



A-LEVEL

Mathematics

Statistics 1B – MS1B

Mark scheme

6360

June 2015

Version/Stage: 1.0: Final

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

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 MS1B

- 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 5.24×10^{-3})

Q	Solution	Marks	Total	Comments
1 (a)	Using summary data with shown method: $r_{xy} = \frac{3629670}{\sqrt{76581640 \times 694250}}$ $= \underline{\underline{0.49 \text{ to } 0.5}}$	M1 A1	2	Used; accept (all 3 values) $\div 10$ Can be implied by a correct answer AWFW (0.497791)
	Using summary data without shown method or using raw data with or without shown method: $r_{xy} = \underline{\underline{0.49 \text{ to } 0.5}}$ $r_{xy} = \underline{\underline{0.4 \text{ to } 0.6}}$	(B2) (B1)		AWFW AWFW
(b)	Moderate/some positive (linear) correlation between gas and electricity consumptions	Bdep1 B1	2	Dependent on $0.4 \leq r_{xy} \leq 0.6$ OE; must qualify strength and state positive Providing $-1 < r_{xy} < +1$ OE; must be in context
Notes	1 Only accept phrases stated; ignore additional comments unless contradictory 2 Use of any of the following terms (even in conjunction with moderate/some): “strong or high or big or good or low or little or small or weak or slight or medium or average or reasonable or pretty” \Rightarrow Bdep0 3 Accept “relationship/association/link” but not “trend” instead of “correlation” 4 As gas consumption increases then electricity consumption increases \Rightarrow Bdep0 B1 5 Do not accept “between x and y ” or “between kWh” or “between consumptions” or “between gas and electricity” without further clarification			
		Total	4	

Q	Solution	Marks	Total	Comments
2 (a)	Mid-points (d): $65.5 \quad 66.5 \quad 67.5 \quad 68.5 \quad 69.5 \quad 70.5 \quad 71.5$ $\text{Mean} = \underline{\underline{68.2 \text{ to } 68.3}}$ $\text{Var}(n) = \underline{\underline{2.42}}$ or $\text{Var}(n-1) = \underline{\underline{2.46}}$ or $\text{Var}(n) \text{ or } \text{Var}(n-1) = \underline{\underline{2.4 \text{ to } 2.5}}$	M1 A1 B2 (B1)	4	At least four seen or implied (only) from $\sum fd = 4095$ or mean = 68.2 to 68.3 AFWW or mean = 68.5 CAO AFWW (68.25) (2.42083) AWRT ($\sum fd^2 = 279629$) (2.46186) AFWW
Notes	1 Value of variance stated as 1.55^2 to 1.57^2 and not evaluated \Rightarrow B1 2 Value of variance or standard deviation stated as 1.55 to 1.57 \Rightarrow B0 3 If, and only if, M0 A0 B0, then award M1 for seen attempt at $\sum f \times (d / LCB / UCB) \div 60$ or $(4095 / 4065 / 4125) \div 60$			
(b)	$\text{Mean} = \frac{(68.2 \text{ to } 68.3)}{25.4}$ $= \underline{\underline{2.68 \text{ to } 2.69}}$ $\text{Var}(n) \text{ or } \text{Var}(n-1) = \frac{(2.4 \text{ to } 2.5)}{25.4^2}$ $= \underline{\underline{0.0037 \text{ to } 0.0039}}$	B1 B1	2	AFWW (2.68701) AFWW (0.0037523 or 0.0038159) Accept $(3.7 \text{ to } 3.9) \times 10^{-3}$ (see GN6)
		Total	6	

Q	Solution	Marks	Total	Comments																													
3				In (b) & (c), accept any equivalent fractional answer with den ≤ 100 or the equivalent percentage answer with %- sign (see GN4)																													
(a)	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2"></th> <th colspan="3">Arrive</th> <th></th> </tr> <tr> <th colspan="2"></th> <th>E</th> <th>OT</th> <th>L</th> <th>Total</th> </tr> </thead> <tbody> <tr> <th rowspan="2">Dep</th> <th>OT</th> <td>0.16</td> <td>0.56</td> <td>0.08</td> <td>0.8(0)</td> </tr> <tr> <th>L</th> <td>0.06</td> <td>0.09</td> <td>0.05</td> <td>0.2(0)</td> </tr> <tr> <th colspan="2">Total</th> <td>0.22</td> <td>0.65</td> <td>0.13</td> <td>1.00</td> </tr> </tbody> </table>			Arrive						E	OT	L	Total	Dep	OT	0.16	0.56	0.08	0.8(0)	L	0.06	0.09	0.05	0.2(0)	Total		0.22	0.65	0.13	1.00	B2 (B1)	2	All 6 correct CAO Any 3 of 6 correct CAO
		Arrive																															
		E	OT	L	Total																												
Dep	OT	0.16	0.56	0.08	0.8(0)																												
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Total		0.22	0.65	0.13	1.00																												
(b)																																	
(i)	$P(OT_D \cap OT_A) =$	0.56	B1	(1)	CAO/OE; even 0.56/1																												
(ii)	$P(L_D) =$	0.2	B1	(1)	CAO/OE; even 0.2/1																												
				2																													
(c)(i)	$P(L_A L_D) = \frac{0.05}{0.2} =$	0.25	M1 A1	(2)	(c's 0.05)/(c's (b)(ii)) Can be implied by a correct answer CAO/OE; not 0.25/1																												
(ii)	$P(L'_A OT_D) = \frac{0.16 + 0.56}{0.8} \quad \text{or} \quad \frac{0.8 - 0.08}{1 - 0.2} \quad \text{or} \quad \frac{0.72}{0.8}$ $\frac{0 < p < 0.8}{0.8}$ $= \underline{\mathbf{0.9}}$	B2 (B1) B1	(3)	Can be implied by a correct answer CAO/OE; not 0.9/1																													
				5																													
(d)	$P(E_A \cap OT_A \cap L_A OT_D) =$ $\frac{0.16}{0.8} \times \frac{0.56}{0.8} \times \frac{0.08}{0.8} \quad \text{or} \quad 0.2 \times 0.7 \times 0.1$ $\times (3! \text{ or } 6)$ $= \underline{\mathbf{0.084}}$	M2 (M1) m1 A1	4	All three correct (equivalent) fractions or decimals multiplied At least one correct (equivalent) fraction or decimal Dependent on M2 CAO																													
Notes	1 Do not penalise the correct answer quoted to more than three decimal places (eg 0.0840)																																
SCs	2 Answers given as 84/1000 or 42/500 or 21/250 or 8.4% or 8.4×10^{-2} (see GN6) \Rightarrow M1 M1 m1 A0																																
	1 Answers of 0.014 or 0.042 (CAO/OE) even without working \Rightarrow M2 mo A0																																
	2 $(0.16 \times 0.56 \times 0.08) \Rightarrow$ M1 m0 A0 (ignore any additional integer multiplier)																																
	3 $\left(\frac{0.16}{1} \times \frac{0.56}{1} \times \frac{0.08}{1}\right) \Rightarrow$ M1 but $\left(\frac{0.16}{p_1} \times \frac{0.56}{p_2} \times \frac{0.08}{p_3}\right) \Rightarrow$ M0 (when all $p_i \neq 0.8$)																																
		Total	13																														

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

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

Q	Solution	Marks	Total	Comments
5 (a)(i)	$P(X < 1.9) = P\left(Z < \frac{1.9-1.81}{0.08}\right)$ $= P(Z < 1.125) = \underline{\mathbf{0.87}}$	M1	(2)	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)
(ii)	$P(X > 1.85) = P(Z > 0.5) = 1 - P(Z < 0.5)$ $= 1 - 0.69146 = \underline{\mathbf{0.31}}$	M1 A1	(2)	Area change; can be implied by any final answer < 0.5 AWRT (0.30854)
(iii)	$P(1.81 < X < 1.85)$ $= (0.691 \text{ to } 0.692) - 0.5$ or $= 0.5 - (0.308 \text{ to } 0.309)$ $= \underline{\mathbf{0.19}}$	B1 B1	(2)	Can be implied by a correct answer AWRT (0.19146)
			6	
(b)(i)	$z = \text{or} < \frac{9.25 - \mu}{\sigma} \quad \text{or} \quad 9.25 = \mu + z\sigma$ $0.88 \Rightarrow z = \underline{\mathbf{1.17 \text{ to } 1.18}}$	M1 B1	2	Either expression or with z replaced by 1.17 to 1.18 (AWFW) AWFW (ignore sign) (1.175)
		Notes 1 Allow \bar{x} /mean instead of μ and/or s /sd instead of σ 2 Result of $9.25 - \mu = z\sigma$ stated without any prior evidence \Rightarrow M0 3 Working back from the given answer $9.25 - \mu = z \times \sigma \Rightarrow$ M0 4 The M1 cannot be scored for work in (b)(ii) 5 The z -value of 1.17 to 1.18 (AWFW) must be seen in (b)(i) to score B1; seen only in (b)(ii) scores B0		
(ii)	$P(Y > 8.75) = 0.975 \Rightarrow z = \underline{\mathbf{1.96}}$ <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	4	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 two fully correct equations including signs of z -values AWFW (9.06260)
Note	1 Accept method as shown or substitution for either μ or σ from one equation into the other, even if z -value signs are incorrect			
		Total	12	

Q	Solution	Marks	Total	Comments
6	Accept 3 dp rounding of probabilities from tables			Accept percentage equivalent answers in (a) & (b) but see GN4
(a) (i)	$P(X \leq 15) = \underline{0.694 \text{ to } 0.695}$	B1	(1)	AWFW (0.6946)
(ii)	$P(X > 10)$ $= 1 - 0.1215$ $= \underline{0.878 \text{ to } 0.879}$ $= 1 - 0.0644 \text{ or } 0.935 \text{ to } 0.936$	M1 A1 (M1)	(2)	AWFW (0.8785)
Note	1 For calculation of individual terms or no method: award B2 for 0.878 to 0.879 (AWFW); B1 for 0.935 to 0.936 (AWFW)			
(iii)	$P(12 < X < 18)$ $\begin{matrix} (p_1) & (p_2) \\ = 0.8761 & \text{or } 0.9301 \end{matrix}$ MINUS 0.3143 or 0.2053 $= \underline{0.561 \text{ to } 0.562}$	M1 M1 A1	(3)	AWFW (0.5618)
Notes	1 For calculation of individual terms or no method: award B3 for 0.561 to 0.562 (AWFW); B2 for 0.670 to 0.671 (AWFW); B2 for 0.615 to 0.616 (AWFW); B2 for 0.724 to 0.725 (AWFW) 2 $(1 - p_2) - (1 - p_1) \Rightarrow$ M1 M1 A1 or M1 M1 or M1			
(iv)	Mean of distribution = $40 \times 0.35 = \underline{14}$ $P(X = 14)$ $= \binom{40}{14} 0.35^{14} 0.65^{26}$ or $= 0.5721 - 0.4408$ $= \underline{0.131 \text{ to } 0.132}$	B1 M1 A1	(3)	CAO; can be implied Fully correct expression Can be implied Correct difference AWFW (0.1313)
			9	
(b)	Selection is at random $P(Y < 30 B(50, 0.7))$ $= 1 - 0.9522$ $= \underline{0.047 \text{ to } 0.048}$ $= 1 - 0.9152 \text{ or } 0.084 \text{ to } 0.085$ $= 1 - 0.9749 \text{ or } 0.025 \text{ to } 0.026$ $= 0.952 \text{ to } 0.953$	B1 M2 A1 (M2) (M2) (M1)	4	Statement must include word "random" AWFW (0.0478)
Note	1 For direct use of $P(Y < 30 B(50, 0.7))$ using calculator or no method: award (B1) B3 for 0.047 to 0.048 (AWFW); (B1) B2 for 0.084 to 0.085 (AWFW); (B1) B2 for 0.025 to 0.026 (AWFW); (B1) M1 for 0.952 to 0.953			
		Total	13	

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

