A-LEVEL
Mathematics

Statistics 1B – MS1B
Mark scheme

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.

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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.

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 AWFW, 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 $c\times10^{-n}$ (eg 0.00524 as 5.24×10^{-3})

Q	Solution	Marks	Total	Comments
1 (a)	Using summary data with shown method: $r_{xy} = \dfrac{3629670}{\sqrt{76581640 \times 694250}}$	M1		Used; accept (all 3 values) ÷ 10 Can be implied by a **correct** answer
	= **0.49 to 0.5**	A1		AWFW (0.497791)
	Using summary data without shown method **or** using raw data with or without shown method: r_{xy} = **0.49 to 0.5** r_{xy} = **0.4 to 0.6**	(B2) (B1)	**2**	AWFW AWFW
(b)	**Moderate/some** **positive** (linear) correlation between **gas** and **electricity consumptions**	Bdep1 B1	**2**	Dependent on **0.4 ≤ r_{xy} ≤ 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" ⇒ Bdep0 **3** Accept "relationship/association/link" but not "trend" instead of "correlation" **4** As gas consumption increases then electricity consumption increases ⇒ 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 66.5 67.5 68.5 69.5 70.5 71.5	M1		**At least four seen or implied** (only) **from** $\sum fd = 4095$ **or** mean = 68.2 to 68.3 AWFW **or** mean = 68.5 CAO
	Mean = **<u>68.2 to 68.3</u>**	A1		AWFW (68.25)
	Var(n) = **<u>2.42</u>** **or** Var(n–1) = **<u>2.46</u>** **or**	B2		(2.42083) AWRT $\left(\sum fd^2 = 279629\right)$ (2.46186)
	Var(n) **or** Var(n–1) = **<u>2.4 to 2.5</u>**	(B1)	**4**	AWFW
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)	Mean = $\dfrac{(68.2 \text{ to } 68.3)}{25.4}$			
	= **<u>2.68 to 2.69</u>**	B1		AWFW (2.68701)
	Var(n) **or** Var(n–1) = $\dfrac{(2.4 \text{ to } 2.5)}{25.4^2}$			
	= **<u>0.0037 to 0.0039</u>**	B1	**2**	AWFW (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)		B2		All 6 correct CAO
		(B1)		Any 3 of 6 correct CAO
			2	
(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)	$P(L_A \mid L_D) = \frac{0.05}{0.2} =$	M1		(c's 0.05)/(c's (b)(ii)) Can be implied by a **correct** answer
	0.25	A1	**(2)**	CAO/OE; not 0.25/1
(ii)	$P(L'_A \mid OT_D) =$ $\frac{0.16+0.56}{0.8}$ **or** $\frac{0.8-0.08}{1-0.2}$ **or** $\frac{0.72}{0.8}$	B2		Can be implied by a **correct** answer
	$\frac{0<p<0.8}{0.8}$	(B1)		
	= **0.9**	B1	**(3)**	CAO/OE; not 0.9/1
			5	
(d)	$P(E_A \cap OT_A \cap L_A \mid OT_D) =$			
	$\frac{0.16}{0.8} \times \frac{0.56}{0.8} \times \frac{0.08}{0.8}$ **or** $0.2 \times 0.7 \times 0.1$	M2		**All three correct** (equivalent) fractions or decimals multiplied
		(M1)		**At least one correct** (equivalent) fraction or decimal
	$\times$ (3! or 6)	m1		Dependent on M2
	= **0.084**	A1	**4**	CAO
Notes	**1** Do **not** penalise the **correct answer** quoted to more than three decimal places (eg 0.0840) **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			
SCs	**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**	

	Arrive			
	E	**OT**	**L**	**Total**
Dep **OT**	0.16	0.56	0.08	**0.8(0)**
Dep **L**	**0.06**	**0.09**	**0.05**	**0.2(0)**
Total	0.22	0.65	**0.13**	1.00

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) = **0.4 to 0.41** b (gradient/slope) = **0.35 to 0.45**	B2 (B1)		AWFW (0.40517) AWFW For answers as fractions, see Note 7
	a (intercept) = **1.2 to 1.4** a (intercept) = **0.45 to 2.35**	B2 (B1)		AWFW (1.30186) AWFW
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$ **or** Attempt at S_{xx} & S_{xy}	(M1)		209 4455 99 & **2077.1** (all 4 attempted) $\left(\sum y^2 = 937.02\right)$ 484 & **196.1** (both attempted) (S_{yy} = 82.02)
	Attempt at substitution into correct corresponding formula for b	(m1)		
	b = **0.40 to 0.41** a = **1.2 to 1.4**	(A1 A1)	**(4)**	AWFW $\left(\bar{x} = 19 \text{ & } \bar{y} = 9\right)$
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 to 1.4) + (0.4 to 0.41)x **or** for (1.2 to 1.4) + (0.4 to 0.41)x **4** Values of a and b interchanged and equation $y = ax + b$ **used** for drawing line ⇒ max of 4 marks **5** Values of a and b interchanged and equation $y = a + bx$ used for drawing line ⇒ 0 marks **6** Values are **not** identified or simply b/a = # and a/b = #, then 0.35 to 0.45 ⇒ B1 and 0.45 to 2.35 ⇒ 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)			
	Scatter diagram **line** Line must be (approximately) straight; **not** dog leg, curve or wavy	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)**	*b*: **each/every/one/an additional tile** takes or **increase per tile** is (on average) ***b* hours/60*b* mins**	B1 BF1	**(2)**	F on *b* providing **$0.35 \leq b \leq 0.45$** and **correct units** are stated
Notes	**1** To score any marks, an explanation must indicate change in *x* affecting change in *y*, **not** change in *y* affecting change in *x* **2** Reference **only** to correlation ⇒ B0 BF0			
SC	**1** As *x*/number of tiles increases then *y*/time increases by *b*/60*b* (OE; value of *b* (0. $35 \leq b \leq 0.45$) must be stated but context and/or units are **not** required) ⇒ B1			
	a: time to replace no/zero tiles, start-up time, minimum time, time for travelling, preparation, erecting ladders, obtaining materials, etc	BF1	**(1)**	OE; in context Reference to the value of *a* is not required F on *a* providing ***a* > 0**
			3	
(c)	$y(15)$ = **7 to 8**	B1	**1**	AWFW (7.37934) From calculation/graph/guesswork Hours **not** required
Note	**1** Accept (420 to 480) minutes only if "minutes/mins" are stated			
(d) **(i)**	$r_6 = 8.8 - a - b \times 20$ = **–0.6 to –0.61** r_6 = **0.5 to 0.7**	B2 (B1)	**2**	AWFW; do not ignore sign (–0.60517) AWFW; ignore sign
Note	**1** If, and only if, B0, then attempted use of $\pm(8.8 - a - b \times 20)$ ⇒ M1 providing $0.35 \leq b \leq 0.45$ and $0.45 \leq a \leq 2.35$			
(ii)	Value will be/is always: **0 or zero or nought or nothing**	B1	**1**	CAO; accept nothing else, but ignore zeros after decimal point (eg 0.00) Ignore any explanation
		Total	**15**	

Q	Solution	Marks	Total	Comments
5				**Accept percentage equivalent answers in (a) but see GN4**
(a)(i)	$P(X < 1.9) = P\left(Z < \frac{1.9-1.81}{0.08}\right)$	M1		Standardising 1.9 with 1.81 and 0.08 but allow (1.81 – 1.9)
	$= P(Z < 1.125) = \underline{\mathbf{0.87}}$	A1	**(2)**	AWRT (0.86971)
(ii)	$P(X > 1.85) = P(Z > 0.5) = 1 - P(Z < 0.5)$	M1		Area change; can be implied by **any final answer < 0.5**
	$= 1 - 0.69146 = \underline{\mathbf{0.31}}$	A1	**(2)**	AWRT (0.30854)
(iii)	$P(1.81 < X < 1.85)$			
	$= (0.691 \text{ to } 0.692) - 0.5$ **or** $= 0.5 - (0.308 \text{ to } 0.309)$	B1		Can be implied by a **correct** answer
	$= \underline{\mathbf{0.19}}$	B1	**(2)**	AWRT (0.19146)
			6	
(b)(i)	$z = \text{or} < \frac{9.25-\mu}{\sigma}$ **or** $9.25 = \mu + z\sigma$	M1		Either expression **or** with z replaced by 1.17 to 1.18 (AWFW)
	$0.88 \Rightarrow z = \underline{\mathbf{1.17 \text{ to } 1.18}}$	B1	**2**	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)	$P(Y > 8.75) = 0.975 \Rightarrow z = \underline{\mathbf{1.96}}$	B1		AWRT (ignore sign)
	Thus $9.25 - \mu = +1.175\sigma$ $8.75 - \mu = -1.96\sigma$			(1.17 to 1.18) AWFW (ignore sign) (1.96) AWRT (ignore sign)
	giving $0.5 = 3.135\sigma$	M1		A valid method for solution of two equations that are correct except for signs of z-values (see Note **1**)
	$\sigma = \underline{\mathbf{0.16}}$	Adep1		AWRT (0.15949) Dependent on **two fully correct equations** including signs of z-values
	$\mu = \underline{\mathbf{9 \text{ to } 9.1}}$	Adep1	**4**	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)	$P(X \leq 15)$ = **<u>0.694 to 0.695</u>**	B1	**(1)**	AWFW (0.6946)
(ii)	$P(X > 10)$ = 1 – 0.1215 = **<u>0.878 to 0.879</u>** = 1 – 0.0644 **or** 0.935 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)	$P(12 < X < 18)$ (p_1) (p_2) = 0.8761 **or** 0.9301 **MINUS** 0.3143 **or** 0.2053 = **<u>0.561 to 0.562</u>**	 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 = 40×0.35 = **<u>14</u**> $P(X=14)$ = $\binom{40}{14}0.35^{14}0.65^{26}$ **or** = 0.5721 – 0.4408 = **<u>0.131 to 0.132</u>**	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** $P(Y < 30 \mid B(50, 0.7))$ = 1 – 0.9522 = **<u>0.047 to 0.048</u>** = 1 – 0.9152 **or** 0.084 to 0.085 = 1 – 0.9749 **or** 0.025 to 0.026 = 0.952 to 0.953	B1 M2 A1 (M2) (M2) (M1)	**4**	Statement must include word "random" AWFW (0.0478)
Note	**1** For direct use of $P(Y < 30 \mid B(50, 0.7))$ 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/√12 or √3/20 or 0.086 to 0.087</u>**			CAO AWFW (0.08660)
	or	B1		Can be implied in what follows
	Var of $\bar{B}$ = **<u>$0.3^2/12$ or 3/400 or 0.0075</u>**			CAO
	$P(\bar{B} < 10)$ =			
	$P\left(Z < \frac{10-10.15}{0.3/\sqrt{12}}\right) = P\left(Z < -0.5\sqrt{12}\right)$	M1		Standardising 10 with 10.15 and **0.3/√12 OE**; allow $(10.15 - 10)$
	$= P(Z < -1.732) = 1 - P(Z < 1.732)$	m1		Area change Can be implied by a **correct** answer **or** by an **answer < 0.5**
	$= 1 - 0.958(37)$ = **<u>0.041 to 0.042</u>**	A1	**4**	AWFW (0.04163)
Note	**1** Use of distribution of total: **B1** for Sd = 0.3√12 (OE); **M1** for P(Z < (120 – 121.8)/(0.3√12)) or P(Z < –6/√12) or P(Z < –0.5√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**	

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