Pearson Edexcel

Examiners' Report
Principal Examiner Feedback

Summer 2023

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

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Introduction

The first 4 questions on this paper were more accessible and most students made progress in each of these. In particular, question 1 parts (a) and (b), question 2 parts (b) and (d), question 3 part (b) and question 4(a) gave the grade E candidates a good source of marks. In addition, question 4(b) was now a familiar hypothesis test and those who had practised similar questions were able to make reasonable progress. The final 2 questions, and especially question 5, were more challenging and provided good differentiation for the more able students.

It was encouraging to see improved familiarity with the large data set in question 3

Comments on individual questions

Question 1

This proved to be a positive and accessible start to the paper.

Part (a) was nearly always correct and most knew how to write down a suitable expression for independence for part (b) which usually resulted in a correct equation for p. Those that didn't achieve this often thought that P(C) = 0.3 or 0.3p or even just p. Solving for p was mostly completed correctly and even those who had an incorrect value for p could often score the follow through for q provided their $p + q = 0.27$

In part (c), some used the simple conditional probability formula

[$\mathrm{P}(A \cap B) = \mathrm{P}(A)\mathrm{P}(A \mid B)$] in the formula booklet to get started whereas others just wrote down a correct ratio of probabilities from their Venn diagram. A fairly common error was to have P(B) = 0.6 as the denominator and a few misinterpreted the formula and used $\frac{\mathrm{P}(A \cap B)}{\mathrm{P}(B')}$. Those using the more complicated formula for P(A|B) in the formula booklet rarely managed to complete part (c) and students should be encouraged to know how to use the formulae in the formula booklet efficiently.

Question 2

This question was also answered well.

In part (a) students were often aware of the conditions needed for a binomial distribution but did not always present their answers in context with the precision required. Some focussed on the need for a fixed number of trials or that packets either did or did not contain a prize but these features were clearly identified in the question. Those scoring the mark either identified the need for prizes to be placed in packets at random or that the probability of a packet containing a prize needed to be constant. There was some confusion between "events", such as a prize being placed in a packet, being independent and the "probability" of such an event being constant. We sometimes saw a statement such as “the probability of a packet containing a prize is independent” which didn’t score this first mark.

Part (b) was generally answered well though some gave answers to 2dp or 2sf rather than the 3sf as instructed on the front of the paper. Most answered (i) correctly but in (ii) common incorrect answers were from those who found $P(T = 3)$ or $P(T \leqslant 3)$. In part (c) many were able to identify the correct distribution and those who stated this were guaranteed the method mark even if their answer to (b)(ii) was incorrect. Whilst many did obtain the correct answer here those with an incorrect answer to (b)(ii) who simply wrote down a probability could not be given either mark. Some students in part (c) didn’t identify the binomial model but wrote an expression for the probability of the form ${}^5C_2 p^2(1-p)^3$ but a few forgot the ${}^5C_2$ term.

The hypothesis test in part (d) was answered well with correct notation used for the hypotheses and the appropriate one-tailed test identified. Most selected the correct binomial model but it was disappointing to see a number finding $P(X = 9)$ rather than

$P(X \leqslant 9)$. A correct conclusion in context was often given: some using the simple response that there is evidence to support Kamil’s claim and others stating that there was evidence that the proportion of packets containing a prize is less than $\frac{1}{7}$. It was encouraging to see that most of those using the second approach were referring to “proportion” rather than “number of” this time.

Question 3

Once again the large data set aspects of this question caused problems for some students but most scored some marks here.

In part (a) a few responses simply quoted standard textbook answers about cleaning data by removing outliers and others were distracted by the class intervals for the data. Many though did realise that the “tr” values needed attention but a number didn’t seem to realise that trace entries had a value between 0 and 0.05 and therefore removing them would have a big effect on the calculations Ben wanted to carry out. Those that did appreciate the value of the “tr” usually suggested a suitable numerical value (usually 0) to replace them with and scored both marks.

Part (b) was, unsurprisingly, answered very well with many scoring full marks. A few lost marks for truncating rather than rounding their answers for example 2.11 in (i) whilst others were convinced that the “tr” values should have been removed and had a denominator of 155 despite the question telling them that all 184 values were used. It is still surprising to see a small number of students using a denominator of 9 or 10 (the number of classes in the table) and a slightly larger proportion who couldn’t use the standard deviation formula, given in the formula booklet, correctly.

It was encouraging to see a good number of students demonstrating some familiarity with the large data set and scoring some marks in part (c). In (i) we were simply looking for an awareness that because the large data set only had data for May to October this would not be representative of the whole population. Some demonstrated a lack of understanding of the principle of using a sample to make inferences by stating that 184 days was not a sufficiently large sample to represent the weather for the whole year. In this case the problem was not the sample size but the fact that the sample was not representative. In (ii) even some of those who had failed to mention May to October in (i) were able to score here by stating that because the missing months were in winter and they expected more rainfall then, the actual mean would be higher. The great storm of October 1987 featured in many incorrect answers to part (c).

Question 4

Whilst it was rare to see an incorrect answer to part (a) a minority of students were unable to use their calculator to evaluate this simple probability using a normal distribution.

In part (b) most students stated their hypotheses correctly in terms of μ with very few using a one-tailed test. To score the method mark in this type of question the students simply need to select and write down the correct model (distribution). A number seemed to be listing numbers they needed for their calculator, but we expect to see the appropriate mathematical notation used. Fortunately, many obtained a correct probability and would therefore receive the method mark by implication. Some chose to standardise and find a z value (1.9088… which should be compared with 1.96) or a critical region ($\bar{S} \geqslant 177.248\ldots$) but given that a p-value was required in part (c) this was not the most efficient route. A common error in stating the model is to use an incorrect value for the mean. On this occasion we condoned $\bar{S} \sim \mathrm{N}\left(177.2, \frac{6.8^2}{52}\right)$ for the M1 and first A1 but penalised the final accuracy mark. In a hypothesis test the probability (or critical region) is always calculated assuming H_0 is true and so the mean should be 175.4 and the probability calculated is $\mathrm{P}\left(\bar{S} > 177.2\right)$. Some students stopped after stating that the result was not significant or not rejecting H_0 but a good number gave a correct conclusion in context.

Part (c) was not answered well with only a few scoring this mark. The common error was to use 0.028 or 0.025 but others used values like 175.4

Question 5

This question proved to be the most challenging on the paper for students.

In part (a) few could see how to use the two bullet points to reach the required result. A good number realised that $\mathrm{P}(S \mid \{X = x\}) = \frac{k}{x}$ but couldn't always use the conditional probability formula to reach $\mathrm{P}\left(S \cap X = 50\right) = b \times \frac{k}{50}$. Those that did get this far were often able to give a convincing proof of the given result. A common misconception was believing that $a = \frac{k}{20}, b = \frac{k}{50}$ etc and then using the sum of the probabilities equalling 1 but this scored no marks. It was good to see a number of students using the result from part (a) to form similar relationships between the probabilities, such as $d = 2b$ and going on to solve their equations to find the probability distribution.

The final part was particularly challenging with many misinterpreting the 30% probability given in the stem to part (c). Many confused this 0.3 [= $P(S \mid X = 100)$] with the

0.4 [= $P(X = 100)$] from the probability distribution and simply compared these two values. Those that did realise that Nav's 30% meant that $k = 30$ often went on to show that when

$x = 20$ this would give a probability [$P(S \mid X = 20)$] > 1 and so the model was not suitable.

Question 6

This question also proved to be quite challenging.

In part (a) most students could use the histogram to calculate the number of patients spending between 10 and 30 hours in hospital but many failed to convert this to a probability by dividing by 90. Some students tried using small squares, but errors were often made and a divisor of 1600 not 1800 was often seen. Part (b) though was not answered so well. Some did explain that the histogram was not symmetric or was skewed and so a normal distribution wouldn't be suitable. Some focussed on the continuous nature of the variable and thought it was therefore suitable whilst others thought that T was discrete and therefore a normal wasn't suitable. The question wanted reference to the histogram and there was no expectation or requirement to find probabilities from the normal distribution nor compare the mean of the data with 14.9 If further calculations were expected these would be asked for and reflected in the mark allocation.

Many students were able to use integration by parts correctly to establish the result in part (c). Some started the wrong way around (using $u = e^{-x}$) and soon realised they were not heading for the given answer and there was some muddling over the signs when applying the limits. Part (d) was not answered so well with only a minority of students realising that the area under the curve should equal 90. Those who did realise this were often able to apply the answer to part (c) though some used $n = 40$ rather than $n = 4$.

The first part of (e) was often answered well and some realised that the answer to part (c) could be used to answer (e)(ii) but some tried using $n = 10$ and 30 and others stopped after find an estimate for the number of patients as 53.1 and failed to complete the question to find the required probability. In part (f) only a small number of candidates realised that the fact that some patients might stay longer than 40 hours was a limitation of the model. Others did not give any context in their answers or discussed the shape of the curve without considering the stated upper limit.

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