OCR
RECOGNISING ACHIEVEMENT

GCE

# Statistics (MEI)

Advanced Subsidiary GCE **AS H132**

# OCR Report to Centres

# June 2013

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This report on the examination provides information on the performance of candidates which it is hoped will be useful to teachers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding of the specification content, of the operation of the scheme of assessment and of the application of assessment criteria.

Reports should be read in conjunction with the published question papers and mark schemes for the examination.

OCR will not enter into any discussion or correspondence in connection with this report.

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**OCR REPORT TO CENTRES**

# G241 Statistics 1

## General Comments

On the whole candidates coped well with this paper. A good number of candidates scored 60 marks or more out of 72. A considerable number of candidates scored the majority of their marks on topics which overlap with Higher Tier GCSE; however, Question 3 on the binomial distribution was well answered. Most candidates supported their numerical answers with appropriate working. However, when written explanations were required, the poor handwriting and use of English of some candidates made it difficult to determine what they were trying to say.

There was no evidence of candidates being unable to complete the paper in the allocated time. As last year only a small minority of candidates attempted parts of questions in answer sections intended for a different question/part and most candidates had adequate space in the answer booklet without having to use additional sheets. Those candidates who overwrote pencil working in ink, even if they made an attempt to rub out the pencil, made the work very difficult to read. Candidates should be advised to refrain from doing this.

Unfortunately, as in recent series, most candidates lost marks due to over specification of some of their answers, despite recent examiners' reports warning against this. The worst cases of this were in both parts of Question 1 and in Question 4(ii), where the vast majority of candidates gave the variance to 8 significant figures. It is possible that they thought that as it was a sum of money it should be exact, but of course the units of the variance would be pounds$^2$.

## Comments on Individual Questions

**1)(i)** The vast majority of candidates answered this part correctly, though many lost marks for over-specification of the standard deviation (often given as 14.475). A small minority managed to over-specify the mean, giving it as 249.40. Only a few candidates found the root mean standard deviation instead of the standard deviation.

**1)(ii)** The mean was usually tackled correctly, but then the mark sometimes lost was for over-specification. Calculating the standard deviation seemed to cause more problems, with attempts made to 'start again' or comments such as 'it remains the same'. Candidates were not penalised a second time if they over-specified again – many in fact gave 6 or 7 significant figures in their (correct) answer.

**2)(i)** Candidates using the ${}^nC_r$ method tended to be more successful, as when using the product of 3 fractions method many did not realise that they needed to multiply the final product by 3. A small minority of candidates did not follow instructions and either left a fraction in unsimplified form (usually 15/36) or gave the answer as a decimal.

**2)(ii)** Most candidates made a reasonable start in this part, using their answer from part (i). However, many only calculated one probability, or missed the coefficient of 4 when calculating the probability of 3 evenings, not realising this was a binomial situation. Some candidates calculated the probability of 3, rather than *at least* 3, and thus only gained 1 mark. A small minority of candidates used statistical functions on graphical calculators to just write down an answer – this was a risky strategy, as a slip in copying the answer was heavily penalised, since no method was shown.

**3)(i)** This question was very well answered, with most candidates scoring all 3 marks. However, a few candidates seemed to have no idea about the binomial distribution.

**3)(ii)** Again another well answered question, although occasionally candidates did not read the question carefully and continued to use $n = 50$ in their calculation.

**3)(iii)** Full marks were available here for a correct follow through from part (ii), so many candidates managed to recover from an incorrect answer. However a large proportion of candidates rounded their answer to the nearest whole number, thus losing a mark. Others over-specified their final answer, again losing a mark. Other common errors were to use $p = 0.1$, rather than their answer to part (ii), or to use $n = 48 \times 20$.

**4)(i)** This was well answered by the majority of candidates with most of them using the product of 3 fractions method. A few successfully used $1/({}^{20}C_3)$. There were a few candidates who used the probabilities in the table to give 1-(0.45+0.45+0.05), for which of course no credit was available.

**4)(ii)** This was very well answered, with nearly all candidates picking up 4 marks out of 5. Very few candidates gained the final mark, due to over-specification of the variance, usually giving an answer of 445511.25. A minority of candidates made the usual errors in this type of question such as: squaring the probabilities when finding $E(X^2)$, subtracting $E(X)$ rather than $[E(X)]^2$ or introducing spurious multipliers or dividers. Candidates should be advised to check carefully the figures which they enter into their calculator, as although the written down calculation was usually correct, sometimes the answer written was not.

**5)** The wording of the researcher's theory appeared to cause confusion for some of the candidates throughout the question. This was translated into some poorly worded explanations and conclusions in all three parts of the question. Good comprehension skills are required in this type of question and, unfortunately, these skills were not always in evidence.

**5)(i)** Many candidates scored both marks. Unfortunately a good proportion lost either the first or the second mark by not mentioning 'guess' or only including it when they quoted the question or not mentioning, in any form, the idea of the two possible outcomes. Some candidates simply just re-stated the null hypothesis in words.

**5)(ii)** This was not as well answered as part (i). There was a failure to distinguish between guessing and being able to identify between the two types of water. A lot of candidates lost the mark because they gave the reason for the alternative hypothesis as '13 people out of 20 in the researcher's sample identified correctly' which of course is not a valid reason.

**5)(iii)** The most successful way of approaching this hypothesis test was to compare P($X$ ≥ 13) with the significance level. Several of the candidates, who used this method failed to gain the final mark due to not putting the explanation in the context of the question. Other candidates used incorrect probabilities, usually P($X$ ≥ 12) or P($X$ ≥ 14). Candidates who used the critical region method normally gained the first two marks but then many of them failed to gain any more marks – usually because they had included 14 in the critical region. Unfortunately some candidates started looking at the two probabilities necessary for the critical region but made no mention of the critical region, or critical value, so did not gain any marks.
It is pleasing to report, on the other hand, that very few candidates tried to use point probabilities. However, although full marks could be obtained by comparing 0.8684 with 95%, many candidates either compared with 5% or made no explicit comparison at all - such candidates were unable to gain any credit.

**6)(i)** Most candidates successfully found the median, although instead of the 13th value some found average of the 12$^{th}$ and 13$^{th}$ values. However, candidates were less successful in finding the interquartile range. The lower quartile was usually found correctly, but the upper quartile was more frequently wrong, with an answer of 3.665 being the most common error. Occasionally candidates did not subtract to find the interquartile range, but instead some found the midpoint of their quartiles.

**6)(ii)** The response to this question was very disappointing. Perhaps because they were faced with a blank space rather than graph paper, most candidates thought that accuracy was not required. Very few had a scale and some of those that did failed to make it linear. Some candidates simply sketched a box and whisker plot and then labelled the diagram with the relevant values. This did not gain marks as the question clearly instructs candidates to 'Draw a box and whisker plot…'. It seems likely that many candidates either did not have, or did not think to use a ruler. Far too many freehand diagrams were seen, with the sizes of the box and whiskers and the position of the median not in proportion.

**6)(iii)** Many candidates correctly found the upper and lower limits for the outliers. The most common misconception was that outliers were calculated using median ± 1.5×IQR, although many other errors were also seen. A few candidates attempted to use the mean and standard deviation, and if they got both of these correct, full marks were available, but unfortunately one or other of the two statistics was usually incorrect.
It was necessary to check both limits to show that there was only one outlier, but some candidates ignored the upper limit. Many candidates failed to give an explanation in context regarding the outlier, though those that did often made a valid point about premature babies.

**6)(iv)** As in part (i), the median was usually found correctly, but some candidates lost a mark due to inaccurate reading of the scales in finding the quartiles.

**6)(v)** Only about one third of candidates scored both marks. Credit was given to those candidates who could only compare medians and interquartile ranges without an explanation of what they meant. Candidates who just said 'boys are heavier' failed to get credit without a comment such as 'generally' or 'on average' or 'tend to be'. Similarly 'more consistent' or 'vary less' or 'less spread' gained credit for interquartile range – 'smaller range' was not awarded credit.

**6)(vi)** This part discriminated very well between the higher-scoring candidates. Many candidates realised that approximately 10 male babies weighed more than 4.34 kg. Unfortunately many then did not know how to proceed, often squaring 0.05 (10/200) rather than multiplying by 9/199. Those candidates who misread the scale but knew how to proceed could gain a Special Case mark. A significant number of candidates missed out this part altogether.

**7)(i)** The majority of tree diagrams were well constructed with correct labelling. Weaker candidates sometimes became confused and made errors in the 2nd and/or 3rd branch.

**7)(ii)*A*** Many candidates employed the 1 – P(misses with all) method, usually successfully, but a significant number used the protracted method of listing all 7 triplets associated with at least one hit. Usually errors were made using such an approach.

**7)(ii)*B*** Most candidates found the correct three products and calculated them correctly. A small number failed to find all three. For those who got the tree diagram wrong, follow through marks were available.

**7)(iii)** Many of those who reached this part were successful. However, there was considerable confusion in finding the conditional probability, often with a correct denominator but a wrong numerator of P(at least one)×P(exactly one). Some candidates inverted the fraction.

**7)(iv)** Approximately one third of candidates were successful in this part. However many were confused. Many candidates successfully found the first product but then failed to find the second, or found additional products. Those who attempted the second product often made errors. The last three probabilities were often $0.1\times0.2\times0.2$ rather than $0.05\times0.2\times0.2$.

# G242 Statistics 2

## General Comments

Many candidates appeared to be well-prepared for this paper and managed to complete all questions, satisfactorily, in the time available. A small number of candidates made little or no attempt at any of the questions. Though there was evidence of uncertainty about underlying distributional assumptions and the key differences between the types of test used, most candidates coped well and could manage to carry out the different techniques required. The overall quality of the entry for this module has improved.

## Comments on Individual Questions

**1)(i)** Generally well-answered. The most common mistake was to compare mean with standard deviation in order to justify the use of a Poisson model.

**1)(ii)** Many fully correct answers were provided. Some candidates failed to make a start on this question or tried to adopt a Chi-squared test approach. As the intention was for candidates to use the Poisson pdf, or tables, in their working, those using 300 – Σ(other expected frequencies) were not given credit.

**1)(iii)** Most candidates provided correct hypotheses though some got them the wrong way round. Many candidates accurately calculated the test statistic. In conclusions, many suitable, non-assertive comments were seen; some candidates reached the wrong conclusion (i.e. rejected the null hypothesis). A significant number of candidates failed to take account of the estimated parameter when working out the number of degrees of freedom.

**2)(i)** Most candidates gained some credit on this question though answers were not always complete. Candidates were familiar with the small sample/unknown population variance conditions for using the $t$ distribution though the assumption, "Normality of the underlying population", was often not stated.

**2)(ii)** Fully correct answers were seen, though many used percentage points from the Standard Normal distribution rather than the $t$ distribution as requested and were, consequently, penalised. In general, candidates managed to obtain the sample mean and centre their confidence interval on it. Most also managed to calculate the sample standard deviation correctly.

**2)(iii)** Overall, candidates did not answer this well. Many realised that they were expected to see if the confidence interval contained the required population mean, 50, and interpret the outcome, though some commented that the interval contained the "sample" mean.

**3)(i)** Though several good responses were seen, many struggled to understand what was required or found it difficult to explain their ideas clearly.

**3)(ii)** Most candidates picked up a lot of marks here. Marks were commonly lost in stating hypotheses; in particular when hypotheses were stated in words rather than symbols, as the key word "population" was usually omitted. The sample mean and test statistic were found correctly by most. Of those using 11 degrees of freedom, most found the correct critical value though not all managed to complete the test correctly, with inappropriate comparisons made and incorrect conclusions drawn.

**4)(i)** Again, many high marks were seen in this part. Common errors included incorrect or omitted assumptions. Many realised the need for the sample to be random but then went on to say that the data in the sample must be assumed to be Normally distributed rather than referring to the underlying population. In stating hypotheses, “population” was frequently omitted. Those candidates who obtained the differences between the sample values and 13 generally managed to score most of the remaining marks. Though correct test statistic and critical value were obtained, some candidates thought that 17 > 8 meant that the result was significant. Candidates should be aware that tied ranks should not occur in this paper (and so look for errors on their part when this happens).

**4)(ii)** As many candidates did not state correct assumptions in part (i) they could not pick up the marks here. Those that did state correct assumptions in part (i) still found this difficult. Of the two marks, the mark for commenting on the randomness of the sample was more frequently given.

**5)(i)** This was well-answered. Most candidates picked up marks for calculating the remaining expected frequencies and contributions. Most candidates correctly identified that there were 2 degrees of freedom, though some failed to state this. Some candidates switched the hypotheses round though most got these correct. Again, in a few cases, there was some uncertainty over whether to accept or reject the null hypothesis using the values obtained.

**5)(ii)** Many candidates did not manage to work out that there are 165 minutes between 08:30 and 11:15. Of those that did, many obtained all 5 marks. Others managed to attempt to use the Normal distribution, usually obtaining a $Z$-value of 0.9091. Of these, some calculated $P(Z > 0.9091)$ rather than $P(Z < 0.9091)$ and others used inappropriate rounding and lost accuracy.

# G243 Statistics 3

## General Comments

There was no evidence of candidates being unable to complete the paper in the allocated time. However, although some candidates were well prepared for the paper, a disappointingly large number gained relatively few marks. In general, candidates supported their numerical answers with appropriate explanations and working.

It is pleasing to report that fewer candidates than last year lost marks because they gave their hypotheses in words and failed to mention 'population' (other than in Question 1). Indeed, most candidates in tests for the mean did use the parameter $\mu$ as mentioned in last year's report and, of these, most then went on to define this as the population mean. As last year, relatively few candidates lost marks because their answers were too assertive. Perhaps surprisingly, Question 1 − on correlation − was found to be more difficult than the remaining questions, with many candidates scoring fairly well on the hypothesis tests in Questions 2, 3 and 4.

## Comments on Individual Questions

**1)(i)** This question was not well answered, with many candidates simply stating that a test based on the product moment correlation coefficient is more accurate than one based on Spearman's rank correlation coefficient. This type of answer did not gain any credit.

**1)(ii)** Most candidates gained a mark for stating that the points did not appear to lie in an elliptical pattern, but rather fewer knew the requirement for bivariate Normality.

**1)(iii)** Under half of the candidature gained any credit here. A very large number of candidates failed to rank the data, or ranked from 1 to 24 rather than ranking each variable from 1 to 12. Most of those who did rank correctly gained full marks.

**1)(iv)** Most candidates stated the hypotheses correctly in terms of association rather than incorrectly mentioning correlation and only a few tried to use symbols. Many then went on to complete the test correctly although a few got the critical value wrong. However, very few candidates gained the mark for 'population'.

**2)(i)** Most candidates gained a mark for saying that the samples are large, but rather fewer mentioned the central limit theorem for the second mark. Many candidates discussed the variances – such comments were ignored, whether correct or incorrect.

**2)(ii)** This was generally fairly well answered, with candidates often gaining all or most of the marks available. A few failed to define the parameter $\mu$, thus losing a mark. However a number of candidates squared the variances, presumably thinking that they were standard deviations. Some instead tried to find a pooled estimate for sample variance and thus failed to gain any credit other than possibly for the hypotheses.

**2)(iii)** About half of the candidates answered this correctly, but many candidates suggested a *t* test and a few thought that a signed rank test was appropriate.

**3)(i)** Although a good number of essentially correct responses were seen, very few candidates stated the hypotheses in terms of the population **difference**. Many candidates also made errors in the signs of the differences or in the ranking. However, provided that their essential method was correct, many such candidates gained method marks and marks for the critical value and the conclusion.

**3)(ii)** Candidates found this question difficult, with many simply saying something such as 'the psychologist wanted to compare with and without alcohol'. The best responses mentioned subjects' ability or aptitude.

**3)(iii)** Many candidates suggested using a larger sample and some gave a good explanation of why this would be an improvement, thus gaining one or two marks. A wide variety of incorrect responses was also seen.

**4)(i)** There were very few correct responses.

**4)(ii)** Most candidates gained a mark for stating that every tenth potato plant should be selected. It is disappointing to report that rather fewer gained the second mark for mentioning randomly selecting one of the first 10 plants as the point at which to start. Some suggested randomly choosing one of the 80 plants as the starting point, but this only gained a mark if it was clear that when the end of the list was reached one went back and started again from the beginning.

**4)(iii)** Most candidates gained some credit, but only a few scored all 6 marks. Those who thought about the ease or otherwise of carrying out the methods tended to score well, with 3 of the 6 marks available for this. A reasonable number of candidates mentioned the soil conditions or shading in the field being a possible disadvantage for methods A and B.

**4)(iv)** Many correct responses were seen, and most candidates gained at least one of the two marks. A few candidates did not distinguish their two answers and some gave three answers, so scored zero.

**4)(v)** A small number of fully correct responses were seen. Most candidates correctly gave their hypotheses in terms of $\mu$. However, the majority of candidates did not know the necessary assumptions. Many candidates also made errors in the variance, often squaring the given variances before calculating a pooled estimate. Others forgot to square root their pooled variance in calculating the test statistic. A disappointing number of candidates gave a wrong critical value, some thinking there were 7 degrees of freedom and others using the Normal tables.

**OCR (Oxford Cambridge and RSA Examinations)**
**1 Hills Road**
**Cambridge**
**CB1 2EU**

**OCR Customer Contact Centre**

**Education and Learning**
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

**www.ocr.org.uk**

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