.98) $\Rightarrow$ $z =$ **2.32 to 2.33**	B1 (B1)		AWFW (2.3263) $t_{79}(0.99) = 2.37$ AWRT
	CI for μ is $\bar{t} \pm z/t \times \frac{s}{\sqrt{n}}$	M1		Used Must have $\sqrt{n}$ with $n > 1$
	Thus $6.31 \pm 2.3263 \times \frac{\sqrt{19.3}}{\sqrt{80}}$	A1F		F on z/t only
	Hence **6.31 ± (1.13 to 1.15)** **or** **(5.16 to 5.18, 7.44 to 7.46)**	A1		CAO and AWFW AWFW (5.17, 7.45)
	Note: Use of t gives 6.31 ± (1.17) **or** (5.14, 7.48)	(A1)	4	AWRT
(c)	$\mu_T < 8$			
	Since **CI / UCL < 8** $\Rightarrow$ **Yes**	B1F		F on (b); must clearly compare 8 with CI/UCL and state a correct follow-through conclusion
	P($T \leq 20$) > 95%			
	P($T > 20$) = **1/80 = 0.1 to 0.013** or P($T \leq 20$) > **79/80 = 0.987 to 0.99**	B1		CAO/AWFW; accept eg '1 in 80' B0 for use of normal distribution CAO/AWFW; accept eg '79 in 80'
	P($T \leq 20$) ≤ **0.05 or 5%** **or** $\Rightarrow$ **Yes** P($T \leq 20$) ≤ **0.95 or 95%**	B1dep	3	Dependent on previous B1 A **correct** comparison must be **clearly** stated together with **clear** conclusion Do **not** accept use of 2% or 98% OE
	Total		**11**	
	TOTAL		**60**	