A-LEVEL
STATISTICS

SS04 – Statistics 4
Report on the Examination

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Question1

In part (a), hypotheses were usually correct and a binomial distribution was usually identified which earned the first 2 marks. However, after that, a number of different errors crept in. The probability of greater than 13 was often found rather than of at least 13. There were quite a few comparisons with 0.10 rather than with 0.05 for a 2-tailed test. There were also some unnecessary normal approximations: $n = 25$ is not really large enough for a good approximation ($n \geq 50$ and $np \geq 10$ is a common rule of thumb) and, in any event, the exact binomial distribution for $n = 25$ is in the statistics tables provided.

In part (b), many candidates pointed out that people travelling in groups would cause a problem with the independence assumption. However, many mentioned sample size, essentially saying that it would probably now be too big to use a binomial distribution so that a normal distribution would **have** to be used. This is incorrect.

Question 2

Many candidates scored full marks. Errors, such as there were, involved using the wrong approximation and problems with the continuity correction. In part (a), there were a few inappropriate normal approximations. For such a small p, 0.03, n of 200 is nowhere near large enough (giving a mean of only 6). In part (b), a normal approximation was usually correctly used, but some candidates approximated binomial to $\mathrm{Po}(2500)$ to $\mathrm{N}(2500, 2500)$. This is not really appropriate as p is not sufficiently small. The main errors in part (b) came with a missing or wrong continuity correction.

Question 3

Nearly all candidates gained 3 out of 3 for part (a)(i), but only a few candidates managed all 6 of the remaining marks, which were all for comments. Sometimes this was because of confusion between ‘accurate’ and ‘approximate’; an answer can be exact but inaccurate or approximate and close to the truth. Most marks were lost because of imprecise, ambiguous and/or incomplete statements, such as the following:

- in (a)(ii), “…it is outside the CI” (What is?) or “Disagree” (What with?)
- in (b), “Would not change because the limits are further away from 75” (Both of them aren’t) or “Would not change because the interval is smaller” (What does this imply about the 75?)
- in (c), “…it’s not normal” (What isn’t?) or “… it won’t be random” (What won’t?).

Generally candidates should be discouraged from overuse of the word ‘it’ in explanations, interpretations and comments. This can often lead to ambiguities and unnecessary loss of marks. A good strategy for candidates would be to reread any such statements and reword them in the context of the question. In part (c), no marks were given for just saying “normal distribution” with no indication of its use as an approximation. Also, no marks were gained from stating general assumptions for a Poisson distribution with no attempt to say that, in this context, the assumptions may be violated.

Question 4

Candidates tended to score either 3 or 0 out of 3 in part (a)(i). Often λ was miscalculated and sometimes a normal approximation was used. Use of the normal distribution led some candidates to give 0 as the answer: “the normal distribution is continuous and cannot equal any specific value”. In part (a)(ii), the value for the variance was frequently incorrect, typically using $10^2 \times 0.92^2$. Only a few candidates used the equivalent approach of finding $P(\overline{X} < 4.5)$. Some marks were unnecessarily lost by candidates just writing answers down and not showing enough working to enable part marks to be awarded. A common error in part (a)(iii) for weaker candidates was to calculate (i) × (ii) rather than (i) × (1 – (ii)). This is unfortunate, particularly as 'at least' in the question is in bold type. Part (b) was very well done. There were few errors in the hypotheses statements or in the calculations. Some candidates had incorrect signs or incorrectly used a normal distribution rather than a t -distribution, especially if they used the p-value approach. Most got the hypotheses the right way round and had a test statistic < a critical value leading to the correct conclusion of "Accept H_0". However there were then a few contradictory conclusions in context.

Question 5

The amount of confusion in part (a) between percentages, proportions and fractions was surprising. This resulted in mixtures of units in the test statistic. The hypotheses were often not well defined, with many incorrectly involving 0.78 (rather than 0.75). Most candidates correctly used a normal approximation to a binomial. There were roughly equal numbers of attempts comparing a test statistic with 1.64 and comparing a p-value with 0.05. Many of the latter attempts used p-values read from their calculators. If candidates are going to do this, a general recommendation is that they would be wise to include the test statistic as well, as miscopies of small p-values occasionally occur (too many or not enough zeroes). The majority of candidates scored full marks in part (b)(i). Careless rounding errors sometimes lost accuracy marks but otherwise this part was very well done. A few students in part (b)(ii) were surprisingly unable to convert $\frac{1}{3}$ to a proportion, and there were a number of attempts to use $\frac{3}{4}$ instead of $\frac{1}{3}$ or to compare $\frac{1}{3}\times 125 = 41.6$ with the proportions in the confidence interval. A few thought that the confidence interval needed to include $\frac{1}{3}$ for the claim to be supported.

Question 6

This question was a good discriminator: good students scored highly in both (a) and (b); weak students scored poorly in both (a) and (b); average students tended to score highly in either (a) or (b). In part (a)(i), $\mathrm{E(X)}$ was usually found correctly. However, $\mathrm{Var(X)}$ was often wrong because of attempts to incorporate the constant 10 resulting in incorrect values of $\mathrm{Var}(X) \pm 10$ or $\mathrm{Var}(X) \pm 10^2$. The method was usually correct in part (a)(ii) but a wrong variance lost accuracy marks in this part. In part (a)(iii), most realised that the calculation in part (a)(ii) involved the difference in times between the two methods, but only the better students gave a full, clear explanation incorporating all the required elements. Many candidates struggled to start part (b). Those that did, often mixed time units or mixed litres with time. There were very few good attempts at finding the variance of litres used. Candidates with full marks usually adopted the easier approach of converting everything to time rather than to litres. Considering this part (b) together with question 4 part (a)(ii), it seems that this element of the specification (variances of linear combinations of random variables) causes the most difficulty. Many candidates would benefit from more practice using the formula $\mathrm{Var}(aX \pm bY) = a^2\,\mathrm{Var}(X) + b^2\,\mathrm{Var}(Y)$ given at the bottom of page 10 in the book of formulae and tables. In fact, many candidates do not seem to be aware that the formula is there. Questions such as these would be much easier for candidates if they were more familiar with this formula and its special cases ($b = 0$ and $a = 1$, $b = 1$). Candidates are expected to know that the variance of a constant is zero.

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 www.aqa.org.uk/umsconversion