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Statistics SS04

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Statistics 4

Report on the Examination

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Question 1

The majority of candidates made good attempts at this question, using a Student's *t* test on 11 degrees of freedom to test the null hypothesis that the population mean weight is 140g and correctly interpreted their results in context, scoring full marks. A few candidates used the alternative but acceptable approach of constructing a 95% confidence interval for the population mean and arguing that 140g was plausible by virtue of its inclusion within the resultant interval. Failure to gain full marks often resulted from use of the standard normal distribution rather than Student's *t* distribution, with intervals based upon 1.96 and $\Phi(-0.420) = 0.337$ compared to 0.025 frequently seen. In a few cases candidates ignored the sample size altogether.

Question 2

Many candidates successfully made full use of the statistical capability of calculators to compute required probabilities in parts (a) and (b). In a number of cases, however, incorrect answers were often presented with little or no evidence of any method.

(a) The great majority of candidates correctly identified and successfully used the normal approximation to the Poisson distribution to compute the correct answer. The most common cause for loss of marks was the failure to use the correct continuity correction factor.

(b) Nearly all candidates correctly approximated the binomial distribution with a Poisson model having a mean 1.4 and went on to successfully compute the probability of two or more faults as 0.408. A minority of candidates inappropriately attempted a normal approximation.

(c) A majority of candidates attempted to relate their results from parts (a) and (b) when commenting on Peter's claim about Elani's effectiveness. Surprisingly most candidates focused on the number of serious faults alone, which might be considered a manufacturing problem, and chose to entirely ignore the level of sales when forming a conclusion. A considerable number of candidates considered a probability of 0.2 to be (very) low and thought this signalled an event that rarely occurs.

Question 3

(a) This was well answered with candidates often scoring full marks. In many cases correct limits were given with little or no working. Where working was shown the sample mean and standard deviation were seldom calculated incorrectly, and intervals usually based upon the correct *t*-value, 2.262. The statement that candidates should assume the distribution of scores to be normally distributed might account for the few who incorrectly used 1.96 instead of 2.262.

(b) Many candidates provided insufficiently precise comments to gain the full 3 marks for this part, often as a result of failing to clearly identify 40 and 8 as the target mean and standard deviation of test scores.

Question 4

This question was well answered by many candidates but proved a challenge for some.

(a) The null and alternate hypotheses were usually correctly stated. The majority of candidates recognised the need to use a normal approximation to the Poisson distribution but an incorrect value for the mean and variance was often chosen with 5.75, 9 and 23 commonly used. A considerable number of candidates applied a continuity correction factor incorrectly. A large number of candidates used the cumulative distribution function on their calculator to compute the tail probability (*p*-value) from either the *Z*-score, usually –2.08, or the observed *X* value with or without correction (23.5 or 23) directly, correctly comparing their result with 0.05. Others used the traditional approach of comparing their test statistic to a critical N(0,1) value, usually 1.28, with similar success. The majority gave consistent conclusions based on their values, interpreting these in context.

(b) The most popular answer was that complaints about behaviour were unlikely to be independent. Comments such as “rate not constant”, “complaints not constant” and “mean not constant” were not uncommon and gained no marks.

Question 5

Most candidates found this question straightforward with the exception of part (b)(i).

(a)(i) Almost without exception the correct mean was stated but several candidates failed to validly derive the standard deviation of the sum of 10 identically distributed random variables.

(a)(ii) Full marks were scored by the majority of candidates, with correct answers often seen with very little or no working.

(b)(i) This part proved a challenge for all but a minority of candidates. Most candidates appeared to know how to compute $V(aX)$ but incorrectly considered the total income as the sum of two independent terms ($X + 2X$), thus failing to correctly compute the variance of the money raised using $V(3X)$, and subsequently lost the final A1 in the next part of the question.

(b)(ii) Most candidates correctly followed through deriving the distribution of the surfeit of funds as money raised – equipment cost, using their mean and variance. A number of candidates lost marks by treating equipment cost as a fixed quantity rather than a random variable, and a small number of candidates incorrectly subtracted the component variances rather than adding. Full marks were rarely gained largely due to errors in the variance component computed in part (b)(i).

Question 6

(a)(i) Most candidates gained full marks, often making use of calculator functions and showing little working. Explicit use of the binomial probability function was exceptionally rare although some candidates appeared to use the PDF command rather than CDF command on their calculator. The use of $p = 0.3$ and (less often) $p = 0.05$ as the binomial parameter was often the main reason for loss of marks.

(a)(ii) The majority of candidates attempted to use a normal approximation to the binomial distribution and applied it correctly. A small number of candidates correctly produced a test statistic based upon the sample proportion. A few candidates used the Poisson approximation which, whilst valid, might ordinarily be considered unsuitable if probabilities needed to be calculated using the probability function or using standard tables. Direct use of the Poisson distribution was allowed, but subsequent approximation using a normal distribution having the same mean and variance was treated as a special case. As in previous questions, many candidates computed cumulative probabilities using their calculators either directly using the observed (continuity corrected) value, 28 (27.5) or indirectly using the Z-score 2.55 (2.43), correctly comparing the result to 0.05.

(a)(iii) Most candidates correctly chose the conclusion based on the larger sample.

(b) The majority of candidates found this part straightforward, used the appropriate formula with $Z = 1.96$ correctly and gained full marks. Use of $n = 28$ was not uncommon and the main reason for loss of marks.

(c) Most candidates simply argued that Jarrald was incorrect because the vouchers were shown to be effective in part (a)(ii). Very few considered that the extra income generated might not offset the discount afforded by the vouchers.

Mark Ranges and Award of Grades

Grade boundaries and cumulative percentage grades are available on the Results statistics page of the AQA Website. UMS conversion calculator www.aqa.org.uk/umsconversion