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

(Specification 6360)

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.

MS/SS1B

Q	Solution	Marks	Total	Comments
1				
(a)	Median = 10	B1		CAO
	Upper quartile = 11	B1		CAO; either
	Lower quartile = 9			May be implied by IQR = 2
	Interquartile range = 2	B1	3	CAO; do not award if seen to be not based on 11 and 9
(b)	Do not group results **Illustrations for B1:** Use all values Replace ≤ 6 by or use (0), 1, ..., 6 Replace ≥ 12 by or use 12, 13, ... Record exact values/frequencies	B1	1	OE statement that implies non grouping **or** recording of all separate observed values **Illustrations for B0:** Record max and/or min values Construct frequency table Use 1, 2 or 12, 13
		Total	**4**	

Q	Solution	Marks	Total	Comments
2				
(a)	Probably correct	B1		CAO; accept minimum of PC or Pc or pC or pc
(b)	Definitely incorrect	B1		CAO; accept minimum of DI or Di or dI or di
(c)	Probably incorrect	B1	3	CAO; accept minimum of PI or Pi or pI or pi
	Notes: Ignore reasoning in all parts, unless it includes 2 of the 4 statements in which case $\Rightarrow$ B0 If answers not labelled, then assume above order			Definitely wrong, etc $\Rightarrow$ B0 Likely correct, etc $\Rightarrow$ B0
		Total	**3**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
3(a) (i)	Volume, $X \sim N(32, 10^2)$			
	$P(X < 40) = P\left(Z < \frac{40-32}{10}\right)$	M1		Standardising 40 with 32 and 10; allow $(32 - 40)$
	$= P(Z < 0.8)$	A1		CAO; ignore inequality and sign May be implied by a correct answer
	$= 0.788$	A1	3	AWRT (0.78814)
(ii)	$P(X > 25) = P(Z > -0.7)$			
	$= P(Z < +0.7)$	M1		Area change May be implied by a correct answer or an answer > 0.5
	$= 0.758$	A1	2	AWRT (0.75804)
(iii)	$P(25 < X < 40) =$ (i) – (1 – (ii)	M1		OE; allow new start ignoring (i) & (ii) Allow even if incorrect standardising providing 0 < answer < 1 May be implied by a **correct** answer
	$= 0.78814 - (1 - 0.75804) = 0.546$ **Note:** If (ii) is 0.242, then $(0.788 - 0\ 242) = 0.546 \Rightarrow$ M0 A0	A1	2	AWRT (0.54618)
(b)	$P(B > £65) =$ $P\left(Z > \frac{48.5-32}{10}\right)$ or $P\left(Z > \frac{65-42.88}{13.4}\right)$	M1		Attempt to change from B to X using (48 to 49), 32 and 10 or Attempt to work with distribution of B using 65, (42.8 to 42.9) and 13.4
	$= P(Z > 1.65) = 1 - P(Z < 1.65)$	m1		Area change May be implied by a correct answer or an answer < 0.5
	$= 1 - 0.95053 = 0.049$ to $0.05(0)$	A1	3	AWFW (0.04947)
(c)	Other **fuels** Other **vehicles** with an example (not other cars) Other types of **customer** Minimum purchase (policy) Purchases in integer/fixed £s Customers filling fuel cans	B2,1	2	Size of car/engine/fuel tank $\Rightarrow$ B0 Price of fuel $\Rightarrow$ B0 Customer paying capacity $\Rightarrow$ B0 Must be **two clearly different** valid reasons for award of B2 Drivers and vehicles related $\Rightarrow$ B1 eg lorry drivers & lorries
		Total	**12**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
4(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
(c)	Mean = 7.7	B1		CAO $\left(\sum x = 77\right)$
	SD = 1.26 to 1.34	B1		AWFW $\left(\sum x^2 = 609\right)$
	(Sample) mean is bigger / greater / different or $7.7/32 = 0.24 > 0.15$ and (Sample) SD is smaller / less / different	Bdep1		Both; dependent on all previous 5 marks of B1 M1 A1 B1 B1 Can be scored for incorrect (b) re-done correctly in (c) Means & SDs different $\Rightarrow$ Bdep0
	So model appears unsuitable	Bdep1	4	OE; dependent on Bdep1
		Total	**14**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
5	**See supplementary sheet for alternative solutions and additional guidelines to parts (b), (d) and (e)**			
(a)	Calorific value depends upon moisture content Moisture (content) is set/are fixed values	B1	1	Must be in context; **not** "it", etc Use of x and y $\Rightarrow$ B0
(b)	b (gradient) = –0.076 b (gradient) = –0.07 to –0.08 a (intercept) = 5.35 to 5.36 a (intercept) = 5.1 to 5.6 Thus y = (5.35 to 5.36) –0.076x	B2 (B1) B2 (B1) BF1	5	AWRT; including –ve sign (–0.07582) AWFW; including –ve sign *Treat rounding of correct answers as ISW* AWFW (5.35385) AWFW F on a and b even if rounded
(c)	a: calorific value of wood with zero/no moisture or dry maximum calorific value b: each 1(%) rise in moisture content reduces calorific value by 0.076 MWh/tonne As x increases y decreases	B1 B2 (B1)	3	OE; $a \leq 0$ $\Rightarrow$ B0 In context and with values; F on b $b \geq 0$ $\Rightarrow$ B0 Negative relationship/correlation
(d)	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
(e)	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
(f)	Good/reasonable/accurate/correct/etc Accept more positive qualifying adjectives	B1	1	OE; ignore reasoning Very good (B1) Not good (B0)
(g)(i)	Extrapolation/outside (observed) range (of x)	B1	1	OE
(ii)	y_{80} = –0.5 to –1 Negative value for calorific value is impossible or More energy needed than is generated	B1 Bdep1	2	AWFW (–0.71209) OE; dependent on B1 Must be in context; negative value impossible $\Rightarrow$ Bdep0
		Total	**17**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
6	**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 or $\frac{8125}{10000}$ or $\frac{1625}{2000}$ or $\frac{325}{400}$ or $\frac{65}{80}$ or $\frac{13}{16}$	M1 M1 B1 A1	 4	 At least one of these expressions or values OE; implied by correct answer AWFW (0.8125) CAO
		Total	**11**	

MS/SS1B (cont)

Q	Solution	Marks	Total	Comments
7(a)				
(i)	$\bar{x} = \frac{2290}{50}$ = 45.8 or 45800	B1		CAO
	$\left(s^2 =\right)\frac{28225.5}{49 \text{ or } 50}$ **or** $\left(s =\right)\sqrt{\frac{28225.5}{49 \text{ or } 50}}$	M1		Ignore notation
	s = 24(.0) or 24000 to 24001	A1	3	AWRT/AWFW (24.00064) (σ = 23.75942)
	SCs: (for no seen working) M1 A1 for 24.0 or 24000 to 24001 M1 A0 for 24 or 23700 to 23800			
(ii)	**See supplementary sheet for alternative solutions**			
	$\bar{x} - ns = \left(45.8 - n \times 24.0\right) < 0$ 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 ($\bar{x}$ & s) from (a)(i) 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 ($\bar{x}$ & s) with $\div\sqrt{50 \text{ or } 49}$ & z(1.64 to 1.65 or 2.32 to 2.33 or 2.57 to 2.58)
	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	**14**	

MS/SS1B (cont)

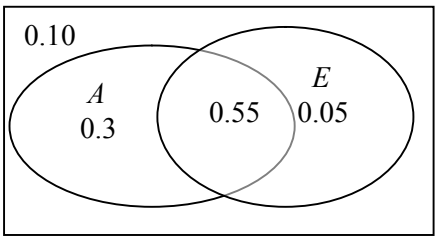
Q	Solution	Marks	Total	Comments
4	**Alternative solution**			
(a)(iii)	B(40, 0.15) expressions stated for at least 3 terms within $5 \leq U \leq 10$ gives probability = 0.5(00) to 0.501	M2 A1		Can be implied by a correct answer AWFW (0.5003)

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

			3	

Q	Solution	Marks	Total	Comments
5	**Alternative solutions and additional guidelines**			
(b)	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		 AWRT AWFW F on a and b even if rounded
	Notes: **1** If a and b interchanged and equation $y = ax + b$ used $\Rightarrow$ max of 5 marks **2** If a and b interchanged and equation $y = a + bx$ used $\Rightarrow$ maximum of BF1 **3** Marks lost here cannot be gained from subsequent work in parts (d) and/or (e)		5	If a and b are not identified anywhere in equation, then: –0.07 to –0.08 $\Rightarrow$ B1 5.1 to 5.6 $\Rightarrow$ B1
(d)	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)
(e)	$r(35, 2.5) = 2.5 - y_{35}$ = 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/SS1B (cont)

Q	Solution	Marks	Total	Comments
6	**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 $P(\geq 1) = 0.85 + 0.60 - 0.55$ OR $0.85 + 0.60 - 0.55 + p = 1$ OR $0.15 + 0.40 - 0.45$ $P(0) = 1 - P(\geq 1)$ 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)	$0.1 \times (1 - 0.4)$ 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/SS1B (cont)

Q	Solution	Marks	Total	Comments
7 (a)(ii)	**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)