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Mathematics MS/SS1B

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Statistics 1B

Report on the Examination

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General

The overall level of achievement on this paper was generally in line with that seen on previous papers. The full range of marks from 0 to 75 was scored; whilst very few candidates scored minimal marks (≤10), the highest marks (≥70) proved difficult to achieve often due to the parts of questions requiring comment and interpretation. It was somewhat disturbing to see the proportion of candidates who appeared unable to string together a sensible readable sentence. Indeed, there were times when it was very difficult, or simply impossible, due to spelling, word order or handwriting to make any sense of a candidate's statement.

The use of calculators, mostly in questions 1, 3 and 7, was appropriate and, in the main, accurate, as was the use of tables in answering questions 2 and 6. However, it was of concern to see the significant proportion of candidates attempting to answer question 3(b) apparently without access to a pencil, eraser or ruler; this should not have occurred. Many candidates also needed to be better aware that the phrase 'Show that ...' required a complete set of convincing steps. For example, in question 4(a), '$\frac{184.5}{49} = 3.77$ so $s = 1.94$' did not justify the mark. Similarly, in question 5(a)(iii)(A), the frequently seen general statement 'J and W are not mutually exclusive as they can occur together' gained no mark.

Finally, when candidates ran out of space, all too often they continued their answer on a subsequent page which was to be used for answering a different question. In such cases, candidates should be instructed to use an additional sheet.

Question 1

Most candidates obtained the correct values for the mode, median, interquartile range and range, although some candidates treated the data as continuous. A small minority hedged their bets for the mode by quoting values of 253 and 20, and similar numbers did not state the difference between their correct values for the upper and lower quartiles or merely stated the range to be 227 to 271. Each of these three errors lost a mark. A majority of candidates obtained an answer for the mean within the range permitted, but far fewer scored the 2 marks for the standard deviation. It was evident that too many candidates were unsure as to how to treat grouped data with the result that they probably used incorrect mid-points, but the absence of any detail made this uncertain.

Of even more concern was the significant number of candidates who failed to use the frequencies, particularly when calculating the standard deviation. Calculating the mean and the standard deviation from a frequency distribution or from a grouped frequency distribution should be bread and butter to candidates entered for this paper. Disappointingly, most candidates apparently had no clue as to what was meant by 'measure of spread'. In fact, the most common response was 'mode' but 'mean', 'median', 'bar chart', 'histogram', 'box and whisker', 'stem and leaf', 'correlation' or even 'CLT' were seen with varying frequencies. It should be noted that the standard responses of 'mean and standard deviation' or 'median and interquartile range' also scored no marks. However, when interquartile range alone was stated, the usual correct reason related to extreme values and, when just standard deviation was quoted, reference was made to it using all the data.

Question 2

Candidates scored well on this question, with many scoring at least 9 of the 11 marks. Answers to part (a)(i) were almost invariably correct, with very few candidates stopping at $z = 1.25$ or finding $P(Z > 1.25)$. It was gratifying to see the absence of the use of $\sqrt{0.04}$ or 0.04^2 for the standard deviation. Few candidates acted on the symmetry of the request in part (a)(ii), but instead carried out the standardising of 57.1 before subtracting two areas. However, such working was usually clear and accurate with a correct final answer. Questions similar to part (b) caused a lot of confusion on previous papers. Here confusion was much less in evidence, with a significant proportion of candidates evaluating $[(a)(i)]^{16}$ in part (b)(i). However, perhaps on the basis of a previous paper, $[(a)(i)]^{6}$ was not too rare and standardisations of the form $\dfrac{57.2-57.15}{0.04}$ or $\dfrac{57.2-57.15}{0.04/\sqrt{16}}$ were still too prevalent. Answers to part (b)(ii) were often sound, if not completely correct, though the usual errors of $\dfrac{57.16-57.15}{0.04}$ or $\mathrm{P}(Z < 1)$ were seen with some regularity.

Question 3

A large majority of candidates scored the first 6 marks in answering parts (a)(i) and (ii). Most used the statistical functions on their calculators to obtain the correct equation, although a small minority subsequently used $y = 191 + 115x$, instead of $y = 115 + 191x$, and so lost at least 5 of the 6 marks. The dwindling proportion of candidates who used the more time consuming formulae approach were reasonably successful, but arithmetic and transcription errors proved the downfall of too many. Answers to part (a)(ii) almost invariably scored 2 marks for £4699, although very few candidates revised this to the more realistic value of £4700. Some candidates were awarded 1 mark for evaluating $\dfrac{y_{23}+y_{25}}{2}$, even after finding the correct equation. Answers to parts (a)(iii) and (iv) were often too vague. In part (a)(iii), many candidates failed to refer to ‘**lower** temperatures’ or simply referred to ‘extrapolation’ or ‘not July’ and so lost the mark available.

Statements in part (a)(iv) were usually weather related, but most failed to specifically describe a variable — for example ‘rain’ instead of ‘rainfall’ — but such ambiguities were overlooked here. It was very disappointing to see the significant proportion of candidates who found part (b) challenging or even beyond any attempt. Whilst most candidates identified at least one z-intercept correctly, far too many then drew at least one incorrect line. Such lines often went through $(40, 6)$ instead of $(40, 5)$ and/or $(10, 0)$ instead of $(10, 1)$ and some candidates drew freehand lines apparently by guesswork. Many candidates appeared unaware that, in addition to the z-intercept, only one other point was needed to draw each line and so spent time evaluating z-values for each of the labelled values of v and w. In some instances this appeared necessary to overcome the absence of a ruler.

Question 4

It was most surprising and disappointing to see the large proportion of weak answers to this question, particularly as the topic has been examined in a similar way on all previous papers. In part (a), more candidates started with $\dfrac{184.5}{49}$ rather than $\dfrac{184.5}{50}$ to obtain s^2, but some then omitted to indicate the square root as the next step. Some candidates appeared to have no idea of the steps required, and either made no attempt or tried substituting $\bar{x} = 251.1$ into $\sum\left(x-\bar{x}\right)^2 = 184$. The construction of the 96% confidence interval caused problems for far too many candidates. Common errors were an incorrect z-value (often 1.7507); use of 251 or 250 for $\bar{x}$; use of 1.92, $\sqrt{1.94}$, 1.94^2 or even 184.5 for s; divisors of 50 or even 1. Some candidates substituted correct values into an incorrect formula, such as $z \pm \dfrac{s}{\sqrt{n}} \times \bar{x}$ or

$\bar{x} \pm \frac{zn}{s}$. Most of these aforementioned errors lost most, if not all, of the 4 marks. Many candidates who had obtained a correct answer in part (b)(i) then struggled in part (b)(ii) by failing to clearly compare 250 (the words 'it' or 'mean' were not acceptable) with their confidence interval in order to comment on the manufacturer's claim. Some stated incorrectly that their interval contained 250 whilst others stated that the claim was false since their interval did not contain 250. Answers to part (c) rarely scored marks due to candidates' providing a qualitative judgement rather than a numerical justification. To score the 2 marks, candidates had to show that $\left[251.1-(\geq 1)\times 1.94\right]$ gave a value less than 250 and so some bags were likely to be underweight.

Question 5

With the exception of part (a)(iii), candidates' answers scored many, and often all, of the remaining 10 marks. As expected, it was rare indeed to find an incorrect completion of the table in part (a)(i). Although most candidates identified the correct probabilities of 0.10 and 0.15 in part (a)(ii), almost half then multiplied these two values instead of adding them. A minority obtained 0.80 from $0.70 + 0.65 - 0.55$ but an even smaller number obtained the correct answer of 0.25 from $0.70 + 0.65 - 2 \times 0.55$. Showing justifications of the two statements in part (a)(iii) proved too challenging to many candidates, with no attempt or general prose being the most common responses rather than the necessary numerical justifications.

In fact, it was clearly evident from the overall responses that most candidates had little knowledge of, or were confused about, the terms 'mutually exclusive', 'exhaustive' and 'independent'. Whilst a minority of candidates used $\mathrm{P}(W \cap J) = 0.55$ to show non–mutually exclusive, very few indeed achieved any marks for justifying non-independence. Consequently, part (b) proved a welcome relief to most candidates with 4 or 5 marks being by far the most common marks. It was very rare to see an incorrect answer to part (b)(i), but in part (b)(ii) some candidates multiplied 2, instead of 3, probabilities and/or introduced combination multipliers of either 2 or 3.

Question 6

This question produced a good range of marks with most candidates scoring some marks in all parts. By far the most common and rewarding approach was to use tables as was intended; uses of formulae and inbuilt calculator functions were, in the main, much less successful. Candidates showed a good understanding of what was required, although there was the usual confusion of interpreting the requests and tables in terms of $<$, $\leq$, $>$ and $\geq$. This was particularly evident in part (a)(ii) where the common incorrect answer was $1 - 0.8202$ and in part (a)(iii) where $[0.9986 - 0.5443]$ or $[0.9901 - (1 - 0.5443)]$ were often seen. In a small but significant proportion of cases, carelessly misreading 0.5443 as 0.5543 lost marks. However, such errors were much less in evidence in part (b), with many candidates scoring most, and often all, of the 5 marks available.

Question 7

Most candidates were much better prepared for part (c) than for parts (a) and (b). In part (a), most candidates recognised that weight could be expected to increase with volume but then did not interpret in context the values obtained by Ryan and Sunil. A minority of candidates merely commented on the fact that the values were different or cast doubts on the competence of the two trainees! Again in part (b), candidates struggled to give answers of sufficient clarity. There was a lack of certainty of the effect on r of measurements being made in different units. All too often vague statements such as 'will generally not effect', 'will make little difference' or 'it doesn't matter' were presented. Similarly, many comments about the effect of sample size were vague, with many candidates referencing accuracy or reliability or merely stating that 'halving the sample size does not half the value of r'. Usually only the best candidates noted that $2 \times 0.612 = 1.224 > 1$ which was impossible since $-1 \leq r \geq 1$. Almost all candidates found the correct value of r in part (c), usually by use of the appropriate statistical function on their calculators. A small minority lost 1 or 2 marks due to stating the value to fewer than three significant figures. Most candidates then made a statement of interpretation relating to the variables of volume and weight by name. However, many candidates included the word 'strong' or used 'medium' or 'average' whilst others omitted the word 'positive'. As a result, many candidates scored only 1 of the final 2 marks.

Mark Ranges and Award of Grades

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