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MS2B Statistics 2B

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General

There were many fully correct solutions seen to each of the eight questions on the paper. It was pleasing to see that, in general, the majority of candidates had again been well prepared for the examination.

Having said this, there remain difficulties for quite a large number of candidates who do not possess the necessary algebraic skills to enable them to show their statistical capabilities. Stating hypotheses correctly and drawing the correct, qualified conclusions in context are still giving cause for concern. Also, drawing simple diagrams and using methods which enable candidates to answer questions in the most efficient way are areas that could be improved.

Question 1

This question, as usual on this topic, proved to be a good source of marks for the majority of candidates. However, there were still some candidates who either did not state their hypotheses in context or omitted them completely. Simply stating "H_0: not associated" and "H_1: associated" was not sufficient. Although the vast majority of candidates realised that Yates's correction had to be used, there was a great number of candidates who could not apply it correctly. The most common incorrect applications were $O_i - E_i - 0.5$ or $\left(O_i - E_i\right)^2 - 0.5$, whereas $\left|O_i - E_i\right| - 0.5$ was required. Although most candidates formulated a conclusion in context, these were usually too positive in nature. Also, simply stating "Reject H_0" was not sufficient to gain full marks.

Question 2

In part (a)(i), the vast majority of candidates realised that the formula or their calculator had to be used in order to obtain the answer. However, there were some who tried to use Table 2 in the booklet provided by averaging the values that they found under $\lambda = 3.4$ and $\lambda = 3.6$, presumably under the misapprehension that this would give them the required value for $\lambda = 3.5$. However, most candidates did use Table 2 correctly in part (a)(ii) by realising that the most efficient way to obtain the result was by using $\mathrm{P}(Y \geq 5) = 1 - \mathrm{P}(Y \leq 4)$. Some candidates did not seem to be able to use these tables (or perhaps even know of their existence) as they worked out $1 - \mathrm{P}(Y = 0, 1, 2, 3 \text{ or } 4)$ by using the formula. Although they usually managed to arrive at the correct answer, this is not the most efficient way of tackling this type of question.

In part (b)(i), candidates had to indicate that the distribution was Poisson and that $\lambda = 9.5$. It was not sufficient to simply write "$\lambda = 9.5$" or just to state "Poisson". Part (b)(ii) caused most of the problems in this question. Whilst the vast majority of candidates realised correctly that $\mathrm{P}(7 \leq T \leq 10) = \mathrm{P}(T \leq 10) - \mathrm{P}(T \leq 6)$, there were some who incorrectly used $\mathrm{P}(7 \leq T \leq 10) = \mathrm{P}(T \leq 11) - \mathrm{P}(T \leq 6)$ or who either used the wrong value of λ or were simply careless and misread the tables. The vast majority of candidates realised that, in part (b)(iii), the correct answer could be obtained by simply evaluating $\left(\text{their part (b)(ii)}\right)^3$. However, there were a few candidates who incorrectly thought that $3 \times \left(\text{their part (b)(ii)}\right)$ was the way forward and did not seem at all deterred when this gave them an answer greater than one.

Question 3

There were some candidates who failed to write down any hypotheses. It was essential that both hypotheses (null and alternative) were stated as it was these that were compared when the test was conducted. The outcome of the test was that one of these hypotheses would be accepted (and that the other would be rejected) and, if they were not stated in the first place, this could not be done sensibly. For the majority of candidates who tried to state their hypotheses, there was the issue of how these should be stated. Hypotheses were often incorrectly stated as H_0: mean = 36 and H_1: mean < 36, or H_0: $\bar{x} = 36$ and H_1: $\bar{x} < 36$, or even H_0: = 36 and H_1: < 36. The forms of the two hypotheses that were acceptable, and which were expected, were either H_0: population mean = 36 and H_1: population mean < 36, or preferably H_0: $\mu = 36$ and H_1: $\mu < 36$.

The generally-considered-good practice of sketching a distribution curve would have helped ensure that the correct critical value of $z = -2.3263$, not $z = +2.3263$, was used. Conclusions should be stated in context and should not be too positive in nature. "The number of putts has reduced from 36" was both too positive and failed to mention the mean number of putts. The fact that '(test statistic) < (critical value) $\Rightarrow$ Reject H_0' did not imply that the mean number of putts had definitely reduced from 36. The evidence suggested this was the case but there could, for example, have been a Type I error.

Question 4

Part (a) caused the most problems in this question. Although many candidates were able to demonstrate why $f(x) = 10$ for $-0.5 \le x \le 0.5$, they were unable to indicate why the values of X had to lie in the given range. Part (b) was often done correctly, if not always by the most efficient method. For this rectangular distribution, there were far too many candidates still using integration, rather than a sketch diagram and simple geometry, to reach the required result. It was expected that candidates would use the formulae from page 11 of the booklet provided to answer part (c). Although many did, there were those who attempted integration methods with little success. Some candidates who managed to find the variance then did not go on to find the standard deviation.

Question 5

The numerical answers to part (a) were usually correct. However, there were many candidates who did not give an assumption or did not know what assumption they had made. The assumption that "The sample is normally distributed" was the usual false statement and "It is normally distributed" or simply "Normally distributed" were also insufficient. In fact it was the population from which the sample was taken that had to be assumed to have a normal distribution.

In part (b), a popular misconception by candidates seemed to be that the 99% confidence interval (29.2, 42.0) indicated that 99% of motorists travelled at speeds of between 29.2 mph and 42.0 mph, whereas it really indicated that there was a 99% confidence that the interval contained the true mean speed of all motorists travelling through the village. Whilst the majority of candidates indicated that 30 mph fell within the confidence interval, most then failed to realise that 80% of the sample had speeds in excess of 30 mph which consequently indicated that the speed limit was not being adhered to by most motorists.

Question 6

This was the least-well-answered question on the paper with many major errors of technique and understanding. It was only answered well by the more able candidates. It was a major concern that so many candidates thought incorrectly that $\mathrm{E}\left(\frac{1}{X}\right) = \frac{1}{\mathrm{E}(X)}$ and $\mathrm{Var}\left(\frac{1}{X}\right) = \frac{1}{\mathrm{Var}(X)}$. These candidates wasted a lot of time evaluating $\mathrm{E}(X)$ and $\mathrm{E}(X^2)$ to no avail. There were also many examples of poor integration techniques. When

$\mathrm{E}\left(\frac{1}{X}\right) = \int_0^1 \frac{1}{x} \times 3x^2 \, \mathrm{d}x$ was correctly stated, some candidates then seemed unable to integrate correctly, with $\ln x \times \frac{3x^3}{3}$ or $\frac{3x^3/3}{x^2/2}$ often seen.

The fact that the variance cannot be less than zero seemed to have escaped the attention of some candidates who were apparently quite comfortable, not only in obtaining negative values for their variance, but also in using such values in part (b), where it was also evident that many candidates were let down by poor algebraic skills . It was expected that candidates would first express $\frac{5+2X}{X}$ as $\frac{5}{X}+2$ and then use $\mathrm{E}\left(\frac{5}{X}+2\right) = 5\mathrm{E}\left(\frac{1}{X}\right)+2$ and $\mathrm{Var}\left(\frac{5}{X}+2\right) = 5^2\,\mathrm{Var}\left(\frac{1}{X}\right)$ to obtain answers of 9.5 and 18.75 respectively. Unfortunately many candidates could not even cope with the first step. On the other hand, there were some good attempts from evaluating $\mathrm{E}\left(\frac{5+2X}{X}\right)$ and $\mathrm{E}\left(\left(\frac{5+2X}{X}\right)^2\right)$ by integration.

Question 7

The majority of candidates found this question to be quite straightforward with many scoring full marks in part (a). A few mistakes were seen in part (b), usually from those candidates who confused the ‘total mark’ with the ‘total number of questions’ to then quote an incorrect answer of $\frac{16}{24}$.

Question 8

The values for $\bar{x}$ and s were usually found correctly. The comments regarding hypotheses, sketches and conclusions, as detailed for question 3, are equally valid here. Many candidates used z-values (usually $\pm\, 1.96$) when t-values were required because the test involved a small sample from a normal distribution with unknown variance. This was a 2-tailed test and, as such, conclusions had to consider whether or not there was a change (not a decrease) from 230 grams in the mean weight of jam.

Answers to part (b) were either correct or incorrect. Some candidates simply stated “Type I error” without any evidence in context to back up their claim, and consequently received no credit. Others incorrectly stated that there was a Type II error because they had rejected H_0 when, in fact, H_0 was true.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the **Results statistics** page of the AQA Website.