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Mathematics MS2B

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Statistics 2B

Report on the Examination

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General

It was very pleasing to see many fully correct solutions to all of the questions. However, parts of the questions that required a comment in words were not well done; this showed a lack of understanding of the concepts on which this paper is based. It was disappointing to find that an increasing number of candidates can neither manipulate numerical and algebraic expressions nor work out numerical answers to questions which require exact or surd answers. Candidates who had to rely on their calculators often fell short on the skills required to answer such questions.

All mathematics candidates at this level should have been able to solve a quadratic equation using the formula or completing the square; this unfortunately was not the case. There were still those candidates who considered probabilities which fell outside the range $0 \le p \le 1$ to be valid answers to questions. Also, some candidates still did not understand which hypothesis test they should use or whether they should use z-values or t-values in their calculations.

Question 1

In part (a)(i), candidates were expected not only to give the value of λ to be 13 but also to state that X followed a Poisson distribution; this was not always seen. Part (a)(ii) was usually done well either by using tables or by applying the correct formula. Unfortunately some candidates used $\lambda = 2.6$. In part (a)(iii), tables were often used correctly and accurately to obtain the correct answer of 0.920. Part (b) was not done at all well, with only the most able candidates gaining any credit. Although many thought that the value of λ would be different from 2.6, they could not give a convincing reason why this should be the case.

Comments such as ‘It is not random’ or ‘Mean not equal to the variance’ by themselves were not specific enough and consequently gained no credit. Part (c) was usually very well answered by the vast majority of candidates who used tables. Those who chose to use the formula approach usually either missed one of the terms out or made some error in their calculations. In part (d), the necessary assumption that was expected was ‘X and Y are independent’. Comments such as ‘They are independent’ or ‘The speeds are independent’ gained no credit. The calculation of the required probability was usually attempted correctly.

Question 2

In part (a)(i), it was expected that candidates would use ‘area of rectangle = 1’. This was not always the case, with integration methods again being employed where they are totally unnecessary and time consuming. Those who did manage to write down area $= 10u \times 0\pi 011 =$ sadly then often seemed unable to complete the required algebraic manipulation in order to obtain the given answer. In part (a)(ii), most candidates managed to correctly find $\mathrm{E}(X)$ and $\mathrm{Var}(X)$ by using the suggested formulae. Some however did not leave their answers in terms of π as requested and consequently lost marks. Part (a)(iii) was very poorly answered except by the most able candidates. Far too many candidates either did not know the formula $C = \pi D$, or failed to realise that this formula needed to be used, and so simply attempted to find $\mathrm{E}\left(X + \frac{10}{X}\right)$ and $\mathrm{Var}\left(X + \frac{10}{X}\right)$, often incorrectly.

However, part (b) was usually very well done. The vast majority of candidates realised that, as the variance of the given distribution was known, a z-value (not a t-value) had to be used.

Question 3

As usual, the question on this topic was the best answered question on the paper with many fully correct solutions seen. The vast majority of candidates managed to correctly state at least the null hypothesis in part (a). In part (b), a few lost a mark for failing to give their answer to one decimal place, this despite the specific request. However, on the whole, this was very well done, often in conjunction with part (c) where the correct values of $\nu = 6$ and $\chi^2 = 16.812$ were usually seen, followed by a correct conclusion in context. Those candidates who stated an incorrect null hypothesis in part (a), or failed to find a value for X^2 within the range $11.9 \le X^2 \le 12.1$ in part (b), lost this mark. The responses to part (d) were better than usual but there was still room for improvement in this area. In part (e), many candidates found the correct value of $\chi^2 = 10.645$ but again lost the mark for the comment in context for the same reasons as in part (c).

Question 4

It was very disappointing to see some candidates still using integration methods in this question involving **discrete** random variables. There were several attempts at $\int x\mathrm{P}(X = x)\,\mathrm{d}x$ seen in part (a) and $\int \frac{1}{x}\mathrm{P}(X = x)\mathrm{d}x$ in part (b)(i). However, part (a) was very well done by the majority of candidates. In parts (b)(i) and (ii), where the answers were given, many candidates failed to show sufficient method to warrant full marks. Candidates should have indicated in some way that they had used $\sum \frac{1}{x} \times p$ and $\sum \frac{1}{x^2} \times p$ somewhere in their calculations. This was not often the case although the majority of candidates ended up with the correct given answers, often following dubious or incorrect methods.

The responses to part (c)(i) were very disappointing. Only the best candidates seemed capable of identifying the values of $Y < 20$ and then adding their corresponding probabilities. Part(c)(ii) was found to be the hardest part on the paper. Very few candidates realised that $\mathrm{P}(X < 4 \mid Y < 20)$ equated to $\mathrm{P}(X = 3) = \frac{9}{40}$. Consequently, although some candidates realised that they had to divide 'something' by their answer to part (c)(i), they gained no marks.

Question 5

In part (a), the vast majority of candidates gained high marks with stated correct hypotheses followed by the correct calculated value of $z = -2.34$. The correct critical z-value of ± 2.5758 was usually used and a correct comment in context was often seen. Only a minority of candidates incorrectly chose to use a t-value, but those who did lost at least three of the available six marks. A few candidates lost the final two marks for either incorrect conclusions or conclusions that were too positive. In order to achieve full marks, this is still an area that needs to be improved.

The alternative hypothesis in part (b)(i) was almost always correctly stated. In part (b)(ii), only the very best candidates gained full marks. Many only considered one critical value — usually the incorrect upper value of $10000 + 1.753 \times 125 = 10219$, rather than the required lower value of $10000 - 1.753 \times 125 = 9780 \text{ to } 9781$ that led to the region $\overline{x} > 9780$ for Christine not to reject the null hypothesis. Those candidates who incorrectly chose to use a z-value gained a maximum of one mark for this part of the question. The majority of candidates correctly stated 'No error' as their answer to part (b)(iii).

Question 6

Although most candidates managed to correctly integrate $\frac{3}{8}\left(x^2+1\right)$ in part (a), many then failed to use the correct limits required to find $\mathrm{F}(x)$, with the vast majority failing to consider any limits at all but simply stating the given answer. In part (b), many candidates stated $\mathrm{F}\left(m\right)=0.5$ but then failed to verify that $m=1$ satisfied this condition. Part (c) was not well answered except by the more able candidates. Many started from the incorrect assumption that $\int_0^q \frac{1}{4}\left(5-2x\right)\mathrm{d}x=\frac{3}{4}$. Consequently, the given equation was often quoted without any foundation at the end of a lot of spurious work.

It was also very disappointing to see candidates on this paper unable to solve the given quadratic equation. Those who did manage to obtain two surd answers were often then unable to give an adequate numerical comparison in order to justify the selection of the given answer. Most candidates simply wrote down the given answer without any justification whatsoever. This lost them the final two marks for this part of the question. Part (d), although relatively straightforward, confounded many candidates as very few realised that all they had to do was to evaluate $\mathrm{F}\left(1.5\right)-\mathrm{F}\left(q\right)$ where $\mathrm{F}\left(q\right)=\frac{3}{4}$ and $\mathrm{F}\left(1.5\right)=\frac{13}{16}$.

Mark Ranges and Award of Grades

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