
A-LEVEL

Mathematics

MS1A/W – Statistics 1A
Mark scheme

6360
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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 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** In general, a correct answer (to accuracy required) without units scores full marks.
- GN4** When applying AFW, 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 3.21×10^{-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
1	Emboldened words (at least one chosen from emboldened options) are required in parts (a) & (d)			
(a)(i)	Mode: 5 is minimum/smallest/lowest value	B1		
(ii)	Range: is affected/skewed/distorted/increased / large/wide/big/high due to value of 95	B1	2	
Notes	1 Use only of “inaccurate or incorrect or wrong OE” ⇒ B0 2 Reasons must relate specifically to the data in the question; general comments (eg mode does not use all values, large spread or range, range only uses maximum and minimum values) ⇒ B0 3 Ignore additional comments, even if incorrect or inaccurate 4 If parts not labelled, then reasons must clearly reference mode or range			
(b)	Median = 17	B1		CAO; ignore method
	Interquartile range (22 – 10) = 12	B1	2	CAO; ignore method
(c)	Mean = 20	B1		CAO; see Note 2 ($\sum x = 460$) & ($\sum x^2 = 16608$)
or	Standard deviation (n) = 17.9 to 18.0	B2		AWFW (17.94678)
or	Standard deviation ($n-1$) = 18.3 to 18.4			Do not ignore method; see Note 3 AWFW (18.35013)
	Standard deviation (n or $n-1$) = 17 to 19	(B1)	3	AWFW
Notes	1 Where no method is shown for mean and standard deviation simply mark numerical values stated 2 If an incorrect method for mean is followed by a numerically correct value ⇒ B1 3 If an incorrect method for standard deviation is followed by a numerically correct value ⇒ 2 solutions so B2 becomes B1 or (B1) becomes (B0)			
(d)	Data is not symmetrical or data is (positively) skewed	B1		Reference only to ‘normal’ ⇒ B0
	Median and IQR or measures/results in (b) or "they" ARE NOT affected/skewed/distorted/influenced/changed by 95/maximum/outlying/extreme/large value	B1		
	OR Mean and SD or measures/results in (c) ARE affected/skewed/distorted/influenced/changed by 95/maximum/outlying/extreme/large value		2	
Note	1 Comments simply about the data (eg large spread) and/or comments or comparisons of measures (eg large Sd or mean > median or Sd > IQR) ⇒ B0			
		Total	9	

Q	Solution	Mark	Total	Comment
2	Emboldened words are required in part (b)			
(a)	$r = \underline{\underline{0.00375}}$ $r = \underline{\underline{0.0037 \text{ to } 0.0038}}$ $r = \underline{\underline{0.003 \text{ to } 0.004}}$ or	B3 (B2) (B1)		CAO; (see GN7) (0.0037498) AWFW; (see GN7) AWFW; (see GN7)
	$\sum t = 290$ $\sum t^2 = 9326$ $\sum tc = 13346.27$ $\sum c = 460$ $\sum c^2 = 24212.2686$ or $S_t = 916$ $S_{cc} = 3052.2686$ $S_{tc} = 6.27$	(M1)		Correct attempt at 5 summations (Look for $\sum tc = \sum t \sum c = 133400$)
	Attempt at substitution into a correct corresponding formula for r	(m1)		Correct attempt at 3 summations
	$r = \underline{\underline{0.00375}}$	(A1)	3	CAO; (see GN7)
(b)	There is no (linear) correlation	Bdep1		Dep on $r = 0.003$ to 0.004
Notes	1 Statements must include the word “no” without qualification or additional phrases together with only “correlation” or “association” or “relationship” 2 Use of any of the following terms (even in conjunction with “no”): “almost or virtually or low or little or small or weak or mild or slightly or fairly or pretty or significant” \Rightarrow Bdep0			
Notes	between the time and cost of items	Bdep1	2	Dep on $r = -0.99$ to $+0.99$
	1 Accept order of “cost of items” and “time” 2 “As time spent increases, cost of items purchased remains the same” \Rightarrow Bdep0 Bdep1 3 “As time/ t increases, cost/ c remains the same” \Rightarrow Bdep0 Bdep0 4 Any suggestion that “as time spent increases, cost of items purchased increases” \Rightarrow Bdep0 Bdep0			
		Total	5	

Q	Solution	Mark	Total	Comment
3	Accept the equivalent percentage answers with %-sign (see GN5)			
(a)(i)	$P(X > 757) = P\left(Z > \frac{757 - 730}{20}\right) =$ $P(Z > 1.35) = 1 - P(Z < 1.35) = 1 - 0.91149$ $= \underline{\underline{0.088 \text{ to } 0.089}}$	M1 m1 A1	3	Standardising 757 with 730 and 20 but allow $(730 - 757)$ Area change; may be implied but only by the correct answer AFWW (0.08851)
(ii)	$P(706 < X < 730)$ $= P(-\underline{\underline{1.2}} < Z < \underline{\underline{0}}) \text{ or } P(\underline{\underline{0}} < Z < \underline{\underline{1.2}})$ $= (0.5 - (1 - 0.88493)) \text{ or } (0.88493 - 0.5)$ $= \underline{\underline{0.384 \text{ to } 0.386}}$	B1 B1	2	CAO 0 and 1.2 AFWW (0.38493)
(b)	$\left(\frac{350 - \mu}{\sigma} = 0\right) \Rightarrow \mu = \underline{\underline{350}}$ $0.99 \Rightarrow z = \underline{\underline{-2.32 \text{ to } -2.33}}$ $\frac{320 - (350 \text{ or } \mu)}{\sigma} = \begin{pmatrix} \pm 2.05 \text{ to } \pm 2.06 \\ \pm 2.32 \text{ to } \pm 2.33 \\ \pm 2.57 \text{ to } \pm 2.58 \end{pmatrix}$ $\Rightarrow \sigma = \underline{\underline{13}}$	B1 B1 M1 A1	4	CAO; this should result immediately from the two 'standard' simultaneous equations; other one is below for M1 AFWW; ignore sign (-2.3263) Standardising 320 with (350 or μ) and σ but allow $((350 \text{ or } \mu) - 320)$ and equating to one of 3 listed z-values but allow inconsistent signs CAO; (12.87 to 12.94) Penalise inconsistent signs here
		Total	9	

Q	Solution	Mark	Total	Comment
4	Emboldened words (at least one chosen from emboldened options) are required in part (a)(ii)			
(a)(i)	b (gradient/slope) = <u>0.0355 to 0.0356</u> b (gradient/slope) = <u>0.035 to 0.036</u> a (intercept) = <u>0.214 to 0.222</u> a (intercept) = <u>0.19 to 0.25</u>	B2 (B1) B2 (B1)		AFWW (0.035544) AFWW AFWW (0.217363) AFWW
	or $\sum x = 780$ $\sum x^2 = 65000$ ($\sum y^2 = 95.0731$) $\sum y = 30.55$ $\sum xy = 2479.9$ or $S_{xx} = 18200$ $S_{yy} = 646.9$ ($S_{yy} = 23.2806$) Attempt at substitution into a correct corresponding formula for b	(M1) (m1)		Correct attempt at 4 summations (Look for $\sum xy = \sum x \sum y = 23829$) Correct attempt at 2 summations
	b (gradient/slope) = <u>0.0355 to 0.0356</u> a (intercept) = <u>0.214 to 0.222</u>	(A1) (A1)	4	AFWW (0.035544) AFWW (0.217363)
Notes	<ol style="list-style-type: none"> 1 Only if equation stated without “$b =$ and $a =$”, then award marks as detailed above for $y = a + bx$ stated in (b)(i); deduct 1 mark if “$y =$” or “$x =$” is missing; deduct 2 marks if both “x and $y =$” are missing 2 Values of a and b interchanged and equation $y = ax + b$ stated in (b)(i) \Rightarrow max of 4 marks 3 Values of a and b interchanged and equation $y = a + bx$ stated in (b)(i) \Rightarrow 0 marks 4 Values are not identified or simply $a = \#$ and $b = \#$, then (0.035 to 0.036) \Rightarrow B1 and (0.19 to 0.25) \Rightarrow B1 but accept, for example, as identification, [$a = \#, b = \#$ with $y = a + bx$ stated with no substitution for a & b] or [intercept(a) = #, gradient(b) = #] 5 (x or y) = $-5.3 + 27.8(y$ or $x)$ \Rightarrow 0 marks; unless corrected later, this will result in only the first B1 in (d) being available 6 Some/all of marks can be scored in (b)(ii), (c) & (d), 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) 			
(ii)	a (intercept): (expected/average/mean/usual/typical) yield of tomatoes when no/0/zero potassium in a plant’s liquid feed or similar/close/near to observed yield (of 0.31)	Bdep1		Dep on $0.19 \leq a \leq 0.25$
Note	1 Value of y /yield when x /potassium = 0 \Rightarrow B0			
	b (gradient/slope): for each/every increase of a /one mg/l of potassium in a plant’s liquid feed a plant’s (expected/average/mean/usual/typical) yield of tomatoes increases by a value within 0.035 (kg) to 0.036 (kg)	B1 Bdep1		Dep on B1 3
Notes	<ol style="list-style-type: none"> 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 Any increase in potassium must be matched by a correct increase in yield to score B1dep (eg 10 (mg/l) and 0.35 (kg) to 0.36 (kg)) 3 Reference only to correlation \Rightarrow B0 Bdep0 			
SC	1 As x /potassium/mg increases then y /yield/kg increases by b (OE) \Rightarrow B1; only if the value of b ($0.035 \leq b \leq 0.036$) is stated here but context and/or units are not required			
(b)	$Res_H = -0.28$ to -0.23 $Res_H = -0.32$ to -0.19 or $Res_H = +0.19$ to $+0.32$	B2 (B1)		AFWW; do not ignore sign (-0.25544) AFWW; either 2
		Total	9	

Q	Solution	Mark	Total	Comment
5	Accept 3 dp rounding of probabilities Emboldened words (at least one chosen from emboldened options) are required in part (a)			Accept the equivalent percentage answers with %-sign (see GN5)
(a)	(i) Appropriate or Yes (ii) Not appropriate or No (iii) Not appropriate or No	B1		All 3 stated correctly Cannot be implied
(i)	$n = \mathbf{20}$ $p = \mathbf{2/6 \text{ or } 1/3 \text{ or } 0.3r \text{ or } 0.33 \text{ or } 33\%}$	B1 B1		CAO B(20, 0.33 (OE)) \Rightarrow B2 CAO
(ii)	Number of trials or tosses or n is not fixed	B1		No other alternatives
(iii)	P(yellow highlighter pen) or p is not constant/not fixed/variable/changes/varies or selection of pens or events is/are dependent/not independent	B1		No other alternatives
			5	
(b) (ii)	$P(2 \leq W_{LH} \leq 6) = 0.9005 \text{ or } 0.7937$ (p_1) minus $0.0805 \text{ or } 0.2228$ (p_2) $= \mathbf{0.82}$	M1 M1 A1		Seen as first term in a subtraction Seen as second term in a subtraction AWRT (0.820001)
Notes	1 For no method or calculation of individual terms; award B3 for 0.82 (AWRT); B2 for 0.677 to 0.678 (AWFW); B2 for 0.713 to 0.714 (AWFW); B2 for 0.570 to 0.572 (AWFW); B0 for anything else 2 Answers seen using [(0.9195 or 0.7772) – (0.0995 or 0.2063)] [ie (1 – p_2) – (1 – p_1)] \Rightarrow M1 M1 A1 max 3 Answers seen using [1 – ($p_1 - p_2$)] even after ($p_1 - p_2$) [eg 1 – (0.9005 – 0.0805) = 0.18] \Rightarrow 0 marks 4 Use of $p_1 \times p_2$ or $p_1 \div p_2$ or $p_1 + p_2$ or p_1 only or p_2 only \Rightarrow 0 marks			
(iii)	Use of B(50, 0.10) $P(W_{NLH} > 40) = P(W_{LH} \leq 9) \text{ or } P(W_{LH} < 10)$ $= 0.9755 \text{ or } 0.9906$ $= \mathbf{0.975 \text{ to } 0.976}$ or	B1 M1 A1		Seen or used; can be implied by either 0.9755 or 0.9906 seen AWFW (0.975462)
	Use of B(50, 0.90) $P(W_{NLH} > 40) = 1 - P(W_{NLH} \leq 40)$ $= 1 - (0.0245 \text{ or } 0.0094)$ $= \mathbf{0.975 \text{ to } 0.976}$	(B1) (M1) (A1)		Seen or used; can be implied by 0.0245 or 0.0094 or 0.9906 seen AWFW (0.975462)
			(3)	
			6	
		Total	11	

Q	Solution	Mark	Total	Comment
6				
(a)	$95\% \Rightarrow z = \underline{1.96}$ CI for μ is: $1075 \pm \left(\begin{array}{c} 1.96 \text{ AWR T} \\ 1.64 \text{ to } 1.65 \text{ AFW F} \end{array} \right) \times \frac{36}{\sqrt{50}}$ Thus: $\underline{1075 \pm 10}$ or $\underline{(1065, 1085)}$	B1 M2 (-1 ee) Adep1	4	AWR T (1.95996) Ignore any notation M0 if CI is not of the form: $\left(\begin{array}{c} 1075 \\ 1072 \end{array} \right) \pm \left(\begin{array}{c} 1.96 \\ 1.64 \text{ to } 1.65 \end{array} \right) \times \left(\frac{36}{6} \right) / \sqrt{\left(\frac{50}{49} \right)}$ CAO (1075 \pm 9.97869) Dependent on award of M2 CAO (1065.02, 1084.98)
Note	1 If award of M0 or M1 is followed by a numerically correct CI \Rightarrow possibly 2 solutions			
SC	1 NMS for CI then (1065, 1085) \Rightarrow 4 marks; (1065.0, 1085.0) (AWRT) \Rightarrow B3			
(b)	$98\% \Rightarrow z = \underline{2.32 \text{ to } 2.33}$ $\left(\begin{array}{c} 1075 \\ \mu \text{ or } \bar{x} \end{array} \right) + \left(\begin{array}{c} 2.32 \text{ to } 2.33 \\ 2.57 \text{ to } 2.58 \end{array} \right) \times \frac{36}{\sqrt{n}} = 1080$ and $\left(\begin{array}{c} 1075 \\ \mu \text{ or } \bar{x} \end{array} \right) - \left(\begin{array}{c} 2.32 \text{ to } 2.33 \\ 2.57 \text{ to } 2.58 \end{array} \right) \times \frac{36}{\sqrt{n}} = 1060$ ----- or $1070 + \left(\begin{array}{c} 2.32 \text{ to } 2.33 \\ 2.57 \text{ to } 2.58 \end{array} \right) \times \frac{36}{\sqrt{n}} = 1080$ ----- or $1070 - \left(\begin{array}{c} 2.32 \text{ to } 2.33 \\ 2.57 \text{ to } 2.58 \end{array} \right) \times \frac{36}{\sqrt{n}} = 1060$	B1 M1		AFW F (2.32635) Use of μ or \bar{x} can score 4 marks Use of 1075 \Rightarrow B1 M1 max Use of anything else \Rightarrow B1 max
	Thus: $\left(\begin{array}{c} 2.32 \text{ to } 2.33 \\ 2.57 \text{ to } 2.58 \end{array} \right) \times \frac{36}{10} = \sqrt{n}$ $n = 69.76 \text{ to } 70.36 \Rightarrow \underline{70 \text{ or } 71}$	m1 A1	4	Re-arranging for \sqrt{n} or n CAO either (70.14)
SC	1 Method of T&I; $z = 2.32 \text{ to } 2.33 \Rightarrow$ B1; evaluation of $\left(\begin{array}{c} 2.32 \text{ to } 2.33 \\ 2.57 \text{ to } 2.58 \end{array} \right) \times \frac{36}{\sqrt{n}}$ with a numerical integer value for $n \Rightarrow$ M1; since $2.32 \times 36 / \sqrt{64} = 10.44(10)$ and $2.33 \times 36 / \sqrt{77} = 9.56(10)$ then $n = \text{int}(64 \text{ to } 77) \Rightarrow$ A1 but $n = 70 \text{ or } 71 \Rightarrow$ A2			
		Total	8	

Q	Solution	Mark	Total	Comment
7	Accept the equivalent percentage answers with %-sign (see GN5)			
(a)				
(i)	$P(L \cap M) = 0.55 \times 0.28 = \underline{\underline{0.154}}$	B1	3	CAO; accept 154/1000 or 77/500
(ii)	$P(L \cup M) = 0.55 + 0.28 = \underline{\underline{0.83}}$	B1		CAO; accept 83/100
(iii)	$P(L \cup M) = 0.83 - 0.154 = \underline{\underline{0.676}}$	B1		CAO; accept 676/1000 or 338/500 or 169/250
Note	1 For fractional answers, do not penalise errors in simplifications; eg $154/1000 = 67/500 \Rightarrow$ B1 (for 154/1000)			
(b)				
(i)	$P(A = 3) = 0.94 \times 0.88 \times 0.76 = \underline{\underline{0.628 \text{ to } 0.629}}$	B1	1	AWFW (0.628672)
(ii)	$P(A = 1) = (0.94 \times 0.12 \times 0.24) + (0.06 \times 0.88 \times 0.24) + (0.06 \times 0.12 \times 0.76)$ or $= 0.027072 + 0.012672 + 0.005472 = \underline{\underline{0.045 \text{ to } 0.0455}}$	M1 A1	2	Fully correct; not $(1 - 0.88)$, etc Fully correct to 4dp AWFW (0.045216)
(iii)				
(A)	$P(A = 4) = \underline{\underline{0.603 \text{ to } 0.604}}$	B1	(1)	AWFW (0.60352512)
(B)				
	$P(A = 0) = (0.06 \times 0.12 \times 0.24) \times 0.52 = \underline{\underline{0.000898 \text{ to } 0.000899}}$	M1 A1	(2)	Fully correct AWFW; (see GN7) (0.00089856)
			3	
		Total	9	