A-LEVEL
STATISTICS

SS04 Statistics 04
Report on the Examination

6380
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Question 1

In part (a) hypotheses were usually stated correctly. Most students correctly used a binomial distribution but sometimes with a wrong value for p (typically 0.25 instead of 0.1) Only a few students ignored the instruction to use an exact test and used an approximation instead – especially a normal distribution – and therefore lost most of the marks in this part.
A fairly common error was to find $P(X > 5)$ rather than $P(X \geq 5)$, which actually leads to rejection rather than acceptance of H_0. Similarly, another relatively common error was comparing their probability value with 0.05 rather than the required 0.025 for a 2-tailed test at the 5% level. Again this led to an incorrect rejection of H_0.

Only a very few students said something contradictory like "$p=0.0432 > 0.025$ so reject H_0" which was pleasing. It was also good to see that most conclusions were phrased in a good statistical manner. For example, a statement such as "There is no evidence of a difference" was much more common than "There is evidence of no difference".

In part (b) as is usual with this type of question, there was a lot of waffle and non-sequiturs but most students managed at least one acceptable comment and many had two. The question was seeking for a contextualised reason based on any two of (i) where the survey was conducted (ii) when it was conducted (iii) the residence of those surveyed (were they out-of-town?) (iv) the fact that those prepared to take part may have greater knowledge/interest in flowers and (v) anything else deemed relevant.

No credit was given for "sample small" (this may result in imprecision but not necessarily unrepresentativeness.) Also, no credit was given for "they may be in groups" because it was given that Gloria interviewed 20 people at random, not in clusters. Also, comments on the reliability of the data obtained (for example, "people may lie") do not address the issue of representativeness of the sample.

Question 2

In part (a)(i) most students recognised this as a Poisson distribution and obtained the correct answer.

For part (a)(ii) there are two possible approaches (algebraically identical) but only a very few students managed a completely correct solution. Those trying 0.1954×0.8^3 very often failed to cube 0.8 and were awarded 1 out of 3 marks. Those trying the alternative approach 0.2226×0.4493 nearly always forgot to account for zero hits from outside the UK **as well as** 3 hits from within. These students got the first element 0.2226 for 2 of the 3 marks.

In part (b) a normal approximation to the Poisson distribution was required. A few students erroneously worked with a binomial here but most identified a Poisson with an increased λ and used a normal distribution correctly. A fairly common error was a missing or incorrect continuity correction (220 or 219.5 rather than 220.5)

In part (c) a normal approximation to the binomial distribution was required. Most students identified the correct distribution to work with and used a subsequent approximation. Those that correctly used the normal distribution, as in part (b), commonly missed or used an incorrect continuity correction (40 or 40.5 rather than 39.5) – again, about equal numbers of each. Many students arrived at a normal approximation via a Poisson approximation first, thus using an inaccurate standard deviation in the denominator for the z-value.

Generally there were high marks overall on this question. Only a few students left out crucial steps in their solutions, for example wrong answers written down from their calculator functions with no commentary, so that if they went wrong, many marks were lost. Students should be encouraged to include intermediate workings in their solutions.

Question 3

Part (a) was generally very well answered although there were some incorrect /unclear notations for μ in the hypotheses. If students wish to use non-standard notation they must define it clearly. Most students correctly used a t-test rather than z-test and one-tailed rather than two-tailed hypotheses. A few had a correct one-tailed H_1 but then proceeded to find a two-tailed critical value. Nearly all students managed the correct form for the test statistic. It was good to see that only a very small number made an inconsistent decision at the end concerning H_0 and hardly any students failed to state their result in context.

As usual, it's the explanatory parts of the paper (parts(b) and (c) in this question) that caused the most problems. Students are often very well drilled in applying the techniques involved, but are less confident in providing commentaries. For part (b) saying something like "looking at the southern region would result in a larger sample" is not a sensible suggestion. The idea that Toby's essentially sensible suggestion would enable some comparison to be made was fundamental here. A *convincing* argument for "Not sensible" was also given some credit. However, for full credit, the notion that a comparison with a non-invaded area would provide at least some useful information was needed - even allowing for the fact that different environmental pressures may affect different areas. In other words, whether the answer was 'yes' or 'no', some idea of a comparison between the regions was required.

In part (c) several students, in both parts (i) and (ii), gave answers that didn't quite answer the questions being asked. Students were told that Toby wanted to perform a similar test to Olga. The Central Limit Theorem seems to be widely known by students but not many are clear about exactly what it means. Most seemed to think that it implies that, in a large sample, the **data** becomes more normal. In this scenario however there is a large sample of skew data, but the Central Limit Theorem addresses the distribution of the sample mean and it's this that can be approximated by a normal distribution.

Question 4

In part (a)(i) nearly all students used proportions directly rather than using numbers and converting at the end. A few tried to force it into a CI for a mean but, in general, this was very well answered.

In part (a)(ii) most students correctly used z values but quite a few used equally acceptable t- values. The large sample means that whichever values are used, the CI's will be very similar.
In parts (b) (i) and (ii) it was good to see that most students were very clear about what values they were comparing with the CI's (0.09 and 0.125) and, since most CI's were correctly calculated, many students got full marks here. Many students essentially drew the correct conclusions in each part but lost a mark by stating them in too definite a manner. (eg "…shown that men and women are the same" or "…conclude that they are different"). Students should be encouraged to draw

conclusions from a hypothesis test with some recognition of uncertainty. Phrases such as "No evidence that…" "…difference is not significant...", "this suggests…" "…likely to be…" …and so on, better reflect the principle of statistical inference. Conclusions should not be made with absolute certainty.

Question 5

Part (a) proved to be challenging. Only a few students managed a full coherent argument using the correct probabilities. Some presented the probabilities then went straight to an answer (usually 5 or 6) with no indication of why. A clear comparison of the probabilities with 0.01 (or 0.99 if using the complements) was needed for full marks. A few students tried to use an inappropriate normal approximation to find some probabilities.

In part (b) hypotheses were usually correctly stated and a Poisson p-value of either 0.0788 or 0.0237 obtained. A surprising number of students went straight from this value to a conclusion, missing out the vital step of a comparison with 0.05. The final conclusion was sometimes stated too strongly.

Question 6

In part (a) students usually scored either all 6 or 4 out of 6 marks. Finding expected values wasn't a problem but the variances often were. Two quite common mistakes were the result of uncertainty as to how to deal with combining variances in parts (i) and (ii). In part (i) for example, the correct variance is given by simply adding the individual variances to get 3×0.07^2. Many incorrectly added standard deviations to get 3×0.07, then squared to get $(3\times 0.07)^2$. Others were confused with the variance of a multiple of a single random variable and ended up with 9×0.07^2. It was however pleasing to see that nearly all students realised in part (iv) that when dealing with a **difference** between rv's, variances should be added, not subtracted, but many still added standard deviations.

Part (b) was generally well done. Most students recognised that they could use their calculations from parts (a)(iii) and (a)(iv) and some credit was given here even if their values in (a) were wrong. However a few students decided to start again and a surprising number of those who came unstuck with the variances in (a), managed to find them correctly in part (b). This may be because part (b) is worded in a more familiar format.

Most students knew what to do in part (c)(i) but only a very small number of students achieved full marks in (c)(ii). Given a 3-way choice to start with, (>, =, <) the most popular choice was the correct one (>)… but not by far. Of those who made the right choice, only a few students made a reasonable stab at justifying it and only a handful justified it fully. This was intended to be a challenge at the end of the paper requiring logical deduction and clarity of thought. It was expected that these marks would only be available to the best students – and so it turned out.

As in previous years, a number of students needlessly lost marks by just writing down answers with no intermediate working. If the answer is correct, that's fine. But if wrong, there is no way of recovering any part marks for method or intermediate accuracy. This happened not only here in question 6, especially part (b), but in other questions as well. The annual recommendation is that students should be discouraged from just writing down answers with no method shown.

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