
AS

Statistics

SS1B

Mark scheme

6380

June 2016

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.

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 SS1B

- 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 AFWF, 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)	$r = \underline{\underline{0.608}}$ $= \underline{\underline{0.6 \text{ to } 0.62}}$ $= \underline{\underline{0.5 \text{ to } 0.7}}$	B3 (B2) (B1)	3	AWRT AWFW AWFW (0.60810)
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ $\sum y^2$ & $\sum xy$ or Attempt at S_{xx} S_{yy} & S_{xy}	(M1)		20.25 41.0455 11.30 12.7862 & 22.8983 (all 5 attempted) 0.03925 0.0172 & 0.0158 (all 3 attempted)
	Attempt at substitution into correct corresponding formula for r $r = \underline{\underline{0.608}}$	(m1) (A1)		AWRT
(b)	Some/moderate positive (linear) correlation /relationship/association	Bdep1		Dependent on $0.5 \leq r \leq 0.7$ Must qualify strength and state positive
Notes	1 Only accept phrase stated; ignore additional comments unless contradictory 2 Any mention of “strong or weak” \Rightarrow Bdep0 3 Use of: “quite/fairly/relatively/reasonably moderate” \Rightarrow Bdep0 4 Use of: “high or big or good or low or small or poor or medium or average” \Rightarrow Bdep0			
	between trunk and tail lengths of male African elephants	B1	2	Context; providing $-1 < r < 1$
Notes	1 “As trunk lengths of elephants increase so do tail lengths” (OE) Bdep0 B1 2 “As trunks/x increase so do lengths/y” (OE) Bdep0 B0			
		Total	5	

Q	Solution	Marks	Total	Comments
2 (a)	Mean = <u>48.1</u>	B1	3	CAO ($\sum x = 481$)
	Var(n) = <u>3.31</u>	B2		AWRT (3.312)
	or Var($n-1$) = <u>3.68</u>			CAO (3.680)
	Var(n) or Var($n-1$) = <u>3.1 to 3.9</u>	(B1)		AWFW
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 = (their mean) \times 0.354	M1	4	Can be implied by a correct answer
	= <u>16.9 to 17.1</u>	A1		AWFW (17.0274)
	Var(n) or Var($n-1$) = $(3.1 \text{ to } 3.9) \times 0.354^2$	M1		Can be implied by a correct answer
	= <u>0.415 to 0.416</u> or <u>0.461 to 0.462</u>	A1		AWFW (0.41505 or 0.46116)
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
3	Accept the equivalent percentage answers with %-sign (see GN5)			
(a)(i)	$P(X < 960) = P\left(Z < \frac{960 - 955}{5}\right)$ $= P(Z < 1) = \underline{\mathbf{0.841}}$	M1 A1	(2)	Standardising 960 with 955 and 5; allow (955 – 960) AWRT (0.84134)
(ii)	$P(X > 946) = P(Z > \underline{\mathbf{-1.8}}) = P(Z < \underline{\mathbf{1.8}})$ $= \underline{\mathbf{0.964}}$	B1 B1	(2)	CAO; ignore sign AWRT (0.96407)
(iii)	$P(X = 950)$ $= \underline{\mathbf{0 \text{ or zero or nought or nothing or nil}}}$	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)
(iv)	$P(946 < X < 960) = P(-1.8 < Z < 1) =$ $(i) - (1 - (ii)) \quad \mathbf{or} \quad (i) + (ii) - 1$ \mathbf{or} $0.841 - (1 - 0.964) \quad \mathbf{or} \quad 0.841 + 0.964 - 1$ $= \underline{\mathbf{0.8 \text{ to } 0.81}}$	M1 A1	(2)	OE; providing $0 < \text{answer} < 1$ Can be implied by a correct answer AWRT (0.80541)
	Part (a)	Total	7	

Q	Solution	Marks	Total	Comments
3	Continued			
	Part (a)	Total	7	
(b) (i)	$P(10 \text{ bottles} > 946) =$ $[(a)(ii)]^{10}$ <p style="text-align: center;">or</p> $(0.964)^{10}$ $= \underline{\underline{0.693 \text{ to } 0.694}}$	M1 A1	 (2)	Providing $0 < (a)(ii) < 1$ AFWW (0.69356)
(ii)	$V(\bar{X}) = \frac{5^2}{10} \text{ or } \frac{25}{10} \text{ or } \underline{\underline{2.5}}$ <p>OR</p> $Sd(\bar{B}) = \frac{5}{\sqrt{10}} \text{ or } \frac{\sqrt{10}}{2} \text{ or } \sqrt{\frac{5}{2}} \text{ or } \underline{\underline{1.58}}$ $P(\bar{X} < 952.5) = P\left(Z < \frac{952.5 - 955}{\sqrt{2.5}}\right)$ $= P(Z < -\sqrt{2.5}) = 1 - P(Z < 1.58)$ $= \underline{\underline{0.056 \text{ to } 0.058}}$	B1 M1 m1 A1	 (4)	CAO Can be implied by what follows CAO/AWRT (1.58114) Standardising 952.5 with 955 and $\sqrt{2.5}$ (OE); allow $(955 - 952.5)$ Can be implied only providing M1 scored and answer < 0.5 AFWW (0.056923)
			6	
Notes	1 In (ii), award of B0 \Rightarrow 0/4 marks 2 Use of distribution of total in (ii): B1 for $Sd = 5\sqrt{10}$ (OE); M1 for $P(Z < (952.5 - 955)/(5\sqrt{10}))$ or $P(Z < -\sqrt{2.5})$; m1 for $1 - P(Z < 1.58)$ A1 for 0.056 to 0.058 (AWFW)			
		Total	13	

Q	Solution	Marks	Total	Comments
4(a)	Accept the equivalent percentage answers with %-sign (see GN5)			
(i)	$P(CW) =$ $\underline{\underline{110/400 = 55/200 = 11/40 = 0.275}}$	B1	(1)	CAO; either of four listed answers
(ii)	$P(SW \cap H) =$ $\underline{\underline{56/400 = 28/200 = 14/100 = 7/50 = 0.14}}$	B1	(1)	CAO; any one of five listed answers
(iii)	$P(B \cap (H \cup C)) = \frac{30+24+24+26}{400} = \frac{104}{400} =$ $\underline{\underline{104/400 = 52/200 = 26/100 = 13/50 = 0.26}}$	M1 A1	(2)	Numerator CAO CAO; any one of five listed answers
(iv)	$P(SW C) =$ $\frac{45/400}{120/400}$ or $\frac{45}{120} =$ $\underline{\underline{45/120 = 15/40 = 9/24 = 3/8 = 0.375}}$	M1 A1	(2)	Fraction CAO CAO; any one of four listed answers
(v)	$P((E \cup C) W) =$ $\frac{(32+17+21+14)/400}{(150+110)/400}$ or $\frac{84}{260} =$ $\frac{42}{130}$ or $\frac{21}{65} =$ $\underline{\underline{42/130 = 21/65 = 0.323}}$	M1 M1 (M2) A1	(3)	Numerator CAO Denominator CAO CAO/AWRT (0.32308)
			9	
(b)	$P(W \cap C) = \frac{45+25}{400}$ or $\frac{70}{400}$ (p_1) $P(B \cap H) = \frac{30+24}{400}$ or $\frac{54}{400}$ (p_2) $\text{Prob} = (p_1)^2 \times (p_2)^2$ $\times \binom{4}{2}$ or 6 $= \underline{\underline{0.00334 \text{ to } 0.00335}}$	B1 B1 M1 m1 A1	5	CAO; OE $\left(\frac{7}{40}, 0.175\right)$ Seen anywhere, even in an incorrect expression CAO; OE $\left(\frac{27}{200}, 0.135\right)$ Seen anywhere, even in an incorrect expression Providing $0 < p_1, p_2 < 1$ $(p_1 \times p_2 \times p_3 \times p_4) \Rightarrow$ M0 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 : $\left(\frac{70}{400} \otimes \frac{69}{400} \otimes \frac{54}{400} \otimes \frac{53}{400}\right) \times n \Rightarrow$ B1 B1 and $\left(\frac{70}{400} \otimes \frac{69}{399} \otimes \frac{54}{398} \otimes \frac{53}{397}\right) \times n \Rightarrow$ B1			
			Total	14

Q	Solution	Marks	Total	Comments
5(a) (i)	b (gradient/slope) = <u>0.372 to 0.373</u> b (gradient/slope) = <u>0.3 to 0.4</u>	B2 (B1)	4	AWFW AWFW (0.37235)
	a (intercept) = <u>6.94 to 6.95</u> a (intercept) = <u>6 to 9</u>	B2 (B1)		AWFW AWFW (6.94648)
	Attempt at $\sum x$ $\sum x^2$ $\sum y$ & $\sum xy$ or Attempt at S_{xx} & S_{xy} Attempt at substitution into correct corresponding formula for b $b = \underline{0.372 \text{ to } 0.373}$ $a = \underline{6.94 \text{ to } 6.95}$	(M1) (m1) (A1 A1)		324 8922.70 204 & 5573.05 (all 4 attempted) $(\sum y^2 = 3493.64)$ 174.70 & 65.05 (both attempted) $(S_{yy} = 25.64)$ AWFW $(\bar{x} = 27 \text{ \& } \bar{y} = 17)$
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 ($^{\circ}\text{C}$) rise in ground temperature results in or increase per degree ($^{\circ}\text{C}$) is (on average) b vibrations per second	B1 BF1	2	F on b providing $0.3 \leq b \leq 0.4$
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 ($0.3 \leq b \leq 0.4$) must be stated but context and/or units are not required) \Rightarrow B1			
(iii)	<u>Given:</u> When temperature/ $x < 15^{\circ}\text{C}$ or $= 0^{\circ}\text{C}$ value of $y = 0$	B1	2	Must be stated clearly
	<u>Equation:</u> When temperature/ $x = 0^{\circ}\text{C}$ vibrations/value of $y = \underline{6 \text{ to } 9}$	BF1		AWFW F on a providing $6 \leq a \leq 9$
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
5	Continued			
	Part (a)	Total	8	
(b)	$y(23) = \underline{15.4 \text{ to } 15.6}$	B1	1	AWFW (15.51059)
Note	1 Ignore any method shown			
(c) (i)	$\begin{aligned} \text{res}(28.6) &= 17.0 - a - b \times 28.6 \\ &= \underline{-0.55 \text{ to } -0.65} \\ &= \underline{0.5 \text{ to } 0.7} \end{aligned}$	B2 (B1)	2	AWFW; do not ignore sign (-0.59576) AWFW; ignore sign
Note	1 If, and only if, B0, then attempted use of $\pm(17.0 - a - b \times 28.6) \Rightarrow$ M1 providing $0.3 \leq b \leq 0.4$ and $6 \leq a \leq 9$			
(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
6 (a)	Accept 3 dp rounding of probabilities from tables	Accept the equivalent percentage answers with %-sign (see GN5)		
	Use of B(30, 0.28) or B(30, 0.45) $P(\text{Vans} = 3) = \binom{30}{3} (0.28)^3 (1 - 0.28)^{30-3}$ $= 4060 \times 0.021952 \times 0.000140597$ $= \underline{\underline{0.012 \text{ to } 0.013}}$	M1 M1 A1	 3	Indicated by an expression or by any one correct probability in (a) or (b) Correct expression Can be implied by a correct answer Ignore additional expressions AFWW (0.01253)
(b)	$P(\text{Cars} < 15) = \underline{\underline{0.644 \text{ to } 0.645 \text{ or } 0.769}}$ $= \underline{\underline{0.644 \text{ to } 0.645}}$	M1 A1	 2	AFWW or AWRT AFWW (0.6448)
Note	1 For calculation of individual terms or no method: award B2 for 0.644 to 0.645 (AWFW); B1 for 0.769 to 0.77 (AWFW)			
(c)	$P(\text{Van or HGV}) = \underline{\underline{0.4}}$ $P(\text{Vans or HGVs} \geq 10) = 1 - 0.1763 = \underline{\underline{0.823 \text{ to } 0.824}}$ $= 1 - 0.2915 \text{ or } 0.708 \text{ to } 0.709$	B1 M1 A1 (M1)	 3	CAO; stated or identified from below AFWW (0.8237)
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)			
(d)	$P(20 < M' \leq 25) = P(M' \leq 25) - P(M' \leq 20); \text{ but } p = 0.85 \text{ is not tabled so must use calculator}$ or $P(M' > 20) = P(M < 10) \text{ and } P(M' \leq 25) = P(M \geq 5)$ so $P(20 < M' \leq 25) = P(5 \leq M < 10) = P(M \leq 9) - P(M \leq 4); \text{ and } p = 0.15 \text{ is tabled or may use calculator}$			
Note	Using $p = \underline{\underline{0.15}}$ gives Using $p = \underline{\underline{0.85}}$ gives 0.9903 or 0.9971 (p_1) 0.4755 or 0.2894 MINUS 0.5245 or 0.7106 (p_2) 0.0097 or 0.0029 $= \underline{\underline{0.464 \text{ to } 0.466}}$	B1 M1 M1 A1	 4	Either CAO Stated or identified from below AFWW (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 $(1 - p_2) - (1 - p_1) \Rightarrow$ (B1) M1 M1 A1 or (B1) M1 M1 or (B1) M1 3 Answer of $1 - 0.4658 = 0.534 \text{ to } 0.536 \Rightarrow$ B1 M1 M1 A0 or B3			
		Total	12	

Q	Solution	Marks	Total	Comments
7(a) (i)	$\bar{x} = 12240/30 = \underline{408}$ $s^2 = 3972/29 = \underline{137}$ $s = \underline{11.7}$ $\sigma^2 = 3972/30 = \underline{132}$ $\sigma = \underline{11.5}$ 98% (0.98) $\Rightarrow z = \underline{2.32 \text{ to } 2.33}$ CI for μ is $408 \pm \begin{pmatrix} 2.32 \text{ to } 2.33 \\ 2.05 \text{ to } 2.06 \\ 2.45 \text{ to } 2.47 \\ 2.14 \text{ to } 2.16 \end{pmatrix} \times \frac{(\sqrt{137} \text{ or } 11.7 \text{ or } \sqrt{132} \text{ or } 11.5)}{\sqrt{30} \text{ or } 29}$ Hence (z) <u>408 ± 5</u> or <u>(403, 413)</u>	B1 B1 B1 M2,1 (-1 ee) Adep1	6	CAO AWRT (136.9655 & 11.70323) Ignore any notation AWRT (132.4 & 11.50652) AFWW (2.3263) Ignore any notation M0 if CI is not of the form: $C \pm (z \text{ or } t) \times (D/\sqrt{30 \text{ or } 29})$; allow any combination in last term CAO/AWRT (4.95 to 5.28) Dependent on award of M2 AWRT
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’ $\Rightarrow \underline{402 \text{ or } 2}$ Clear correct comparison of 402 with CI {eg 402 < CI or 402 < LCL} Sample meets requirement or Yes	B1 BF1 Bdep1	3	CAO 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 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 = <u>4</u> which is greater than <u>3</u> or Percent < 388 = <u>13</u> which is greater than <u>10</u> Sample does not meet requirement	B1 BF1	2	Requires 4 & 3 Requires 13(AWRT) & 10 Dependent on B1
(c)	CLT used in part (a)(i) or first part or construction of CI	B1	1	“First question” \Rightarrow B0 Ignore additional words providing they are not contradictory
			12	