A-LEVEL
STATISTICS
SS06 STATISTICS 6
Report on the Examination

6380
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General comments

Many students are finding the decision of what type of data they are dealing with and, hence, which hypothesis test to use to be challenging. The decision of whether the data is from samples that are paired or is from independent samples is not being made correctly by many students. Many students that can make this decision correctly seem to be unaware that a 'matched pairs' test is investigating a 'population median difference' (rather than testing for a difference between population medians); this confusion then leads to the statement of incorrect hypotheses.

Students should be aware that they should use the given context when stating conclusions and assumptions.

Only a very small minority of students made no attempt at questions.

Question 1

Part (a) - This was a one-factor ANOVA. Many students managed to find the test statistic correctly and a high proportion of these students also found the critical value correctly and went on to state a correct conclusion in context. Common mistakes included incorrect hypotheses- either using suffices '1, 2, 3, 4' or 'A, B, C, D' without making it clear what these stood for (possibly included in the headings stated in the table, as done correctly by some students) or omitting the word 'population' if the hypotheses were not written using symbols. Many students failed to state 'at least two of the population means differ' in the alternative hypothesis. Marks were also lost by failing to state that there is 'significant evidence of a difference in mean marks' in the conclusion where students statements implied there is (definitely) a difference by omitting the 'evidence', or by omitting the word 'mean'. Only an extremely small minority of students went on to find the mean mark for each category, justifying their choice of the two categories that are most likely to be different, and to identify that 'students handing in coursework more than 24 hours before the deadline gain higher marks, on average, than those handing in coursework less than 2 hours before the deadline'.

Part (b) - This required the statement, in context, that 'marks are normally distributed with a common variance'. Common mistakes were students stating that 'students are normally distributed…..' or that 'times are normally distributed……'.

Question 2

This question used ‘matched pairs’ data.

Part (a) - This was a ‘paired *t*-test’. Many students managed to complete this correctly. A common mistake was the statement of incorrect hypotheses with students failing to appreciate that they were using ‘differences’ so their hypotheses should be investigating a ‘population mean difference’ (rather than a difference between population means). Many students made ‘slips’ in finding the differences between the times with a common mistake that the final difference of ’$21 - 19$’ regularly being stated as ‘3’. Another common mistake was students omitting the ‘zero’ in their calculations, which would be correct in a non-parametric sign or Wilcoxon signed-rank test but not in this parametric test. A few students used ‘11’ in their divisor rather than the ‘12’ that they should have used. A few students also correctly rejected the null hypothesis but then stated their conclusion as if it had been accepted. The conclusion mark was regularly lost due to the omission that there is ‘evidence’ or that this was ‘on average’.

Part 2(b) - This was a ‘paired sign test’. Many students managed to complete this correctly. A common mistake was the statement of incorrect hypotheses with students failing to appreciate that they were using ‘differences’ so their hypotheses should be investigating a ‘population median difference’ (rather than a difference between population medians). A large number of students wrote down the correct signs but then counted them incorrectly. Some students found the correct binomial probability but then compared it incorrectly with 0.10 (as if it was a 1-tail test).

The conclusion mark was lost by many students due to the omission that there is ‘evidence’ or that this was ‘a difference in the average time’ or what the actual context was. Only a few students attempted to find a critical region; many of these lost marks by failing to justify their choice by the statement of appropriate binomial probabilities and their comparison with the significance level of the test.

Question 3

This was a question on experimental design.

Part (a) - The first two parts of this were generally done well by students with only a small minority failing to identify the blocking and treatment factors correctly. In part (iii) many students stated that the purpose was to ‘reduce experimental error’ correctly; only a small minority of these stated the purpose correctly in the given context.

Part (b) - Part (i) required students to construct a table that could be filled in and was achieved correctly by many students. Some students constructed the ‘experimental design’ as seen in texts rather than a table that could be used. Parts (ii) and (iii) required the identification of ‘Randomised Block’ and ‘Two-factor ANOVA’ respectively which was done correctly by most students; common mistakes included these being written down the wrong way round (as students are unclear which is the ‘experimental design’ and which is the ‘technique’) and the use of incorrect wording.

Question 4

This was a question on statistical process control using a proportion of non-conforming items.

Part (a) required students to find the mean sample size and to verify the value of the proportion non-conforming. This was achieved successfully by most students with only a few failing to find the mean sample size as 65.

Part (b)(i) required students to find the upper control limits. Many students identified the use of z-scores of 1.96 and 3.09 correctly. A common mistake was the use of '12' or '780' in the denominator of the variability, rather than the correct mean sample size of '65'.

Part (b)(ii) saw many students manage to find the proportion of non-conforming springs in each sample correctly and to plot them on the control chart although only a small minority of students documented the proportions they were using or managed to plot the upper warning and upper action limits correctly.

Part (b)(iii) required students to identify that the process is under control apart from sample 5 where the proportion was between the upper warning and action limits (where another sample had been taken but the process had been found to be back in control). This was only achieved correctly by a small minority of students.

Part (c) required students to find the proportion non-conforming springs for samples 13 and 14 (which was achieved by most students) and then to identify that sample 13's proportion was 'between the warning and action limits' so 'another sample should be taken' whereas that for sample 14 was 'above the action limit' so 'stop production'. Some students are stating 'take action' rather than 'stop production' and are losing the final mark as they are not stating clearly what the action is that should be taken.

Question 5

This question was based on acceptance sampling by variable.

Part (a) required students to find the probability of accepting a batch with given values of the 'Mean weight'. Most students managed to find at least three of the values correctly with a high proportion finding all four values correctly.

Part (b) required students to analyse two requirements in context and to construct simultaneous equations in the new mean (k) and sample size (n), before solving these. This part of the question proved to be extremely challenging to most students; only a small minority of students managed to start this part of the question correctly and only a few of these managed to achieve the correct values of k and n.

Question 6

This was a question involving a Latin square analysis of variance.

Part (a) - This required students to identify that they were dealing with a ‘Latin square’ experimental design. Many students stated this correctly. Common mistakes included stating that this was a ‘completely randomised’ or ‘randomised block’ or ‘Latin squared’ design or stating it was ‘2 factor ANOVA’.

Part (b)(i) - This was carrying out the corresponding Latin square ANOVA on the given table. Correct solutions were extremely rare. Common mistakes included incorrect statement of hypotheses, incorrect evaluation of degrees of freedom and hence of ‘mean squares’ and the test statistic. Many students lose marks in their hypotheses by either using incorrect suffices on their μ’s, or failing to use the word ‘population’ in their null hypothesis (if they state their hypotheses in words), or failing to state that ‘at least two means differ’ in the alternative hypothesis. The vast majority of students managed to find the ‘Error sum of squares’ correctly but most of these failed to identify that the correct ‘degrees of freedom’ for the total is 24 and hence were unable to complete the test correctly.

Part (b)(ii) - This required students to state that there must be ‘no interaction’ between the factors. This was done correctly by the minority of students. Only an extremely small minority of students succeeded in stating the meaning of this correctly in context, the vast majority of attempts failing to give a correct meaning of ‘no interaction’.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.

Converting Marks into UMS marks

Convert raw marks into Uniform Mark Scale (UMS) marks by using the link below.

UMS conversion calculator