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General Certificate of Education (A-level)
January 2012

Mathematics MS/SS1A

(Specification 6360)

Statistics 1A

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.

MS/SS1A/W

Q	Solution	Marks	Total	Comments
1				
(a)	$\underline{U \sim B(40,\ 0.15)}$	M1		Used somewhere in (a)
(i)	$P(U = 6) = 0.6067 - 0.4325$ or $= \binom{40}{6}(0.15)^6(0.85)^{34}$	M1		Accept 3 dp rounding or truncation Can be implied by a correct answer
	$= 0.174$	A1	3	AWRT (0.1742)
(ii)	$P(U \leq 5)$ $= 0.432$ to 0.433	B1	1	AWFW (0.4325)
(iii)	**See supplementary sheet for individual probabilities**			
	$P(5 < U < 10) = 0.9328$ or 0.9701 (p_1)	M1		Accept 3 dp rounding or truncation but allow 0.97 $p_2 - p_1 \Rightarrow$ M0 M0 A0 $(1-p_2) - p_1 \Rightarrow$ M0 M0 A0 $p_1 - (1-p_2) \Rightarrow$ M1 M0 A0 $(1-p_2) - (1-p_1) \Rightarrow$ M1 M1 (A1) only providing result > 0
	MINUS 0.4325 or 0.2633 (p_2)	M1		Accept 3 dp rounding or truncation
	$= 0.5(00)$ to 0.501	A1	3	AWFW (0.5003)
(b)	Mean or $\mu = 32 \times 0.15$ $= 4.8$	B1		CAO
	(V or σ^2 =) $\underline{32 \times 0.15 \times 0.85}$ or (SD or σ =) $\underline{\sqrt{32 \times 0.15 \times 0.85}}$	M1		Either numerical expression; ignore terminology May be implied by 4.08 CAO seen or 2.02 AWRT seen
	(SD or σ) = 2.02	A1	3	AWRT (2.0199) Do not award if labelled V or σ^2
		Total	**10**	

MS/SS1A/W (cont)

Q	Solution	Marks	Total	Comments
2(a) (i)	Weight, $X \sim N(2200, 160^2)$			
	$P(X < 2500) = P\left(Z < \frac{2500-2200}{160}\right)$	M1		Standardising 2500 with 2200 and 160; allow $(2200 - 2500)$
	$= P(Z < 1.87 \text{ to } 1.88)$	A1		AWFW; ignore inequality and sign May be implied by a correct answer
	$= 0.969 \text{ to } 0.97(0)$	A1	3	AWFW (0.96960)
(ii)	$P(X > 2000) = P(Z > -1.25)$			
	$= P(Z < +1.25)$	M1		Area change May be implied by a correct answer or an answer > 0.5
	$= 0.894 \text{ to } 0.895$	A1	2	AWFW (0.89435)
(iii)				OE; allow new start ignoring (i) & (ii)
	$P(2000 < X < 2500) =$ (i) – (1 – (ii))	M1		Allow even if incorrect standardising providing $0 <$ answer < 1 May be implied by a correct answer
	$= 0.96960 - (1 - 0.89435) = 0.863 \text{ to } 0.865$	A1	2	AWFW (0.86395)
	Note: If (ii) is 0.105 to 0.106, then $(0.96960 - 0.10565) = 0.86395 \Rightarrow$ M0 A0			
(b)	$10\% \Rightarrow 90\% (0.90) \Rightarrow z = 1.28$	B1		AWRT (1.2816)
	$z = \frac{1000-1125}{\sigma}$	M1		Standardising 1000 with 1125 and σ; allow $(1125 - 1000)$
	$= -1.2816$	A1		Only allow: ±1.28 ±1.64 to ±1.65 ±2.32 to ±2.33
	$\sigma = 97 \text{ to } 98$	A1	4	AWFW (97.53433)
	Note: Inconsistent signs $\Rightarrow$ B1 M1 A1 A0 max			
		Total	**11**	

MS/SS1A/W (cont)

Q	Solution	Marks	Total	Comments
3	**See supplementary sheet for alternative solutions and additional guidelines to parts (a), (c) and (d)**			
(a)	b (gradient) = –0.076 b (gradient) = –0.07 to –0.08	B2 (B1)		AWRT; including –ve sign (–0.07582) AWFW; including –ve sign *Treat rounding of correct answers as ISW*
	a (intercept) = 5.35 to 5.36 a (intercept) = 5.1 to 5.6	B2 (B1)		AWFW (5.35385) AWFW
	Thus y = (5.35 to 5.36) –0.076x	BF1	5	F on a and b even if rounded
(b)	a: calorific value of wood with zero/no moisture or dry maximum calorific value	B1		OE; $a \leq 0 \Rightarrow$ B0
	b: each 1(%) rise in moisture content reduces calorific value by 0.076 MWh/tonne	B2	3	In context and with values; F on b $b \geq 0 \Rightarrow$ B0
	As x increases y decreases	(B1)		Negative relationship/correlation
(c)	y_{27} = 3.28 to 3.32 = 2.5 to 3.5	B2 (B1)	**2**	AWFW (3.30659) AWFW; even if by interpolation from original data giving likely values of 3 or 3.04
(d)	r(35, 2.5) = –0.21 to –0.19 = 0.1 to 0.3	B2 (B1)	2	AWFW; including –ve sign (–0.20000) AWFW; ignore sign
(e)	Good/reasonable/accurate/correct/etc Accept more positive qualifying adjectives	B1	1	OE; ignore reasoning Very good (B1) Not good (B0)
			13	

MS/SS1A/W (cont)

Q	Solution	Marks	Total	Comments
4	**See supplementary sheet for alternative solutions to parts (a)(i) and (b)(ii)**			
(a)(i)	Table Method (2- way with either R or C totals) *A* | *A′* | **Total** ***E*** | 0.55 | **0.05** | 0.60 ***E′*** | **0.30** | **0.10** | **0.40** **Total** | 0.85 | **0.15** | 1.00	B1 B1 Bdep1	3	0.15 or 0.4; CAO; allow fractions 0.05 and 0.3; CAO; allow fractions 0.1; AG so dependent on B1 B1
(ii)	P(≥1) = 0.9 or 9/10	B1	1	CAO
(iii)	P(1) = 0.3 + 0.05 = 1 – (0.55 + 0.10) = 0.35 or 35/100 or 7/20	B1	1	CAO
(b)(i)	P(3) = 0.55 × 0.30 = 0.165 or 165/1000 or 33/200	B1 B1	2	OE; implied by correct answer CAO
(ii)	0.55 × (1 – 0.3) or 0.385 (0.3 × 0.75) or 0.225 or (0.05 × 0.75) or 0.0375 or (0.35 × 0.75) or 0.2625 (0.385 + 0.2625) + 0.165 = 0.812 to 0.813	M1 M1 B1 A1	4	At least one of these expressions or values OE; implied by correct answer AWFW (0.8125) CAO; for equivalent fraction
		Total	**11**	

Q	Solution	Marks	Total	Comments
5	151.5 cm = 1.515 m ≈ 1.5 m Thus (could be) correct n × 26.6 > 10 Thus (likely to be) incorrect	B1 Bdep1 B1 Bdep1	4	OE OE; dependent on B1 OE; accept any $n \geq 1$ OE; dependent on B1
			4	

MS/SS1A/W (cont)

Q	Solution	Marks	Total	Comments
6(a)	**See supplementary sheet for alternative solutions**			
	$\bar{x} - ns = (45.8 - n \times 24.0) < 0$ SC: Accept quoted values of (–4 to –1) ($n = 2$) or (–28.5 to –23.5) ($n = 3$) (both AWFW) and	M1		Allow (45 to 47) and any multiple of (23.5 to 24.5) which gives value < 0 Must clearly state the value of a numerical expression
	negative salaries are impossible	A1	2	OE; must be in context Negative values impossible ⇒ A0
(b)(i)	Large sample or $n > 25$ or 30 or $n = 50$ so	B1		OE
	CLT applies	Bdep1	2	Must indicate CLT; dependent on B1 Indication that other than sample mean is normally distributed ⇒ Bdep0
(ii)	99% (0.99) ⇒ z = 2.57 to 2.58	B1		AWFW (2.5758)
	CI for μ is $\bar{x} \pm z \times \frac{s}{\sqrt{n}}$	M1		Used with (45.8 & 24.0) and z(1.64 to 2.58) & $\div\sqrt{n}$ with $n > 1$
	Thus $45.8 \pm 2.5758 \times \frac{24.0}{\sqrt{50}}$	AF1		F on z(1.64 to 1.65 or 2.32 to 2.33 or 2.57 to 2.58) and $\div\sqrt{50 \text{ or } 49}$
	Hence 45.8 ± (8.7 to 8.8) or 45800 ± (8700 to 8800) OR (37.(0) to 37.1, 54.5 to 54.6) or (37000 to 37100, 54500 to 54600)	A1	4	CAO/AWFW (8.74) Ignore (absence of) quoted units AWFW
(c)	**See supplementary sheet for additional illustrations**			
	Clear correct comparison of 55 or 55000 with c's UCL or CI	B1		Accept 55000 compared with c's 54.5 to 54.6 (ie different units)
	(6/50 or 0.12 or 12%) </≠ 0.25 or 25%	B1		OE; correct comparison mentioning both 12% and 25%
	Reject both/each of the two claims	Bdep1	3	Dependent on B1 B1
		Total	**11**	

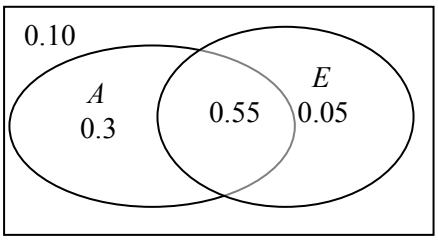
MS/SS1A/W (cont)

Q	Solution	Marks	Total	Comments
1	**Alternative solution**			
(a)(iii)	B(40, 0.15) expressions stated for at least 3 terms within $5 \leq U \leq 10$ gives probability = 0.5(00) to 0.501	M2 A1	**3**	Can be implied by a correct answer AWFW (0.5003)

u	(5)	6	7	8	9	(10)
$P(U = u)$	(0.1692)	0.1742	0.1492	0.1087	0.0682	(0.0373)

Q	Solution	Marks	Total	Comments
3	**Alternative solutions and additional guidelines**			
(a)	Attempt at $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$ $\left(\sum y^2\right)$ **or** Attempt at S_{xx} & S_{xy} $\left(S_{yy}\right)$	M1		455 20475 35.1 & 883.5 (121.33) (all 4 attempted) 4550 & **–345** (26.56) (both attempted)
	Attempt at correct formula for b (gradient) b (gradient) = –0.076 a (intercept) = 5.35 to 5.36 Thus y = (5.35 to 5.36) –0.076x	m1 A1 A1 BF1	5	AWRT AWFW F on a and b even if rounded
	Notes: 1 If a and b interchanged and equation $y = ax + b$ used ⇒ max of 5 marks 2 If a and b interchanged and equation $y = a + bx$ used ⇒ maximum of BF1 3 Marks lost here cannot be gained from subsequent work in parts (d) and/or (e)			If a and b are not identified anywhere in equation, then: –0.07 to –0.08 ⇒ B1 5.1 to 5.6 ⇒ B1
(c)	y_{27} = (5.35 to 5.36) –0.076 × 27 = 3.28 to 3.32	M1 A1	2	Clear evidence of correct use of c's equation with $x = 27$ AWFW (3.30659)
(d)	$r(35, 2.5) = 2.5 - y_{35}$ = 2.5 – {(5.35 to 5.36) –0.076 × 35} = –0.21 to –0.19	M1 A1	2	Used; allow $y_{35} - 2.5$ AWFW (–0.20000)

MS/SS1A/W (cont)

Q	Solution	Marks	Total	Comments
4	**Alternative solutions**			
(a)(i)	Venn Diagram Method  	B1 B1 Bdep1	 3	0.55; CAO 0.3 and 0.05; CAO 0.1; AG so dependent on B1 B1
(a)(i)	Formula Method P(≥1) = 0.85 + 0.60 – 0.55 OR 0.85 + 0.60 – 0.55 + p = 1 OR 0.15 + 0.40 – 0.45 P(0) = 1 – P(≥1) OR = 1 – 0.9 = 0.1 0.9 + p = 1 OR = 0.1	M2 (M1) A1	 3	Full justification for numerical expression Insufficient justification or numerical expression only AG; gained from M2 or M1
(b)(ii)	0.1 × (1 – 0.4) or 0.06 (0.3 × 0.25) or 0.075 or (0.05 × 0.25) or 0.0125 or (0.35 × 0.25) or 0.0875 or (0.1 × 0.4) or 0.04 1 – (0.1875) = 0.812 to 0.813	M1 M1 B1 A1	 4	 At least one of these expressions or values OE; implied by correct answer AWFW (0.8125) CAO for equivalent fraction
(b)(ii)	($0.55 + p$) where $0 < p < 0.45$ (0.3 × 0.75) or 0.225 or (0.05 × 0.75) or 0.0375 or (0.35 × 0.75) or 0.2625 0.55 + 0.2625 = 0.812 to 0.813	M1 M1 B1 A1	 4	 At least one of these expressions or values OE; implied by correct answer AWFW (0.8125) CAO for equivalent fraction

MS/SS1A/W (cont)

Q	Solution	Marks	Total	Comments
6(a)	**Alternative solutions**			
	$P(X < 0 \mid N(45.8, 24.0^2)) = P(Z < -1.91)$	M1		Standardising 0 using 45.8 & 24.0
	$= 0.027$ to 0.03	A1	2	In addition to probability within range, must state that negative salaries are impossible
	$P(X > 60 \mid N(45.8, 24.0^2)) = P(Z > 0.59)$	M1		Standardising 60 using 45.8 & 24.0
	$= 0.27$ to 0.28	A1	2	In addition to probability within range, must compare calculated value to 6/50 = 0.12 OE
(c)	**Additional comment illustrations**			
	It/(claimed) mean/(claimed) value > UCL/CI	B0		Must indicate 55 or 55000
	99% have (mean) weights between CLs so ...	B0		
	Any comparison of 60 (£60 000) with UCL/CI	B0		Value of 60 does not refer to mean
	$P(X > 60 \mid N(45.8, 24.0^2)) = P(Z > 0.59)$ $= (0.27$ to $0.28) > 6/50 = 0.12$	B0		Assumes salaries ~ N; cf (a)(ii)