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Mathematics 6360

MS2B Statistics 2B

Report on the Examination

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General

It was again very pleasing to see so many excellent solutions to each of the questions on this paper. Candidates quoted hypotheses in the correct form, used the correct test and gave sensible and relevant conclusions in context. However, there were still some weaknesses to be found on continuous distribution questions where candidates' inabilities to integrate and differentiate simple functions often let them down.

Question 1

This question was very well answered by the majority of candidates, many of whom gained full marks. A few candidates persisted in using z-values when asked to construct a confidence interval for μ, whatever the given situation. However, this was not as prevalent as in previous papers.

Question 2

Part (a) was generally answered well. However, there were some candidates who attempted to use tables in part (a)(i), even though values are not tabulated for $\lambda = 3.5$, whilst in part (a)(iii) some candidates could not interpret 'fewer than 10' to mean '≤ 9'. It was, however, very pleasing to see fewer candidates than usual attempting to use the formula in part (a)(ii). Only the most able candidates managed to complete part (b) successfully, with the majority not realising that there were 5 ways of selecting 4 days from 5.

Part (c) was done really well by most candidates, although, in part (c)(ii), several thought that the mean had to be equal to the variance in order for a Poisson distribution to form a suitable model. Here, $\overline{x} = 9.2$ and $s^2 = 9.29$ were close enough to each other to draw this conclusion.

Question 3

The vast majority of candidates managed to gain full marks on this question. The usual errors in the calculation of s or s^2 from summary data were still seen, with $s = \sqrt{15321}$ being a popular misconception. The null and alternative hypotheses were usually stated correctly; however, a few candidates thought that it was sufficient to write "$\mathrm{H}_0 = 85.9,\ \mathrm{H}_1 \neq 85.9$" or "$\mathrm{H}_0 : \text{mean} = 85.9,\ \mathrm{H}_1 : \text{mean} \neq 85.9$", neither of which was acceptable. Since it was a large sample size, it was expected that candidates would use a z-test with critical values of ± 1.96, although the use of $t = \pm 1.984$ was clearly an acceptable alternative.

There were still candidates who insisted on being far too dogmatic when drawing their conclusions. Statements such as "This proves that the mean has not changed" or even "The mean has not changed" were the usual responses from weaker candidates, whereas "Insufficient evidence to suggest that the mean has changed from 85.9" was the type of response required and often seen from the more able candidates.

Question 4

This proved to be a very popular question, with the overwhelming majority of candidates gaining full marks. Parts (a) and (b)(i) were done well, with very few numerical errors seen. Almost all candidates managed to calculate $\mathrm{E}\left(X^2\right) = \sum x^2 \times \mathrm{P}\left(X = x\right)$ in part (b)(ii), with very few candidates wrongly thinking that this was the same as the variance.

In part (c), although the majority of candidates used the most efficient ways of finding $\mathrm{E}(Y)$ and $\mathrm{SD}(Y)$ by evaluating $\mathrm{E}(Y) = 5 \times \mathrm{E}(X) + 2$ and $\mathrm{SD}(Y) = \sqrt{25 \times \mathrm{Var}(X)} = 5 \times \sqrt{\mathrm{Var}(X)}$, there were frequent attempts made to tabulate the probability distribution for Y, followed by the use of methods already employed in part (b). Although this process was often successful, it used up valuable time which could have been allocated to other more demanding parts of the paper. A few confused candidates thought that $\mathrm{Var}(Y) = 25 \times \mathrm{E}(X)$, whilst others simply found the variance, not realising that the standard deviation had been requested.

Question 5

This question proved to be another good source of marks with the majority of candidates gaining at least 7 marks. Part (a) was done by a variety of correct methods, with good conclusions in context often seen. Most candidates realised that a *t*-test was required, with only a few weaker candidates wrongly using $z = 2.3263$, instead of $t = 2.821$, as their critical value. In part (b), it was the population of times taken to complete the French assignment that must be assumed to be normally distributed and not, as was often quoted, the sample itself.

Question 6

Most candidates, in part (a), made a good attempt at sketching the graph of the probability function, although there were the usual weak attempts where candidates did not recognise that $\mathrm{f}(t) = \frac{3}{8}t^2$ is a quadratic curve whilst $\mathrm{f}(t) = \frac{1}{16}(t+5)$ is a straight line.

Part (b) was rarely attempted using the most efficient method of finding the area of a trapezium, but those candidates who did usually did so correctly. The vast majority attempted to use integration when answering this part of the question, with either $\int_1^3 \frac{1}{16}(t+5)\,\mathrm{d}t$ or $1 - \int_0^1 \frac{3}{8}t^2\mathrm{d}t$ often being used correctly. However, integration was not necessary and its use here again used up valuable time which could have been helpful to some candidates elsewhere.

It was disappointing to see that only the most able students coped well with part (c)(i). Very few realised that $\mathrm{F}(t) = \mathrm{F}(1) + \int_1^t \mathrm{f}(t)\,\mathrm{d}t$ was required here, with the vast majority simply evaluating $\int_1^t \frac{1}{16}(t+5)\,\mathrm{d}t$ and then writing down the answer that was given in the question. Part (c)(ii) was tackled much better, with many candidates obtaining the correct answer. The negative root to the obtained quadratic equation was correctly rejected but often without any justification being given.

Question 7

This type of question is always popular and this year it again proved to be a good source of marks. Most candidates correctly stated the null hypothesis and their conclusions were usually correctly stated in context. Many candidates used their calculator to perform all of the necessary working and simply stated their value for $\sum_i \left(\frac{(O_i - E_i)^2}{E_i} \right)$ and gave the critical value of $\chi^2 = 10.645$ before then stating their conclusion in context. This is a method to be encouraged, especially for those candidates who can use their calculators proficiently.

It should be understood, however, that the wrong value stated for $\sum_i \left(\frac{(O_i - E_i)^2}{E_i} \right)$, together with no numerical calculations seen to indicate that a correct method has been used, will usually result in a loss of many marks. The responses to part (b) were rather mixed, with the correct answer "More of those students achieving level 7 at KS3 gained a grade A at GCE than was expected" often being seen. However, there were many general comments seen that did not relate to this group of students at all.

Question 8

There were very many excellent solutions to this question with full marks seen on a regular basis; however some candidates seem to struggle with questions where the cumulative distribution function is given, rather than the probability density function. In part (a), some candidates were unable to differentiate the function and some treated the given function as the probability density function and attempted, usually with very little success, some sort of integration. Of the very many candidates who did manage to differentiate $\mathrm{F}(x)$ correctly, a few failed to quote the full answer for $\mathrm{f}(x)$, simply giving the answer as $\frac{1}{9}$.

In part (b), those candidates who had obtained the correct answer to part (a) usually drew the correct graph. Unfortunately, some candidates showed their lack of understanding of what was given in the question by simply attempting to draw the graph of $\mathrm{F}(x)$. Part (c) was done well by those candidates who understood the question, many using the graph that they had drawn in part (b) to help them to obtain the correct answer. For those who realised that this was a continuous rectangular distribution, part (d) was done very quickly by using the correct formulae from page 11 of the supplied booklet of formulae and statistical tables. However, some candidates attempted, usually with little success, to use integration methods in order to find the mean and variance of the given distribution.

Mark Ranges and Award of Grades

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