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

(Specification 6360/6380)

Statistics 1B

Final

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.

Q	Solution	Marks	Total	Comments
1(a)(i)	Mean = **62.2 to 62.3**	B1		AWFW (62.25)
	SD = **17.4 to 17.6 or 16.7 to 16.9**	B1	2	AWFW (17.519 or 16.774)
(ii)				AWFW (16.806)
	Mean = **16.77 to 16.84**	BF1		F on (a)(i) only providing **45 < mean < 65**
	SD = **9.66 to 9.78 or 9.27 to 9.39**	BF2	3	AWFW (9.733 or 9.319) F on (a)(i) only providing **10 < SD < 20**
(b)				CAO
	r_{xy} = **0.997**	B1		Award on value only; ignore any explanation or working $r_{xy} = r_{uv}$ with no value stated $\Rightarrow$ B0
	***r* not affected** by **change(s) in/different units** **or** ***r* not affected** by **linear scaling** **or** **Scaling/coding/transformation/change/ conversion** to *u* and *v* is **linear**	B1	2	Accept 'Formula' or 'It' for *r* and reference to '**linear**' is **not** necessary Accept 'Formula' or 'It' for *r* but reference to '**linear**' is necessary OE; but reference to '**linear**' is necessary
	Total		**7**	

Q	Solution	Marks	Total	Comments
				Accept percentage equivalents in (a)
2(a)(i)	Weight, $X \sim N(421, 2.5^2)$ $P(X = 421) =$ **0 or zero or nought or 0%**	B1		CAO; accept nothing else but ignore additional words providing that they are not contradictory (eg impossible so = 0)
(ii)	$P(X < 425) = P\left(Z < \frac{425 - 421}{2.5}\right)$	M1		Standardising 425 with 421 and 2.5 but allow (421 – 425)
	$= P(Z < 1.6) =$ **0.945 to 0.946**	A1		AWRT (0.94520)
(iii)	$P(418 < X < 424) = P(-a < Z < a) =$			
	$P(Z < a) - (1 - P(Z < a))$ **or** $2 \times P(Z < a) - 1$	M1		OE; $a = 1.2$ or correct standardising are **not** required May be implied by **0.885** (AWRT) **seen anywhere** **or** by a **correct** answer
	$= 0.885 - (1 - 0.885) = 0.885 - 0.115$ **or** $= 2 \times 0.885 - 1$	A1		AWRT (0.88493/0.11507) Implied by a **correct** answer
	$=$ **0.769 to 0.77**	A1	6	AWFW (0.76986)
(b)	$0.98 \Rightarrow z =$ **2.05 to 2.06**	B1		AWFW (2.0537)
	$\left(\frac{x - 421}{2.5}\right) = 2(.0)$ to 2.4	M1		Standardising x with 421 and 2.5 but allow $(421 - x)$; **and** equating to a ***z*-value** (*ignore sign*) May be implied by a **correct** answer
	$x =$ **426 to 426.3**	A1	3	AWFW (426.13) ***Must be consistent signs throughout***
(c)	$0.01 \Rightarrow z =$ **–2.33 to –2.32**	B1		AWFW; (*ignore sign*) (–2.3263)
	$z = \left(\frac{410 - \mu}{3.0 \text{ or } 2.5}\right)$	M1		Standardising 410 with μ and (3.0 or 2.5) but allow $(\mu - 410)$
	$\left(\frac{410 - \mu}{3.0}\right) = -2.6$ to -2.3	A1		Equating to a ***z*-value** (*ignore sign*) May be implied by a **correct** answer
	$\mu =$ **417**	Adep1	4	AWRT (416.98) Dependent on previous A1 ***Must be consistent signs throughout***
	Total		**13**	

Q	Solution	Marks	Total	Comments
				Accept percentage equivalents except for 27
3(a)(i)	$\underline{O \sim \text{B}(40, p)}$			
	$\text{P}(NS \leq 10) = \mathbf{\underline{0.97}}$	B1	1	AWRT (0.9701)
(ii)				Requires '1 –'
	$\text{P}(LPE \geq 25) = \mathbf{\underline{1 - (0.9231 \text{ or } 0.9597)}}$	M1		Accept 3 dp rounding Can be implied by (0.0769 to 0.077) but **not** by (0.04 to 0.0403)
	$= \mathbf{\underline{0.077}}$	A1	2	AWRT (0.0769)
(iii)	$\text{P}(UPE = 2) = \binom{40}{2}(0.175)^2(0.825)^{38}$	M1		Correct expression; may be implied by a **correct** answer Ignore extra terms
	$= \mathbf{\underline{0.016}}$	A1	2	AWRT (0.0160)
(iv)				CAO; award on value only May be implied by any of four probabilities below or by a **correct** answer
	$p = 0.85 - 0.50 = \mathbf{\underline{0.35}}$	B1		
	$\text{P}(10 < X < 15) =$ **0.5721 or 0.6946** (p_1)	M1		Accept 3 dp rounding May be implied by a **correct** answer
	MINUS 0.1215 or 0.0644 (p_2)	M1		Accept 3 dp rounding May be implied by a **correct** answer
	$= \mathbf{\underline{0.45 \text{ to } 0.451}}$	A1	4	AWFW (0.4506)
(b)	$p = 0.85 - 0.175 = \mathbf{\underline{0.675}}$ **or** $p' = \mathbf{\underline{0.325}}$	B1		CAO; may be implied by 27 Each can be found in several ways CAO; may be implied by 13 or 27
	Number $= 40 \times 0.675 = \mathbf{\underline{27}}$	B1	2	CAO; can be found in several ways
	Total		**11**	

Q	Solution	Marks	Total	Comments
4(a)(i)	$r_{gy} = \dfrac{24.15}{\sqrt{0.1196 \times 5880}} =$ **0.91 to 0.911**	M1 A1		May be implied by a **correct** answer in (a)(i) or (a)(ii) or (c)(i) AWFW (0.91067)
(ii)	$r_{ly} = \dfrac{10.25}{\sqrt{0.0436 \times 5880}} =$ **0.64 to 0.641**	A1	3	AWFW (0.64017)
(b)	(Very) **Strong positive** correlation	Bdep1		Dependent on $0.9 \leq r_{gy} < 1$
	(Some) **Moderate positive** correlation	Bdep1		Dependent on $0.6 \leq r_{ly} \leq 0.7$ Bdep0 for any mention of 'strong'
	between girth and weight **and/or** length and weight	B1	3	At least one interpretation in context
(c)(i)	$r_{xy} = \dfrac{5662.97}{\sqrt{5656.15 \times 5880}} =$ **0.98 to 0.982**	B1		AWFW (0.98196)
	Most strongly correlated with y is ***x***	Bdep1	2	CAO; dependent on $0.97 \leq r_{xy} < 1$
(ii)	$x = 69.3 \times 1.25^2 \times 1.15$ = **124 to 125**	M1 A1	2	May be implied by a **correct** answer AWFW (124.52)
(iii)	$b = \dfrac{5662.97}{5656.15}$	M1		116/115.4 (= 1.005) ⇒ M0 A0
	= **1 to 1.002**	A1		AWFW (1.00121)
	$a = 116 - 115.4b =$ **0.3 to 0.6**	B1	3	AWFW (0.46085)
(iv)	r_{xy} ≈/nearly/almost/close to (+)**1 or very strong/almost exact** (positive) **correlation** (Stating r_{xy} =0.98 to 0.982 ⇒ Bdep0)	Bdep1		OE Dependent on $0.97 \leq r_{xy} < 1$ OE; 'strong' is not sufficient
	b =/≈/nearly/almost/close to (+)**1**	Bdep1		OE; must reference value of 1 or unity Dependent on M1 A1 in (c)(iii)
	a ≈/nearly/almost/close to **0** (Stating a = 0.4 to 0.6 ⇒ Bdep0)	Bdep1		OE; must reference value of 0 or origin Dependent on B1 in (c)(iii)
	Estimate (not 'it' or 'this' or 'value', etc) is (very/highly/likely to be) accurate/precise/ reliable **or** (almost) exact/correct	Bdep1	4	OE; dependent on scoring **at least 2** of the previous 3 marks in (c)(iv) Fairly accurate, good approximation, (quite) likely, (very) close, reasonable, etc ⇒ Bdep0
	Total		**17**	

Q	Solution	Marks	Total	Comments
5(a)(i)	$P(A = 2) = 0.90 \times 0.95 =$ **<u>0.85 to 0.86</u>**	B1		AWFW (0.855 or 171/200 OE)
(ii)	$P(A = 1) = (0.90 \times 0.05) + (0.10 \times 0.95)$ **or** $= 1 - [0.855 + (0.10 \times 0.05)]$	M1		May be implied by a **correct** answer Do **not** ignore extra terms
	= **<u>0.14</u>**	A1	3	CAO (7/50 OE)
(b)(i)	$P(A_W \cap D_W) = 0.90 \times 0.80$	M1		May be implied by a **correct** answer
	= **<u>0.72</u>**	A1	2	CAO (18/25 OE)
(ii)	$P(A_B \cap D_B) =$ (b)(i) $\times 0.95$ ($\times 1$) **or** $= 0.90 \times 0.80 \times 0.95$ ($\times 1$) **or** = (a)(i) $\times 0.80$	M1		May be implied by a **correct** answer
	<u>0.68 to 0.685</u>	A1	2	AWFW (0.684 or 171/250 OE)
(iii)	$P(A_T \cap D'_T) = 0.95 \times 0 =$ **<u>0</u>**	B1	1	CAO; award on value only
(iv)	P(neither) = $P([A'_W \cap D'_W] \cap [A'_T \cap D'_T])$			
	$(1 - 0.90) \times (1 - 0.15)$	M1		Accept 0.085 or 17/200 OE Award M1 and m1 on value(s) only
	$(1 - 0.95) \times (1 - 0)$	m1		Accept 0.05 or 1/20 OE
	or P(neither) = $P(A'_W \cap A'_T) \cap P(D'_W \mid A'_W) \cap P(D'_T \mid A'_T)$			
	$(1 - 0.90) \times (1 - 0.95)$	(M1)		Accept 0.005 or 1/200 OE Award M1 and m1 on value(s) only
	$(1 - 0.15) \times (1 - 0)$	(m1)		Accept 0.85 or 17/20 OE
	$= 0.085 \times 0.05$ **or** 0.005×0.85			OE
	= **<u>0.0042 to 0.0043</u>**	A1	3	AWFW (0.00425 or 17/4000 OE)
	Total		**11**	

Q	Solution	Marks	Total	Comments
6(a)(i)	$\bar{x} = \frac{497.5}{25} =$ **<u>19.9</u>**	B1		CAO
	98% (0.98) $\Rightarrow$ $z =$ **<u>2.32 to 2.33</u>**	B1		AWFW (2.3263)
	CI for μ is $\bar{x} \pm z \times \frac{\sigma}{\sqrt{n}}$	M1		Used with z (2.05 to 2.58), $\bar{x}$ (497.5 or 19 to 21) and σ(0.4) and $\div\sqrt{n}$ with $n > 1$
	Thus $19.9 \pm 2.3263 \times \frac{0.4}{\sqrt{25}}$	A1		z (2.05 to 2.06 or 2.32 to 2.33 or 2.57 to 2.58), $\bar{x}$ (19.9) and σ(0.4) and $\div\sqrt{25 \text{ or } 24}$
	Hence **<u>19.9 ± 0.2</u>** **or** **<u>(19.7, 20.1)</u>**	A1	5	CAO/AWRT (0.186104) AWRT
(ii)	**Clear correct comparison** of **20** with **CI** eg 20 is within CI **or** LCL < 20 < UCL so	BF1		F on CI providing it contains 20 Quoting values for CI is **not** required
	Agree with claim **or** no reason to doubt claim	Bdep1	2	OE; dependent on previous BF1
(iii)	**Weight** of sand in a bag or ***X*/*x*** or **original distribution** or **parent population** is **normal**	B1	1	It/mean/data/sample/information/sand is normal $\Rightarrow$ B0 Reference **only to** sample size **or** standard deviation $\Rightarrow$ B0

Q	Solution	Marks	Total	Comments
				Accept percentage equivalent probabilities
6(b)(i)	$\underline{Y \sim \text{N}(25.25,\ 0\ 35^2)}$			
	V(mean) = **$\underline{0.35^2/10$ or 0.0122 to 0.0123}$** **or** SD (mean) = **$\underline{0.35/\sqrt{10}$ or 0.11 to 0.111}$**	B1		CAO/AWFW (0.01225) CAO/AWFW (0.11068)
	$\text{P}\left(\bar{Y} < 25\right) = \text{P}\left(Z < \frac{25 - 25.25}{0.35/\sqrt{10}}\right)$	M1		Standardising 25 using 25.25 and **$0.35/\sqrt{10}$ OE** but allow (25.25 – 25)
	$= \text{P}(Z < -2.25877) = 1 - \text{P}(Z < 2.25877)$	m1		**Correct** area change May be implied by a **correct** answer **or** an answer **< 0.5**
	$= 1 - (0.98809 \text{ to } 0.98778)$			
	$= \underline{\textbf{0.011 to 0.013}}$	A1	4	AWFW (0.01195) (0.987 to 0.989) ⇒ B1 M1 m0 A0
(ii)	$\text{P}\left(Y > 25\right) = \text{P}\left(Z > \frac{25 - 25.25}{0.35}\right)$	M1		Standardising 25 using 25.25 and 0.35 but allow (25.25 – 25)
	$= \text{P}(Z > -0.71429) = \text{P}(Z < 0.71429)$			
	$= \underline{\textbf{0.761 to 0.764}}$	A1		AWFW (0.76247) (0.236 to 0.239) ⇒ M1 A0
	$\text{P}(Y > 25 \text{ in each of } 10) = \underline{\boldsymbol{p}^{10}}$	M1		Any p^{10} providing $0 < p < 1$ May be implied by a **correct** answer
	$= \underline{\textbf{0.065 to 0.068}}$	A1	4	AWFW (0.06641)
	Total		**8**	
	TOTAL		**75**	