A-LEVEL

Statistics

Statistics 5 – SS05
Mark scheme

6380
June 2015

Version 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.

Q	Solution	Marks	Total	Comments
1(a)	(i) mean lifetime = 30 000 miles	B1		cao
	(ii) standard deviation = 30 000 miles	B1		cao: sc B1 for 3,3
			2	
(b)	(i) P(X< 1) = 1 - e$^{(-⅓)}$	B1, M1		B1: Using 1 for X , M1: use of correct F(X) with X = 1 or X = 10 000
	= 0.283	A1		0.283 ~0.284
	(ii) P(3 < X < 4) = P(X < 4) – P (X < 3)	M1		M1 : Attempt at P(X < 4) – P (X < 3)
	= (1 – e$^{(-4/3)}$) - (1- e$^{(-1)}$)			
	or = e$^{(-1)}$ - e$^{(-4/3)}$	m1		m1: use of correct F(X) with X = 3 and X = 4 and ⅓
	= 0.104	A1		0.104~ 0.105
			6	
	Total		**8**	

Q	Solution	Marks	Total	Comments
2(a)	$\bar{x}_{2012} = 264 \quad \bar{x}_{2010} = 256.4$	B1,B1		264 , 256~256.5
	$\sigma^2_{2012} = 551 \; \sigma^2_{2010} = 660$ $(s^2_{2012} = 558 \; s^2_{2010} = 669)$	B1, B1		Accept either σ^2 or s^2 but must be consistent. awfw 551~558, 660~670
			4	
(b)	(i) $H_0: \mu_{2012} = \mu_{2010}$ $H_1: \mu_{2012} > \mu_{2010}$	B1		both
	t.s. $z = \frac{264-256.4}{\sqrt{\left(\frac{558}{90}+\frac{669}{75}\right)}}$	M1 M1		M1: numerator ; accept 256.4 –264 M1: denominator ; allow use of (consistent) s^2 or σ^2 (ft only on a small numerical slip)
	= 1.954	A1		1.9 ~ 2.1; accept ±
	c.v. z = 1.6449	B1		1.64 ~ 1.65 ; accept ± or p = 0.0253 (0.024~ 0.026) compared with 0.05
	1.954 > 1.6449 reject H_0 Evidence at the 5% level that the mean weight of chicks was greater in 2012 than in 2010.	E1		Comment in context; All working correct with consistent signs. Accept “mean weight greater in 2012” oe
			6	
	(ii) sample sizes are large so means are approx. normally distributed due to Central Limit Theorem.	E2		E1 large samples E1 CLT
			2	

(c)	This would mean concluding that the mean weight of chicks was greater in 2012 than in 2010 when in fact the means were the same.	E2		Statement in context s.c. E1 – no context: eg Type 1 error is when H_0 is rejected when it is true.
			2	
	Total		**14**	

	Solution	Marks	Total	Comments
3(a)	(i) s_x=86.09 s_y = 150.9 or s_x^2 = 7411.11…. s_y^2 = 22772.56…	B1		B1 either 86~86.2 ; 150~151 7390~7430 ; 22500~22800
	$H_0: \sigma_x{}^2 = \sigma_y{}^2$ $H_1: \sigma_x{}^2 \neq \sigma_y{}^2$	B1		oe; both,
	t.s. F = $\frac{150.9^2}{86.09^2}$ = 3.07	M1 A1		3.02~3.09 (3.07276 …)
	cv $F_{11,8} = 4.243$	B1, B1		B1 df ; B1 cv. or p = 0.1219…(0.12 ~0.13) compared with 0.05
	3.07 < 4.243 accept H_0 , no evidence at the 5% level that the variances differ .	A dep 1		Conclusion ; dep on A1 for ts and B1 for cv . no contradiction.
			7	
	(ii) Flats have been selected randomly and independently ;	E1		Context needed
	Rental cost per calendar month is normally distributed	E1		
			2	
(b)	(i) $H_0: \mu_y - \mu_x = 1000$ $H_1: \mu_y - \mu_x > 1000$	B2		B1: an inequality <u>and</u> 1000 B1:both correct
	(ii) $\bar{x}$= 463.9 $\bar{y}$=1581.75	B1		B1 either – seen anywhere 463 ~ 464, 1580~1582
	$S_p{}^2 = \frac{8 \times 86.1^2 + 11 \times 151^2}{19} = 16300$	M1		M1 : (16250 ~16350 or 125~130 for S_p)
	t.s. = $\frac{1580-464(-1000)}{\sqrt{16300\left(\frac{1}{9}+\frac{1}{12}\right)}}$ = 2.09	M1 M1		M1 numerator M1 denominator - ft their $S_p{}^2$ only on a small numerical slip) ; must have 1/9 +1/12
		A1		A1 2.00 ~ 2.10
	c.v. $t_{19} = \pm 1.729$	B1		or p value = 0.024~0.03 compared with 0.05
	2.06 > 1.729 reject H_0	Adep1		correct conclusion ; dep on previous A1 and B1. sign of cv and t.s. must be consistent
	Evidence at 5% level that the rental cost of a one-bedroom unfurnished flat is, on average, more than £1000 per calendar month greater in London than in Darlington.	Edep1		Statement in context ; dependent on previous A1
			10	
	Total		**19**	

Q	Solution	Marks	Total	Comments
4(a)(i)	15-km race times must be normally distributed.	B1		Context necessary
			1	
(ii)	$s = 1.43$ or $s^2 = 2.04$ df = 14 – 1 = 13 $\chi^2_{13} = 5.009\,, 24.736$ Upper limit $\frac{13\times1.43^2}{5.009} = 5.29$ Lower limit $\frac{13\times1.43^2}{24.736} = 1.07$ 95% C.I. $1.07 < \sigma^2 < 5.29$.	B1 B1 B1 M1 m1 A1,A1		1.42~1.43 or 2.03~ 2.04 Both, 5.00~5.01, 24.73~24.74 M1: Either limit; ft on *s* or s^2 m1: correct attempt at both limits A1: 5.23 ~ 5.31 A1 : 1.05 ~ 1.08
			7	
(iii)	$\bar{x} = 24.7$ $t_{13} = 2.160$ $24.7 \pm 2.160 \times \frac{1.43}{\sqrt{14}}$ 95% CI $23.8 < \mu < 25.5$	B1 B1 M1 m1 A1,A1		24.6~ 24.7 M1: use of their $\frac{s}{\sqrt{14}}$ m1: correct method for interval 23.8~23.9 , 25.4 ~25.5 (Answers without working must be in the range 23.84 ~23.85 and 25.45 ~25.50)
			6	
(b)	 26.2 is above the upper value of the CI in a(iii). Sandy's mean race time is less with the new bicycle 3.39 lies inside the CI in a(ii) . There is a similar spread of times with old and new bicycle.	M1 Edep1 Edep1		Correct comment about either 26.2 or 3.39 and "their" CI's in (a). Numerical comparison <u>and</u> correct comment in context dep on correct CI in a(iii) – accept "mean race time has improved" oe. Numerical comparison <u>and</u> correct comment in context dep on correct CI in a(ii) – accept "variability is unchanged" oe.
			3	
	Total		**17**	

<table>
<tr><th>Q</th><th>Solution</th><th>Marks</th><th>Total</th><th>Comments</th></tr>
<tr><td>**5(a)**</td><td>H_0: this sample of beads provides evidence to support the claim stated in the list of contents.

H_1: this sample of beads does not provide evidence to support the claim.

<table>
<tr><th>*Colour*</th><th>*O*</th><th>*E*</th><th>$(O - E)^2$</th><th>$\frac{(O-E)^2}{E}$</th></tr>
<tr><td>Red</td><td>37</td><td>$\frac{150\times5}{25} = 30$</td><td>49</td><td>1.633</td></tr>
<tr><td>Yellow</td><td>22</td><td>24</td><td>4</td><td>0.166</td></tr>
<tr><td>Pink</td><td>11</td><td>18</td><td>49</td><td>2.72</td></tr>
<tr><td>Green</td><td>15</td><td>12</td><td>9</td><td>.75</td></tr>
<tr><td>Orange</td><td>25</td><td>24</td><td>1</td><td>.0417</td></tr>
<tr><td>Purple</td><td>9</td><td>12</td><td>9</td><td>.75</td></tr>
<tr><td>Blue</td><td>31</td><td>30</td><td>1</td><td>.033</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>6.094</td></tr>
</table>

d.f. 7 – 1 = 6

c.v. $\chi^2_6 at\ 1\%\ sig. = 16.812$

$6.094 < 16.812$
Accept H_0,numbers of beads in the different colours have been supplied in the advertised ratio</td><td>B1

M1

m1
m1

A1

B1

B1

E1dep</td><td>**8**</td><td>Both

M1: Attempt at E's, at least 1 correct
m1: attempt at (O -E) or $(O -E)^2$
m1: attempt at $\frac{(O-E)^2}{E}$ and summing

A1: 5.95 ~ 6.20

B1: df

B1: c.v.

E1: correct conclusion in context dep on A1 for ts and B1 for cv.</td></tr>
<tr><td>**(b)**</td><td>(i) $k = 0.1$</td><td>B1</td><td>1</td><td></td></tr>
<tr><td></td><td>(ii) mean = $\frac{37.5+47.5}{2} = 42.5$
variance = $\frac{1}{12}(10)^2 = 8.33$
s.d = 2.886..</td><td>B1

M1
A1</td><td>3</td><td>

2.88 ~ 2.89</td></tr>
<tr><td></td><td>(iii) $P(42.5 - 2.886.. < x < 42.5 + 2.8886..) = \frac{5.7723..}{10}$
= 0.577</td><td>M1

A1</td><td>**2**</td><td>M1 (2 x their sd) × their k

awrt 0.58</td></tr>
<tr><td></td><td>(iv) $P(X > 45) = \frac{2.5}{10} = 0.25$; $P(X < 45) = 0.75$ for one thread
For 10 threads:
$P(X \geq 1) = 1 - P(X = 0) = 1 - (0.75)^{10}$
= 0.944</td><td>B1

M1
A1</td><td>**3**</td><td>either

0.943 ~0.944</td></tr>
<tr><td></td><td>Total</td><td></td><td>**17**</td><td></td></tr>
</table>