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A-LEVEL

# Mathematics

Statistics 1A – MS1A/W

Mark scheme

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6360

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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 MS1A/W**

- 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** When applying AFWF, a slightly inaccurate numerical answer that is subsequently rounded to fall within the accepted range cannot be awarded full marks.
- GN4** 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
- GN5** In questions involving probabilities, do **not** award **accuracy** marks for answers given in the form of a ratio or odds such as 11/30 given as 11:30 or 11:19
- GN6** Accept decimal answers, providing that they have **at least two** leading zeros, in the form  $c \times 10^{-n}$  (eg 0.00524 as  $5.24 \times 10^{-3}$ )

Q	Solution	Marks	Total	Comments
1	<p>Ordered data:</p> <p>156 157 158 158 159 160 161 161 162 163</p> <p>Median (M) = <math>\frac{159+160}{2} = \underline{159.5}</math></p> <p>LQ = <u>158</u>                      UQ = <u>161</u></p> <p style="padding-left: 150px;">IQR = <u>3</u></p> <p>or</p> <p>LQ = <u>157.75</u>                      UQ = <u>161.25</u></p> <p style="padding-left: 150px;">IQR = <u>3.5</u></p> <p>or</p> <p>LQ = <u>157.5</u>                      UQ = <u>161.5</u></p> <p style="padding-left: 150px;">IQR = <u>4</u></p>	<p>M1</p> <p>A1</p> <p>A1</p> <p>Adep1</p> <p>(A1)</p> <p>(Adep1)</p> <p>(A1)</p> <p>(Adep1)</p>	<p>4</p>	<p><i>May be near printed values</i></p> <p>If seen, then <math>\geq 5</math> correctly ordered</p> <p>If not seen, then can be implied from <math>\geq 1</math> of M, LQ &amp; UQ or IQR correct</p> <p>CAO</p> <p>Both CAO; ignore notation</p> <p>CAO; dependent on A1</p> <p>Both CAO; ignore notation</p> <p>CAO; dependent on A1</p> <p>Both CAO; ignore notation</p> <p>CAO; dependent on A1</p>
Notes	<p>1 If values are not ordered, then M = 159, LQ = 156.5 or 156.75, UQ = 158.5 or 159.5, IQR = 2 or 2.75</p> <p>2 If answers are not identified, then assume that order of values is median, (quartiles), IQR</p>			
		<b>Total</b>	<b>4</b>	

Q	Solution	Marks	Total	Comments
<b>2</b>	Accept 3 dp rounding of probabilities from tables			Accept percentage equivalent answers in (a) & (b) but see GN4
(a)	$P(X \leq 15) = \underline{\underline{0.694 \text{ to } 0.695}}$	B1	(1)	AWFW (0.6946)
(b)	$P(12 < X < 18)$ $\quad \quad \quad (p_1) \quad (p_2)$ $\quad \quad \quad = 0.8761 \text{ or } 0.9301$  <b>MINUS</b> 0.3143 or 0.2053  $\quad \quad \quad = \underline{\underline{0.561 \text{ to } 0.562}}$	M1 M1 A1	(3)	AWFW (0.5618)
<b>Notes</b>	<b>1</b> For calculation of individual terms or no method: award <b>B3</b> for 0.561 to 0.562 (AWFW); <b>B2</b> for 0.670 to 0.671 (AWFW); <b>B2</b> for 0.615 to 0.616 (AWFW); <b>B2</b> for 0.724 to 0.725 (AWFW) <b>2</b> $(1-p_2) - (1-p_1) \Rightarrow$ M1 M1 A1 or M1 M1 or M1			
(c)	Mean of distribution = $40 \times 0.35 = \underline{\underline{14}}$  $P(X=14)$ $\quad \quad \quad = \binom{40}{14} 0.35^{14} 0.65^{26}$ <b>or</b> $\quad \quad \quad = 0.5721 - 0.4408$  $\quad \quad \quad = \underline{\underline{0.131 \text{ to } 0.132}}$	B1 M1 A1	(3)	CAO; can be implied  <b>Fully correct</b> expression Can be implied <b>Correct</b> difference AWFW (0.1313)
			<b>7</b>	
		<b>Total</b>	<b>7</b>	

Q	Solution	Marks	Total	Comments
<b>3</b>				Accept any equivalent fractional answer with den $\leq 100$ or the equivalent percentage answer with %- sign (see GN4)
(a)(i)	$P(A' \cap B') = 0.30 \times 0.40 = \underline{0.12}$	B1	(1)	CAO/OE
(ii)	$P((A \cap B') \cup (A' \cap B)) =$ $0.70 \times 0.40 + 0.30 \times 0.60$ <b>or</b> $0.70 + 0.60 - (2 \times 0.70 \times 0.60)$ <b>or</b> $1 - (i) - (0.70 \times 0.60)$ $= \underline{0.46}$	M1  A1	(2)	Either term Allow 'no $\times 2$ ' $0 < (i) < 0.58$ CAO/OE
			<b>3</b>	
(b)(i)	$P(A \cap B \cap C) = (0.70 \times 0.60) \times p_1$ $= 0.70 \times 0.60 \times 0.85 = \underline{0.357}$	M1 A1	(2)	$0 < p_1 < 1$ ; <b>not</b> a product of $\geq 2$ probabilities CAO/OE
(ii)	$P(A' \cap B' \cap C') = (0.30 \times 0.40) \times p_2$ $= 0.30 \times 0.40 \times 0.75 = \underline{0.09}$	M1 A1	(2)	$0 < p_2 < 1$ ; <b>not</b> a product of $\geq 2$ probabilities CAO/OE
(iii)	$P(A \cap B' \cap C) = (0.70 \times 0.40) \times p_3$ $= 0.70 \times 0.40 \times 0.25 = \underline{0.07}$	M1 A1	(2)	$0 < p_3 < 1$ ; <b>not</b> a product of $\geq 2$ probabilities CAO/OE
(iv)	$P(2) =$ $(0.70 \times 0.60 \times 0.15)$ <b>or</b> 0.063 $+ (0.70 \times 0.40 \times 0.25)$ <b>or</b> 0.070 <b>or</b> (iii) $+ (0.30 \times 0.60 \times 0.85)$ <b>or</b> 0.153 $= \underline{0.286}$	M2 (M1) A1	(3)	<b>All three correct</b> and multiplied <b>At least two correct</b> CAO
			<b>9</b>	
		<b>Total</b>	<b>12</b>	

Q	Solution	Marks	Total	Comments
<b>4</b> <b>(a)</b> <b>(i)</b>	$b$ (gradient/slope) = <u><b>0.4 to 0.41</b></u> $b$ (gradient/slope) = <u><b>0.35 to 0.45</b></u>  $a$ (intercept) = <u><b>1.2 to 1.4</b></u> $a$ (intercept) = <u><b>0.45 to 2.35</b></u>  Attempt at $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$  <b>or</b>  Attempt at $S_{xx}$ & $S_{xy}$  Attempt at substitution into correct corresponding formula for $b$ $b = \underline{\mathbf{0.40 to 0.41}}$ $a = \underline{\mathbf{1.2 to 1.4}}$	B2 (B1)  B2 (B1)  (M1)  (m1)  (A1 A1)	<b>(4)</b>	AFWW (0.40517) AFWW  For answers as fractions, see Note 7  AFWW (1.30186) AFWW  209 4455 99 & <b>2077.1</b> (all 4 attempted) ( $\sum y^2 = 937.02$ )  484 & <b>196.1</b> (both attempted) ( $S_{yy} = 82.02$ )  AFWW ( $\bar{x} = 19$ & $\bar{y} = 9$ )
<b>Notes</b>	<b>1</b> Treat rounding of correct, but <b>not</b> of incorrect, answers as ISW <b>2</b> Written form of equation is <b>not</b> required <b>3</b> Award 4 marks for $y = (1.2 \text{ to } 1.4) + (0.4 \text{ to } 0.41)x$ <b>or</b> for $(1.2 \text{ to } 1.4) + (0.4 \text{ to } 0.41)x$ <b>4</b> Values of $a$ and $b$ interchanged and equation $y = ax + b$ <b>used</b> for drawing line $\Rightarrow$ max of 4 marks <b>5</b> Values of $a$ and $b$ interchanged and equation $y = a + bx$ used for drawing line $\Rightarrow$ 0 marks <b>6</b> Values are <b>not</b> identified or simply $b/a = \#$ and $a/b = \#$ , then $0.35 \text{ to } 0.45 \Rightarrow$ B1 and $0.45 \text{ to } 2.35 \Rightarrow$ B1 but accept, for example, as identification, [ $b = \#, a = \#$ with $y = a + bx$ but no substitution for $b$ & $a$ ] <b>or</b> [ $\text{slope/gradient}(b) = \#, \text{intercept}(a) = \#$ ] <b>7</b> Answers in fractions can score at most B1 B1 or M1 m1 <b>8</b> Some/all of marks can be scored in (b)(ii), (c) & (d)(i), even if some/all of marks are lost in (b)(i), but marks lost in (b)(i) <b>cannot</b> be recouped by subsequent working in (b)(ii), (c) or (d)(i)			
<b>Notes</b>	Scatter diagram <span style="float: right;"><b>line</b></span>  Line must be (approximately) straight; <b>not</b> dog leg, curve or wavy	B2	<b>(2)</b>	From <b>at least</b> $x = 8$ to $x = 30$ (allow a tolerance of 2 squares (ie 4 mm) on line length) <b>and</b> within red tolerance lines on overlay, even if drawn by eye
	<b>1</b> If, and only if, B0, then award M1 for <b>seen</b> use of an equation for <b>at least two</b> points <b>2</b> If, and only if, B0, then award M0 for points or line marked on scatter diagram without supportive working			
			<b>6</b>	
	<b>Part (a)(i)</b>	<b>Total</b>	<b>6</b>	



Q	Solution	Marks	Total	Comments
<b>4</b>	<b>Continued</b>			
	<b>Part (a)(i)</b>	<b>Total</b>	<b>6</b>	
<b>(a)</b> <b>(ii)</b>	<i>b</i> : each/every/one/an additional tile takes or <b>increase per tile</b> is  (on average) <i>b</i> hours/60 <i>b</i> mins	B1  BF1	  <b>(2)</b>	F on <i>b</i> providing $0.35 \leq b \leq 0.45$ and <b>correct units</b> are stated
<b>Notes</b>	<b>1</b> To score any marks, an explanation must indicate change in <i>x</i> affecting change in <i>y</i> , <b>not</b> change in <i>y</i> affecting change in <i>x</i> <b>2</b> Reference <b>only</b> to correlation $\Rightarrow$ B0 BF0			
<b>SC</b>	<b>1</b> As <i>x</i> /number of tiles increases then <i>y</i> /time increases by <i>b</i> /60 <i>b</i> (OE; value of <i>b</i> ( $0.35 \leq b \leq 0.45$ ) must be stated but context and/or units are <b>not</b> required) $\Rightarrow$ B1			
	<i>a</i> : time to replace no/zero tiles, start-up time, minimum time, time for travelling, preparation, erecting ladders, obtaining materials, etc	BF1	  <b>(1)</b>	OE; in context Reference to the value of <i>a</i> is not required F on <i>a</i> providing $a > 0$
			<b>3</b>	
<b>(b)</b>	$y(15) = \underline{7 \text{ to } 8}$	B1	  <b>1</b>	AWFW (7.37934) From calculation/graph/guesswork Hours <b>not</b> required
<b>Note</b>	<b>1</b> Accept (420 to 480) minutes only if “minutes/mins” are stated			
<b>(c)</b> <b>(i)</b>	$r_6 = 8.8 - a - b \times 20 =$ $r_6 =$	$\underline{-0.6 \text{ to } -0.61}$ $\underline{0.5 \text{ to } 0.7}$	B2 (B1)  <b>2</b>	AWFW; do not ignore sign (-0.60517) AWFW; ignore sign
<b>Note</b>	<b>1</b> If, and only if, B0, then attempted use of $\pm(8.8 - a - b \times 20) \Rightarrow$ M1 providing $0.35 \leq b \leq 0.45$ and $0.45 \leq a \leq 2.35$			
<b>(ii)</b>	Value will be/is always:  <b><u>0 or zero or nought or nothing</u></b>	B1	  <b>1</b>	CAO; accept nothing else, but ignore zeros after decimal point (eg 0.00) Ignore any explanation
		<b>Total</b>	<b>13</b>	

Q	Solution	Marks	Total	Comments
<b>5</b> <b>(a)(i)</b>	$P(X < 1.9) = P\left(Z < \frac{1.9-1.81}{0.08}\right)$ $= P(Z < 1.125) = \underline{\mathbf{0.87}}$	M1	<b>(2)</b>	Accept percentage equivalent answers in (a) but see GN4
		A1		Standardising 1.9 with 1.81 and 0.08 but allow (1.81 – 1.9) AWRT (0.86971)
<b>(ii)</b>	$P(X > 1.85) = P(Z > 0.5) = 1 - P(Z < 0.5)$ $= 1 - 0.69146 = \underline{\mathbf{0.31}}$	M1 A1	<b>(2)</b>	Area change; can be implied by <b>any final answer &lt; 0.5</b> AWRT (0.30854)
<b>(iii)</b>	$P(1.81 < X < 1.85)$ $= (0.691 \text{ to } 0.692) - 0.5$ <p>or</p> $= 0.5 - (0.308 \text{ to } 0.309)$ $= \underline{\mathbf{0.19}}$	B1 B1	<b>(2)</b>	Can be implied by a <b>correct</b> answer AWRT (0.19146)
<b>(b)(i)</b>	$z = \text{or} < \frac{9.25 - \mu}{\sigma} \quad \text{or} \quad 9.25 = \mu + z\sigma$ $0.88 \Rightarrow z = \underline{\mathbf{1.17 \text{ to } 1.18}}$	M1 B1	<b>2</b>	Either expression <b>or</b> with $z$ replaced by 1.17 to 1.18 (AWFW) AWFW (ignore sign) (1.175)
<b>Notes</b>	<p>1 Allow <math>\bar{x}</math>/mean instead of <math>\mu</math> and/or <math>s</math>/sd instead of <math>\sigma</math></p> <p>2 Result of <math>9.25 - \mu = z\sigma</math> stated without any prior evidence <math>\Rightarrow</math> M0</p> <p>3 Working back from the given answer <math>9.25 - \mu = z \times \sigma \Rightarrow</math> M0</p> <p>4 The M1 cannot be scored for work in (b)(ii)</p> <p>5 The <math>z</math>-value of 1.17 to 1.18 (AWFW) must be seen in (b)(i) to score B1; seen only in (b)(ii) scores B0</p>			
<b>(ii)</b>	$P(Y > 8.75) = 0.975 \Rightarrow z = \underline{\mathbf{1.96}}$ <p>Thus</p> $9.25 - \mu = +1.175\sigma$ $8.75 - \mu = -1.96\sigma$ <p>giving</p> $0.5 = 3.135\sigma$ $\sigma = \underline{\mathbf{0.16}}$ $\mu = \underline{\mathbf{9 \text{ to } 9.1}}$	B1 M1 Adep1 Adep1	<b>4</b>	AWRT (ignore sign) (1.17 to 1.18) AFWW (ignore sign) (1.96) AFWT (ignore sign) A valid method for solution of two equations that are correct except for signs of $z$ -values (see Note 1) AWRT (0.15949) Dependent on <b>two fully correct equations</b> including signs of $z$ -values AWFW (9.06260)
<b>Note</b>	1 Accept method as shown or substitution for either $\mu$ or $\sigma$ from one equation into the other, even if $z$ -value signs are incorrect			
		<b>Total</b>	<b>12</b>	

Q	Solution	Marks	Total	Comments
<b>6</b> (a)	Sd of $\bar{B}$ = <u><math>0.3/\sqrt{12}</math> or <math>\sqrt{3}/20</math> or <math>0.086</math> to <math>0.087</math></u>  <b>or</b> Var of $\bar{B}$ = <u><math>0.3^2/12</math> or <math>3/400</math> or <math>0.0075</math></u>  $P(\bar{B} < 10)$ = $P\left(Z < \frac{10 - 10.15}{0.3/\sqrt{12}}\right) = P(Z < -0.5\sqrt{12})$  $= P(Z < -1.732) = 1 - P(Z < 1.732)$  $= 1 - 0.958(37) = \underline{0.041 \text{ to } 0.042}$	B1            M1            m1            A1	<b>4</b>	CAO AFWW (0.08660)  Can be implied in what follows  CAO  Standardising 10 with 10.15 and <b><math>0.3/\sqrt{12}</math> OE</b> ; allow (10.15 – 10)  Area change Can be implied by a <b>correct</b> answer <b>or</b> by an <b>answer &lt; 0.5</b>  AFWW (0.04163)
<b>Note</b>	<b>1</b> Use of distribution of total: <b>B1</b> for Sd = $0.3\sqrt{12}$ (OE); <b>M1</b> for $P(Z < (120 - 121.8)/(0.3\sqrt{12}))$ or $P(Z < -6/\sqrt{12})$ or $P(Z < -0.5\sqrt{12})$ ; <b>m1</b> for area change [ $P(Z < -1.732) = 1 - P(Z < 1.732)$ ]; <b>A1</b> for 0.041 to 0.042 (AWFW)			
	<b>Part (a)</b>	<b>Total</b>	<b>4</b>	

Q	Solution	Marks	Total	Comments
<b>6</b>	<b>Continued</b>			
	<b>Part (a)</b>	<b>Total</b>	<b>4</b>	
<b>(b)</b> <b>(i)</b>	<p>99% (0.99) <math>\Rightarrow z = \underline{2.57 \text{ to } 2.58}</math>  <b>or</b> <math>\Rightarrow t = \underline{2.70 \text{ to } 2.71}</math></p> <p>CI for <math>\mu</math> is</p> $304.6 \pm \begin{pmatrix} 2.57 \text{ to } 2.58 \\ 2.32 \text{ to } 2.33 \\ 2.70 \text{ to } 2.71 \\ 2.42 \text{ to } 2.43 \end{pmatrix} \times \frac{(5.37 \text{ or } 5.43 \text{ to } 5.44)}{\sqrt{40 \text{ or } 39}}$ <p>Hence <b><u>304.6 ± (2.2 or 2.3)</u></b></p> <p><b>or</b> (answers must be to 1 dp)  <b><u>(302.3, 306.9)</u> or <u>(302.4, 306.8)</u></b></p>	B1          Adep1	          <b>4</b>	<p>AWFW (2.5758)  AWFW (2.708)</p> <p>Ignore any notation</p> <p>M0 if CI is not of the form:  <math>\bar{x} \pm z \times \frac{\sigma}{\sqrt{40 \text{ or } 39}}</math></p> <p><math>5.37 \times \sqrt{\frac{40}{39}} = 5.4384</math></p> <p><b>CAO</b>; note 'or' (not 'to')</p> <p>Dependent on award of M2</p> <p><b>CAO</b>; note 'or'</p>
<b>Note</b>	1 An incorrect expression for CI followed by a numerically correct CI $\Rightarrow$ 2 solutions $\Rightarrow ((0 \text{ or } 1) + 4)/2 \Rightarrow$ 2 marks			
<b>(ii)</b>	<p><b>Claim 1:</b></p> <p><b>Clear correct comparison of 300 with CI</b></p> <p>eg 300 is below CI <b>or</b> <math>LCL &gt; 300</math></p> <p><b>Agree with or accept claim</b></p>	BF1    Bdep1	       <b>(2)</b>	<p>Statement must include reference to 300  F on CI providing it is <b>above</b> 300  Must have found an <b>interval</b> in (b)(i) but  quoting values for CI or CLs is <b>not</b> required</p> <p>OE; dependent on BF1</p>
<b>Notes</b>	1 Statement must clearly indicate that "300 is <b>below</b> the CI" OE 2 Statements of the form "It/mean/value/etc is below/outside/not within the CI" $\Rightarrow$ BF0 3 Statements of the form "300 is below/outside/not within 99% of the data/values/weights" $\Rightarrow$ BF0 4 Statements such as "Claim is likely/reasonable/supported/correct/true/possible/valid" $\Rightarrow$ Bdep1 providing BF1			
	<p><b>Claim 2:</b></p> <p>Attempt at <b><math>304.6 - 5.37n</math></b></p> <p><b>Result &lt; 300 so disagree with or reject claim</b></p>	M1    A1	       <b>(2)</b>	<p>Allow <math>0.86 \leq n \leq 3</math> with a <b>correct numerical answer</b> (see Note 1)</p> <p>OE  Must be a clear correct comparison of <b>stated 300</b> with calculated result</p>
<b>Notes</b>	1 Likely values are $n = 0.86 \Rightarrow \underline{300}$ ; $n = 1 \Rightarrow \underline{299}$ ; $n = 2 \Rightarrow \underline{294}$ ; $n = 3 \Rightarrow \underline{288 \text{ or } 289}$ (all AWRT); check answers for other values of $n$ within range 2 $P(F < 300) = P(Z < (300 - 304.6)/5.37)$ or $(z = \pm(300 - 304.6)/5.37) = P(Z < -(0.85 \text{ to } 0.86))$ $\Rightarrow \underline{0.19 \text{ to } 0.20}$ (AWFW) $\Rightarrow$ M1 <b>Result &gt; 0</b> so disagree with <b>or reject claim</b> $\Rightarrow$ A1 3 $(300 - 304.6)/5.37 = \underline{0.85 \text{ to } 0.86}$ (AWFW) $\Rightarrow$ M1 <b>Result &lt; (1, 2 or 3)</b> so disagree with <b>or reject claim</b> $\Rightarrow$ A1			
			<b>4</b>	
			<b>12</b>	