Examiners' Report/ Principal Examiner Feedback

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GCE Statistics S2 (6684) Paper 01

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General Introduction

The paper was accessible to the candidates and most seemed to have enough time to complete all the questions. The presentation was good. Many candidates could understand and apply the statistical techniques but could find algebra and arithmetic often challenging. They often had difficulty rearranging algebraic equations correctly and solving both simultaneous and quadratic equations.

Question 1

This question was accessible to the majority of candidates, with many gaining full marks. Responses to part (a) reflected some misunderstanding in interpreting the question. This was shown by candidates who gave a list of 'conditions for a Poisson distribution to be used' rather than how the Poisson could be used 'as an approximation to the binomial distribution'. Common errors seen in part (a) included $n > 30$, $p < 0.5$ and p is low. Part (b) was generally well answered and a high proportion of candidates correctly used Po (10) as the approximation to B(1000, 0.01). Common errors usually involved interpretation of inequalities e.g. using $P(X \geq 4) = 1 - P(X \leq 4)$ or $1 - P(X \leq 5)$, or finding $P(X \leq 3)$.

Question 2

Overall this question was well answered and responses reflected good preparation and understanding in using a Poisson distribution and also using a normal approximation to a Poisson. A high percentage of candidates attempted both parts of (a) successfully, with the majority of candidates using Po(3) and getting at least one mark for (a)(i). Marks lost for part (a) were normally for finding $P(X \geq 4) = 1 - P(X \leq 4)$ or $P(X = 4)$, in (a)(ii) or occasionally for writing the answer to (a)(i) as 0.22. In part (b) candidates showed their ability to standardise correctly using a continuity correction to get a negative 'z' value, or in the case of candidates who used the symmetric properties of the distribution, the equivalent positive value. A minority of candidates lost marks through either using an incorrect continuity correction, i.e. 18.5 or 20.5, or none at all. Occasionally a candidate failed to find $1 - \Phi(1.92)$ although it was rare to see a final answer > 0.5.

Question 3

Part (a)(i) again tested candidates' ability to handle inequalities which they often found challenging. This was shown by incorrect answers such as $P(X \leq 5) = 0.9456$ or those finding $1 - P(X \leq 5)$. Part (b) challenged a significant number of candidates although the majority who attempted this question were able to state $(1 - p)^{12} = 0.05$. The final solution to this part, however, often proved beyond the ability of many candidates. Successful candidates were adept at finding roots using calculators or using logs to get the solution whereas those less successful made several attempts before admitting defeat.

Common errors seen involved using a mix of common and natural logs or having written correctly $\log(1 - p) = \frac{\log 0.05}{12}$ then not being able to write an expression for '$1 - p = \ldots\ldots$'. A high proportion of candidates answered part (c) confidently and successfully, with the majority of candidates gaining at least one mark for writing Variance = $12p(1 - p)$ or for $12pq = 1.92$ and attempting to solve their quadratic. Errors were quite often due to writing/using the quadratic formula incorrectly due to errors in basic arithmetical calculations.

Question 4

There were many exemplary responses to this question with candidates getting full marks. Errors in parts (d) and (e) often reflected some candidates' lack of competence in the manipulation of algebraic fractions.

Errors in part (a) were down to a few candidates giving the mean as 5 or 2.

Responses to part (b) showed that the majority of candidates were able to find the required probability using a continuous uniform distribution over the given range. Some candidates found $P(X > 2.4)$ and did not proceed to find the correct solution using $1 - P(X > 2.4)$. Also, a small number of candidates tried to find the probability using a discrete uniform distribution.

Part (c) challenged many candidates and the ability to interpret $P(-3 < X - 5 < 3)$ was varied. An answer of 0.6 was often seen which was found from working such as $P(-3 < X < 3)$, ignoring $X - 5$, or from $P(2 < X < 8)$.

Many excellent responses to part (d) were seen but equally it was evident that this question proved very challenging for a high proportion of candidates by the number of attempts (including pages of crossed-out working) at finding the required solution. The majority of candidates followed the instruction to '**use integration** to show...' and gained at least one mark for writing $\int \frac{y^2}{4a - a}\,dy$ or the equivalent. Candidates who used a as the variable were more likely to lose marks through errors made in treating the constant $3a$ in the denominator as a variable and cancelling this with the expression in the numerator, either before or after integration. This, in turn, created problems for candidates when substituting the values for the limits of integration. Working was also seen on a number of occasions where candidates lost the final two marks when substituting the limits and calculating $(4a)^3 = 4a^3$.

Candidates who used $E(Y^2)\ E(Y)^2$ did not score any marks for this part of the question. Part (e) was also generally accessible to the majority of candidates. Candidates who used $\frac{(b-a)^2}{12}$ were less likely to lose marks through errors than those who used $E(Y^2)E(Y)^2$. A common error was where candidates found the value of the mean but then forgot to square it before subtracting from $E(Y^2)$.

In part (f) a high proportion of candidates successfully found $P\left(X < \frac{8}{3}\right) = \frac{2}{3}$ and solved $P\left(Y < \frac{8}{3}\right) = \frac{2}{3}$ to get an answer $a = \frac{8}{9}$. For a large minority of candidates finding $P\left(Y < \frac{8}{3}\right)$ proved difficult, and in some cases impossible. This was evident in the number of attempts shown. A number of candidates lost the final mark through errors in handling algebraic fractions, e.g it was common to see working $\frac{8}{9a} - \frac{1}{3} = \frac{2}{3}$ followed by $\frac{8}{9a} = 1$ or $\frac{8}{9}a = 1$, giving a final answer of $\frac{9}{8}$

Question 5

Many candidates found parts (a) and (c) difficult.

Part (a) was testing candidates' understanding of the cumulative distribution function, F(t). It perhaps helps to think visually, in terms of area, but ultimately the algebraic definition $F(t) = P(T \le t)$ is required.

In part (b) nearly all candidates were able to calculate $P(T < 3) = 11/36$. The response to part (c) was disappointing with very many candidates scoring no marks. Of those who realised that a conditional probability was required the most common error was to find $\frac{P(X \ge 5)}{P(X \ge 3)}$ or $\frac{P(X \ge 5)}{P(X \le 3)}$. Part (d) required candidates to solve a quadratic equation. Any written method would have been acceptable, but by far the easiest was to rearrange the equation to obtain $(t + 15)^2 = 2250$ and then to square root both sides. Many candidates multiplied out the brackets and then either used the formula or completed the square.

Question 6

Apart from part (a), this question was well answered and responses reflected good preparation and understanding of hypothesis tests.

Only a few candidates were able to discuss a hypothesis in terms of a population parameter in part(a). Candidates' errors included discussing hypotheses and critical values. Part(b) was generally well answered although some candidates wrote comments such as 'it is an area where a hypothesis could be rejected' without identifying which of the two hypotheses was being referred to. References to 'original' and 'new' hypotheses rather than H_0 and H_1 were also seen. Correct terminology is important.

In part(c) many candidates achieved full marks but there were some common errors. These included absence or incorrectly stated hypotheses, finding $P(X = 5)$ rather than $P(X \le 5)$, comparing 0.553 to 0.05 if using a two-tailed test or with 0.25 when using a one-tailed test, conflicting non-contextual conclusions and incorrect (or no) contextual conclusion, some including double negatives.

Part (d) of the question was tackled well by a large number of candidates, with some able to complete it accurately with little or no working. Those that investigated $P(X = 0)$ for various values of n nearly always attained a correct solution and most of those using logs also gained full marks, the main error being forgetting to reverse the inequality sign when dividing by log 0.55.

Question 7

This question provided many difficulties for weaker candidates, particularly those weak at algebraic manipulation.

In part(a) nearly all candidates attempted to integrate the given expression with most placing the resultant expression equal to 1, substituting 5 and multiplying by 2 to provide the given equation.

Most candidates attempted part (b) successfully and achieved a correct equation. Many candidates then tried to rearrange the equation but often they did not posses the algebraic skills to do so accurately. Marks were awarded for the correct equation in this part as incorrect subsequent working was ignored. The candidates then unfortunately used their rearranged incorrect equation in part (c). All the candidates attempted to solve 'their' equations simultaneously and most of those with the correct equation attained the correct values for a and b. Part (d) of the question was not answered well by a large number of candidates. Those that had the correct values of a and b usually managed to integrate correctly but errors in substitution into the quadratic formula and/or in calculating the two possible values of m (the median) were not uncommon. In part (e) The majority of candidates compared 'their' median with the given mean correctly and most of them also stated the correct skew for 'their' values. Some candidates attempted to compare the mean or median (or both) with the mode with varying degrees of success. This comparison was only considered if 'their' mode was stated and, when given, these values varied anywhere between 0 and 5.

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