A-LEVEL

Statistics

Statistics – SS06

Mark scheme

6380

June 2015

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.

Q	Solution	Marks	Total	Comments
1(a)	A method of random allocation should be used. For example, a single digit RN 0-9 could be generated and, if even or zero, the volunteer is assigned to take the *Ginkgo biloba* but if odd the volunteer is not.	B1 E1	**2**	Random allocation by third party Example or explanation – any correct effort at RN allocation
(b)(i)	Those volunteers who received the tablets that contained *Ginkgo biloba*	B1		
(ii)	Those volunteers who received the tablets that contained inactive ingredients.	B1	**2**	
(c)(i)	In order to avoid those volunteers who did not receive *Ginkgo biloba* feeling different or deprived compared **t**o those who did receive tablets containing the *Ginkgo biloba.* Tablets for all should prevent any possibility of volunteers being affected by not receiving a tablet and this possibly in turn affecting their dementia symptoms at the end of the trial.	B1 E1		All appear to be treated same Fully explained in context - Not being treated the same would affect the outcome of the trial
(ii)	A double blind trial would ensure that volunteers all felt 'equal' as they all were given tablets and none of them knew which contained the *Ginkgo biloba.* It would also ensure that the researchers treated all the volunteers the same as there would be no possibility of behaving differently to those with or without *Ginkgo biloba* in their tablets. OR There should be no effect on outcome/assessment of the volunteers as no volunteers felt better/worse because they did or didn't receive the *Ginkgo biloba* and the researchers could not be influenced in their approach or final assessment of the volunteers.	E1 E1 E1 E1	**4**	No effect on volunteers explained Expectations the same No effect on researchers explained or Outcome/assessment not affected explained
	Total		**8**	

<table>
<tr><th>Q2</th><th>Solution</th><th>Marks</th><th>Total</th><th>Comments</th></tr>
<tr><td>(a)(i)</td><td>Assume that differences in pulse/rate measurements are normally distributed and that the 12 people can be regarded as a random sample.</td><td>E1

E1</td><td>2</td><td>

Normal dist and random sample in context</td></tr>
<tr><td>(ii)</td><td>H_o pop mean diff/ μ_d = 0
H_1 pop mean diff/ μ_d ≠ 0
2 tail 5%

d = After - before
<table>
<tr><td></td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>d</td><td>5</td><td>6</td><td>1</td><td>0</td><td>-1</td><td>0</td></tr>
<tr><td></td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr>
<tr><td>d</td><td>5</td><td>1</td><td>-1</td><td>-5</td><td>4</td><td>2</td></tr>
</table>
$\bar{d}$ = 1.417 s = 3.175 n = 12

$t = \frac{1.417-0}{3.173/\sqrt{12}}$ = 1.545

df = 11 cv = ± 2.201
1.545 < 2.201

Accept H_o

No significant evidence to suggest that there is a difference in average pulse rates before and immediately after minor dental treatment</td><td>B1

M1

m1dep
diffs

M1

A1

B1

A1

E1</td><td>8</td><td>Hypotheses

sc 0's ignored B1 M1 m1 M1 only

Differences – can be reverse sign

attempt to find $\bar{d}$, s seen/labelled

Use of $\frac{s}{\sqrt{12}}$ ft on 's'
(±) 1.54 or 1.55 (1.53 – 1.56)

(or p =0.15 compared with 0.025) for correct cv

Correct conclusion with consistent comparison

Correct conclusion in context</td></tr>
<tr><td>(iii)</td><td>Type II error</td><td>B1</td><td>1</td><td></td></tr>
<tr><td>2(b)</td><td>H_o pop mean/median diff = 0
H_1 pop mean/median diff < 0
Diff After - Before
<table>
<tr><td>Pers</td><td>A</td><td>B</td><td>E</td><td>G</td><td>J</td><td>K</td><td>L</td></tr>
<tr><td>Diff
A - B</td><td>-
2½</td><td>-
3</td><td>-
6½</td><td>+
1½</td><td>-
1</td><td>-
2</td><td>+
1½</td></tr>
<tr><td>Rank</td><td>5</td><td>6</td><td>7</td><td>2½</td><td>1</td><td>4</td><td>2½</td></tr>
</table>
T_- = 5 + 6 + 7 + 1 + 4 = 23
T_+ = 2½ + 2½= 5

ts T_+ = 5 cv = 6 T_+ < 6 Reject H_0

There is significant evidence to suggest that average anxiety levels are lower immediately after the minor dental treatment than before the treatment.</td><td>B1

M1

m1dep
m1dep

A1
B1

E1</td><td>7</td><td>Hypotheses

Differences (consistent with H_1 or disallow B1)

Ranks (rank 1 = smallest abs diff)
Total of (any) ranks
dep differences

ts total correct – either 5 or 23
cv correct and correct comparison
5,6 or upper tail 22,23

in context</td></tr>
<tr><td></td><td>Total</td><td></td><td>18</td><td></td></tr>
</table>

Q3	Solution	Marks	Total	Comments
3(a)(i)	H_O $\mu_A = \mu_B = \mu_C = \mu_D$ H_1 at least 2 of the means differ	B1		Hypotheses – must include 'at least two'
	T = 701 $\sum x_i^2$ = 33587 N = 15			
	Between print providers ss $\sum \frac{T_i^2}{n_i} = \frac{197^2}{4} + \frac{199^2}{4} + \frac{146^2}{4} + \frac{159^2}{3}$ = 33358.5	M1		$\sum \frac{T_i^2}{n_i}$
	$SS_{\text{print prov}}$ = 33358.5 - $\frac{701^2}{15}$ = 598.4	M1		ss for printing providers
	SS_{Total} = 33587 - $\frac{701^2}{15}$ = 826.9	M1		ss total
	<table><tr><td></td><td>SS</td><td>df</td><td>ms</td></tr><tr><td>Print prov</td><td>598.4</td><td>3</td><td>199.5</td></tr><tr><td>Error</td><td>228.5</td><td>11</td><td>20.8</td></tr><tr><td>Total</td><td>826.9</td><td>14</td><td></td></tr></table>	B1 M1		df = 3 pp correct ms ft if effort at ss seen
	F ratio = $\frac{199.5}{20.8}$ = 9.60 F_{11}^{3} = 6.217 < 9.60	m1 A1 B1	**10**	F ratio ms printing prov / error ms F correct (9.5 – 9.7) cv correct (or p = 0.0021 comp 0.01)
	Reject H_O.	A1		Reject H_O
(ii)	The conclusion indicates that there is a significant difference between the mean scores for at least two of the providers. Printing provider C is clearly the worst and provider D is the best from consideration of means/medians. Choose D. <table><tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td></tr><tr><td>Means</td><td>49.25</td><td>49.75</td><td>36.5</td><td>53</td></tr><tr><td>Meds</td><td>49.5</td><td>49</td><td>35</td><td>54</td></tr></table>	E1 E1	**2**	At least two differ (may be in (i))or C differs from D D best with reason/correct evidence seen(53/4)
(iii)	The scores are normally distributed with a common underlying variance	E1 E1	**2**	Must be in context – refer to scores.
(b)	Randomised Block	B1 B1	**2**	Randomised Block
	Total		**16**	

Q	Solution	Marks	Total	Comments
4a	Mean range = $\frac{1.9+0.7+\cdots..+2.0}{8}$ = 1.725			
	$\hat{\sigma}$ = 0.3946 × 1.725 = 0.6807or 0.68 (2dp)	M1 A1	**2**	Mean range × 0.3946 product and answer ag
4b (i)	Warning 100 ± 1.96× $\frac{0.68}{\sqrt{6}}$	B1		1.96, 3.09 both used
	= (99.46 , 100.54)	M1		$100 \pm k\frac{0.68}{\sqrt{6}}$ M0 if 100.05 used
	Action 100 ± 3.09× $\frac{0.68}{\sqrt{6}}$	A1		Warning 99.4/5 100.5
	= (99.14 , 100.86)	A1		Action 99.1 100.8/9
(ii)	0.535 × 0.68 = 0.36 1.066 × 0.68 = 0.72 or 0.73 4.361 × 0.68 = 2.96 or 2.97 5.619 × 0.68 = 3.82	M1 A1	**6**	Correct D values All correct to 2 dp
(c)	Sample 9: $\bar{X}$ = 100.1/2 Range = 1.7	M1 A1		Effort to find $\bar{X}$ and range Both correct
	Mean and range both within warning limits. No action needed	E1		No action and reason 100.05 or n=8 used E0
	Sample 10: $\bar{X}$ = 100.9 Range = 3	A1		$\bar{X}$ (and range) correct
	Mean beyond (upper) action line.(Range in between action and warning lines). Stop production immediately.	E1	**5**	Stop process and reason– can refer only to mean 100.05 used E0
(d)	$X \sim N\,(101, 0.68^2)$			
	$P\,(X > 102.5) = 0.0137$ z = 2.21 $P\,(X < 97.5) = 0.0$ z = -5.15	M1 M1		Correct model and probabilities effort z values found
	Proportion outside tolerance 1.4 %	A1	**3**	awfw 0.013 – 0.014
	Total		**16**	

Q	Solution	Marks	Total	Comments
5(a)	Importer P(Acc) ≤ 0.05 P($X \leq r$) ≤ 0.05 for p = 0.15	M1		Attempt at relevant probs B(50, 0.15)
	P (X ≤ 2) = 0.0142 P (X ≤ 3) = 0.046 ≤ 0.05	A1		explained with comparisons
	P (X ≤ 4) = 0.1121			
	Manufacturer P(Rej) ≤ 0.02 P($X \leq r$) ≥ 0.98 For p = 0.02	M1		Attempt at relevant probs B(50, 0.02)
	P (X ≤ 1) = 0.7358 or P (X > 1) = 0.2642 P (X ≤ 2) = 0.9216 or P (X > 2) = 0.0784 P (X ≤ 3) = 0.9822 ≥ 0.98 or P (X > 3) = 0.0178 ≤ 0.02	A1	**4**	explained with comparisons
(b) **(i)**	P (X ≤ 3) = 0.7604 p = 0.05	B1		or 0.76
(ii)	P (X ≤ 3) = 0.2503 p = 0.10	B1	**2**	or 0.25
(c)(i)	On grid	M1 A1	**2**	Through (0, 1) + general shape OK Through (.05,.76) (.1,.25) (.15,.046) and correct
(ii)	On grid	M1 A1	**2**	Line (0,1) to (.04,1) Correct and ruler used
(d) (i)	B(40, 0.15) P(Acc) = P($X \leq 2$) + P($X = 3$) × P($X \leq 1$) = 0.0486 + (0.0816 × 0.0121) = 0.0496 < 0.05 OK for importer	M1 M1 A1		Prob expression used P($X \leq 2$) +… Correct probs B(40, 0.15) subst Correct answer and comparison
	B(40, 0.02) P(Acc) = P($X \leq 2$) + P($X = 3$) × P($X \leq 1$) = 0.9543 + (0.0375 × 0.8095) = 0.9847 > 0.98 OK for manufacturer or P(Rej) = 0.0153 < 0.02	M1 A1	**5**	Correct probs B(40, 0.02) subst Correct answer and comparison
(ii)	Advantage – more battery units can be sampled if quality uncertain/may require less sampling	E1		Advantage – Double SS has higher chance of accepting good batch (p=2%)
	Disadvantage - Sampling may take longer or cost more to carry out Adv/Disadv must be identified as such	E1	**2**	Disadvantage – Double SS has a lower probability of rejecting a poor batch (p = 15%)
	Total		**17**	