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# A-LEVEL

# Statistics

SS1B – Statistics 1B  
Mark scheme

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6380

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Version/Stage: 1.0 Final

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Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from [aqa.org.uk](http://aqa.org.uk)

**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.**

**General Notes for SS1B**

- GN1** There is no allowance for misreads (MR) or miscopies (MC) unless specifically stated in a question.
- GN2** In general, a correct answer (to accuracy required) without working scores full marks but an incorrect answer (or an answer not to required accuracy) scores no marks.
- GN3** In general, a correct answer (to accuracy required) without units scores full marks.
- GN4** When applying AFWF, a slightly inaccurate numerical answer that is subsequently rounded to fall within the accepted range cannot be awarded full marks.
- GN5** Where percentage equivalent answers are permitted in a question, then penalise by **one accuracy mark** at the first **correct** answer but only if no indication of percentage (eg %) is shown.
- GN6** In questions involving probabilities, do **not** award **accuracy** marks for answers given in the form of a ratio or odds such as 13/47 given as 13:47 or 13:34 .
- GN7** Accept decimal answers, providing that they have **at least two** leading zeros, in the form  $c \times 10^{-n}$  (eg 0.00321 as  $3.21 \times 10^{-3}$ ).
- GN8** **Where a candidate's response to a part of a question is simply to label the part (eg (d)(i)) with nothing else (ie no attempt at a solution), then this is still treated as a response and marked as 0 rather than NR. Also, deleted work, if not replaced, should be marked and not treated as NR.**

Q	Solution	Mark	Total	Comment
<b>1(a)</b>				
(i)	SD1: $r = \underline{-0.99 \text{ to } -1(.00)}$	B1		AWFW (-1.00000)
(ii)	SD2: $r = \underline{0.75 \text{ to } 0.95}$	B1		AWFW (0.89935)
			<b>2</b>	
<b>(b)</b>				
(i)	SD3: Data/relationship/graph is <b>non-linear/curved/parabolic</b>	B1		OE; two relationships/correlations
(ii)	SD4: No correlation if <b>outlier</b> ignored Correlation caused only by <b>outlier</b>	B1		OE; must reference 'outlier' or 'anomaly'
			<b>2</b>	
<b>(c)</b>				
(i)	<b>Possibly correct</b>	B1		CAO; ignore reasoning/explanation
(ii)	<b>Probably incorrect</b>	B1		CAO; ignore reasoning/explanation
(iii)	<b>Definitely incorrect</b>	B1		CAO; ignore reasoning/explanation
			<b>3</b>	
		<b>Total</b>	<b>7</b>	

Q	Solution	Marks	Total	Comments
<b>2</b>				
<b>(a)</b>	Mid-points: <b>1 3 5 7 9 12.5 17.5 25</b>	B1		CAO; $\geq 5$ correct or can be implied by mean = 10.0 to 10.8
	Mean = <b>10.6</b>	B1		CAO ( $\sum x = 1060$ )
	Sd(n) = <b>5.81 to 5.82</b>	B2		AWFW (5.812912)
<b>or</b>	Sd(n-1) = <b>5.84 to 5.85</b>	B2		AWFW ( $\sum x^2 = 14615$ )
<b>or</b>	Sd(n) or Sd(n-1) = <b>5.6 to 6.0</b>	(B1)		AWFW (5.842201)
			<b>4</b>	
<b>Notes</b>	1 Where no method is shown for mean and standard deviation, then simply mark numerical values stated 2 If an incorrect method for mean is followed by a numerically correct value $\Rightarrow$ B1 B1 3 If an incorrect method for standard deviation is followed by a numerically correct value $\Rightarrow$ 2 solutions so B2 becomes B1 or (B1) becomes (B0)			
<b>(b)</b>	Mean = $1.85 + 1.3 \times [\text{mean in (a)}]$	m1		<b>Dep on</b> mean(a) = 10.0 to 10.8 <b>or</b> mean(b) = 15.37 to 15.89
	= <b>15.63 or 1563</b>	A1		CAO; units (£/p) can be assumed
	Standard deviation = $1.3 \times [\text{sd in (a)}]$	m1		<b>Dep on</b> sd(a) = 5.6 to 8.2
	= <b>7.55 or 7.56 or 7.59 or 7.60</b>	A1		CAO; units (£/p) can be assumed
<b>or</b>	= <b>755 or 756 or 759 or 760</b>	A1		(7.556792 or 7.594861)
			<b>4</b>	
		<b>Total</b>	<b>8</b>	

Q	Solution	Mark	Total	Comment
<b>3</b> <b>(a)(i)</b>	$P(X < 377.5) = P\left(Z < \frac{377.5 - 365.0}{10.0}\right) =$ $P(Z < 1.25) = \underline{\mathbf{0.894}}$	M1 A1	(2)	Standardising <b>377.5</b> with <b>365</b> and <b>10</b> but allow (365 – 372.5) AWRT (0.89435)
<b>(ii)</b>	$P(X > 367.5) = P(Z > 0.25) =$ $1 - P(Z < 0.25) = 1 - 0.59871$ $= \underline{\mathbf{0.401}}$	M1 A1	(2)	Area change; can be implied by answer < 0.5 AWRT (0.40129)
<b>(iii)</b>	$P(365 < X < 367.5) = [1 - \text{(ii)}] - 0.5$ $= \underline{\mathbf{0.099}}$	B2	(2)	AWRT (0.09871)
			<b>6</b>	
<b>(b)</b> <b>(i)</b>	$0.05(0.95) \Rightarrow z = \underline{\mathbf{-1.64 \text{ to } -1.65}}$ $\frac{450 - 475}{\sigma} = \begin{pmatrix} \pm 1.28 \text{ AWRT} \\ \pm 1.64 \text{ to } \pm 1.65 \\ \pm 1.96 \text{ AWRT} \end{pmatrix}$ $\sigma = \underline{\mathbf{15.2}}$	B1 M1 A1	<b>3</b>	AWFW; ignore sign (-1.6449) Standardising <b>450</b> with <b>475</b> and $\sigma$ but allow (475 – 450) <b>and</b> equating to one of 3 listed z-values CAO (15.198492) Must be <b>consistent signs</b> giving $\sigma > 0$
<b>(ii)</b> <b>(A)</b>	$P(12 \text{ ELP} > 450.0) = 0.95^{12} = \underline{\mathbf{0.54 \text{ to } 0.541}}$	B1	(1)	AWFW (0.540360)
<b>(B)</b>	$\text{Sd}(\bar{Y}_{12}) = \frac{15.1 \text{ to } 15.3}{\sqrt{12}} = \underline{\mathbf{4.36 \text{ to } 4.42}}$ <p><b>or</b></p> $\text{Var}(\bar{Y}_{12}) = \frac{15.1^2 \text{ to } 15.3^2}{12} = \underline{\mathbf{19.00 \text{ to } 19.51}}$ $P(\bar{Y}_{12} > 470.0) = P\left(Z > \frac{470.0 - 475.0}{\text{(b)(i)}/\sqrt{12}}\right)$ $= P(Z > \underline{\mathbf{-1.13 \text{ to } -1.15}})$ $= \underline{\mathbf{0.87 \text{ to } 0.875}}$	B1 M1 A1 A1	(4)	AWFW (4.387862) OE AWFW (19.253333) Standardising <b>470</b> with <b>475</b> and ((b)(i))/ $\sqrt{12}$ (OE); (b)(i) > 0 and allow (475 – 470) AWFW; ignore sign Can be implied by answer AWFW (0.87275)
			<b>5</b>	
		<b>Total</b>	<b>14</b>	

Q	Solution	Mark	Total	Comment
4(a) (i)	$P(\text{HC} \cup \text{WC}) = \frac{6+6+8+8}{50} \text{ or } \frac{50-22}{50} =$ $\frac{28}{50} \text{ or } \frac{14}{25} \text{ or } 0.56$	B1	(1)	CAO
(ii)	$P(\text{SC} \cup \text{MC}) - P(\text{SC} \cap \text{MC}) =$ $\frac{22+8+6-22}{50} = \frac{14}{50} \text{ or } \frac{7}{25} \text{ or } 0.28$	B1	(1)	CAO
(iii)	$P(\text{SC}   \text{MC}) = \frac{22}{28} =$ $\frac{11}{14} \text{ or } (0.785 \text{ to } 0.786)$	M1 A1	(2)	Denominator CAO/AFWF (0.78571)
			<b>4</b>	
(b) (i)	$P(0 \text{ DC} \cap \text{SC}) =$ $\underline{1 \text{ or one or } 100\% \text{ or unity}}$	B1	(1)	CAO; ignore reasoning/explanation
(ii)	$P(2 \text{ MC}) = \frac{28}{50} \times \frac{27}{49} \times \frac{22}{48} \times \frac{21}{47} (= 0.06319)$ $\times 6$ $= \frac{2095632}{5527200} = \frac{891}{2350} \text{ or } 0.379$	M1 M1 B1 A1	(4)	Numerator Denominator OE CAO/AWRT (0.37915)
(iii)	$P(\geq 1 \text{ MC} \cap \text{SC}) = 1 - P(0 \text{ MC} \cap \text{SC})$ $= 1 - \left( \frac{28}{50} \times \frac{27}{49} \times \frac{26}{48} \times \frac{25}{47} \right)$ $= 1 - \left( \frac{491400}{5527200} \right) = 1 - \left( \frac{117}{1316} \right)$ $= \frac{1199}{1316} \text{ or } 0.911$	M1 A1 A1	(3)	Use of '1 - 4 ratios multiplied' 4 correct ratios multiplied (1 - 0.08891) CAO/AWRT (0.91109)
Note	$1 P(1-4 \text{ MC} \cap \text{SC}) = \left( \frac{1}{50 \times 49 \times 48 \times 47} \right) [(22 \times 28 \times 27 \times 26 \times 4) + (22 \times 21 \times 28 \times 27 \times 6) + (22 \times 21 \times 20 \times 28 \times 4) + (22 \times 21 \times 20 \times 19)]$ $= \left( \frac{1729728 + 2095632 + 1034880 + 175560}{5527200} \right) = \frac{5035800}{5527200} = \frac{1199}{1316} \text{ or } 0.911$ $= (0.31295 + 0.37915 + 0.18723 + 0.03177) = 0.911 \Rightarrow \text{M1}(\geq 4 \text{ expressions} \times \geq 4 \text{ terms}) \text{A1}(\text{all terms correct}) \text{A1}(\text{answer})$			
			<b>8</b>	
		<b>Total</b>	<b>12</b>	

Q	Solution	Mark	Total	Comment
5 (a)	<p><math>x</math> is the <b>independent/controlled</b> variable  <math>x</math> are <b>set values/percentages</b>  <math>y</math> is the <b>response/dependent</b> variable  <math>y</math> are <b>measured values/degrees</b>  <math>y</math> <b>depends</b> on <math>x</math> or <math>x</math> <b>does not depend</b> on <math>y</math></p>	B1	1	OE
(b) (i)	<p> <math>b</math> (gradient/slope) = <u><b>-0.485</b></u>  <math>b</math> (gradient/slope) = <u><b>-0.47 to -0.50</b></u>    <math>a</math> (intercept) = <u><b>0.278 to 0.729</b></u> </p> <p><b>or</b></p> <p> <math>\sum x = 105</math>   <math>\sum x^2 = 2275</math>   (<math>\sum y^2 = 487.5</math>)  <math>\sum y = -47.4</math>   <math>\sum xy = -1050.5</math>                      or  <math>S_{xx} = 700</math>   <math>S_{yy} = -339.5</math>   (<math>S_{yy} = 166.53429</math>)  <math>b</math> (gradient/slope) = <u><b>-0.485</b></u>  <math>a</math> (intercept) = <u><b>0.278 to 0.729</b></u> </p>	B2 (B1)  B1   M1  A1 A1	3	CAO AFWW  AFWW (0.50357)  Correct attempt at 4 summations  Correct attempt at 2 summations  CAO AFWW
Notes	1 Values of $a$ and $b$ interchanged or not identified but equation $y = ax + b$ <b>stated</b> $\Rightarrow$ max of 3 marks 2 Values of $a$ and $b$ interchanged or not identified and equation $y = a + bx$ <b>stated</b> $\Rightarrow$ 0 marks 3 $y = 0.504 - 0.485$ or $0.504 - 0.485x$ stated without working $\Rightarrow$ 2 marks 4 $x = 1.20 - 2.04y$ (OE) or $y = 1.20 - 2.04x$ (OE) $\Rightarrow$ 0 marks			
(ii)	<p>For each <b>unit increase</b> in                      (concentration of) <b>antifreeze</b></p> <p><b>freezing point decreases</b> by <math> b ^\circ\text{C}</math>  <b>or</b>  <b>freezing point increases</b> by <math>b^\circ\text{C}</math></p>	B1  Bdep1	2	OE  OE; dep on $-0.47 \leq b \leq -0.50$
SC	1 As the percentage of antifreeze increases, the freezing point decreases $\Rightarrow$ B1 (must be in context, not simply $x$ and $y$ )			
(c) (i)	<p> <math>\text{Res}(15, -6.3) = -6.3 - (a + b \times 15)</math>  <math>=</math> <u><b>+0.46 to +0.48</b></u>    <math>=</math> <u><b>(+0.02 to +0.93) or (-0.02 to -0.93)</b></u> </p>	B2  (B1)	2	AFWW; do not ignore sign (0.47143)  AFWW; either
(ii)	<p> <math>\text{Sum}_5 = 0 - [-0.65 + (c)(i)]</math>    <math>=</math> <u><b>+0.17 to +0.19</b></u>    <math>=</math> <u><b>-0.17 to -0.19 or +1.11 to +1.13</b></u> </p>	B2  (B1)	2	Or <b>sum</b> of remaining 5 residuals (-0.504, -0.179, 0.246, 0.896, -0.279)  AFWW; do not ignore sign (0.18214)  AFWW; do not ignore sign
SC	1 Use of $\text{Sum}_7 = 0$ to obtain (realistic) $\text{Sum}_5 = -\text{Sum}_2 \Rightarrow$ M1			
		<b>Total</b>	<b>10</b>	



Q	Solution	Mark	Total	Comment
<b>6</b>	<b>Accept 3 dp rounding of probabilities from tables</b>			
(a)	$P(A+ = 3) = \binom{10}{3}(0.34)^3(1-0.34)^7$ $= 120 \times 0.039304 \times 0.054551607$ $= \underline{\underline{0.257}}$	M1 A1	<b>2</b>	Allow 'slip' in $(1 - 0.34)$ AWRT (0.257292)
(b)	$B \sim B(20, 0.1)$ $P(B < 3) = \underline{\underline{0.677}}$	B1	<b>1</b>	AWRT (0.676927)
(c)	$O \sim B(30, 0.45)$ $P(O > 10) = 1 - 0.1350$ $= \underline{\underline{0.865}}$ $= (1 - 0.0694) \text{ or } (0.930 \text{ to } 0.931)$	M1 A1 (M1)	<b>2</b>	(0.135045) AWRT (0.864995) (0.069407)
<b>Note</b>	<b>1</b> For calculation of individual terms or no method: award <b>B2</b> for 0.865 (AWRT); <b>B1</b> for 0.930 to 0.931 (AWFW)			
(d)	$(A \& AB)' \sim \underline{\underline{B(40, 0.55)}}$ <p>or</p> $(A \& AB) \sim \underline{\underline{B(40, 0.45)}}$ $P((A \& AB)' \leq 20) = P((A \& AB) \geq 20)$ $= 1 - 0.6844$ $= \underline{\underline{0.315 \text{ to } 0.316}}$ $= (1 - 0.787) \text{ or } (0.213)$	B1 M1 A1 (M1)	<b>3</b>	Seen or used AWFW (0.684414) (0.315586) (0.786956)
<b>Note</b>	<b>1</b> For calculation of individual terms or no method: award <b>B3</b> for 0.315 to 0.316 (AWFW); <b>B2</b> for 0.213 (AWRT); <b>B1</b> for $B(40, 0.55)$ or $B(40, 0.45)$ seen or implied by a numerical value			
(e)	$\text{Negative} \sim \underline{\underline{B(50, 0.20)}}$ $P(6 \leq N \leq 12) =$ $(0.8139 \text{ or } 0.7107)$ <p><b>minus</b></p> $(0.0480 \text{ or } 0.1034)$ $= \underline{\underline{0.765 \text{ to } 0.766}}$	B1 M1 M1 A1	<b>4</b>	Seen or used Seen as <b>first term</b> in a <b>subtraction</b> Seen as <b>second term</b> in a <b>subtraction</b> AWFW (0.765916)
<b>Note</b>	<b>1</b> For calculation of individual terms or no method: award <b>B4</b> for 0.765 to 0.766 (AWFW); <b>B3</b> for 0.7105 (AWRT); <b>B3</b> for 0.662 to 0.663 (AWFW); <b>B3</b> for 0.607 to 0.608 (AWFW); <b>B1</b> for $B(50, 0.20)$ seen or implied by a numerical value			
		<b>Total</b>	<b>12</b>	

Q	Solution	Mark	Total	Comment
7(a) (i)	<p>Mean = <b>402</b></p> <p>90% <math>\Rightarrow z = \underline{1.64 \text{ to } 1.65}</math></p> <p>CI is:</p> $(402) \pm \left( \begin{matrix} 1.64 \text{ to } 1.65 \\ 1.28 \text{ AWR} \end{matrix} \right) \times \left( \frac{25}{\sqrt{34}} \right)$ <p>Thus:</p> <p><b>or</b></p> <p style="text-align: center;"><b><u>402 <math>\pm</math> 7</u></b></p> <p style="text-align: center;"><b><u>(395, 409)</u></b></p>	<p>B1</p> <p>B1</p> <p>M2 (-1ee)</p> <p>Adep1</p>	<b>5</b>	<p>CAO; <b>can be scored in (a)(ii)</b></p> <p>AWFW (1.6449)</p> <p>Ignore any notation M0 if CI is not of the form:  <math display="block">\left( \begin{matrix} 402 \\ 390 \end{matrix} \right) \pm \left( \begin{matrix} 1.64 \text{ to } 1.65 \\ 1.28 \end{matrix} \right) \times \left( \frac{25}{5} \right) / \sqrt{\left( \frac{34}{33} \right)}</math></p> <p>CAO; dep on M2 (394.92 to 394.97, 409.03 to 409.08)</p>
Notes	<p>1 If award of M0 or M1 is followed by a numerically correct CI <math>\Rightarrow</math> possibly 2 solutions</p> <p>2 Deduct Adep1 if answer correct but not rounded to nearest minute</p> <p>3 Use of 390 instead of 402 <math>\Rightarrow</math> max of 3 marks</p>			
(ii)	<p><b>CI/LCL &gt; 390 or 'bags &amp; boxes' mean</b></p> <p>so</p> <p style="text-align: center;"><b>claim appears justified</b></p>	<p>Bdep1</p> <p>Bdep1</p>	<b>2</b>	<p>OE; dep on 390 &lt; CI 390 <math>\notin</math> CI <math>\Rightarrow</math> Bdep0</p> <p>OE; dep on Bdep1</p>
SC	1 Correct comparison of 402 with 390 $\pm$ 7 (AWRT) or (383, 397) (AWRT) $\Rightarrow$ Bdep1 and then Bdep1 for correct conclusion			
(iii)	<p><b>CI would be narrower (smaller width/range)</b></p> <p>80% CI <math>\in</math> 90% CI <b>or</b> 80% LCL &gt; 90% LCL</p> <p><b>or</b></p> <p>80% CI is <b>402 <math>\pm</math> (5 to 6 AFW)</b> &gt; 390</p> <p>80% CI is <b>390 <math>\pm</math> (5 to 6 AFW)</b> &lt; 402</p> <p>so <b>'No' or 'No change'</b></p>	<p>B1</p> <p>Bdep1</p>	<b>2</b>	<p><b>z-value would be smaller</b> (1.28 AWR)</p> <p>OE</p> <p style="text-align: right;">(396 to 397, 407 to 408) (384 to 385, 395 to 396)</p> <p>OE; dep on B1</p>
Note	1 There must be a valid justification for awarding B1; simply stating that 390 is still below the new LCL (OE) or that 402 is still above the new UCL(OE) $\Rightarrow$ B0 Bdep0			
(b) (i)	Collections sampled at <b>random</b>	B1	<b>(1)</b>	OE; just normal $\Rightarrow$ B0
(ii)	<p><b>Sample is (sufficiently) large</b></p> <p><b>or</b></p> <p><b><math>n &gt; 20/25/30</math></b></p> <p>so</p> <p><b>CLT is applicable/valid/appropriate</b></p>	<p>B1</p> <p>Bdep1</p>	<b>(2)</b>	<p>Ignore any <b>additional</b> reference to 'value of standard deviation is known or unchanged'</p> <p>OE; dep on B1 Do <b>NOT</b> award this mark for suggestion that the 'sample (OE) is normally distributed'</p>
			<b>3</b>	
			<b>12</b>	
		<b>Total</b>	<b>12</b>	