Pearson Edexcel

Examiners' Report

Principal Examiner Feedback

Summer 2024

Pearson Edexcel GCE

In A Level Further Mathematics (9FM0)

Paper 4B Statistics 2

Summer 2024
Publications Code 9FM0_4B_2406_ER*

9FM0-4B Examiners’ Report June 2024

The 9FM0-4B Further Statistics 2 paper provided a lot of challenge to all candidates. The paper was accessible to all candidates, who were able to demonstrate their understanding of the more advanced statistical techniques.

Time did not appear to be an issue and it was rare for candidates to not attempt all questions on the paper. The most demanding part of a question on the paper was 4(c), whilst Question 6 proved to be much more challenging than would possibly have been anticipated.

Question 1

This opening question on the topic of linear regression brought more challenge than expected for some candidates. In part (a) candidates were required to find the regression line h on t having been given coded data in the form of two other variables, v and w. Whilst the majority of candidates made good progress on most of this question, with parts (a) and (c) the most commonly fully correct, there were some who got mixed up with the variables and attempted to find the line h on t.

In part (b), many candidates lost the accuracy mark by using prematurely rounded values of the coefficients obtained in part (a), and some compounded their error by failing to show full workings for finding the residual, and also lost the method mark. Some candidates showed their workings clearly but subtracted the wrong way round for the residual so gained no credit.

Many of the candidates who were successful with (c) also went on to make, and adequately justify, the correct decision in (d).

Question 2

This question was on Spearman's rank and testing for correlation.

There were many fully correct responses, but whilst many candidates took the correct approach throughout this question, a good number failed to understand the rankings as presented in part (a), instead treating the letters as ranks with $A = 1$ etc. Candidates did not always show their working, so it is important that present full solutions with the values in their calculations.

In part (b), candidates were usually successful in setting up correct null and alternative hypotheses. The most common errors were using r instead of ρ with some incorrectly deducing that agreement meant a two-tailed instead of a one-tailed test. Candidates usually found the correct critical value and made a correct comparison, although some candidates had reached a negative value in (a) which should have resulted in going back and realising that the method was incorrect. Others lost the final mark for not mentioning the context in the conclusion.

Question 3

This question involved finding a confidence interval for the mean of bolts and a critical region for a hypothesis test using the sample variance. The question was well-answered throughout by a good proportion of candidates, although a fair proportion of those taking the correct approach compared a standard deviation to a variance in (c) so did not score full marks.

Part (a) was usually fully correct, although some candidates found an incorrect z value. In part (b), many candidates erroneously found a lower limit for the variance, selected an incorrect value from the chi-squared distribution or made errors manipulating their equation or inequality when proceeding to $S^2 > \ldots$ Some candidates forgot to square the standard deviation that was given in the question. A few found a confidence interval instead of a critical region.

Part (c) caused a number of issues for many candidates. Quite often candidates failed to either square the standard deviation to compare with the critical region, or they did not square the variance from (b) to make a correct comparison. Some explanations lacked clarity in the inference that was being made or lacked any contextual interpretation. Other candidates struggled as their incorrectly found critical region in part (b) resulted in them having to make inconsistent conclusions.

Question 4

This question tested the continuous uniform distribution and an application of this to solve a geometrical problem using the expected value function.

Parts (a) and (b) were generally answered correctly, although a few candidates made lots of work for themselves by using integration rather than the standard formulae for the uniform distribution. Only arithmetical slips typically prevented candidates scoring the first four marks on this question.

A number of candidates made little progress on part (c) because they worked with a particular value of K, usually $\mathrm{E}(K)$, seeming to make the underlying assumption that the expectation of the area would correspond to when $k = \mathrm{E}(K)$. Those who drew a clear correct diagram at the start were usually able to earn a number of marks. Integration to find the expectation was generally preferred by candidates, though those who used expectation algebra were just as successful. Those who opted to integrate sometimes omitted the $\frac{1}{5}$, whilst those who were using expectation algebra sometimes just squared $\mathrm{E}(K)$ rather than working with $\mathrm{Var}(K)$ to find the appropriate value for $\mathrm{E}(K^2)$.

Question 5

This question required candidates to have a good understanding of continuous random variables and the ability to integrate the probability density function to find the cumulative distribution function.

The most common mistake in both parts (a) and (b) was to integrate to find the cumulative distribution function but fail to recognise the need for a constant of integration (or a lower limit of 2). The approach in the main scheme of deriving simultaneous equations via definite integrals seemed slightly more popular than finding the cdf, and proved safer for those who used it.

Of those who took the cdf approach with a constant of integration, a few were perplexed to find $\mathrm{F}(2) = 0$ told them nothing new and became stuck. A small number of candidates formed equations with values of x below 2, e.g. expecting $\mathrm{F}(0) = 0$ when this is not necessarily the case.

A pleasing number of those who did not finish part (a) were nevertheless able to attempt (b) using the one equation they had obtained in (a) and the given value of $a = 3$, with many gaining full marks in (b).

Question 6

The start of this question on carrying out a paired *t*-test should have been a good source of marks, and many candidates should have been able to score highly on this question. The underlying theory, however, proved to be more of a challenge and confusion over whether to carry out a two-sample *t*-test or a paired *t*-test compromised many of these marks.

Parts (a) to (c) were generally quite poorly answered. In (a) and (c) many candidates were not sufficiently aware of the assumptions and conditions necessary for the use of the particular statistical model. In (b), few read the question carefully enough to realise it was asking about sampling considerations. Many wrote lots about the controlling conditions the lambs were kept in, but this was not relevant to sampling and gained no credit.

In (d), evidence of method was often lacking, leading to a loss of method marks where errors were made, and the method was not shown. A significant number of candidates incorrectly worked with the method to find a confidence interval from two independent samples, using difference of means and a pooled variance. This was somewhat surprising, given that part (a) stated that this method is not suitable and part (c) indicating a paired *t*-test was possibly the correct approach. Some credit was given as a special case, however a good proportion of these candidates did not square root the correct elements of their formula or failed to fully substitute their values in their workings, so could not score marks.

In part (e), the distinction between then population mean, and sample mean was important in the hypotheses, with many students using the wrong symbol and so writing incorrect hypotheses. Candidates needed to clearly convert 200(g) to 0.2(kg) to compare to the confidence interval and a number failed to do so. Marks were also lost with incorrectly two-tailed hypotheses, comparing the sample mean to the confidence interval, instead of the supposed population mean, and by incorrectly taking 0.2's presence in the confidence interval as evidence to support the alternative rather than the null hypothesis.

Question 7

This question tested unbiased estimators and required a series of routine algebraic manipulation. Candidates appeared comfortable in general with what was asked and was possibly familiar in style to previous questions on this topic. Many fully correct solutions to this question were seen.

The vast majority of candidates had success with (a), though a number did not fully 'show' where the given answers came from - use of *np* and *mp* as the expectation was needed.

Those who were successful in part (a) were often able to proceed via a similar route in part (b) and achieve a further two marks. Sometimes the result in (b) was more obvious given that *a* and *b* were in the separate fractions and the expression needed to be set equal to *p* meant that the other parts of the fraction needed to equal p for them to cancel; this possibly helped candidates to go back and repeat part (a).

In part (c), a number of candidates failed to realise that Var(X) and Var(Y) were different, and to express them in terms of n and p. Treating them both as σ^2 meant that they were unable to gain credit for their attempts at Var(Q) and Var(R). Many candidates taking the right approach in part (b) made things more difficult for themselves by expanding $p(1-p)$ unnecessarily and substituting values of m and n before they needed to, or only partially, leading to more unwieldy expressions. Relatively few candidates were unable to make any progress at all with this question, however. A number did not start working with variances in part (c) when cued to by 'R is a better estimator than Q', so were working in vain in other directions which did not yield any marks. Errors in (c) were not common but included those in manipulation of the fractions, erroneous attempts at simplifying the inequality, and several candidates dealt with the k incorrectly leading to a factor of 4 rather than $\frac{1}{4}$. A few candidates fell at the last hurdle, either writing $\frac{1}{2} < a < \frac{1}{6}$, or by failing to give the strict inequality that was required for R to be 'better'.

Question 8

This was possibly one of the most successfully answered questions on the paper and demonstrated great confidence amongst the majority of candidates when working with combinations of random variables.

Typically, in parts (a) and (b) candidates were able to select appropriate models and found correct means for their variables. Where errors did occur, it was often in finding the variance with the misconception that they were working with e.g. $\text{Var}(3X) = 9\text{Var}(X) = 9\sigma^2$ rather than $\text{Var}(X_1) + \text{Var}(X_2) + \text{Var}(X_3) = 3\sigma^2$.

In part (b), those who kept the model simple and intuitive $(L-2S)$ were most likely to avoid errors in choosing the required probability to achieve the answer in part (b). Fortunately, those who had misunderstood how to find the variance when combining three independent random variables in part (a) did not result in making the same error in this part as they correctly found $5^2 + 4 \times 20^2$ with the only rare error being in forgetting to square the standard deviations given in the question. Some candidates did form the model $(L-2S-30)$, although this was less common.

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom