A-LEVEL
STATISTICS

SS04
Report on the Examination

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Question 1

Hypotheses were usually correct and a normal approximation was usually used as required. All of the four alternative approaches (numbers or proportions with critical values or *p*-values) were regularly seen. When using numbers, a continuity correction (CC) was used about half the time with, unfortunately, a fair number of wrong corrections (29.5 used instead of 28.5) which lost candidates two marks. When using proportions, CCs were never seen. This strange anomaly (CCs with numbers, no CCs with proportions) is commonplace in Statistics and full credit is given for each approach.

Conclusions were usually consistent with the candidate’s comparison of test statistic and critical value (or p-value and 0.01) and almost everyone provided context which was good to see.

A few candidates decided to answer their own question and use an exact Binomial distribution rather than an approximate distribution as instructed. Whilst it is of course possible for candidates to use their calculators to do an exact test, this was not the point of the question. Awareness of links between various distributions and use of approximations is expected..

Question 2

This was the best answered question. There were many full marks, probably because no interpretation or comments were required. Errors, such as there were, involved using a normal approximation in part (a) which is not really appropriate as p (and np) are so small. But nearly every candidate had read the question carefully and tried an approximation rather than just copy down the exact binomial probability from their calculators.

In part (b), a few candidates tried to find a confidence interval for the mean number of computers *infected* rather than the mean number of *infections* but, overall, even weaker candidates managed part (b) well.

A general point: where no required accuracy is stated in the question, the instruction on the front cover that final answers “should normally be given to three significant figures” should be applied. Some final answers to (b) gave far too many decimal places than was justified but these spuriously accurate answers were not penalised. However, candidates should be made aware that they may well be penalised in the future.

Question 3

(a)(i) Most used a Poisson distribution here but often to find $\mathrm{P}(\mathrm{X} > 4)$ rather than $\mathrm{P}(\mathrm{X} \geq 4)$ as required. In such tests (whether using binomial, Poisson or normal) candidates should be aware that they require the probability of getting the *observed value or more extreme*. Not just “more extreme” Also there were quite a few attempts at using a normal approximation which is not appropriate as λ is too small. In any case, the question asked for an *exact* test so candidates should have been more alert to this. Careful reading of the question cannot be emphasised enough.
(ii) Most candidates correctly applied a *t*-test but a few still insist on using normal tables for everything. A *z*-test is not appropriate here as we are using a sample standard deviation and the sample size is small.

Decisions and conclusions in context were well made in both parts of (a) – as they were elsewhere in the paper. Pleasingly, hardly any questions on the paper involving a test had candidates drawing conclusions that were inconsistent with their calculations. Also, all bar a handful of candidates attempted to draw conclusions in context.

(b) The first mark here was usually earned but only a few candidates earned the second mark for commenting on the fact that the newspaper's statements are too strong or too definite. For example, failing to reject H_0 does not mean we have "proved" that H_0 is true – just that we have no evidence to the contrary. Some recognised the unwarranted certainty of the statements by making reasonable comments about the types of error that may have been made, but such comments were rare. In general, it is hoped that candidates will not say they have proved that H_0 is true because they have not done so. That is not the function of a significance test.

Question 4

(a) Even the weaker candidates got 3/3 here.

(b) There seemed to be no difficulty with finding the mean of total profit but the standard deviation was more problematic. The most common error was failing to square 0.22 and 0.15

(c)(i) As in (b), the mean (of L) was usually correct while the standard deviation was not. A surprising number of candidates miscopied or misread their 17.16 as 17.6 hence using -1.3 as the mean, so carelessly losing marks. Many did not recognise that the standard deviation to be used here was the same as the 1.69 given in part (b) so wasted time on further unnecessary calculations. However it was interesting (and rather odd) that quite a few candidates started again and successfully found 1.69 having failed to find it in part (b) where the answer was given.

Many marks were lost here (and elsewhere in the paper) by candidates not putting down enough information for part-marks to be awarded. Numbers appeared apparently from thin air with no indication of what they were supposed to be (Is it a mean? A standard deviation? A variance?) Too many candidates lost marks by just writing down an incorrect probability from their calculators. Candidates should be encouraged to include intermediate working and clearly indicate what their figures mean and where they came from. Examiners are not mind readers! (ii) A comparison of profits was required here not weights or amounts sold.

(a) A number of candidates were confused about which was the sample value and which was the hypothesised value. In this question, hypotheses involving the sample mean (82) rather than the value to be tested (78) were fairly common. As were negative test statistics arising from calculating (78 – 82) in the numerator. In general, candidates should know that for t or z tests, the form of the test statistic has

(sample value) – (hypothesised value)

in the numerator, not the other way round. They should also know that H_0 and H_1 involve hypothesised/assumed values not calculated sample values.

A final point on part (d) is that many candidates (even the better ones) used a t-test here even though a sample standard deviation was not being used.

Question 5

Full marks were hard to come by with 7/10 being the best that most could achieve for various reasons.

(a) Most managed 0.1 in part (i) but many had no idea how to proceed in part (ii). It required a fairly straightforward application of probability rules or use of the tabulated $\mathrm{B}(5,\ 0.1)$ distribution. However the slightly unusual context threw all but the best candidates. A surprisingly common answer to part (i) was zero. The argument was that if the confidence interval is constructed around μ then it is bound to include μ. This suggests a basic misunderstanding of what a confidence interval actually is i.e. a range of plausible values based around a sample estimate. The question said that a confidence interval “is to be constructed” so it should be understood that a sample would be needed to do this.

(a) (i) Most constructed a confidence interval in the correct form but there were many attempts to use normal z-values instead of t-values. It was clear in the question that the standard deviation to be used was calculated from a sample. To emphasise this, the notation $s = 0.021$ rather than σ was used. With such a small sample ($\mathrm{n} = 6$) this should immediately make candidates think of using t-values rather than normal. A surprising number of candidates don’t know the difference between decimal places and significant figures. Consequently, the instruction to give their limits to 3 decimal places resulted in the fairly useless interval $(10.3,\ 10.3)$

Another unfortunate way of losing all 4 marks in this part was to just write an interval down with no working. If this is not correct to 3 decimal places then, even if it’s very close to the required answer, it can still only score 0/4 because there is no way of knowing if z or t was used or if a 90% t-value was used or if $\mathrm{n}=6$ was used …and so on. In general, candidates will get the benefit of the doubt when presenting correct answers with no working but NOT if the answers are (even slightly) wrong.

(ii) There were two common ways of losing marks here. Firstly, many were not precise enough about what value they were comparing with the confidence interval. Candidates should be encouraged to specify numerical values in such situations. Secondly, many seemed to be confused between speed and time, interpreting a lower mean (10.280 after training, 10.325 before) as a “bad” thing. This probably resulted from not thinking clearly enough about the context of the question. Effective sprint training should *increase* speed and *decrease* time.

Question 6

Many candidates clearly ran out of time on this question which, together with the fact that it included a number of tricky little parts, resulted in a lot of very low ($<4/17$) marks. However, the very best candidates, still managed to score highly ($>14/17$).

(a) (i) If attempted, most managed 3/3 here. Some credit was given for using a $\mathrm{B}(450\ ,\ \frac{1}{30})$ distribution in this part, rather than a $\mathrm{Po}(15)$ because there is some logic for doing so and the large n and small p gives a good approximation. However the same logic doesn’t apply in the following part (ii) where use of a binomial distribution was disallowed.

(ii) Those that used a Poisson distribution usually only dropped marks for continuity correction errors.

(iii) This was not answered as well as expected. Candidates needed to calculate $(1 - \text{(ii)})^2$ Common errors were just calculating (ii)^2 (probably from not reading the question wording carefully enough) or $\text{(ii)}\times 2$ which is less excusable. Just doubling their answer suggests that a surprising number of candidates thought that P(A **and** B) = P(A) + P(B). The word "and" was in bold in the question to emphasise what was needed.

(b)(i) The main problem here was showing that $p = 0.223$. This part was intended to be challenging so that the very best candidates could show their worth, and so it turned out. Realising that a Poisson is needed to find the "p" for a Binomial distribution is not easy. Only a few managed 4/4 and some dropped a mark by missing a step out. Just writing down that $P(S=0) = 0.233$ if $S \sim Po(1.5)$ is not convincing enough as the answer is given. The 4th mark here was awarded for indicating that $P(S=0) = e^{-1.5}$. This required the use of the Poisson probability formula not just reliance on a calculator.

(ii) This was an easy mark that was sometimes lost by candidates writing down the rounded answer of 17 with no working. They seemed to think that expected values for discrete variables must themselves be whole numbers.

(iii) This part required logic and common sense and was generally answered well although some explanations for an increase in $E(G)$ were rather garbled or contradictory. Sloppy wording was extremely common (e.g. "G will increase" rather than "E(G) will increase") but, given the time constraints that candidates were working under at this stage of the exam, this was condoned.

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