A-LEVEL
STATISTICS

SS04 Statistics 4
Report on the Examination

6380
June 17

Version: 1.0

General

Students generally tried at all questions but were challenged by some of the interpretation demands.

Question 1 proved to be a trickier starting question than usual and question 2 was the best answered question.
Students seemed confident at writing down hypotheses and the majority made all comments and conclusions in the context of the question.

Question 1

(a) Many students stated the mean, 39, or total, 234, number of births and the z-value correctly and then struggled to proceed.

The **total** number of births is distributed $\mathrm{Po}(234)$ so has mean and variance both equal to 234, but the **mean** number of birth over the 6 weeks has mean $\frac{234}{6} = 39$ but variance $\frac{234}{6^2} = 6.5$. A very common error was to assume that these would be the same and use a variance of 39. This gave a maximum of only 3 marks out of the 5 marks available for this part. Students might have had more success by working with the total and dividing through at the end.

(b) Full marks were very rare in this part. Many students produced a discussion regarding whether the conditions were correct for a Poisson distribution. Also, issues involving sample size were often raised, although the sample size was the same in parts (a) and (b).

Question 2

This was probably the best answered question on the paper with many students getting full marks in part (a) and even the weakest students managing some marks in parts (b) and (c).

(a) Nearly all students showed their working by calculating a test statistic and providing a critical t- value.

A few students confidently used their calculators to take the risky approach of just writing down a p-value for this test. However, those that did almost always produced a completely correct solution.

Very few students used an inappropriate z-test here.

It was good to see that most students stated the hypotheses correctly and drew their conclusions in context.

Very few students incorrectly concluded from the non-significant test statistic (or p-value) that they had evidence that the mean is 53.4 or less. This misinterpretation was certainly more common in previous years.

(b)/(c) With such a wide range of acceptable comments and suggestions in these parts, virtually all students managed to get at least 1 mark of the 4 available. The more able students easily gained all 4 marks and included answers with more than the two reasons or two suggestions required. The mark scheme lists most of what was considered acceptable but other sensible comments were also given credit.

A relatively common incorrect answer in (b) was to state that the sample is small. The issue of sample size will affect precision and power but not validity. It would be valid to test the claim with data from only two students for example but it would not be a very powerful test.

Question 3

(a) This part was usually done very well with the most common error in part (ii) being to not scale λ correctly.

(b) This part was very well done with most students managing to gain at least 3 of the 5 marks available. Common errors were to forget to do a continuity correction or to apply an incorrect one, ie using 39.5 rather than 40.5. Nearly all students used the correct normal approximation.

(c)(i) This part of the question was answered poorly. Students found it challenging to state the two conditions required for a binomial distribution in context. Many students stated that “probabilities” or “numbers caught” should be independent. However, it is the event “catching at least 5 fish” that should be independent from afternoon to afternoon. Also, many students thought that the ‘constant p’ condition in this context required that all fish had the same probability of being caught. In part (c), U is a count of how many afternoons Ken catches at least 5 fish; it is **not** the number of afternoons he catches just one fish.

There also seemed to be confusion between what is an **assumption** that needs to be made, and what information has been **given** so no such assumption is necessary. Many students stated, “n fixed” and “two outcomes” as assumptions, but the question provided these as given. The question clearly referred to a fixed number of $n = 90$ afternoons and the trial outcomes were clearly “catches at least 5 fish” or not. These did not have to be **assumed**. However, independent trials and a constant probability of success in each trial were **not** givens and had to be assumed.

Many students forgot to state n and p even though they went on to use it in part (ii). As a result, these students lost marks. For those students who did remember to state them, $n = 90$ was nearly always correct but many failed to see the link with part (a)(i). A common error was to believe that p was $\frac{5}{90}$. Quite often these calculations for p ended up with a very small value which then led students to use a Poisson approximation in part (ii).

(c)(ii) Normal approximations were the most common, followed by Poisson approximations and only a few exact binomial distributions were seen. As found in part (b), continuity corrections were quite often either missing or wrong. There was also some premature rounding that lost final accuracy marks. Generally, though, this part was well answered.

Question 4

(a) Two common errors in this part were calculating confidence limits using z-values rather than t-values and failing to square root the variance in the formula.

With a small sample, students should know that, unless a population variance is given, they should use the sample variance. The fact that $s = 1.4$ was given, rather than having to be calculated, may have led some students to assume that this was a known population value.

(b) Most students found part (i) straightforward but couldn't cope with part (ii).

A common wrong answer was $0.90 \times 0.99 = 0.891$ which assumes that the events "the 90% interval will contain μ_L" and "the 99% interval will contain μ_L" are independent. Clearly these intervals are not independent since the intervals are centred on the same mean and, if the 90% interval contains μ_L, then the wider 99% interval must also contain it. Thus, the required probability is $0.90 \times 1 = 0.90$.

(c) Many students were successful in this part although a few were careless with calculating 0.1×0.01, obtaining 0.0001 in error. The most common incorrect answer was $0.1 + 0.01 = 0.11$.

Question 5

In general, apart from the more able students picking up full marks in part (a), this question was not answered well.

(a) Hypotheses were usually correctly stated and only a few students ignored the instruction to use an exact distribution and went for an approximation instead. This was usually a normal approximation, but occasionally a Poisson approximation.

If students adopted the same approach in both (i) and (ii), most of the marks in part (a) were lost. The most common error was finding $\mathrm{P}(X > 10)$ rather than $\mathrm{P}(X \geq 10)$ in (i) and $\mathrm{P}(X > 4)$ rather than $\mathrm{P}(X \geq 4)$ in (ii).

In general, the p-values in these exact tests are the probabilities of obtaining a test value **or a more extreme value**.

Pleasingly, conclusions were generally well worded and demonstrated awareness that such conclusions cannot be made with certainty. Many students omitted the word 'male' in the conclusion for part (ii) but only rarely missed it in part (i).

(b) Few students obtained full marks. Comparisons that were only made with the general public were not enough. Tennis players, whether elite or club players, can be expected to have an advantage over the general public regardless of handedness. The best comparison to make is within tennis players, elite and amateur, and to examine whether there is a higher incidence of left-handedness in elite players compared to amateurs. The tests and information in the question show that there seems to be a difference for male players but not for females.

(c) Answers were of three types:

- correct answers noting that the sample proportion is less than 0.1 and hence there was no point in testing to see if it was greater
- 'not quite' correct answers noting that $\frac{4}{30}$ was not significant in (a)(ii) so $\frac{4}{50}$ cannot be significant in part (c) — that requires that both tests would be done at the same significance level

- incorrect answers based on often extensive but largely spurious arguments involving various aspects of playing tennis.

A few students carried out the test, obtaining a large p-value. None of those who adopted this approach, obtained the correct p-value.

Students should, in general, be encouraged to carefully read what is being asked of them. Also, in this question, part (c) is only worth 1 mark and part (b) only 2 marks, so writing long essays is not a good use of limited exam time.

Question 6

Only a few students disregarded the instruction to show means and variances where appropriate, but a significant number of students did not show any further working and hence, if their answer was wrong, many intermediate marks were lost.

(a) This was mostly done very well. The most common error was using 3^2 rather than 3 in the expression for the variance.

(b) Pleasingly, most of the students attempted to use the difference between random variables to answer this part, although some of these students then proceeded to obtain the difference in the variances rather than the sum.

(c)(i) Nearly all students managed to get the mean swede weight after peeling but could not deal with the corresponding variance.

Only a few students went for the alternative approach of calculating the required unpeeled swede weight first so that they could use the original means and variances.

Most students adopted the scaling approach but many used 0.9 rather than 0.9^2. Also, a surprising number of students thought that the variance would remain unchanged and continued to work with an unscaled variance of 400.

(c)(ii) Only the best students successfully negotiated all the various pitfalls in this part. Common errors were not noticing that onion weights were reduced by only 5%, not 10%, and a variety of errors were seen in calculating the variance either by incorrectly squaring quantities or not squaring those quantities that should be squared.

Most students followed the instruction to give answers to four significant figures.

Use of statistics

Statistics used in this report may be taken from incomplete processing data. However, this data still gives a true account on how students have performed for each question.

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