AQA

AS
Mathematics

MS1A/W Unit Statistics 1A
Mark scheme

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Version 1.0: Final Mark Scheme

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.

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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 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 AWFW, 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})

Q	Solution	Marks	Total	Comments
1 (a)	$r =$ **0.959** $=$ **0.95 to 0.97** $=$ **0.9 to 0.99**	B3 (B2) (B1)		AWRT (0.95915) AWFW AWFW
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ $\sum y^2$ & $\sum xy$ **or** Attempt at S_{xx} S_{yy} & S_{xy}	(M1)		1980 327726 1896 300598 & **313826** (all 5 attempted) 1026 1030 & **986** (all 3 attempted)
	Attempt at substitution into **correct** corresponding formula for r	(m1)		
	$r =$ **0.959**	(A1)	**3**	AWRT
(b)	(Very/extremely) **strong positive** (linear) **correlation**	Bdep1		Dependent on $\mathbf{0.9 \leq r \leq 0.99}$
Notes	**1** Statements **must** include the words "strong" **and** "positive" **together with** "correlation" **or** "association" **or** "relationship"; ignore additional comments unless clearly contradictory **2** The **only acceptable qualifiers** for "strong" are "very" **or** "extremely" **3** The use of: "highly/moderately/quite/fairly/relatively/reasonably/respectively strong" $\Rightarrow$ Bdep0 **4** The use of: "high or big or good or some or moderate or medium or average" $\Rightarrow$ Bdep0			
	between **Height(s)** and **arm span(s)** of **men** aged 21 to 40	B1	**2**	Context; providing $\mathbf{-1 < r < 1}$ Must contain at least the 4 emboldened words
Notes	**1** "As heights of men (aged 21 to 40) increase so do arm spans" (OE) Bdep0 B1 **2** "As heights/x increase so do arm spans/y" (OE) Bdep0 B0			
		Total	**5**	

Q	Solution	Marks	Total	Comments
2				
	Ordered data: 110 115 230 370 370 425 445 450 455 480 550 550 575 585 590			
(a)	Range =590 – 110 = **480**	B1		CAO
	Two modes/more than one mode/no single mode/no unique mode	B1	**2**	OE
(b)	A **sensible** attempt at ordering the data	M1		Can be implied
	Median = **450**	A1		CAO; (8^{th} value)
	IQR = 550 – 370 = **180**	A1	**3**	CAO; (12^{th} value – 4^{th} value)
Notes	**1** Answers of 455 and 180 with no method ⇒ M1 A1 A1 **2** An answer of 450 or/and 180 with incorrect method(s) ⇒ M1 A1 A0 or M1 A0 A1 or M0 A0 A0 **3** Unordered data ⇒ median = 480 and IQR = 370 – 590 = ±220 ⇒ M0 A0 A0			
(c)	Mean = **420**	B1		CAO $\sum x = 6300$
	Sd(n) = **153** **or** Sd(n–1) = **158**	B1	**2**	AWRT (152.872) $\sum x^2 = 2996550$ AWRT (158.238)
Note	**1** If, and only if, B0 B0 scored, then award M1 for **seen** attempt at $(6200 \text{ to } 6400) \div 15$			
		Total	**7**	

Q	Solution	Marks	Total	Comments
3(a)	**Accept the equivalent percentage answers with %-sign in parts (a)(i) to (a)(iv) but not in parts (a)(v) and (b) (see GN5)**			
(i)	$P(A_{41\text{-}65}) =$ **$\underline{176/500 = 88/250 = 44/125 = 0.352}$**	B1	**(1)**	CAO; any one of four listed answers
(ii)	$P(A_{\geq 66} \cap B_2) =$ **$\underline{68/500 = 34/250 = 17/125 = 0.136}$**	B1	**(1)**	CAO; any one of four listed answers
(iii)	$P(A_{19\text{-}40} \cap B_{\leq 1}) = \frac{17+62}{500} = \frac{79}{500}$ $= \underline{\mathbf{0.158}}$	M1 A1	**(2)**	Numerator CAO CAO
(iv)	$P(A_{\geq 41} \mid B_2) =$ $\frac{(35+68)/500}{130/500}$ **or** $\frac{(130-5-22)/500}{130/500}$ **or** $\frac{103}{130}$ $= \underline{\mathbf{0.792}}$	M1 A1	**(2)**	Fraction CAO AWRT (0.79231)
(v)	$P(B_{\geq 2} \mid A_{\leq 65}) =$ $\frac{5+(0)+22+3+35+31}{80+104+176}$ **or** $\frac{96}{360}$ $\frac{48}{180}$ **or** $\frac{24}{90}$ **or** $\frac{12}{45}$ **or** $\frac{4}{15}$ $= \underline{\mathbf{0.267}}$	M1 M1 (M2) A1	**(3)**	Numerator CAO (130 – 68 + 40 – 6) Denominator CAO (500 – 140) (Accept numerator and denominator each ÷ 500) **CAO (3 dp only)** (0.26667)
			9	
(b)	$P(A_{41\text{-}65} \cap B_{>0}) =$ $\frac{82+35+31}{500}$ **or** $\frac{176-28}{500}$ **or** $\frac{148}{500}$ (p_1)	B1		CAO; OE $\left(\frac{74}{250}, \frac{37}{125}, 0.296\right)$ Seen anywhere, even in an incorrect expression
	$P(A_{\geq 66} \cap B_{1 \text{ or } 2}) =$ $\frac{53+68}{500}$ **or** $\frac{140-13-6}{500}$ **or** $\frac{121}{500}$ (p_2)	B1		CAO; OE (0.242) Seen anywhere, even in an incorrect expression
	Prob $= (p_1)^2 \times (p_2)^2$ or $(p_1 \times p_2)^2$	M1		Providing $0 < p_1,\ p_2 < 1$ Must be equivalent to product of two squared probabilities with no extra terms
	$\times \binom{4}{2}$ or 6	m1		
	$= \underline{\mathbf{0.0308}}$	A1	**5**	**CAO (3 sf only)** (0.03078686)
SCs	**1** Answer of 0.00513 (AWRT) even without working $\Rightarrow$ B1 B1 M1 mo A0 **2** Answer of 0.0716 (AWRT) even without working $\Rightarrow$ B1 B1 M0 mo A0 **3** In each of the following (incorrect) expressions, $(\otimes \Rightarrow \times \text{ or } +)$ Ignore order of terms and/or value of n providing n is an integer ≥ 1 $\left(\frac{148}{500} \otimes p_3 \otimes \frac{121}{500} \otimes p_4\right) \times n \Rightarrow$ B1 B1 and $\left(\frac{148}{500} \otimes p_3 \otimes p_4 \otimes p_5\right) \times n$ or $\left(p_3 \otimes p_4 \otimes \frac{121}{500} \otimes p_5\right) \times n \Rightarrow$ B1 **4** Use of divisors of 504, 503, 502, and 501 $\Rightarrow$ max of M1 m1 but much more likely to be M0 mo **5** A final answer of 3.08×10^{-2} does score A1			
		Total	**14**	

Q	Solution	Marks	Total	Comments
4(a)	**Accept the equivalent percentage answers with %-sign (see GN5)**			
(i)	$P(X < 1540) = P\left(Z < \frac{1540-1525}{9.6}\right)$	M1		Standardising 1540 with 1525 and 9.6 but allow (1525 – 1540)
	$= P(Z < 1.56(25)) =$ **<u>0.94 to 0.942</u>**	A1	**(2)**	AWFW (0.94091)
(ii)	$P(X > 1535) =$ $P(Z > 1.04(17) = 1 - P(Z < 1.04)$	M1		Area change; can be implied by **any final answer < 0.5**
	$= 1 - 0.85122 =$ **<u>0.148 to 0.15</u>**	A1	**(2)**	AWFW (0.14878)
(iii)	$P(1515 < X < 1540) = P(-1.04 < Z < 1.56)$ $= 0.94091 - (1 - 0.85122)$			
	= **<u>0.79 to 0.793</u>**	B2	**(2)**	AWFW (0.79213)
(iv)	$P(X \neq 1500) =$ **<u>1 or one or unity or 100%</u>**	B1	**(1)**	CAO; accept nothing else but ignore zeros after decimal point (eg 1.00) Ignore additional words providing that they are not contradictory (eg certain so = 1)
			7	
	Part (a)	**Total**	**7**	

Q	Solution	Marks	Total	Comments
4	**Continued**			
	Part (a)	**Total**	**7**	
(b)	Each **pack** contains a **random sample** of bottles **or** **Packs** contain **random samples** of bottles	B1	**(1)**	Must contain at least the 3 emboldened words **and** clearly infer that 'bottles in a pack are a random sample' **This mark can be scored anywhere in (c)**
Note	**1** "Samples (of bottles) are random" (OE) or "Each bottle is randomly selected" (OE) ⇒ B0 **2** "Packs are selected at random" (OE) or "Each pack is selected at random" (OE) ⇒ B0 (Stated in question!) **3** "Packs/bottles are selected independently" (OE) or "Packs/bottles are normally distributed" (OE) ⇒ B0			
(i)	$p = \text{P(bottle} > 505) = \text{P}\left(Z > \dfrac{505-508.5}{3.5}\right) =$			
	$\text{P}(Z > -1) = \text{P}(Z < 1) =$ **<u>0.84</u>**	B1		AWRT (0.84134) Can be implied by a **correct** answer
	$\text{P(6 bottles} > 505) = p^6$	M1		Providing $0 < p < 1$
	= **<u>0.35 to 0.356</u>**	A1	**(3)**	AWFW (0.35469)
Notes	**1** Calculation of $(1 - 0.84134) = 0.15866$ ⇒ B0 **2** Calculation of $(1 - 0.84134)^6$ ⇒ B0 M1 A0			
(ii)	$\text{V}\left(\bar{B}\right) = \dfrac{3.5^2}{6}$ **or** $\dfrac{12.25}{6}$ **or** **<u>2.04</u>**			CAO/AWRT (2.04167)
	or	B1		Can be implied by what follows
	$\text{Sd}\left(\bar{B}\right) = \dfrac{3.5}{\sqrt{6}}$ **or** **<u>1.43</u>**			CAO/AWRT (1.42887)
	$\text{P}\left(\bar{B} > 505\right) = \text{P}\left(Z > \dfrac{505-508.5}{3.5/\sqrt{6}}\right)$	M1		Standardising 505 with 508.5 and $\mathbf{3.5/\sqrt{6}}$ **(OE)**; allow $(508.5 - 505)$
	$= \text{P}(Z > -\sqrt{6}) = \text{P}(Z > -2.45) =$ **<u>0.99 to 0.995</u>**	A1	**(3)**	AWFW (0.99285)
			7	
Notes	**1** Do **not** give BOD for unclear/dubious/questionable identifications of (i) & (ii) **2** If answers to (i) & (ii) are not identified, then mark as (i) followed by (ii) **3** If answers to (i) & (ii) are switched, then the **only mark available** is the B1 for stating the 'necessary assumption' **4** In (ii), award of B0 ⇒ 0/3 marks			
SC	**1** Use of distribution of total in (ii): **B1** for Sd = $3.5\sqrt{6}$ (OE); **M1** for $\text{P}(Z > (3030 - 3051)/(3.5\sqrt{6}))$ or $\text{P}(Z > -\sqrt{6})$ or $\text{P}(Z > -2.45)$ **A1** for 0.99 to 0.995 (AWFW); award of B0 ⇒ 0/3 marks			
		Total	**14**	

Q	Solution	Marks	Total	Comments
5(a)	**Accept 3 dp rounding of probabilities from tables**			**Accept the equivalent percentage answers with %-sign (see GN5)**
(i)	$P(\text{Red} = 4) = \binom{50}{4}(0.12)^4(0.88)^{46}$	M1		
	$= 230300 \times 0.00020736 \times 0.002793849$			
	$= \underline{\mathbf{0.133 \text{ to } 0.134}}$	A1	**2**	AWFW (0.13342)
(ii)	$P(\text{Orange} \leq 12) = \underline{\mathbf{0.814}}$	B1	**1**	AWRT (0.8139)
(iii)	$P(20 < \text{Pink} < 30) =$			
	0.9765 or 0.9844 (p_1)	M1		
	MINUS			
	0.2862 or 0.1974 (p_2)	M1		
	$= \underline{\mathbf{0.69 \text{ to } 0.691}}$	A1	**3**	AWFW (0.6903)
Notes	**1** For calculation of individual terms or no method: award **B3** for 0.69 to 0.691 (AWFW); **B2** for 0.778 to 0.78 (AWFW); **B2** for 0.787 to 0.789 (AWFW); **B2** for 0.697 to 0.699 (AWFW) **2** $(1-p_2) - (1-p_1) \Rightarrow$ M1 M1 A1 or M1 M1 or M1			
(b) **(i)**	$P(\text{Black} = 0) = (1 - 0.075)^{50} = (0.925)^{50}$	M1		Can be implied by a **correct** answer
	$= \underline{\mathbf{0.02}}$	A1	**2**	AWRT (0.02028)
(ii)	$p_{(\text{Red or Yellow})} = p_{(\text{Black or Purple})} = \underline{\mathbf{0.35}}$	B1		CAO; stated or identified by any one of the probabilities in MS solution
	$P(\text{Either} < 20) = 0.7264 \text{ or } 0.8138$	M1		
	$P(\text{Both} < 20) = 0.7264^2 = \underline{\mathbf{0.527 \text{ to } 0.528}}$	A1	**3**	AWFW (0.5277)
Note	**1** For calculation of individual terms or no method: award **B3** for 0.527 to 0.528 (AWFW); **B2** for 0.662 to 0.663 (AWFW); **B1** for 0.35 (CAO) **stated**			
		Total	**11**	

Q	Solution	Marks	Total	Comments
6 **(a)**	99% (0.99) $\Rightarrow$ z = **2.57 to 2.58**	B1		AWFW (2.5758)
	CI for μ is			
	$317.5 \pm \begin{pmatrix} 2.57 \text{ to } 2.58 \\ 2.32 \text{ to } 2.33 \\ 2.70 \text{ to } 2.71 \\ 2.42 \text{ to } 2.43 \end{pmatrix} \times \frac{(146.3 \text{ or } 148.1 \text{ to } 148.2)}{\sqrt{40 \text{ or } 39}}$	M2,1 (–1 ee)		Ignore any notation M0 if CI is not of the form: $317.5 \pm (z \text{ or } t) \times \left((s \text{ or } s^2) / \sqrt{40 \text{ or } 39} \right)$ Allow any combination in last term NB: $146.3 \times \sqrt{40/39} = 148.16377$
	Hence **317.50 ± (58.50 to 60.50)**			CAO/AWFW; **1 or 2 dp only**
	or	Adep1		Dependent on award of M2
	(257.00 to 259.00, 376.00 to 378.00)			AWFW; **1 or 2 dp only**
			4	
Notes	**1** If award of M0 is followed by a numerically correct CI $\Rightarrow$ 2 solutions **2** Use same rules as above for t = 2.7 to 2.71 (AWFW) $\Rightarrow$ 317.50 ± (62.00 to 63.00) or (254.50 to 255.50, 379.50 to 380.50)			
(b) **(i)**	€400 equates to (£) **333 to 334**			AWFW (£333.33)
	or	B1*		*** This mark may be scored in (b)(ii) ***
	CI (€): **381 ± (70 to 73)**			CAO/AWFW (2 dp **not** required)
	or **(308 to 311, 451 to 454)**			AWFW (2 dp **not** required)
	Clear correct comparison of **(333 to 334)** with **CI in (a)** {eg 333.33 is within CI in (a)}			Statement must include reference to 333 to 334 F on CI providing it is **includes** 333 to 334 Must have found an **interval** in (a) but quoting values for CI or CLs is **not** required
	or (Must be clear that comparing like with like)	BF1		
	Clear correct comparison of **(400)** with **CI in (b)(i)** {eg 400 is within CI in (b)(i)}			Statement must include reference to 400 F on CI providing it is **includes** 400 Must have found an **interval** in (b)(i) but quoting values for CI or CLs is **not** required
	Agree with or accept claim Claim is (likely to be) **true/correct/right/valid/accurate**	Bdep1		OE; dependent on BF1
			(3)	
Notes	**1** Statement must **clearly** indicate that "(333 to 334 or 400) is **within** the **corresponding** CI" OE **2** Statements of the form "It/this/mean/value/etc is within the (corresponding) CI" $\Rightarrow$ BF0 **3** Statements of the form "(333 to 334 or 400) is within 99% of the data/values/pounds/euros" $\Rightarrow$ BF0 **4** Statements such as "Claim is likely to be reasonable/supported/correct/true/possible/valid" $\Rightarrow$ Bdep1 providing BF1			
(ii)	€200 equates to (£) **166 to 167**			AWFW (£166.67) *** Award B1 if 1st B1 not scored in (b)(i) ***
	Per cent < €200/£166.67			Can be implied by 17.5 or 20 (OE) or 7 or 8
	$\frac{7 \text{ or } 8}{40} \times 100$ = **17.5 or 20** seen with **25**			Requires **both correct** numbers (OE) from any of these pairs
	or **7 or 8** seen with **10**	B1		
	or (€)**200** seen with (€)**225**			eg 17.5 & 25, 0.2 & 0.25, 8 & 10 $\Rightarrow$ B1 7 & 25 only $\Rightarrow$ B0
	or (£)**166 to 167** seen with (£)**187.5(0)**			
	Agree with or accept claim Claim is (likely to be) **true/correct/right/valid/accurate**	Bdep1		OE; dependent on B1
			(2)	
			5	
		Total	**9**	