

**General Certificate of Education (A-level)
June 2013**

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

Q	Solution	Marks	Total	Comments
2(a)(i)	Weight, $X \sim N(421, 2.5^2)$			Accept percentage equivalents in (a)
	$P(X = 421) = \underline{\mathbf{0 \text{ or zero or nought or } 0\%}}$	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)
	$= P(Z < 1.6) = \underline{\mathbf{0.945 \text{ to } 0.946}}$	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
	$= \underline{\mathbf{0.769 \text{ to } 0.77}}$	A1	6	AWFW (0.76986)
	(b) $0.98 \Rightarrow z = \underline{\mathbf{2.05 \text{ to } 2.06}}$	B1		AWFW (2.0537)
	$\left(\frac{x - 421}{2.5}\right) = 2(.0) \text{ to } 2.4$	M1		Standardising x with 421 and 2.5 but allow (421 - x); and equating to a z-value (<i>ignore sign</i>) May be implied by a correct answer
$x = \underline{\mathbf{426 \text{ to } 426.3}}$	A1	3	AWFW (426.13) Must be consistent signs throughout	
(c) $0.01 \Rightarrow z = \underline{\mathbf{-2.33 \text{ to } -2.32}}$	B1		AWFW; (<i>ignore sign</i>) (-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 ($\mu - 410$)	
$\left(\frac{410 - \mu}{3.0}\right) = -2.6 \text{ to } -2.3$	A1		Equating to a z-value (<i>ignore sign</i>) May be implied by a correct answer	
$\mu = \underline{\mathbf{417}}$	Adepl	4	AWRT (416.98) Dependent on previous A1 Must be consistent signs throughout	
	Total		13	

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

Q	Solution	Marks	Total	Comments
4(a)(i)	$r_{gy} = \frac{24.15}{\sqrt{0.1196 \times 5880}} = \underline{\mathbf{0.91 \text{ to } 0.911}}$	M1 A1		May be implied by a correct answer in (a)(i) or (a)(ii) or (c)(i) AWFW (0.91067)
(ii)	$r_{ly} = \frac{10.25}{\sqrt{0.0436 \times 5880}} = \underline{\mathbf{0.64 \text{ to } 0.641}}$	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)	$r_{xy} = \frac{5662.97}{\sqrt{5656.15 \times 5880}} = \underline{\mathbf{0.98 \text{ to } 0.982}}$	B1		AWFW (0.98196)
	Most strongly correlated with y is <u>x</u>	Bdep1	2	CAO; dependent on $0.97 \leq r_{xy} < 1$
(ii)	$x = 69.3 \times 1.25^2 \times 1.15 = \underline{\mathbf{124 \text{ to } 125}}$	M1 A1	2	May be implied by a correct answer AWFW (124.52)
(iii)	$b = \frac{5662.97}{5656.15} = \underline{\mathbf{1 \text{ to } 1.002}}$	M1 A1		116/115.4 (= 1.005) \Rightarrow M0 A0 AWFW (1.00121)
	$a = 116 - 115.4b = \underline{\mathbf{0.3 \text{ to } 0.6}}$	B1	3	AWFW (0.46085)
(iv)	$r_{xy} \approx/\text{nearly}/\text{almost}/\text{close to } (+)\mathbf{1}$ or very strong/almost exact (positive) correlation (Stating $r_{xy} = 0.98 \text{ to } 0.982 \Rightarrow$ Bdep0)	Bdep1		OE Dependent on $0.97 \leq r_{xy} < 1$ OE; 'strong' is not sufficient
	$b \approx/\text{nearly}/\text{almost}/\text{close to } (+)\mathbf{1}$	Bdep1		OE; must reference value of 1 or unity Dependent on M1 A1 in (c)(iii)
	$a \approx/\text{nearly}/\text{almost}/\text{close to } \mathbf{0}$ (Stating $a = 0.4 \text{ to } 0.6 \Rightarrow$ 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 \Rightarrow Bdep0
	Total		17	

Q	Solution	Marks	Total	Comments
5(a)(i)	$P(A = 2) = 0.90 \times 0.95 = \underline{0.85 \text{ to } 0.86}$	B1		AWFW (0.855 or 171/200 OE)
(ii)	$P(A = 1) = (0.90 \times 0.05) + (0.10 \times 0.95)$ or $= 1 - [0.855 + (0.10 \times 0.05)]$ $= \underline{0.14}$	M1 A1	3	May be implied by a correct answer Do not ignore extra terms CAO (7/50 OE)
(b)(i)	$P(A_W \cap D_W) = 0.90 \times 0.80$ $= \underline{0.72}$	M1 A1	2	May be implied by a correct answer 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 $= (a)(i) \times 0.80$ $\underline{0.68 \text{ to } 0.685}$	M1 A1	2	May be implied by a correct answer AWFW (0.684 or 171/250 OE)
(iii)	$P(A_T \cap D'_T) = 0.95 \times 0 = \underline{0}$	B1	1	CAO; award on value only
(iv)	$P(\text{neither}) = P([A'_W \cap D'_W] \cap [A'_T \cap D'_T])$ $(1 - 0.90) \times (1 - 0.15)$ $(1 - 0.95) \times (1 - 0)$ or $P(\text{neither}) = P(A'_W \cap A'_T) \cap P(D'_W A'_W) \cap P(D'_T A'_T)$ $(1 - 0.90) \times (1 - 0.95)$ $(1 - 0.15) \times (1 - 0)$ $= 0.085 \times 0.05 \text{ or } 0.005 \times 0.85$ $= \underline{0.0042 \text{ to } 0.0043}$	M1 m1 (M1) (m1) A1	3	Accept 0.085 or 17/200 OE Award M1 and m1 on value(s) only Accept 0.05 or 1/20 OE Accept 0.005 or 1/200 OE Award M1 and m1 on value(s) only Accept 0.85 or 17/20 OE OE 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 $\div\sqrt{25}$ or 24
	Hence <u>19.9 \pm 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 Agree with claim or no reason to doubt claim	BF1		F on CI providing it contains 20 Quoting values for CI is not required	
(iii) Weight of sand in a bag or X/x or original distribution or parent population is normal	Bdep1	2	OE; dependent on previous BF1	
	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	
6(b)(i)	$Y \sim N(25.25, 0.35^2)$			Accept percentage equivalent probabilities	
	V(mean) = <u>$0.35^2/10$ or 0.0122 to 0.0123</u> or	B1		CAO/AWFW (0.01225)	
	SD (mean) = <u>$0.35/\sqrt{10}$ or 0.11 to 0.111</u>			CAO/AWFW (0.11068)	
	$P(\bar{Y} < 25) = P\left(Z < \frac{25 - 25.25}{0.35/\sqrt{10}}\right)$	M1		Standardising 25 using 25.25 and $0.35/\sqrt{10}$ OE but allow (25.25 - 25)	
	= $P(Z < -2.25877) = 1 - P(Z < 2.25877)$	m1		Correct area change May be implied by a correct answer or an answer < 0.5	
	= $1 - (0.98809 \text{ to } 0.98778)$				
	= <u>0.011 to 0.013</u>	A1	4	AWFW (0.01195) (0.987 to 0.989) \Rightarrow B1 M1 m0 A0	
	(ii)	$P(Y > 25) = P\left(Z > \frac{25 - 25.25}{0.35}\right)$	M1		Standardising 25 using 25.25 and 0.35 but allow (25.25 - 25)
		= $P(Z > -0.71429) = P(Z < 0.71429)$			
		= <u>0.761 to 0.764</u>	A1		AWFW (0.76247) (0.236 to 0.239) \Rightarrow M1 A0
$P(Y > 25 \text{ in each of } 10) = p^{10}$		M1		Any p^{10} providing $0 < p < 1$ May be implied by a correct answer	
	= <u>0.065 to 0.068</u>	A1	4	AWFW (0.06641)	
	Total		8		
	TOTAL		75		