Questions matter

Level 3
Certificate in Mathematical Studies

1350/2A Statistical Techniques

Report on the Examination

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General

Overall, students found this year's paper more challenging than last year's, but most attempted all of the questions. It was encouraging to see effective use of advanced scientific calculators. Proficiency with scientific calculators was evident, and there were fewer instances of students relying on statistical tables. Nevertheless, areas that required written explanations, interpretations of results, or discussions about reliability and methodology revealed gaps in understanding. Students should focus on developing their ability to articulate their reasoning and interpretations clearly, giving greater emphasis on qualitative analysis alongside quantitative skills to help address weaknesses in these areas.

Question 1

In part **(a)**, the vast majority of students were able to estimate the number of premium Google (including YouTube Music) subscriptions.

In part **(b)**, students generally excelled in offering suggestions for improvements rather than merely criticising the existing graphs. One frequent suggestion, which did not earn any credit, was to arrange the average ages in numerical order. A few responses were too vague to receive marks, such as 'add grid lines' or 'use more decimal points.' It is also worth noting that some students lost marks by commenting on Diagram 1, which is on page 4 of the Preliminary Material, despite the question's instruction to refer to the graphs on pages 2 and 3.

Only a minority of students were able to score in part **(c).** Those who did score the mark were most likely to state that some percentages (eg 30-34%) were given as a range. Common incorrect responses included references to arrows that were either not labelled or did not follow linear directions, mentions of weekly usage, and unspecified missing labels. However, the most common correct responses identified issues such as the figure 55% appearing twice, the percentages not summing to 100%, and the use of percentages within a range.

Most students earned the first method mark in part **(d)** by correctly calculating or evaluating 20/27 or 5/14 (Alternative 1), comparing 20:27 to 20:36 or 20:27 to 15:27 (Alternative 4), or calculating 20/27 and 5/9 (Alternative 6). Students attempting Alternative method 1 frequently made the incorrect comparison of 42.5% to 5% rather than the required 5 ÷ 14, and similarly, those attempting Alternative method 6 compared 74% to 87%. Several students who completed the full calculations and compared the correct values did not gain the final mark as they failed to make a definitive decision. Most students who achieved full marks followed Alternative method 1.

The majority of students earned the first mark in part **(e)** by making an acceptable comment on the claim made by The Recorder. However, it is important to note that a clear conclusion is required in this type of question, and some students lost the mark by not clearly stating whether or not the claim was valid. Most students earned the first mark by comparing 30% with 27% in the first part and correctly stating that the statement was valid. The most challenging aspect of the second part of this question for students was identifying the relevant information from the Preliminary Material. Those who succeeded in finding the correct values typically achieved most of the available marks. Three marks were available for commenting on the claim made by Waxing Lyrical, as this required more detailed analysis. The most common approach involved simplifying the ratio 7:4 to 1.75:1 and then comparing this against the relevant ratio of subscribers.

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Part **(f)** was not well answered. The majority of students added the percentages for daily users from Graph 1 to get 87%, then concluded that the claim was correct. However, those who critically analysed the data recognized that the claim is not valid because some consumers may be daily users of more than one service. The most common incorrect response was to conclude that the comment was valid because the percentages 87% and 13% added up to 100%. Students who made the correct analysis noted that people accessed multiple streaming services or that Graph 1 only showed the leading streaming service providers.

Question 2

A significant number of students did not recognize that the £9.99 already included VAT and thus represented 120% of the original amount when answering part **(a).** The most common error was calculating 9.99×0.2 and giving an answer of 2. The most common correct method (Alternative method 1) involved calculating 9.99÷1.2, followed by 9.99−8.32 or 8.33. Most students using this approach scored full marks. It was encouraging to see a substantial minority perform the calculation 9.99÷6 and complete their explanation to gain full marks. Some students used Alternative method 4; however, after calculating 1.67÷0.2 or 1.67×5, they did little else to earn the remaining marks. Among those who answered the question correctly, many preferred the unitary method over the multiplier method. The most capable students correctly divided £9.99 by the multiplier of 1.2 to get 8.32, then subtracted this from 9.99 to give £1.67 and answered 'No'.

In part **(b),** many students were able to score at least one mark. The two most common responses were identifying the error in writing "22.6 million" and recognising that 16.5% is not the same as 0.0165. A number of students carried over their misconception from part (a), mistakenly believing that VAT was already included, and therefore incorrectly stated in part (b) that Molly did not include VAT. The least mentioned mistakes were those related to VAT, indicating that students likely did not make the connection between the two questions regarding VAT.

Question 3

For the first two marks, students were expected to describe in words the increase or decrease in the number of students from 2012 to 2022 in both French and Spanish, either as a raw number or a percentage. Students who only addressed one qualification or simply stated the change from one figure to another did not receive full credit. The terms "increase" or "decrease" (not just + or -) along with the numerical difference is needed to gain the marks. Several students only noted that the numbers had increased or decreased, and some incorrectly described the change from 2022 to 2012.

For the second two marks, students were expected to calculate the percentage of entries from male students for each qualification and compare them, noting, for example, that the proportions were approximately the same at around 43%. Relatively few students did this correctly. Some students rounded their values incorrectly, and some misunderstood the request, thinking it was about how the total number of male students was divided between French and Spanish, leading to incorrect comparisons.

Question 4

Overall, students displayed a good understanding of the concepts related to point estimates with many scoring at least one mark for identity truthfulness of two out of the three statements.

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Question 5

This question in part **(a)** involved the symbols μ and σ, representing the mean and standard deviation in statistics, respectively. The task required students to match statistical probabilities with the appropriate percentages. The introduction of these statistical symbols presented a new challenge for students, resulting in not many students being able to score more than one mark. Those who attempted to use numbers for μ and σ were generally more successful in matching the boxes correctly.

Part **(b)** was not well answered. Students did not fully understand how the normal distribution curve behaves, particularly its symmetry and how the gradient changes from positive to negative as it passes the mean.

Question 6

Not many students answered part **(a)** correctly. Common mistakes included assuming that 'population' must refer to people, leading to answers such as 'house owners,' or thinking that a numerical size of the population was required, resulting in answers like '16 houses or another quantity of houses. Additionally, some incorrect responses mentioned only the 'town,' without referencing 'the houses.

The majority of students provided a correct reason in context for part **(b).** Common correct responses typically mentioned that sampling is "easier" or "takes less time."

Many students were able to make a good attempt at finding the confidence interval in part **(c)(i).** Those who knew the method for calculating the limits could still earn several marks even if they had an incorrect mean or z-value. However, premature rounding or truncating often led to inaccuracies. Some students struggled to find the correct z-value for a 95% interval from the supplied tables or their calculator, and a few wrote their limits in reverse order on the answer line. The most common incorrect z-value used was 1.64. Other frequent mistakes included finding the standard deviation or variance of the sample data incorrectly, using an incorrect z-value, or forgetting to find the square root of either the variance or the number of values (or both) when constructing the formula. Students are advised to avoid using rounded or truncated answers during intermediate steps, especially when calculating the sample mean and evaluating the standard error. The vast majority of students did not read part **c(ii)** carefully and misinterpreted "less" as requiring 0.5 to be subtracted from their limits in part **(c)(i)**. In fact, 0.5 needed to be added.

In part **(d)**, many students were unfamiliar with how changes in sample size affect the confidence interval. There is a lack of understanding regarding the inverse relationship between sample size and the width of the confidence interval. Many students might incorrectly believe that a larger sample size should increase the width of the confidence interval, thinking that more data points suggest greater variability. They fail to realise that a larger sample size actually provides a more accurate estimate of the population parameter, resulting in a narrower confidence interval.

Question 7

Students did not perform well on part **(a).** Many did not recognise that the required statistical measure was the correlation coefficient (pmcc). Among those who did identify the correct measure, few discussed the strength of the correlation or compared their pmcc values. Students who scored zero either provided qualitative responses with minimal numerical analysis or incorrectly referred to mean and standard deviation calculations. Some students who knew how to enter the data on their calculator were unsure

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which summary statistics value was the product moment correlation coefficient, and so listed this along with the regression line coefficients of a and b.

However, there were slightly better responses for part **(b)**. Many students recognised that the measurements for letter V were outside the data set and referenced extrapolation. A significant number of students did not comment on the reliability as requested in the question.

Question 8

Parts **(a)(i), (a)(ii),** and **(a)(iii)** were generally well-answered, demonstrating proficient use of advanced scientific calculators. Students showed a strong preparedness in utilizing the statistical functions on their calculators. Many students correctly calculated and displayed the value of the *z*-score, and some enhanced their answers with diagrams, showing a better understanding of the normal distribution. While some students included diagrams and *z*-values, the majority used their calculators to efficiently reach the correct answers. Very few students now rely on statistical tables for this type of question. Correct values, even when presented without showing the intermediate steps, were awarded full credit. It is advisable for students to avoid converting their decimal values into percentages, as many made errors in this process.

Part **(b)** proved to be one of the most challenging on the paper, with many students unable to make any progress. Some students did gain a mark for correctly calculating $P(T < 170)$. There were several attempts to set up an equation of the form $z = \frac{t-140}{25}$, but this often highlighted misconceptions. Many students confused probabilities with *z*-values or drew diagrams that did not correctly summarise the information given in the question. Of those who successfully obtained the correct answer, the most common method was trial and improvement. This method leveraged the fact that students are generally more familiar with the normal distribution probability function than the inverse normal function on their calculators. By trialling values of *t* in $P(t < T < 170)$ students were able to get close enough to the required probability and scored all 4 marks successfully.

Question 9

A very high proportion of students successfully calculated the mean point for two sets of data, which was encouraging to see for part **(a).** However, not many of these students went on to accurately plot the mean point. They either forgot to plot the point or made errors by misinterpreting the scale on the axis, causing their plotted point to fall outside the acceptable range.

Part **(b)** was poorly answered. The most common response was to state "strong correlation." Several students correctly calculated the pmcc as 0.92 but failed to provide an interpretation, such as indicating that this value demonstrates a strong correlation.

In part **(c)(i),** students demonstrated good use of calculators by writing down their calculated values for *a* and *b*. Those who found these coefficients generally proceeded to write the correct regression line. However, a few students were unable to state the regression equation and instead simply wrote the two values along with the pmcc value. Some students struggled to draw the line using their regression equation but managed to draw the line of best fit for part **(c)(ii).** Most students who correctly determined the regression equation successfully used it to calculate and plot two points, then joined them to form the correct regression line from $R = 7.5$ to $R = 17.5$. In a few cases, students stopped short of this domain, which prevented them from scoring full marks.

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It was pleasing to see that many students were able to score full marks in part **(d)** by substituting the value of R into their regression equation to find the correct value of F. For those opting to find the value of F using the graph, many were able to find the correct value by drawing the line $R = 11$.

Part **(e)** had few students able to correctly explain why the regression line should not be used to predict hourly pay. Among the students who answered correctly, most referred to the fact that the regression line shows F on R but does not show R on F. However, some students only partially answered by stating the first part of this reasoning without completing it, which resulted in no marks being awarded. Typical incorrect responses included general references to "causation," "outliers," or "sizes of family."

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Mark Ranges and Award of Grades

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

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