Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2024

Pearson Edexcel GCE
In Mathematics (9MA0)
Paper 31 Statistics

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Introduction

The paper proved accessible to all students, and it was encouraging to see most attempting all the questions. There were some more challenging parts such as 2(d), 5(d) and the end of question 6 but these questions enabled the better students to shine.
Poor, barely legible handwriting is an increasing concern from some students especially where a reason or explanation was required such as in 2(c), 3(c) and 4(c) and a number of students were truncating their answers rather than rounding to 3 significant figures as we usually require. Premature rounding was also quite prevalent this year, for example in question 2(b). We expect students to work with sufficient accuracy in order to be able to present their final answer correct to 3 significant figures.

Comments on individual questions

Question 1

Almost all students were able to write down or use the correct binomial model in part (a) and usually evaluate P(X = 3) correctly. Some struggled with part (ii) and an answer of 0.930… from P($X \leqslant 3$) was often seen suggesting that students are not entirely familiar with how their calculator operates. Others seemed to mis-interpret the inequality and attempted 1 – P($X \leqslant 2$). In part (b) a new random variable was needed and students who defined this clearly usually made good progress, but some simply tried to use B(60, $\frac{1}{6}$). Interpreting the phrase "at least 12 days" caused problems for some students but generally this part was answered well. The final two parts required a third random variable S ~B(600, $\frac{1}{6}$) and many wrote down the correct mean for part (c) and often stated that this random variable was approximated by N(100, …) to get started in part (d). Many students seemed unsure about finding the standard deviation (the formulae are available in the formula booklet) and there was a great deal of mislabelling or use of the variance instead of the standard deviation. A good number realised that a continuity correction was required, though of course not always in the right direction, but the correct final answer was not uncommon.

Question 2

Whilst most students showed they had a good grasp of the concepts of correlation and regression some failed to give sufficient detail in their answers. In part (a) the requirement to "interpret" meant, as usual, that we needed a fully contextual response. Some simply stated "negative correlation" or gave the value of the gradient as – 1.28 whereas a full interpretation of the rate expected to see mention of the height decreasing by 1.28 m(etres) for each second of flight. In part (b) most students interpreted this situation as a one-tailed test and stated the hypotheses correctly in terms of ρ but a few equated this equal to – 0.510 rather than 0 for the null hypothesis. Almost all the students gave a critical value that matched their alternative hypothesis, and an encouraging number gave a correct contextual conclusion to the test mentioning both height and time. Some however lost the final accuracy mark for having contradictory or incorrect statements such as "reject H_0" followed by a correct contextual conclusion such as "there is insufficient evidence of a negative correlation between h and t". Although we did not require a comparison of the test statistic with the critical value if one was seen it had to be correct and some students lost the final mark for statements such as – 0.510 < – 0.5494 or for comparing 0.510 with the significance level of 0.05 In part (c) most students realised that the given equation was not an appropriate model but did not give a strong enough explanation as to why this was so. Those who noted that the scatter diagram showed a curved set of data scored the mark whilst those who suggested that the points seemed to form a (negative) quadratic probably also gave themselves lead in to part (d). Of those who did not score the mark in part (c) some simply discussed correlation rather than stating that the line had negative gradient throughout whereas the scatter diagram had a positive gradient initially and then a negative gradient. Others just compared one or two points rather than concentrating on the overall shape of the scatter diagram and some simply stated "non-linear" without developing their answer and drawing out a difference between the scatter diagram and Amar's linear model. Part (d) proved challenging for most students and many simply moved on to the next question. There were many convoluted attempts involving calculus or multiplying out the bracket or substituting a value such as (1, 28). Students should be encouraged to consider the number of marks available as a guide to the amount of work required to answer the question. Those who had identified the scatter diagram as representing a parabola and saw the connection with the quadratic nature of Jane's model could simply estimate the equation of the axis of symmetry and usually chose a suitable value of k.

Question 3

It is encouraging to see most students now attempting the question on the large data set and a growing familiarity with it.
In part (a) many wrote down rainfall or windspeed but other quantitative variables such as hours of sunshine or maximum wind gust were sometimes seen but these are not variables available for overseas locations. Some students gave answers like "trace" or "outlier" which have appeared in previous papers but had no relevance to this question. Part (b) was a straightforward calculation and was accessible to all the students. Almost everyone scored the mark for the mean and most had a correct expression for the standard deviation, but some used their rounded value of 15.2 for the mean and this meant that their final answer for the standard deviation was not accurate to 3 significant figures. A few students omitted the square root sign or forgot to square the mean.
The final part of the question required students to know that Perth on the large data set was in the southern hemisphere and therefore the warmer months would be during our autumn and winter. They were told that the mean air temperature for the month in question was 19.4 and needed to observe that this was larger than the overall mean of 15.2 for the 6 months of the large data set. Using their knowledge that the large data set only covers the months from May to October they could then infer that the month in question was October. Many were able to identify that the month to be identified was a warmer month (and scored the first mark) but then suggested an answer such as November or December which of course are not available in the large data set. It was sometimes difficult to know whether a candidate was using "summer" to simply refer to the months from June to August or referring to the warmest months of the year in Perth, often an example month was given which helped clarify what the student meant.

Question 4

In part (a) most gave the hypotheses correctly in terms of p though some failed to have the H_0 and H_1 labels and some had $p = 0$ for the null hypothesis perhaps confusing this with a test for correlation. Most used the correct distribution to try and find the critical region but notation was often poor with $P(X = 8)$ being written when $P(X \leqslant 8)$ was meant or calculated and a number struggled to find $P(X \geqslant 9)$ correctly leading to upper tails of the critical region of $X \geqslant 8$ or $X \geqslant 10$. There were many errors with the probabilities in each tail with $P(X = 0) = 0.0147$ (a truncated answer) frequently seen instead of 0.0148 the correct rounded value. Students don't seem to be aware that the table function on their calculator truncates values rather than rounding them. Some students gave their critical regions inside probability statements and of course failed to secure the accuracy mark, and some didn't think that $X = 0$ was a valid part of the critical region and omitted this from their answer. Many students who had identified a critical region were able to add their tail probabilities to give the significance level, but some merely wrote down 0.025 or doubled the probability of 0.0155 found in part (a).
In part (c) some students didn't have a critical region of the correct form and were unable to access this mark. Others simply said that they would "accept H_0" without any attempt to give a contextual conclusion and some thought that because the test was not significant Freya's belief was therefore correct. A few students incorrectly used the probability $\frac{7}{40}$ and then compared this against their probabilities of 0.0148 or 0.0155 from part (a).

Question 5

Part (a) was answered very well by most students and in part (b) a good proportion also recognised the need for the events to be independent. Some students failed to score the mark in part (b) because they did not use correct mathematical language: we saw comments such as "they are not affected by each other" or "the events are not mutually exclusive" and a few simply said "it is continuous data" or "they must take part in both events". Many students answered part (c) successfully, but some made errors when trying to find $P(T < 300)$ either by using a continuity correction and finding $P(T < 299.5)$ or failing to convert minutes to seconds and trying to find $P(T < 5)$.
There were many good attempts at part (d). Most students could start the problem and write down a pair of linear equations in μ and σ with suitable values of z. Many students showed some working when solving their equations whilst others simply wrote down solutions using their calculators. This is fine if the equations are correct but if there are errors in the equations then the method mark cannot be awarded if no method for solving the equations is <u>seen</u>. The front of the paper indicates that if students use their calculators instead of the tables, then they should use an equivalent degree of accuracy which in this case, for finding the z values, was 4 decimal places. Some failed to do this and lost one of the accuracy marks but there were a good number of students scoring full marks for this part. A common error here was missing the minus sign on the z value for the lower tail and a few students assigned the z values the wrong way around.

Question 6

It was encouraging to see most students attempting this final question and many made good progress with the first two parts. The major obstacles to success here were poor use of, sometimes invisible, brackets and weaknesses in manipulating fractions involving algebra and decimals.
Part (a) was answered very well with many giving all 3 pairs which was fine provided they were all correct. Part (b) was answered well too with most successfully finding $p = 0.13$ although a few students omitted the 0.08 from $P(C)$. Part (c) proved more discriminating. Whilst many students knew $\mathrm{P}(A \mid B') = \dfrac{\mathrm{P}(A \cap B')}{\mathrm{P}(B')}$ they were not able to find the relevant values from the Venn diagram. Some thought $\mathrm{P}(A \cap B') = \mathrm{P}(A) \times \mathrm{P}(B')$ and quite a few were unable to establish the relationship $q + r = 0.22$ and some of those who did get this far believed that r couldn't be 0 and gave an answer of $\dfrac{0.21}{0.55}$. A common error was to write $\mathrm{P}(A \mid B') = \dfrac{\mathrm{P}(A)}{\mathrm{P}(B')} = \dfrac{q + 0.05}{q + r + 0.25 + 0.08}$. In part (d), having been given an equation with which to work, students were much more successful with many gaining all 3 marks. There were errors with the conditional probability again and many slips in adding probabilities, but it was common to see $\dfrac{0.4}{0.73 + r} = 0.5$ leading to the correct values for r and q. When part (e) was attempted, it was usually correct however a few students multiplied 0.25 and 0.08 instead of adding them. Part (f) proved to be one of the most discriminating parts of the paper. There were many blank responses, and some simply gave an answer of $p = 0.13$. Some though could find the correct region but gave the answer as a probability e.g. $\mathrm{P}(B \cap A' \cap C')$ rather than an event which was unfortunate as they had usually not made this mistake in part (a).

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