AQA

# AS
# FURTHER MATHEMATICS

## Paper 2 - Statistics
## Report on the Examination

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## General

Both the weaker and average students were able to score reasonable marks on this paper. On the other hand, the highest marks were rarely achieved by the strongest students. This was almost entirely due to difficulties in the interpretation of statistical results and concepts or not constructing fully rigorous arguments. Future students should work on ensuring that their mathematical arguments are complete and can be easily followed by other mathematicians. Care should also be taken when using statistical language to describe concepts or interpret results.

## Question 1

The majority of students did not score the mark for this question. Most students simply substituted $x = 1$ into the provided probability density function to obtain $\frac{3}{4}$. Some students either integrated the probability density function between 0 and 1 or between 1 and 2 to obtain $\frac{1}{2}$.

## Question 2

The majority of students scored the mark for this question. The most common incorrect answers were $P(X \leq 1) = 0.199$ or $P(X \geq 1) = 0.950$.

## Question 3

The majority of students scored three marks for this question but lost the final mark for not giving a complete, clear, easy to follow solution. It was common for students to not make it clear that their final line of working was for $E(X^2 + Y^2)$. Some students calculated $E(X^2)$ and/or $E(Y^2)$ without making it clear that was what was being calculated. Other common errors included finding $E(X)$ and $E(Y)$ and squaring them, or squaring $yf(y)$ within the integral for $E(Y^2)$. Some students put $y^2$ outside the integral for $E(Y^2)$.

## Question 4

In part (a), the majority of students scored at least three marks. The most common error was to incorrectly calculate the standard error by using 10 as the standard deviation rather than the variance. Some students obtained a probability for the z value or found the z value for a different confidence interval. A small minority of students transposed the digits for the sample mean, obtaining 34.5 instead of 35.4. Some students lost the final mark for not giving their confidence interval to four significant figures.

Most students did not score the mark for part (b). Many understood that Dante would reject the null hypothesis but many did not give a reason or were unclear in their explanation. It was common for students to state that 'it' was not in the confidence interval without explaining what they meant by 'it'. A minority of students wrote that Dante would accept the null hypothesis as the sample mean was in the confidence interval. Some students attempted to calculate the probability for the hypothesis test but none were successful.

**Question 5**

Part (a) was answered correctly by the vast majority of students. The most common errors were to either write 'continuous random variable' or to give an interval for the mode. Some students attempted the probability density function here and did not attempt part (b).

Part (b) was the most challenging on the paper with many students scoring zero marks or not responding at all. The most common response scoring zero marks was to write down the probability density function with either gaps left for the two straight lines or constants written there instead. A significant number of students understood that they needed to find the $y$ coordinate of the maximum point of the probability density function but could not develop their solution any further. Many students managed to find the straight line for the first interval but made errors in attempting to find the second. The most common error for finding the straight line for the second interval was to assume that it passed through the origin. Some students who successfully found the two straight lines did not define the probability density function as zero for all other values.

**Question 6**

The question was attempted well by most students with many scoring full marks. Some students lost the final mark by writing the correct calculations but not making clear what the calculations were finding. Other students lost the final mark by writing $X$ when referring to the random variable $Y$. A minority of students mistook the random variable as continuous when calculating expectation and variance whilst treating it as discrete when finding $k$. Some students simply added the probabilities when attempting to find the expectation and found the expectation when attempting to find the variance. Very few students attempted the question by finding the values of $5Y - 2$ first and most of these were unsuccessful.

**Question 7**

In part (a), the majority of students scored at least three marks. Most students stated the correct hypotheses with some students using $\mu$ instead of $\lambda$. A minority of students stated hypotheses for a goodness of fit test or used the sample value in their hypotheses. Most students calculated the Poisson probability correctly. The most common error was to calculate the probability of exactly 30 rather than 30 and less. A significant proportion of students found the critical region instead but some students incorrectly calculated the region or did not provide enough evidence that they had found the critical region. When comparing the Poisson probability with the significance level, some students made errors in order of magnitude, either mistaking 0.00159 as 1.59% or 1% as 0.1 or 0.001. Some students lost the final mark for being too definite in their final conclusion or not writing a conclusion in context.

In part (b), most students correctly identified Type I error but many failed to do so in context. Some students described Type II error instead or described the probability of Type I error. A small amount of students were not careful with the use of double negatives in their language.

The majority of students did not score the mark for part (c). Many students criticised the time that Xander took the sample but did not relate this to the Poisson model assumption of a constant rate over time. A significant proportion of students declared that the process was not random whilst giving descriptions in context of the events not being independent.

**Question 8**

In part (a), the vast majority of students scored full marks. Some students made a numerical error with one of the entries in the table but it was very rare to make more than one error. Some students truncated the value of 12.9375 to 12,937 as some calculators give the table with only five digits displayed for each number. Highlighting the numbers on the calculator and reading the full output on the calculator would avoid this error.

The majority of students scored at least four marks for part (b). The most common hypotheses stated by students were 'no association' for $H_0$ and 'association' for $H_1$. Some students used 'independent' and 'not independent' instead, or a mixture. Some students failed to mention the variables in the hypotheses. Many students failed to merge the columns for 2 and 3+ even though the expected value of 4.375, which is less than 5, was given. Some students made numerical slips when calculating the test statistic. Many compared their test statistic with a critical value rather than calculating a corresponding probability. A minority of students drew a sketch to compare the test statistic with the critical value. Some sketches were not sufficiently clear and lost a mark.

**Mark Ranges and Award of Grades**

Grade boundaries and cumulative percentage grades are available on the Results Statistics page of the AQA Website.