A-LEVEL
Mathematics

MS04 – Statistics 4
Report on the Examination

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General

This year the quality of work was of a good standard, but below that seen last year. Correct answers were produced for all questions, invariably to the appropriate degree of accuracy, indicating evidence of generally good preparation of the topics examined. Substantial attempts were made at all questions, indicating that students had sufficient time to work through the paper. Students continued to make good use of the answer booklet, which had plenty of space for their solutions, and they also made good use of the appropriate formulae and tables in the booklet provided. Hypotheses were stated correctly, and requisite tests and calculations were performed accurately and clearly.

Question 1

There was generally sound work on this first question. Some students' notation left a little to be desired. In part (a), a common error was to omit saying that $\mathrm{F}(t) = 0$ for $t < 0$. The use of the word 'otherwise' was also acceptable. In part (b), a number of students gave the probability that $T < \mathrm{E}(T)$ rather than the probability that was asked for in the question. Some answers to part (c) were left in an unsimplified form, which did not earn the final mark.

Question 2

There were many completely correct solutions to this question. In part (a), the lack of an answer or an incorrect comment lost the first mark. The confidence interval for σ^2 in part (b) was found successfully by the majority of students, who then went on to make a correct comment. There was a small minority of students who mistakenly thought that they could use the *t*-distribution in this question.

Question 3

There was extremely accurate work in finding the confidence interval for the variance ratio in part (a). The lack of confusion in the students' minds when using the F-distribution tables was good to see and showed that they had a firm understanding of the topic. Only the occasional candidate made an error in calculating the confidence interval, usually by dividing instead of multiplying, or vice versa. The vast majority were able to make a good comment in part (b), where follow-through marks could be earned based on a candidate's confidence interval.

Question 4

In part (a), stating that there were normal distributions with a common variance was deemed to be a single assumption. Unfortunately, some students stopped there, possibly thinking that they had given two assumptions. Likewise, 'independent random samples' was also treated as a single assumption. The work in part (b) was extremely accurate. Hypotheses were invariably stated correctly and the conclusion was stated correctly in context. The vast majority of students realised the need to calculate a pooled estimate of the population variance in order to perform the *t*-test.

Question 5

More good work was in evidence in this chi-squared goodness of fit test. Almost all students were able to calculate correctly the value of 0.3 for the probability that a randomly chosen clip was blue. Most then went on to use either their calculators or the tables provided to find the probabilities of the $\mathrm{B}(12, 0.3)$ distribution. This enabled them to find the correct expected frequencies corresponding to the observed frequencies given in the question. A small number of students did not see the need to combine the first two classes, because the expected frequencies fell below 5, though most combined the later classes correctly. Providing 2 was deducted from the number of classes, students suffered no further penalties for working with 5 degrees of freedom, as opposed

to the correct value of 4. Again the null hypothesis was correctly stated and the conclusion correctly given in context.

Question 6

Parts (a) and (b) were generally answered satisfactorily, although students should realise that they do not gain marks for merely stating what is already in the question. At this level, the responses in part (c) were somewhat disappointing. Elementary differentiation with variables other than x and y proved too challenging for some students. Likewise, the sample sizes n_1 and n_2 given in the question caused so much confusion in the minds of some students that they decided to assume that $n_1 = n_2 = n$ for the rest of the question, which gained them little credit. The more discerning students did not have the above problems and proceeded to work correctly throughout the question and gave sensible explanations in part (d)(ii) in terms of 'weighted averages' or 'pooled estimates'. In the final part, full marks could be obtained simply by saying that there was 'minimum variance'. A few able students realised that this meant 'greatest efficiency', although the occasional candidate confused the terms 'efficiency' and 'consistency' which displayed a lack of complete mastery of the topic.

Question 7

The work in parts (a)(i) and (ii) was generally done well. There were a variety of different approaches, some starting from a series for $\mathrm{E}(X^2)$ itself, and others from a series for $\mathrm{E}(X[X-1])$. The more successful students usually used q for $1-p$ in their working. The calculation in (a)(iii) was usually done correctly even when mistakes occurred in the previous parts, which displayed the good examination technique of using the printed result in the question. The better students were able to complete all three parts of part (b) correctly. Some students correctly wrote down the three probabilities that needed to be added in order to answer part (b)(i). Curiously, few then realised that they were the first three terms of a geometric progression which they needed to sum to infinity in order to answer part (b)(ii). Part (b)(iii) then required the same strategy but in the case of Robin winning the game rather than the game ending in a draw.

Mark Ranges and Award of Grades

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