AS

Statistics

SS1A/W Statistics 1A
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.

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 SS1A/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)**	Mean = **48.1** = **3.31** **or** **3.68** **or** Var(n) or Var(n–1) = **3.1 to** **3.9**	B1 B2 (B1)		CAO $\left(\sum x = 481\right)$ AWRT (3.312) $\left(\sum x^2 = 23169.22\right)$ CAO (3.680) AWFW
		Var(n)		
		Var(n–1) =		
				3	
Notes	**1** Value of variance stated as 1.81^2 to 1.93^2 and not evaluated $\Rightarrow$ B1 **2** Value of variance or standard deviation stated as 1.81 to 1.93 $\Rightarrow$ B0 **3** If, and only if, B0 B0, then award M1 for **seen** attempt at $(480 \text{ to } 482) \div 10$			
(b)	Mean = $\big($their mean$\big) \times 0.354$ = **16.9** **to 17.1** Var(n) or Var(n–1) = $\big(3.1 \text{ to } 3.9\big) \times 0.354^2$ = **0.415 to 0.416** or **0.461 to 0.462**	M1 A1 M1 A1		Can be implied by a **correct** answer AWFW (17.0274) Can be implied by a **correct** answer AWFW (0.41505 or 0.46116)
			4	
Notes	**1** New Sd = $(1.8199 \text{ to } 1.9183) \times 0.354 = (0.644 \text{ to } 0.680) \Rightarrow$ M0 **2** New Var = $[(1.8199 \text{ to } 1.9183) \times 0.354]^2 = (0.644 \text{ to } 0.680)^2 \Rightarrow$ M1 **3** If no marks scored, then **seen** multiplication of data values by 0.354 $\Rightarrow$ M1 only			
		Total	**7**	

Q	Solution	Marks	Total	Comments
2	Accept the equivalent percentage answers with %-sign (see GN5)			
(a)	$P(X < 960) = P\left(Z < \dfrac{960 - 955}{5} \right)$	M1		Standardising 960 with 955 and 5; allow (955 – 960)
	$= P(Z < 1) =$ **0.841**	A1	**(2)**	AWRT (0.84134)
(b)	$P(X > 946) = P(Z > -\underline{\mathbf{1.8}}) = P(Z < \underline{\mathbf{1.8}})$	B1		CAO; ignore sign
	$= \underline{\mathbf{0.964}}$	B1	**(2)**	AWRT (0.96407)
(c)	$P(X = 950)$ $= \underline{\mathbf{0\ or\ zero\ or\ nought\ or\ nothing\ or\ nil}}$	B1	**(1)**	CAO; accept nothing else but ignore zeros after decimal point (eg 0.00) Ignore additional words providing they are not contradictory (eg impossible so = 0)
(d)	$P(946 < X < 960) = P(-1.8 < Z < 1) =$ (i) – (1 – (ii)) **or** (i) + (ii) – 1 **or** 0.841 – (1 – 0.964) **or** 0.841 + 0.964 – 1	M1		OE; providing 0 < answer < 1 Can be implied by a **correct** answer AWRT
	$= \underline{\mathbf{0.8}}$ **to 0.81**	A1	**(2)**	AWFW (0.80541)
		Total	**7**	

Q	Solution	Marks	Total	Comments
3(a)	**Accept the equivalent percentage answers with %-sign (see GN5)**			
(i)	P(CW) = <u>110/400 = 55/200 = 11/40 = **0.275**</u>	B1	**(1)**	CAO; either of four listed answers
(ii)	P(SW $\cap$ H) = <u>56/400 = 28/200 = 14/100 = 7/50 = 0.14</u>	B1	**(1)**	CAO; any one of five listed answers
(iii)	P(B $\cap$ (H $\cup$ C)) = $\dfrac{30+24+24+26}{400} = \dfrac{104}{400}$ =	M1		Numerator CAO
	<u>104/400 = 52/200 = 26/100 = 13/50 = 0.26</u>	A1	**(2)**	CAO; any one of five listed answers
(iv)	P((E $\cup$ C) | W) = $\dfrac{(32+17+21+14)\big/400}{(150+110)\big/400}$ **or** $\dfrac{84}{260}$ =	M1 M1		Numerator CAO Denominator CAO
	$\dfrac{42}{130}$ **or** $\dfrac{21}{65}$ =	(M2)		
	<u>42/130 = 21/65 = **0.323**</u>	A1	**(3)**	CAO/AWRT (0.32308)
			7	
(b)	P(W $\cap$ C) = $\dfrac{45+25}{400}$ **or** $\dfrac{70}{400}$ (p_1)	B1		CAO; OE $\left(\dfrac{7}{40},\ 0.175\right)$ Seen anywhere, even in an incorrect expression
	P(B $\cap$ H) = $\dfrac{30+24}{400}$ **or** $\dfrac{54}{400}$ (p_2)	B1		CAO; OE $\left(\dfrac{27}{200},\ 0.135\right)$ Seen anywhere, even in an incorrect expression
	Prob = $\left(p_1\right)^2 \times \left(p_2\right)^2$	M1		Providing $0 < p_1,\ p_2 < 1$ $(p_1 \times p_2 \times p_3 \times p_4)\ \Rightarrow\ $ M0
	$\times \dbinom{4}{2}$ **or** 6	m1		
	= <u>**0.00334 to 0.00335**</u>	A1	**5**	AWFW (0.0033488)
SCs	**1** Answer of 0.00056 (AWRT) without working $\Rightarrow$ B1 B1 M1 m0 A0 **2** Answer of 0.02362 to 0.02363 (AWFW) without working $\Rightarrow$ B1 B1 M0 m0 A0 **3** In each of the following (incorrect) expressions, $(\otimes \Rightarrow \times$ or $+)$ and ignore the value of n: $\left(\dfrac{70}{400} \otimes \dfrac{69}{400} \otimes \dfrac{54}{400} \otimes \dfrac{53}{400}\right) \times n \ \Rightarrow\ $ B1 B1 and $\left(\dfrac{70}{400} \otimes \dfrac{69}{399} \otimes \dfrac{54}{398} \otimes \dfrac{53}{397}\right) \times n \ \Rightarrow\ $ B1			
		Total	**12**	

Q	Solution	Marks	Total	Comments
4(a)				

(i)	b (gradient/slope) = **0.372 to 0.373**	B2 (B1)		AWFW (0.37235)	
	b (gradient/slope) = **0.3 to 0.4**			AWFW	
	a (intercept) = **6.94 to 6.95**	B2 (B1)		AWFW (6.94648)	
	a (intercept) = **6 to 9**			AWFW	

	Attempt at $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$ **or** Attempt at S_{xx} & S_{xy}	(M1)	324 8922.70 204 & **5573.05** (all 4 attempted) $\left(\sum y^2 = 3493.64\right)$ 174.70 & **65.05** (both attempted) $\qquad (S_{yy} = 25.64)$	
	Attempt at substitution into correct corresponding formula for b	(m1)		
	b = **0.372 to 0.373** $\qquad$ a = **6.94 to 6.95**	(A1 A1) **4**	AWFW $(\bar{x} = 27$ & $\bar{y} = 17)$	

Notes	**1** Written form of equation is **not** required
	2 Award 4 marks for $y = (6.94 \text{ to } 6.95) + (0.372 \text{ to } 0.373)x$ **or** for $(6.94 \text{ to } 6.95) + (0.372 \text{ to } 0.373)x$
	3 Values of a and b interchanged and equation $y = ax + b$ **stated or used in (b) or (c)** $\Rightarrow$ max of 4 marks
	4 Values of a and b interchanged and equation $y = a + bx$ **stated or used in (b) & (c)** $\Rightarrow$ 0 marks
	5 Values are **not** identified, then $\Rightarrow$ B0 B0
	6 Some/all of marks can be scored in (a)(ii), (a)(iii), (b) & (c)(i), even if some/all of marks are lost in (a)(i), but marks lost in (a)(i) **cannot** be recouped by subsequent working in (a)(ii), (a)(iii), (b) or (c)(i) but see **Note 3**

(ii)	**Each/every/one degree** (°C) **rise** in ground temperature results in	B1		
	or **increase per degree** (°C) is (on average) b **vibrations** per second	BF1 **2**	F on b providing $0.3 \le b \le 0.4$	

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 Accept, for example, 10°C and 10b vibrations
	3 Reference **only** to correlation $\Rightarrow$ B0 BF0
SC	**1** As x/temperature increases (by c) then y/vibrations increases by b (OE; value of b $(0.3 \le b \le 0.4)$ must be stated but context and/or units are **not** required) $\Rightarrow$ B1

(iii)	Given: When temperature/x < **15** °C **or** = **0** °C value of **y = 0**	B1	**Must be stated clearly**	
	Equation: When temperature/x = **0** °C vibrations/value of y = **6 to 9**	BF1 **2**	AWFW F on a providing $6 \le a \le 9$	

Notes	**1** B1 is for a **clear statement** of information given in the question in terms of temperature/x and y
	2 BF1 is for a **clear statement** of the value of vibrations/y shown by the equation when temperature/x = 0

	Part(a)	**Total**	**8**

Q	Solution	Marks	Total	Comments
4	**Continued**			
	Part (a)	**Total**	**8**	
(b)	$y(23) = $ <u>**15.4 to 15.6**</u>	B1 **1**		AWFW (15.51059)
Note	**1** Ignore any method shown			
(c) **(i)**	res(28.6) $= 17.0 - a - b \times 28.6$ $= $ <u>**–0.55 to –0.65**</u> $= $ <u>**0.5 to 0.7**</u>	B2 (B1) **2**		AWFW; do **not** ignore sign (–0.59576) AWFW; ignore sign
Note	**1** If, and only if, B0, then attempted use of $\pm(17.0 - a - b \times 28.6) \implies$ M1 providing $0.3 \le b \le 0.4$ and $6 \le a \le 9$			
(ii)	Value will be/is always: <u>**0 or zero or nought or nothing or nil**</u>	B1 **1**		CAO; accept nothing else, but ignore zeros after decimal point (eg 0.00) Ignore any explanation
		Total	**12**	

Q	Solution	Marks	Total	Comments
5	**Accept 3 dp rounding of probabilities from tables**		**Accept the equivalent percentage answers with %-sign (see GN5)**	
(a)	Use of B(30, 0.28)	M1		Indicated by an expression **or** by a **correct** answer
	P(Vans = 3) = $\binom{30}{3}(0.28)^3(1-0.28)^{30-3}$	M1		Correct expression Can be implied by a **correct** answer Ignore additional expressions
	= 4060 × 0.021952 × 0.000140597			
	= **0.012 to 0.013**	A1	3	AWFW (0.01253)
(b)	P(Van or HGV) = **0.4**	B1		CAO; stated or identified from below
	P(Vans or HGVs ≥ 10)			
	= 1 − 0.1763	M1		
	= **0.823 to 0.824**	A1		AWFW (0.8237)
	= 1 − 0.2915 **or** 0.708 to 0.709	(M1)	3	
Note	**1** For calculation of individual terms or no method: award **B3** for 0.823 to 0.824 (AWFW); **B2** for 0.708 to 0.709 (AWFW)			
(c)				
Note	P(20 < M′ ≤ 25) = P(M′ ≤ 25) − P((M′ ≤ 20); but $p = 0.85$ is not tabled so must use calculator **or** P(M′ > 20) = P(M < 10) and P(M′ ≤ 25) = P(M ≥ 5) so P(20 < M′ ≤ 25) = P(5 ≤ M < 10) = P(M ≤ 9) − P(M ≤ 4); and $p = 0.15$ is tabled or may use calculator			
	Using $p =$ **0.15** gives Using $p =$ **0.85** gives	B1		Either CAO Stated or identified from below
	0.9903 **or** 0.9971 (p_1) 0.4755 **or** 0.2894	M1		
	MINUS			
	0.5245 **or** 0.7106 (p_2) 0.0097 **or** 0.0029	M1		
	= **0.464 to 0.466**	A1	4	AWFW (0.4658)
Notes	**1** For calculation of individual terms or no method: award **B4** for 0.464 to 0.466 (AWFW); **B3** for 0.472 to 0.473 (AWFW); **B3** for 0.279 to 0.281 (AWFW); **B3** for 0.286 to 0.287 (AWFW) **2** $(1 − p_2) − (1 − p_1)$ ⇒ (B1) M1 M1 A1 or (B1) M1 M1 or (B1) M1 **3** Answer of 1 – 0.4658 = 0.534 to 0.536 ⇒ B1 M1 M1 A0 or B3			
		Total	**10**	

Q	Solution	Marks	Total	Comments
6(a) **(i)**	$\overline{x} = 12240/30$ $= \underline{\mathbf{408}}$	B1		CAO
	$s^2 = 3972/29 = \underline{\mathbf{137}}$ $s = \underline{\mathbf{11.7}}$ $\sigma^2 = 3972/30 = \underline{\mathbf{132}}$ $\sigma = \underline{\mathbf{11.5}}$	B1		AWRT (136.9655 & 11.70323) Ignore any notation AWRT (132.4 & 11.50652)
	$98\%\ (0.98) \Rightarrow z = \underline{\mathbf{2.32\ to\ 2.33}}$ CI for μ is	B1		AWFW (2.3263) Ignore any notation
	$408 \pm \begin{pmatrix} 2.32\,\text{to}\,2.33 \\ 2.05\,\text{to}\,2.06 \\ 2.45\,\text{to}\,2.47 \\ 2.14\,\text{to}\,2.16 \end{pmatrix} \times \dfrac{\left(\sqrt{137}\,\text{or}\,11.7\,\text{or}\,\sqrt{132}\,\text{or}\,11.5\right)}{\sqrt{30\,\text{or}\,29}}$	M2,1 (–1 ee)		M0 if CI is not of the form: $C \pm (z\,\text{or}\,t) \times \left(D/\sqrt{30\,\text{or}\,29}\right)$; allow any combination in last term
	Hence (z) $\underline{\mathbf{408 \pm 5}}$ **or** $\underline{\mathbf{(403,\ 413)}}$	Adep1		CAO/AWRT (4.95 to 5.28) Dependent on award of M2 AWRT
			6	
Note	1 If award of M0 is followed by a numerically correct CI $\Rightarrow$ possibly 2 solutions			
(ii)	0.5% 'above 400' or 'of 400' $\Rightarrow$ **402 or 2**	B1		CAO
	Clear correct comparison of **402** with **CI** {eg $402 < CI$ or $402 < LCL$}	BF1		Statement must include reference to 402 F on CI providing it is **above** 402 Must have found an **interval** in (a)(i) but quoting values for CI or CLs is **not** required
	Sample **meets requirement** or **Yes**	Bdep1	**3**	Dependent on BF1
Notes	1 Statement must clearly indicate that "**402** is **below** the CI" OE 2 Statements of the form "402 is within 98% of the data/values/loaves/weights/grams" $\Rightarrow$ B1 BF0 Bdep0 3 Comparison of 402 with 408 **or** comparison of 402 with CI which includes 402 $\Rightarrow$ B1 BF0 Bdep0 4 Use of 420 (5%) or 600 (50%) $\Rightarrow$ B0 BF0 Bdep0			
(b)	Number $< 388 = \underline{\mathbf{4}}$ which is greater than $\underline{\mathbf{3}}$ **or** Percent $< 388 = \underline{\mathbf{13}}$ which is greater than $\underline{\mathbf{10}}$	B1		Requires 4 & 3 Requires 13(AWRT) & 10
	Sample does **not meet requirement**	BF1	**2**	Dependent on B1
(c)	CLT used in part **(a)(i)** or **first part** **or** construction of **CI**	B1		"First question" $\Rightarrow$ B0 Ignore additional words providing they are not contradictory
			1	
			12	