Examiners' Report
Principal Examiner Feedback

Summer 2019

Pearson Edexcel GCE AS Mathematics

In Statistics (9MA0/31)

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Introduction

This is the second year of this new specification and candidates appeared to be better prepared than in the previous sitting. Work on the Normal distribution discriminated at the top end with Q5 proving to be the most challenging. Questions involving the large data set were poorly attempted and often left blank.

Comments on individual questions

Question 1

On the whole, this accessible question was answered very well by majority of candidates with nearly 40% going on to achieve full marks. Most were able to draw the correct tree diagram in part (a) and label both outcomes and probabilities clearly. However, a number of candidates made mistakes due to deciding Bag A contained only 9 marbles, B contained 4 marbles and C contained 2 marbles. Some candidates attempted a 3 branch tree diagram and made little progress. Others thought that the successive draws from Bag C could take place. All branches must be labelled as blank branches are not assumed to represent a probability of 0.

Part (b) was almost universally answered correctly, even if the tree diagram was incorrect, with the majority of candidates gaining full marks or at least follow through marks, although occasionally the three probabilities were added rather than multiplied together.

Many correct responses were seen in part (c) with the majority of candidates gaining full marks or at least follow through marks for the method. The most common error was the inclusion of 0.1 for P(red) in addition to the two correct products, perhaps indicating that the candidates failed to interpret ‘at least’ correctly.

Part (d) was somewhat less successfully answered. Many candidates were unable to recognise that this involved conditional probability, with the most common wrong answer of $\frac{9}{10} \times \frac{1}{5}$ often seen. A small number had the conditional probability the wrong way round, attempting to find P(R|B) instead of P(B|R).

Question 2

Parts (a), (c) were well attempted by most candidates with part (d) being tackled by more able candidates. Parts (b) and (e) were a problem for those less familiar with the large data set.

In (a) most candidates correctly read the quartile values from the diagram to obtain and use the interquartile range to find outlier boundaries. (Where IQR was incorrect it was commonly given as 7.4). Surprisingly there were some inaccuracies in using the formula for outliers even though it was given. Not all candidates showed any working which meant marks could not be awarded if the box plot was not correct. The left hand whisker was commonly drawn to 9.1 (sometimes to 8.6) as required but the right hand whisker was more occasionally incorrect, often extending off the grid instead of stopping at the stated maximum value of 32.5 Usually the two outliers were plotted although they were sometimes omitted by candidates who had shown the correct calculations.

Candidates are required to be familiar with the large data set. It was clear from responses in part (b) that many were not aware that for all locations the data is for the months of May to October only. Successful candidates often explained that Beijing was in the northern hemisphere and so low outliers for temperature were likely to be for winter, and so October. Some candidates perhaps did not read the question carefully enough and stated two months.

Most candidates scored well in part (c), usually using the given $\sqrt{\frac{S_{xx}}{n}}$ formula. A small number appeared unaware of this method instead choosing to work back from S_{xx} to find $\sum x^2$, to then use in the 'standard' formula. Some were successful here although there were a number who mistakenly took the given S_{xx} to be $\sum x^2$. Most candidates showed their calculation giving the result to at least 4 significant figures so that they could show it rounded to 5.19

The most popular approach in part (d) here seemed to be use of the inverse Normal function on a calculator to find the 10th and 90th percentiles. This was usually successful although many candidates then went no further, hence gaining only the first mark. It was evident that some were not aware of what was meant by interpercentile range; it was not understood that the difference needed to be found (as when finding IQR), some stating a range for x as an inequality (e.g. $15.9 \le x \le 29.3$) with others instead reaching a probability answer of 0.8. Of those continuing to find the IPR some had prematurely rounded both percentile values to 3 significant figures before subtraction, leading to 13.4 as an inaccurate final answer. Candidates need to be encouraged to work with accurate figures, only rounding their final answer. Fewer candidates used the more 'traditional' (and longer) approach of standardisation to obtain the percentiles needed, although this was often done successfully.

Part (e) was very poorly done with only a handful of candidates scoring marks here. Depth of familiarity was lacking by many candidates. Some misunderstood the question entirely and cited the conditions for a Normal being a suitable approximation to a Binomial. Others thought this part was related to the variable under study and suggested the Normal was not suitable for modelling air temperature for a variety of reasons including the skew on the box plot. Those who did suggest two other variables from the LDS rarely gave acceptable reasons for their choice; some gave no reasons at all even when their choice was a suitable one. The use of the Beaufort scale for wind speed was mentioned but it was wrongly said to be discrete with only a few saying that it was non-numeric. Wind direction which was non-numeric was quite often seen but was not an acceptable answer. Some other wrong reasons were: the data is non-uniform, the values are too variable; it is not possible to have values below 0. The most commonly suggested variable was cloud cover, presumably because it was used as the basis for Q4 and possibly because it appeared in last summer's 8MA02

Question 3

This was the second most successful question on the paper with nearly a quarter of candidates scoring full marks. In part (a) the required symbol ρ was often written as p in the hypotheses and though this was condoned for the first mark. Candidates who lost the mark were mainly using r or pmcc instead of the parameter ρ. Occasional two-tailed hypotheses were stated.

The majority of candidates were successful in finding the critical value but some final conclusions were confused with candidates thinking that the critical region was where the pmcc was less than the critical value. A small number of candidates incorrectly tried to apply a Binomial distribution writing X~B(24, 0.446) or tried to standardise using 1.6449 = (x – 24)/0.446 to find the critical value.

Many gave a correct response in part (b) using the idea that the correlation was stronger or the value closer to 1. Some candidates only compared the value of 0.822 to 0.446 (or 0 or 0.3438) without explaining how this supported Barbara's belief by showing a stronger correlation compared to the uncoded data. A common incorrect answer was to state that 0.882 was close to 0.89, the gradient of the regression equation.

A variety of approaches were taken to answer part (c). Those that opted to take method 2 (working from the model) on the whole were usually more successful, as many could jump straight to $\log_{10} y = \log_{10} a + n\log_{10} x$. A common error was to give n = 7.762… $\left(10^{0.89}\right)$ Those candidates that struggled with this question were able to score the first mark as many could state $\log_{10} y = -1.82 + 0.89(\log_{10} x)$ but then failed to make y the subject. Even those candidates that could deal with logarithms often lost the final mark as did not evaluate their value of a (too many left this as $10^{-1.82}$).

Question 4

This question demonstrated that most candidates are confident in carrying out statistical calculations, particularly probabilities, but only the most able are confident in interpreting in context what these mean. Most earned the mark in part (a) except the few candidates who did not give an answer to the required degree of accuracy.

In part (b)(i) most candidates scored both marks, usually going down the route of 1 – P($X \leq 5$) and rounding to a minimum of three significant figures. Where mistakes were seen they were generally down to the accuracy of the rounding (only to two significant figures) or those who had attempted P(X=6) or incorrectly assumed P($X \geq 6$) = 1 – P($X \leq 6$).

In part (b)(ii) while candidates rarely had difficulty finding P(X=7) they frequently went no further, despite the question's requirement for the expected value.

Part (c) was not particularly well attempted by candidates with many leaving it out completely. Where there was a clear attempt those failing to score the mark usually only compared one set of the values, generally the 51.7 and the 52.

Most who attempted part (d) scored the mark.

Part (e) was the least successfully answered part of the question with lots of blanks seen. Where candidates scored the 2 marks it was usually through stating that if there had been cloud cover the day before there was a higher chance of cloud cover the next day. Those going completely down the wrong route failed to realise that the data was from the same source and were mostly commenting on the size of the sample rather than what the statistics already demonstrated. In general there was far too much tendency to describe vague contextual knowledge rather than use the figures found previously. Of those who did try and compare figures an error often seen was to compare the result in (d) to 0.76. The failure to focus on the fact that the model was Binomial, and whether therefore the conditions of independence had been met, demonstrated the general unfamiliarity with modelling.

Question 5

This question as whole proved to be one of the more challenging questions on the paper with many candidates unable to make any meaningful attempt at any part of the question.

In part (a) candidates struggled to come up with a complete strategy to answer this multi-step question. Some candidates were unable to use the given information to find the missing standard deviation. Although many realised that they needed to standardise, they incorrectly used the given probability rather than the associated z-value. Many of the candidates who found the correct standard deviation went on to give a correct answer although a significant number then made mistakes manipulating the probability statements and therefore failed to score after this. Candidates should be reminded of the benefits of drawing a diagram that would have helped in this part. It is worth noting that many candidates showed very little method once they had calculated the standard deviation, this meant that candidates who had an incorrect answer often lost 3 marks. With increased reliance on the calculator the use of diagrams and probability statements are essential to demonstrate what methods are being used. Candidates also need to get into the habit of checking their answers for example by substituting their answers into the original question. Although most candidates gave their answer to 2 decimal places, as requested, some gave answers to a smaller degree of accuracy.

Part (b) was one of the most discriminating parts of the entire paper. There were a range of errors seen. Many failed to set up the correct Normal approximation and many tried to use the model found in part (a). Some appeared to struggle with the phrase ‘fewer than half’. It was also quite common to see candidates ignore the request for an approximation and complete the question using the binomial distribution given in the question. Candidates need to be aware that they will not be awarded marks for using the binomial distribution to calculate a probability if they have been asked to use an approximation. Candidates who did manage to set up the correct Normal distribution often made errors with the continuity correction, either they made no attempt to use one or they used one in the wrong direction.

Part (c) was a standard hypothesis test for a sample mean from a Normal distribution that should have been relatively straight forward but in many cases candidates struggled. It was common for candidates to use the wrong parameter when defining the null and alternative hypotheses; they need to be fully aware that they must use the standard parameters when setting up hypotheses, in this case μ.

For those who did make progress failing to divide the variance by n was a common error and candidates often gave large probabilities that were nowhere near 0.05 which should be a warning sign that they likely have a mistake in their working. Some used $\sigma = 0.16$ or $\mu = 24.94$. Those using a critical regions approach were rare and these candidates often had issues when rounding the critical region to 2 decimal places which meant it was equal to the test statistic. The majority of candidates made an attempt to interpret their results and give a contextual conclusion. Those candidates that opted to give their contextual conclusion in terms of 'Hannah's belief' were usually more successful than those who tried to write a statement about the mean amount of liquid being less than 25ml. Some candidates wrote 'the mean is less than 25' which does not mention the context and was therefore not acceptable.

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