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General Certificate of Education

Mathematics 6360

MS2B Statistics 2B

Report on the Examination

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General

The majority of candidates appeared to have been well-prepared for this paper and there were many excellent solutions seen to each of the six questions. More emphasis could have been placed on the choice of the correct test, especially when choosing whether to use a *t*-test or a *z*-test. A better understanding of simple probability, and especially of how binomial probabilities are derived, would have helped some candidates.

Sketches should be an accurate representation of the given function. Although the stating of hypotheses was much better than in previous series, there were still some candidates, especially when answering the χ^2 question, who felt justified in stating, for example, "Accept H_0" as part of their conclusion even though they had not stated anywhere in their solution what H_0 was.

Question 1

On the whole this question was attempted very well and by a variety of correct methods. However, it must be understood that when the value of the population standard deviation is known (i.e. $\sigma = 8$ in this case), then a *z*-test and not a *t*-test should be used. Thus here, $t = -2.110$ should not have been stated as the critical value. This said, the majority of candidates correctly stated the null and alternative hypotheses and then correctly carried out a 2-tailed *z*-test with $z_{\text{crit}} = \pm 1.96$. This was usually followed by a sensible (not too positive) conclusion in context.

Question 2

There were many fully-correct solutions seen to this question. The vast majority of candidates used the tables provided to enable them to find the correct answer to part (a)(i) by the most efficient method. A minority of candidates seemed only able to use the formula and consequently worked out the individual probabilities before obtaining their answer. In part (a)(ii), the formula was often used correctly to obtain the correct answer of 0.0471. However, there were some candidates who seemed to think that they had to use tables whatever the value of λ and so attempted to average the values found in the tables under $\lambda = 1.4$ and $\lambda = 1.6$ incorrectly thinking that this would give them the required value for $\lambda = 1.5$.

In part (b)(i), most candidates interpreted 'more than 5' correctly using $\mathrm{P}(X + Y > 5) = 1 - \mathrm{P}(X + Y \leq 5)$, whilst others incorrectly used $1 - \mathrm{P}(X + Y \leq 4)$ or $1 - \mathrm{P}(\mathrm{X+Y} \leq 6)$. Only the most able candidates then went on to use their answer to correctly determine the numerical solution to part (b)(ii). There were many erroneous attempts at using various expressions with $0.631^7 + 0.631^8$ or $0.631^7 \times 0.369$ or even $6.5 \times 0.631^7 \times 0.369$ seen, rather than the required $p = {}^8C_7 (0.631)^7 (0.369) + (0.631)^8$. In part (c)(i), the vast majority of candidates correctly stated that $\bar{x} = 8$ and that $s^2 = 16.9$, but with some stating the sample variance as 15.2. These answers usually enabled candidates to indicate correctly in part (c)(ii) that a Poisson distribution was probably not a good model since the mean and the variance had very different values.

Question 3

This topic, as usual, proved to be the best source of marks on the paper, especially for those candidates who realised that when the expected frequency of any one category falls below 5 then this category must be combined with another. When combining, this should have been done with the category to which it was most closely related. In this case, the 16-17 and 18-21 age groups should have been combined, and also the 50-65 and Over 65 age groups, since each of these pairs of categories probably contained people with fairly similar and quite closely

related views on the reorganisation of schools. It was not thought that combining the 16-17 age group with the Over 65 age group was sensible in the context of this question. Some candidates only combined once, either at the top end or at the bottom end of the age range and it was quite disappointing to see others not combining any categories at all with the consequential loss of marks.

The null hypothesis was usually stated correctly and the correct conclusion in context was often seen. However, some candidates were unable to state the correct critical value found from the χ^2 tables, whilst a few thought incorrectly that the use of a *t*-value or a *z*-value was appropriate.

Question 4

In part(a), too many candidates seemed to have the wrong perception that the request for a 'sketch' entitled them to draw a very poor quality graph or copy some unscaled diagram which they had managed to take from the display on their graphics calculators. All such attempts lost some or all of the marks available. The axes and straight lines should have been drawn with the aid of a ruler and should have contained the appropriate scales: O or $(0, 0)$, $(1, 0)$ and $(3, 0)$ on the x-axis and $(0, 0.5)$ on the y-axis as a bare minimum. A straight line from $(0, 0.5)$ to $(1, 0.5)$ and a straight line from $(1, 0.5)$ to $(3, 0)$ should then have been drawn. It was often quite difficult to decide whether the sketch contained the required 'straight' lines or curves, so badly attempted were the sketches.

Similarly, part (b) was very poorly attempted with most candidates simply showing that $\mathrm{f}(1) = 0.5$ or solving $\mathrm{f}(x) = 0.5$ to give $x = 1$. Both of these were inappropriate and so gained no credit.

There were many good attempts at finding $\mathrm{E}(X)$ in part (c). However when, as here, the answer is given in the question, sufficient relevant working must be shown for full credit to be obtained.

Although there were many excellent solutions to part (d), there were only a few candidates who used the most efficient method of $1 - \frac{1}{2} \times 0.75 \times \frac{3}{16}$; most chose an alternative method which required integration. There were a large number of usually less able candidates who wrote $\mathrm{P}\left(X > 2\frac{1}{4}\right) = \mathrm{f}\left(2\frac{1}{4}\right) = \frac{3}{16}$, thus gaining no marks.

Question 5

This was often the worst answered question on the paper. Many candidates were unable to show enough convincing working in part (a) to gain full credit. However, part (b) was usually done quite well, except by those candidates who simply wrote down a 2×2 table or stated $+45$ rather than -45. Most realised that the probabilities had to add up to one, so correctly obtaining $\frac{26}{45}$.

The values in the table were then usually used correctly to obtain the given value of $\mathrm{E}(X)$.

Part (c)(i) was usually done quite well with many finding $\mathrm{E}(Y) = 5$. Unfortunately some candidates failed to multiply this answer by 100 to give the final answer of 500 pence or £5. There were some excellent solutions, by various methods, to the final part of this question, but these were mainly given by the more able candidates.

Question 6

Many excellent solutions were seen to part(a)(i), with $\bar{x} = 43.5$, $s = 2$ and $t = 2.365$ often used in the calculation of the 95% confidence interval as $43.5 \pm 2.365 \times \frac{2}{\sqrt{8}}$. Some candidates stated $s = 1.87$ or $s^2 = 3.5$, which only gained credit if used correctly in $43.5 \pm 2.365 \times \frac{1.87}{\sqrt{7}}$.

The vast majority of candidates either did not state an assumption or simply stated "It is normal" or "Sample is normal" or "Boxes are normally distributed". None of these gained any credit as it was the parent population or the weights of boxes of black peppercorns that were assumed to be normally distributed. In part (a)(ii), the comment was either too positive with candidates stating "Bishen's belief is true" or no reason was given as to why Bishen's belief may or may not have been justified.

In part (b)(i), the hypotheses were usually stated correctly, followed by a correct evaluation of the test statistic as -2.12. However, far too many candidates stated that the critical value was $t = +1.895$ or $t = \pm 1.895$ and consequently went on to consider the wrong tail of the distribution, with the inevitable loss of credit. Part (b)(ii) was usually done very well, with only the occasional incorrect mention of a Type II error.

Mark Ranges and Award of Grades

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