
A-LEVEL

Mathematics

Statistics 1B – MS1B
Mark scheme

6360
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Version/Stage: 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.

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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.

Q	Solution	Marks	Total	Comments
1 (a) (i)	No MR or MC in this question			Ignore units throughout this question
	Mode = <u>71</u>	B1		CAO; ignore any reference to 8
	Range = <u>9</u>	B1		CAO
Note	1 If answers are not identified, then assume that order of values is mode, range			
(ii)	Median = <u>70</u>	B1		CAO
	IQR = <u>3</u>	B2		CAO; providing not from incorrect working eg see Note 1
	UQ = <u>72</u> LQ = <u>69</u>	(B1)		Both values CAO; ignore labels
Notes	1 Ordering of weeks (1, 1, 2, 2, 2, 3, 4, 5, 7, 8) \Rightarrow median = 2.5 \Rightarrow B0 B0 even if IQR = 3 (5 - 2) 2 If answers are not identified, then assume that order of values is median, IQR			
(iii)	Mean = <u>70.4</u>	B2		CAO
	Mean = <u>70.1 to 70.7</u>	(B1)		AWFW; but exclude 70.5 unless with a correct method (see Note 2)
	SD = <u>2.03 or 2.06</u>	B2		Either AWRT (2.0312 or 2.0608)
	SD = <u>2 to 2.1</u>	(B1)		AWFW
Notes	1 $\sum fx = 2464$ and $\sum fx^2 = 173610$ 2 Using only x -values gives Mean = 70.5 and SD = 3.16 or 3.32 \Rightarrow B0 B0 3 Using only f -values gives Mean = 3.18 and SD = 2.44 or 2.56 \Rightarrow B0 B0 4 If, and only if, B0 B0, then award M1 for seen attempt at $\sum fx \div 35$ or for $2464 \div 35$			
(b)	Henrietta keeps $(x - 60)$ so:			
	Mean = <u>10.4</u>	BF1		FT on any mean > 60 from (a)(iii) but must subtract 60 and state numerical value > 0
	SD = <u>2.03 or 2.06</u>	BF1		FT on any SD > 0 from (a)(iii) but must state unchanged numerical value > 0
Notes	1 Mean is "60 fewer" than previously/in (a)(iii) (OE) \Rightarrow BF0 2 SD is "exactly same" as previously/in (a)(iii) (OE) \Rightarrow BF0 3 If mean and SD calculated using $(x - 60)$, $\sum f(x - 60) = 364$ and $\sum f(x - 60)^2 = 3930$, then, to score marks, the answers must be 10.4 (CAO) and 2.03 (AWRT) or 2.06 (AWRT)			
		Total	11	

Q	Solution	Marks	Total	Comments
2	No MR or MC in this question			Accept %age equivalents in (a)(i) to (i)
(a)	<u>Length, $X \sim N(1.86, 0.04^2)$</u>			
(i)	$P(X < 1.90) = P\left(Z < \frac{1.90 - 1.86}{0.04}\right)$ $= P(Z < 1) = \underline{\mathbf{0.841}}$	M1 A1	(2)	Standardising 1.90 with 1.86 and 0.04 but allow (1.86 – 1.90) AWRT (0.84134)
(ii)	$P(X > 1.80) = P(Z > -1.5) = P(Z < 1.5)$ $= \underline{\mathbf{0.933}}$	M1 A1	(2)	Correct area change; neither 1.5 or correct standardising are required Can be implied by final answer > 0.5 AWRT (0.93319)
(iii)	$P(1.80 < X < 1.90) = P(Z < 1) - P(Z < -1.5) =$ <p>(i) – [1 – (ii)] or (ii) – [1 – (i)] or (i) + (ii) – 1</p> $= \underline{\mathbf{0.774 \text{ to } 0.775}}$	M1 A1	(2)	OE; any correct difference in areas that results in answer > 0 Can be implied by correct answer but see Notes AWFW (0.77453)
Notes	1 If answer to (ii) is 0.06681, then use of (i) – (ii) = 0.84134 – 0.06681 = 0.774 to 0.775 \Rightarrow M0 A0 2 If answer to (ii) is 0.06681, but answer here starts afresh with $P(1.80 < X < 1.90)$, then M1 A1 is available			
(iv)	$P(X \neq 1.86) = \underline{\mathbf{1 \text{ or one or unity or } 100\%}}$	B1	(1)	CAO; accept nothing else but ignore zeros after decimal place (eg 1.00) Ignore additional words providing that they are not contradictory (eg certain so = 1)
Note	1 $P(X \neq 1.86) = P(Z \neq 0) \Rightarrow$ B0 unless followed by 1 OE			
			7	
(b)	$0.98 \Rightarrow z = \underline{\mathbf{2.05 \text{ to } 2.06}}$ $\left(\frac{1.80 - 1.86}{\sigma}\right) \Leftrightarrow \begin{pmatrix} -2.05 \text{ to } -2.06 \\ \text{or} \\ -2.32 \text{ to } -2.33 \end{pmatrix}$ $\sigma \Leftrightarrow \underline{\mathbf{0.029 \text{ to } 0.03}}$	B1 M1 A1	3	AWFW; seen anywhere, ignore sign (2.0537) Standardising 1.80 with 1.86 and σ or s but allow (1.86 – 1.80); and equating to a z-value in either range (<i>ignore sign</i>) AWFW (0.02922) If working is shown, then there must be consistent signs throughout so, for example, $(1.80 - 1.86)/\sigma = +2.0537 \Rightarrow$ B1 M1 A0
Note	1 Allow use of 1.92 instead of 1.80 so $(1.92 - 1.86)/\sigma = +2.0537 \Rightarrow$ B1 M1 (A1)			
		Total	10	

Q	Solution	Marks	Total	Comments
3 Notes for part (a)	No MR or MC in this question except as indicated in the following Notes			
	1 If correct fraction, percentage or ratio is followed by incorrect decimal, then apply ISW but apply penalties as in Notes 2 to 5			
	2 At least one decimal answer given to more than 3 dp (including 0.0320) or at least one recurring decimal answer (eg 0.29 $\bar{3}$ or 0.29 $\dot{0}$) are penalised by 1 mark			
	3 At least one fractional answer (eg 22/75) is penalised by 1 mark			
	4 At least one percentage answer (eg 29.3) is penalised by 1 mark			
5 At least one ratio answer (eg 22:75) is penalised by 2 marks				
Mark answers as below and then apply MR-1 or MR-2 as appropriate (if available) at end of question before totalling marks				
(a)(i)	$P(\text{FH}) = \frac{220}{750} = \frac{22}{75} = \underline{0.293}$	B1	(1)	CAO/AWRT (0.29333)
(ii)	$P(\text{AH} \cap \text{BE}) = \frac{24}{750} = \frac{8}{250} = \frac{4}{125} = \underline{0.032}$	B1	(1)	CAO
(iii)	$P(\text{AH} \cup \text{BE} \text{ but not both}) = \frac{110 + 215 - 2 \times 24}{750}$ $= \underline{277/750} = \underline{0.369}$	M1	(2)	OE Can be implied by correct answer
		A1		CAO/AWRT (0.36933)
SC	Award B1 for 301/750 or 0.401(33)			
(iv)	$P(\text{GE} \text{FH}) = \frac{64}{750} \div \frac{220}{750} =$ $\underline{64/220} = \underline{32/110} = \underline{16/55} = \underline{0.291}$	M1	(2)	OE Can be implied by correct answer
		A1		CAO/AWRT (0.29091)
(v)	$P(\text{FH} \text{GE}) = \frac{64}{750} \div \frac{195}{750} =$ $\underline{64/195} = \underline{0.328}$	M1	(2)	OE Can be implied by correct answer
		A1		CAO/AWRT (0.32821)
SC	If, and only if, answers to (iv) & (v) are correct but reversed , then award M1 A0 M1 A0			
			8	
(b)	$P((\text{DH} \cap \text{BE}) \cap (\text{DH} \cap \text{BE}) \cap (\text{MH} \cap \text{GE})) =$ $\frac{92}{750} \times \frac{91}{749} \times \frac{55}{748}$ Multiplied by 3 or $\binom{92}{2} \binom{55}{1} \div \binom{750}{3}$ $= \underline{0.00328 \text{ to } 0.00329}$	M1 M1	4	Correct 3 values multiplied in numerator Correct 3 values multiplied in denominator $0.123 \times 0.121 \times 0.074$ (all AWRT) \Rightarrow M1 M1 (OE products) Dependent on at least one M1 scored Numerator Denominator AWFW (0.00328752)
		m1 (M1 M1) (M1) A1		
Notes	1 Incorrect answer with no working \Rightarrow 0 marks			
	2 The 3 correct fractions or decimals identified but not multiplied (eg added) \Rightarrow M1 M0 m0 A0			
	3 The 3 correct fractions or decimals identified along with 0.0011 (AWRT) \Rightarrow M1 M1 m0 A0			
	4 Do not penalise a correct answer given to more than 3sf			
	5 Answer given as 3.28×10^{-3} to 3.29×10^{-3} \Rightarrow M1 M1 m1 A1			
		Total	12	

Q	Solution	Marks	Total	Comments
4 (a) (i)	No MR or MC in this question			
	$r_{uv} = \underline{0.915}$ $= \underline{0.9 \text{ to } 0.92}$ $= \underline{0.8 \text{ to } 0.99}$	B3 (B2) (B1)		AWRT AWFW AWFW (0.91468)
	Attempt at $\sum u$ $\sum u^2$ $\sum v$ $\sum v^2$ & $\sum uv$ or Attempt at S_{uu} S_{vv} & S_{uv} Attempt at substitution into correct corresponding formula for r_{uv} $r_{uv} = \underline{0.915}$	(M1) (m1) (A1)	3	81.58 808.2288 70.11 632.3553 & 701.6158 (all 5 attempted) 142.69916 140.81409 & 129.65842 (all 3 attempted) AWRT
(ii)	$r_{xy} = \underline{0.915}$	BF1		F on (i) providing $-1 < r_{uv} < +1$ Value quoted must be 0.915(AWRT) or identical to answer in (i)
Notes	1 Award on value only; ignore any explanation or working		2 $r_{xy} = r_{uv}$ with no value stated \Rightarrow B0	
	3 Calculating r_{xy} using values of x & $y \Rightarrow$ B1 only if $r_{xy} = 0.915$ (AWRT)			
Notes	r is not affected by linear scaling			OE; accept "Formula" or "It" for r but reference to " linear " is necessary
	or Scaling/coding/transformation/change/conversion to u and v is linear	Bdep1		Dependent on BF1 OE; but reference to " linear " is necessary
	1 All values changed using (same) linear scale/formula \Rightarrow B1		2 All values changed using (same) scale/formula/-100 \Rightarrow B0	
	3 Linear formula has no effect on $r \Rightarrow$ B1		4 Formula has no effect on $r \Rightarrow$ B0	
	5 r is not affected by units (June 2013!) \Rightarrow B0			
			2	
(b)	(Very) strong positive (linear) correlation	Bdep1		Dependent on $0.8 \leq (r_{xy} \text{ or } r_{uv}) \leq 0.99$ OE; must qualify strength and state positive
Notes	1 Only accept phrase stated; ignore additional comments unless contradictory			
	2 Use of: "quite/fairly/extremely/relatively strong or high or big or good or moderate or medium or average" \Rightarrow Bdep0			
	3 Accept "relationship/association/link" but not "trend" instead of "correlation"			
	between (average) qualifying speed and (average) race speed	B1		Context; providing $-1 < (r_{xy} \text{ or } r_{uv}) < 1$
Notes	1 Accept "qualifying mph" and "race mph" but not "mph" without identification			
	2 Accept "fastest/qualifying lap" and "three/ race laps"			
		Total	7	

Q	Solution	Marks	Total	Comments
5 (a) (i)	No MR or MC in this question			Accept percentage equivalents in (a)
	$p(0) = \underline{\mathbf{0.18}}$	B1		CAO; can be implied from working or correct answer
	$P(H=3) = \binom{30}{3}(p)^3(1-p)^{27}$ $= \underline{\mathbf{0.111 \text{ to } 0.112}}$	M1 A1		Correct expression using $p = \mathbf{0.18, 0.47, 0.25 \text{ or } 0.10}$ Can be implied by correct answer Ignore extra terms AWFW (0.11151)
(ii)	$p(\geq 3) = \underline{\mathbf{0.1}}$	B1		CAO; can be implied from working or correct answer
	$P(H \leq 5) = \underline{\mathbf{0.926 \text{ to } 0.927}}$	B1		AWFW (0.9268)
(iii)	$p(\geq 2) = \underline{\mathbf{0.35}}$	B1		CAO; can be implied from 0.5078 or 0.3575 (accept 3dp rounding) or correct answer
	$P(H > 10) = \underline{\mathbf{1 - (0.5078 \text{ or } 0.3575)}}$	M1		Requires "1 - either probability" Accept 3 dp rounding Can be implied by (0.492) but not by (0.642 to 0.643)
	$= \underline{\mathbf{0.492}}$	A1		AWRT (0.4922)
SC	For calculation of individual terms: award B1 B2 for 0.492 (AWRT); award B1 for 0.642 to 0.643 (AWFW)			
(iv)	$p(=2) = \underline{\mathbf{0.25}}$			
	$P(5 < H < 10) = \mathbf{0.8034 \text{ or } 0.8943}$ (p_1)	M1		Accept 3 dp rounding Can be implied by correct answer
	MINUS $\mathbf{0.2026 \text{ or } 0.0979}$ (p_2) $= \underline{\mathbf{0.6 \text{ to } 0.601}}$	M1 A1		Accept 3 dp rounding Can be implied by correct answer AWFW (0.6008)
Notes	1 First M1 is for $(+p_1)$ in calculation 2 Second M1 is for $(-p_2)$ in calculation 3 $(1-p_2) - (1-p_1) \Rightarrow$ M1 M1 (A1) 4 B(30, 0.25) probabilities shown for at least 3 values within $4 \leq X \leq 10 \Rightarrow$ M2 May be implied by a correct answer Ans = $\underline{\mathbf{0.6 \text{ to } 0.601}} \Rightarrow$ A1			
(b)	Mean (μ or \bar{x}) = $\underline{\mathbf{108}}$	B1		CAO; B(150, 0.72)
	Variance (σ^2 or s^2) = $\underline{\mathbf{30.2 \text{ to } 30.3}}$	B1		AWFW (30.24)
Notes	1 If answers are not identified, then assume that order of values is mean, variance 2 If 30.2 to 30.3 labelled as SD (σ or s) \Rightarrow B0			
		Total	13	

Q	Solution	Marks	Total	Comments
6	No MR or MC in this question	Accept height but not length instead of depth throughout question		
(a)(i)	$a = \underline{15}$	B1	1	CAO; eg $14.9 \Rightarrow 15 \Rightarrow B0$
(ii)	b (gradient/slope) = $\underline{-0.029}$ b (gradient/slope) = $\underline{-0.025 \text{ to } -0.035}$ a (intercept) = $\underline{14.9}$ a (intercept) = $\underline{14 \text{ to } 16}$	B2 (B1) B2 (B1)		AWRT (-0.02903) AWFW AWRT (14.90968) AWFW
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$ or Attempt at S_{xx} & S_{yy} Attempt at correct formula for b $b = \underline{-0.029}$ (AWRT) $a = \underline{14.9}$ (AWRT)	(M1) (m1) (A1 A1)	4	1450 280000 107 & 13490 (all 4 attempted) ($\sum y^2 = 1204.42$) 69750 & -2025 (both attempted) ($S_{yy} = 59.52$) $(\bar{x} = 145 \text{ \& } \bar{y} = 10.7)$
Notes	1 Treat rounding of correct answers as ISW 2 Written form of equation is not required 3 Award 4 marks for $y = 14.9 - 0.029x$ or $y = 14.9 + -0.029x$ or $14.9 - 0.029x$ or $14.9 + -0.029x$ 4 Values of a and b interchanged and equation $y = ax + b$ stated in (a)(ii) \Rightarrow max of 4 marks 5 Values of a and b interchanged with no equation stated or equation $y = a + bx$ stated in (a)(ii) \Rightarrow 0 marks 6 Values of a and b are not identified, then -0.025 to $-0.035 \Rightarrow B1$ and 14 to $16 \Rightarrow B1$ 7 Answers in fractions can score maximum of M1 m1 8 Some/all of marks can be scored in (a)(iii) & (b) & (c), even if some/all of marks are lost in (a)(ii), but marks lost in (a)(ii) cannot be recouped by subsequent working in (a)(iii) or (b) or (c)(ii)			
(iii)	Seal depth reduces/decreases by 0.03 (AWRT) when pressure increases by 1 -0.03 (AWRT) when pressure increases by 1 or (y, cm) reduces/decreases as (x, kPa) increases	B1 Bdep1 (Bdep0) (B1)	2	OE; must be in context OE; must be in context (double negative) OE; context not required B0 for reference only to correlation
Note	1 To score any marks, an explanation must indicate change in x affecting y , not change in y affecting x			
(b)	$y_{225} = \underline{8.3 \text{ to } 8.4}$ $y_{225} = \underline{6.1 \text{ to } 10.4}$	B2 (B1)	2	AWFW but see Note 1 (8.37442) AWFW; even if by $(9.0 + 7.5)/2$
Notes	1 If an answer is in the range 8.3 to 8.4 and seen to be from other than the use of $y = 14.9 - 0.029x$, then award B1 only 2 If, and only if, B0, then award M1 for seen use of $y = a + b \times 225$ or $y = 15 + b \times 225$			
(c)(i)	Extrapolation/outside (observed) range (of x)	B1	(1)	OE
(ii)	or $y_{525} = \underline{-0.3 \text{ to } -0.4}$ $x_0 = \underline{510 \text{ to } 515}$ Negative seal depth is impossible Seal is off/above/under/below the ground Seal is within the barrier	B1 Bdep1	(2)	AWFW (-0.33226) AWFW (513.59) OE; must be in context Dependent on B1 Negative value is impossible $\Rightarrow B0$
			3	
		Total	12	

Q	Solution	Marks	Total	Comments
7 (a) (i)	No MR or MC in this question			
	Attempt at $\bar{v} - n\sigma = 118 - 65n < 0$ and negative usage/volume is impossible	M1 A1	 2	Allow 1.82, 2, 3 or 4 for n with a correct numerical answer OE; must be in context Negative value is impossible \Rightarrow A0
Notes	1 $n = 1.82 \Rightarrow \approx 0$; $n = 2 \Rightarrow -12$; $n = 3 \Rightarrow -77$; $n = 4 \Rightarrow -142$ 2 Attempt at $P(V < 0) = P\left(Z < \frac{0-118}{65}\right)$ or $\left(z = \pm \frac{0-118}{65}\right) \Rightarrow$ M1 (Standardising 0 using 118 and 65) $\Rightarrow P(Z < -1.81 \text{ to } 1.82) \Rightarrow$ 0.03 to 0.04 (AWFW) AND negative usage/volume is impossible \Rightarrow A1 or \Rightarrow 0 is (1.81 to 1.82)SDs from mean AND negative usage/volume is impossible \Rightarrow A1			
(ii)	Sample (size/number/ n) is large or 80/sample (size/number/ n) is greater than 25/30 so can apply/use Central Limit Theorem (CLT)	B1 Bdep1	 2	OE OE; is sufficient/is enough/implies Dependent on B1
	Notes	1 Even if CLT is stated, then reference to parent population is thus normal \Rightarrow Bdep0 2 Value(s) of (population) standard deviation (and mean) is/are known \Rightarrow B0 Bdep0		
(b)(i)	98% (0.98) $\Rightarrow z =$ 2.32 to 2.33	B1		AWFW (2.3263)
	CI for μ is: $118 \pm \begin{pmatrix} 2.05 \text{ to } 2.06 \\ 2.32 \text{ to } 2.33 \\ 2.57 \text{ to } 2.58 \end{pmatrix} \times \frac{(65 \text{ or } 65.4(\text{AWRT}))}{\sqrt{80 \text{ or } 79}}$	M1		Evaluation of only one CL \Rightarrow M0 Ignore notation $\sqrt{\frac{65^2 \times 80}{79}} = 65.4101$
	Thus $118 \pm (2.32 \text{ to } 2.33) \times \frac{65}{\sqrt{80}}$	A1		Fully correct expression
	Hence or <u>118 \pm 17</u> <u>(101, 135)</u>	Adep1	4	CAO/AWRT (16.90574) Dependent on A1 AWRT
Notes	1 A correct answer with no working \Rightarrow 4 marks 2 Seen use of t -value (2.37 to 2.38) \Rightarrow 0 marks 3 An incorrect expression for CI followed by a numerically correct CI \Rightarrow 2 solutions $\Rightarrow ((0 \text{ or } 1) + 4)/2 \Rightarrow$ 2 marks			
(ii)	Clear correct comparison of 140 with CI eg 140 is outside/above CI or $140 > \text{UCL}$ Disagree with/doubt/reject claim or μ unlikely to be/is not 140	BF1 Bdep1	 2	F on CI providing it does not contain 140 Must be an interval but quoting values for limits is not required OE; dependent on BF1
	Notes	1 Statement must clearly indicate that "140 is outside/above the CI" or " $140 > \text{UCL}$ " 2 "It/mean/value/OE" is outside/above CI or greater than UCL \Rightarrow BF0 3 Statements of the form "140 is outside/above 98% of the data/values" \Rightarrow BF0 4 Statements such as " Claim unlikely/unreasonable/unsupported/incorrect/false/inaccurate/invalid" \Rightarrow Bdep1 but only if BF1 awarded		
		Total	10	