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Examiners' report

FURTHER MATHEMATICS B (MEI)

H635
For first teaching in 2017

Y412/01 Summer 2018 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

Paper Y412/01 series overview

Y412 is one of six available options. Candidates must take Core Pure (Y410) and then choose two of the optional papers to be credited AS Level in Further Mathematics B (MEI). Candidates are expected to know the content of AS Level Mathematics (H630) and Y410.

To do well in this paper candidates need a good understanding of the different probability and statistics models contained in this specification, the ability to calculate probabilities and statistics accurately, an awareness of any assumptions necessary for applying the models and the ability to provide concise, clear explanations.

This paper proved to be readily accessible to all candidates and there was no evidence of candidates having insufficient time to complete all questions. A wide range of marks were seen and none of the six questions stood out as being either particularly difficult or particularly easy. Higher ability candidates showed both the ability to choose and apply appropriate calculations and to provide clear, concise explanations when required. Lower ability candidates had some difficulty in selecting appropriate calculations or critical values and in providing suitable wording where explanations were required and in hypothesis tests. The vast majority of candidates kept to the guidelines regarding accuracy of final answers – few candidates were penalised for over-specification. Many cases of incorrect rounding were seen.

Regarding calculators - Some candidates made excellent use of the in-built statistical functions. Others were less efficient, preferring to calculate many individual values. With respect to providing sufficient detail of working - Some candidates presented solutions omitting most, if not all, of the working which made it difficult for them to gain method marks where their answers were incorrect.

Question 1(iv)

(iv) Find the probability that at least 36 particles are detected in a period of 60 seconds. **[2]**

Most candidates calculated the new mean of 36.6 correctly but many did not succeed in their calculation of P($X \geq 36$).

Question 1(v)

(v) Another radioactive source emits particles randomly and independently at a constant average rate of 1.7 particles per 5 seconds. Find the probability that at least 10 but no more than 15 particles are detected altogether from the two sources in a period of 10 seconds. **[2]**

This part proved to be the most difficult of this question. Many candidates did not realise that the sum of the two Poisson variables was required. For those obtaining the correct probability distribution, many did not manage to successfully calculate P($10 \leq X \leq 15$).

Question 2(i)

2 In a quiz, competitors have to match 5 landmarks to the 5 British counties which the landmarks are in. The random variable X represents the number of correct matches that a competitor gets, assuming that the competitor guesses randomly. The probability distribution of X is given in the following table.

r	0	1	2	3	4	5
$P(X = r)$	$\frac{11}{30}$	$\frac{3}{8}$	$\frac{1}{6}$	$\frac{1}{12}$	0	$\frac{1}{120}$

(i) Explain why $P(X = 4)$ must be 0. **[1]**

In questions of this nature, it is expected that candidates will provide a comment based on the underlying structure rather than simply relying on the sum of the probabilities being 1.

Question 2(ii)

(ii) Explain how the value $\frac{1}{120}$ for $P(X = 5)$ is calculated. **[2]**

Question 2(iii)

(iii) Draw a graph to illustrate the distribution. **[2]**

Most candidates realised that a line graph was required. Many candidates were hampered by their unhelpful labelling of the axis representing probability. Candidates who used a clearly marked linear scale with values which made it easier for them to draw lines of correct height tended to obtain both marks.

Question 2(vi)

(vi) There are 12 competitors in the quiz. Assuming that they all guess randomly, find the probability that at least one of them gets all five matches correct. **[2]**

This proved to be challenging. Many of the candidates who recognised the correct distribution to use did not succeed in calculating the required probability.

Question 3(i)

3 Samples of water are taken from 10 randomly chosen wells in an area of a country. A researcher is investigating whether there is any relationship between the levels of dissolved oxygen, x, and the amounts of radium, y, in the water from the wells. Both quantities are measured in suitable units. The table and the scatter diagram in Fig. 3 show the values of x and y for the ten wells.

x	45.9	48.3	52.2	64.6	66.6	67.6	69.3	75.0	77.4	82.8
y	25.4	23.9	26.6	18.8	18.9	19.0	16.8	16.3	17.8	17.2

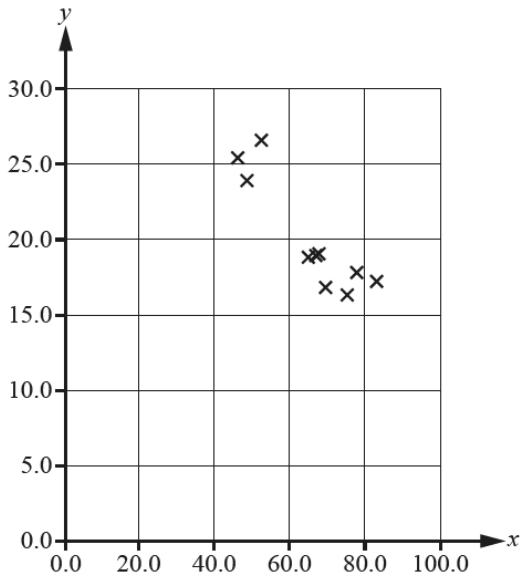


Fig. 3

(i) Explain why it may not be appropriate to carry out a hypothesis test based on the product moment correlation coefficient. **[2]**

Key point call out

In questions of this nature candidates are expected to state that there is a requirement for the underlying **population** to have a bivariate Normal distribution and that an indication of this is that the points on the scatter diagram fall within an ellipse.

Here, candidates needed to recognise that the non-elliptical shape on the scatter diagram might indicate that the underlying population might not have a bivariate normal distribution. Many referred incorrectly to the **data** not being bivariate normally distributed.

Question 3(ii)

(ii) Calculate Spearman's rank correlation coefficient for these data. **[3]**

Some candidates attempted to use the Spearman's rank correlation coefficient calculation with *x* & *y* values rather than ranks. Generally, this was well answered.

Question 3(iii)

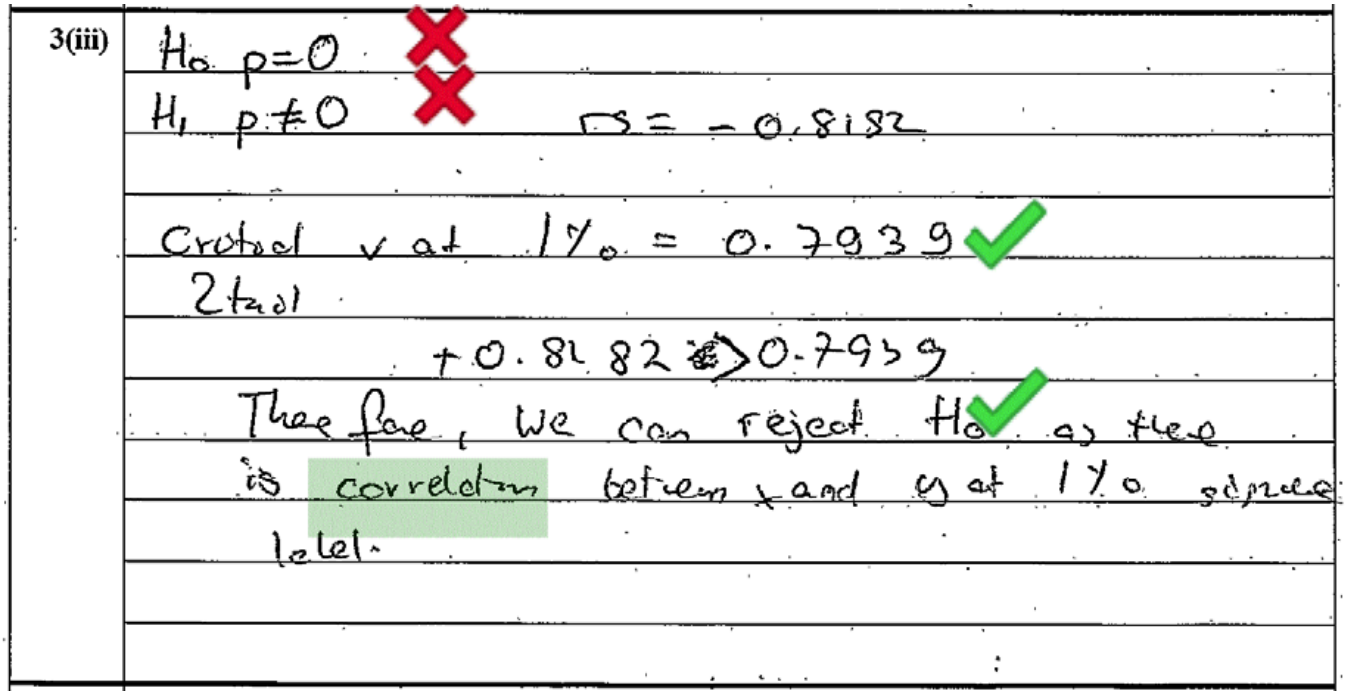
(iii) Using this value of Spearman's rank correlation coefficient, carry out a hypothesis test at the 1% significance level to investigate whether there is any association between *x* and *y*. **[5]**

Key point call out

Conclusions to hypothesis tests must be stated in context, in a non-assertive way and with reference to the alternative hypothesis.

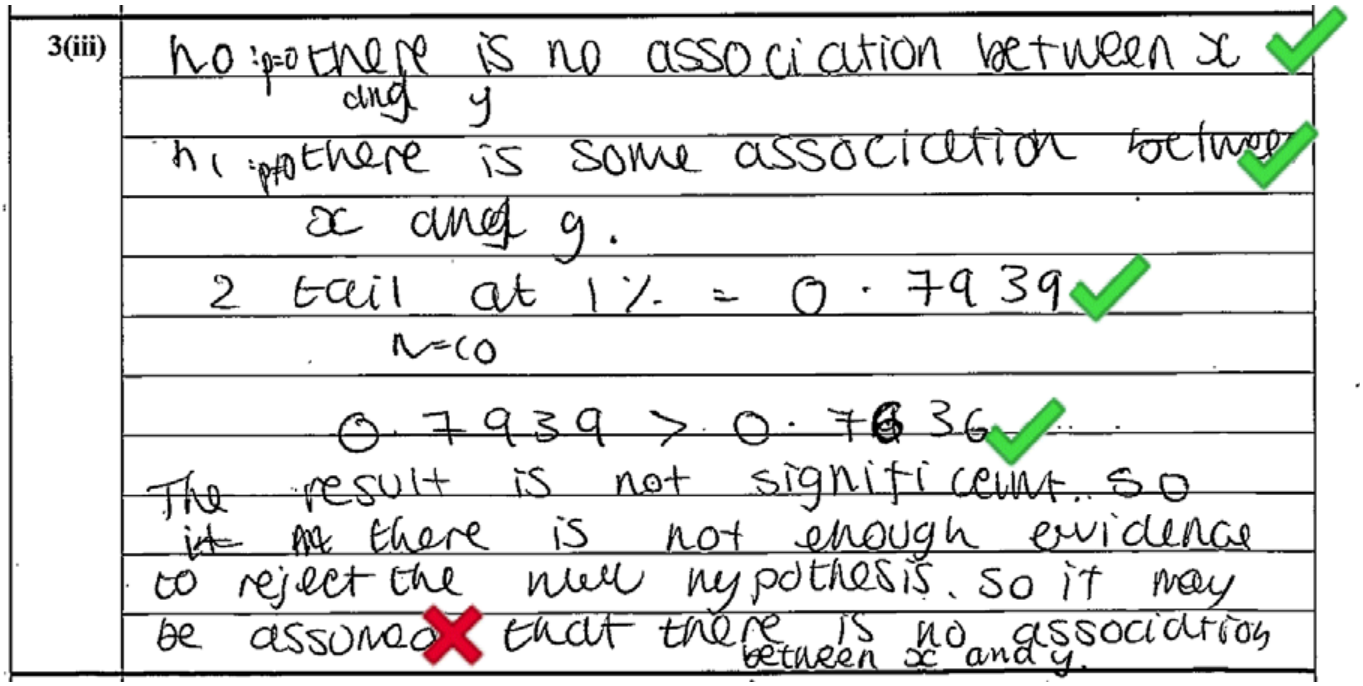
Hypotheses needed to be stated in terms of association in order to gain credit. Some were not. Most candidates identified the critical value correctly and compared it correctly with their test statistic, though some incorrectly compared a negative test statistic with a positive critical value. Conclusions needed to be stated in context in a non-assertive way with reference to the alternative hypothesis.

Exemplar 1



In exemplar 1 the candidate states hypotheses in terms of *p*. This is not appropriate for a test involving Spearman's rank correlation coefficient. The conclusion is too assertive as well as mentioning 'correlation' rather than the required 'association'.

Exemplar 2



In exemplar 2 the candidate refers to the null hypothesis in their final conclusion so loses the final mark. Note also that since variables *x* and *y* are defined in the question, reference to *x* and *y* is accepted as context.

Question 3(iv)

(iv) Explain the meaning of the term 'significance level' in the context of the test carried out in part **(iii)**. **[2]**

Some candidates correctly provided the correct response of 'the probability of rejecting H_o when H_o is true' but few were able to put this into the context.

When asked for answers 'in context' candidates are expected to refer to the variables used in the question rather than just providing answers in general terms.

Question 4(iv)

The player continues to throw more darts at the bullseye after she has hit it for the first time.

(iv) Find the probability that the player hits the bullseye at least twice in the first ten throws. **[2]**

Candidates who identified the need to use the Binomial distribution succeeded, though it was common not to see this used.

Question 4(v)

(v) Find the probability that the player hits the bullseye for the second time on the tenth throw. **[2]**

Higher ability candidates realised that this needed to be calculated as one success from the first nine throws [using B(9, 0.12)] followed by success on the tenth throw. Most found this difficult.

Question 5(iii)

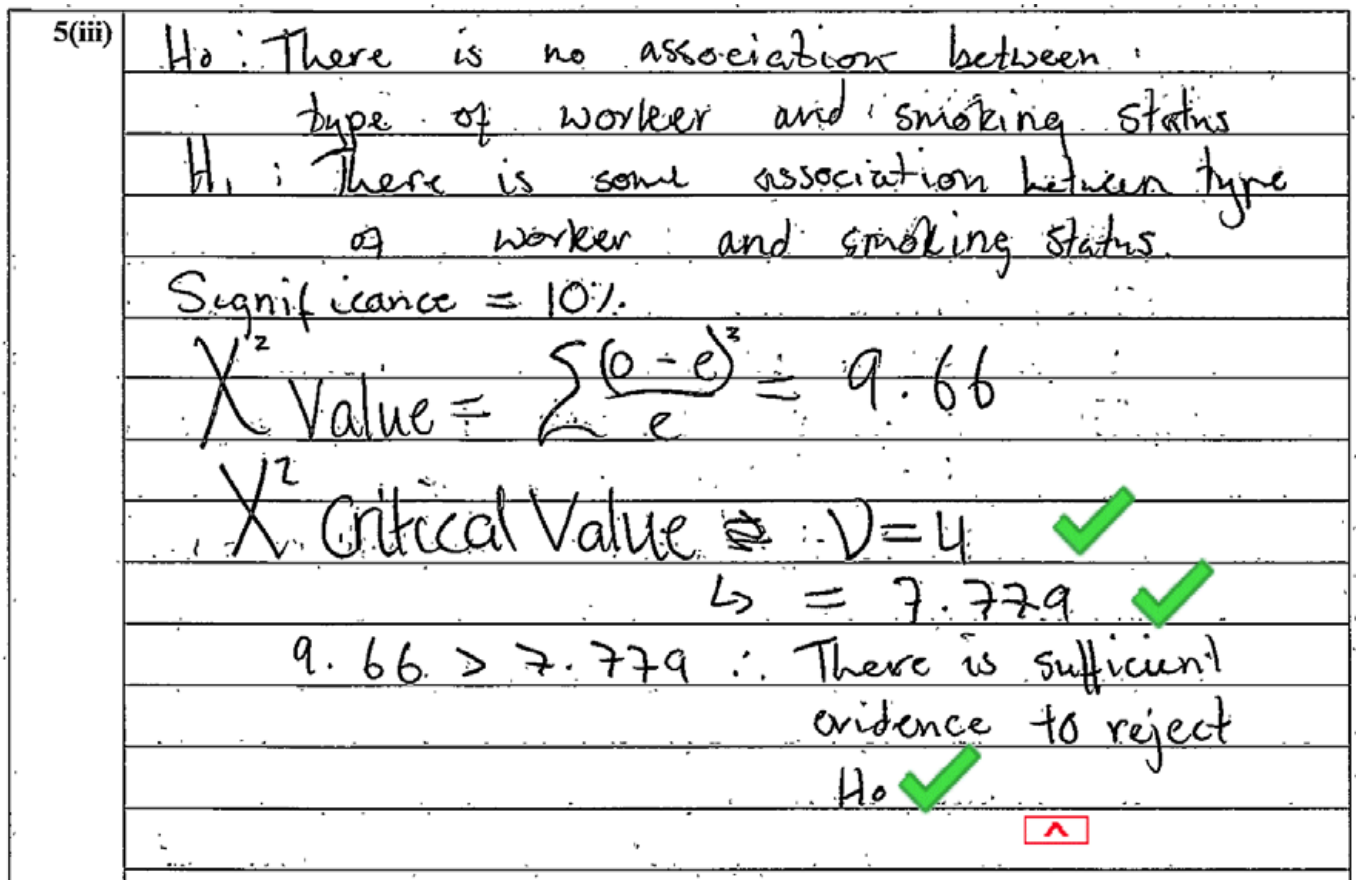
(iii) Complete the hypothesis test at the 10% level of significance. **[4]**

Key point call out

Conclusions to hypothesis tests must be stated in context, in a non-assertive way and with reference to the alternative hypothesis.

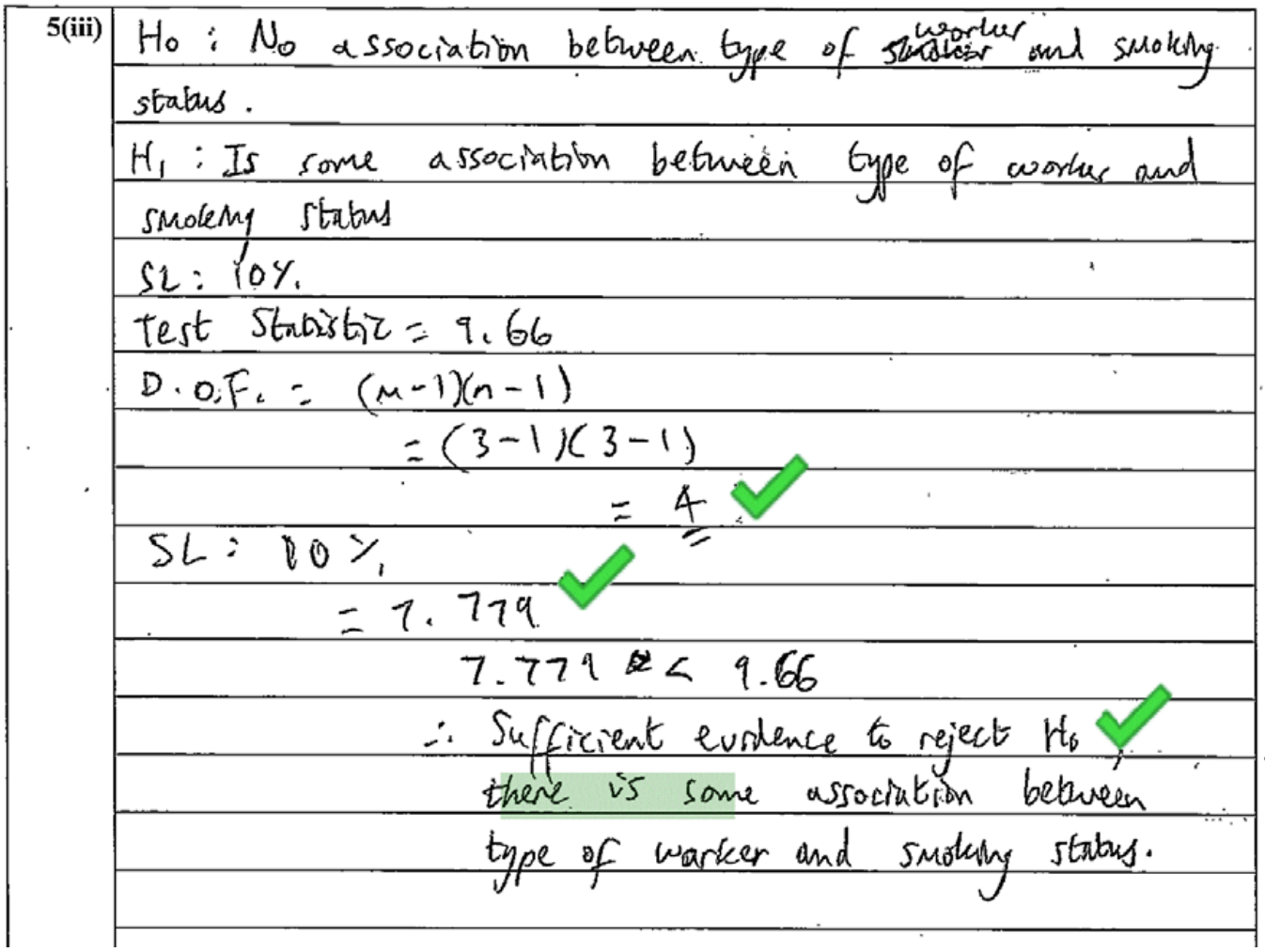
Some candidates did not correctly identify the degrees of freedom. Many chose incorrect critical values.

Exemplar 3



This candidate did not complete their conclusion with a suitable non-assertive comment.

Exemplar 4



5(iii)

H_0 : No association between type of worker and smoking status.

H_1 : Is some association between type of worker and smoking status

SL : 10%

Test Statistic = 9.66

D.O.F. = $(r-1)(c-1)$

$= (3-1)(3-1)$

$= 4$ ✓

SL : 10%

$= 7.779$ ✓

$7.779 < 9.66$

∴ Sufficient evidence to reject H_0 ✓

there is some association between type of worker and smoking status.

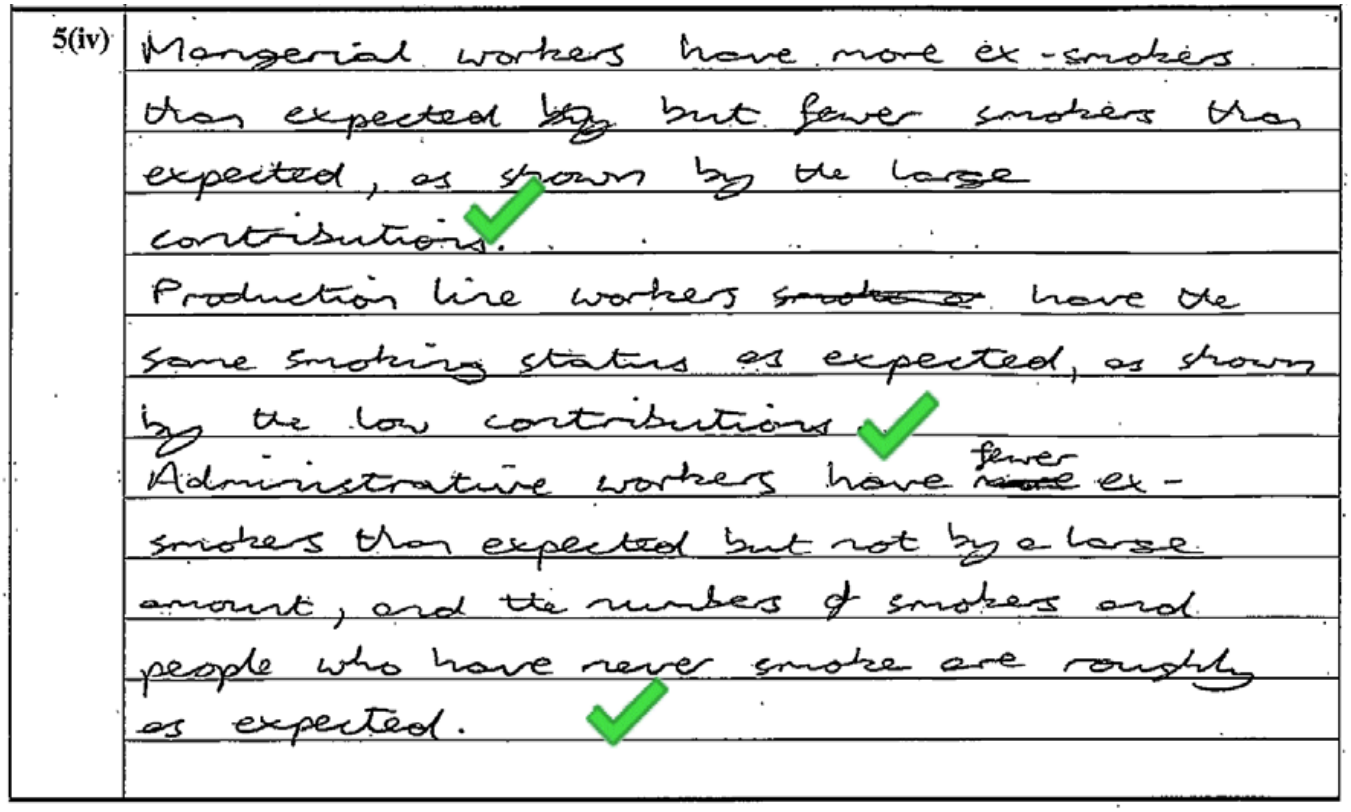
Inserting the words 'this suggests that' before 'there is some' in the conclusion to this candidates answer would make it suitably non-assertive.

Question 5(iv).

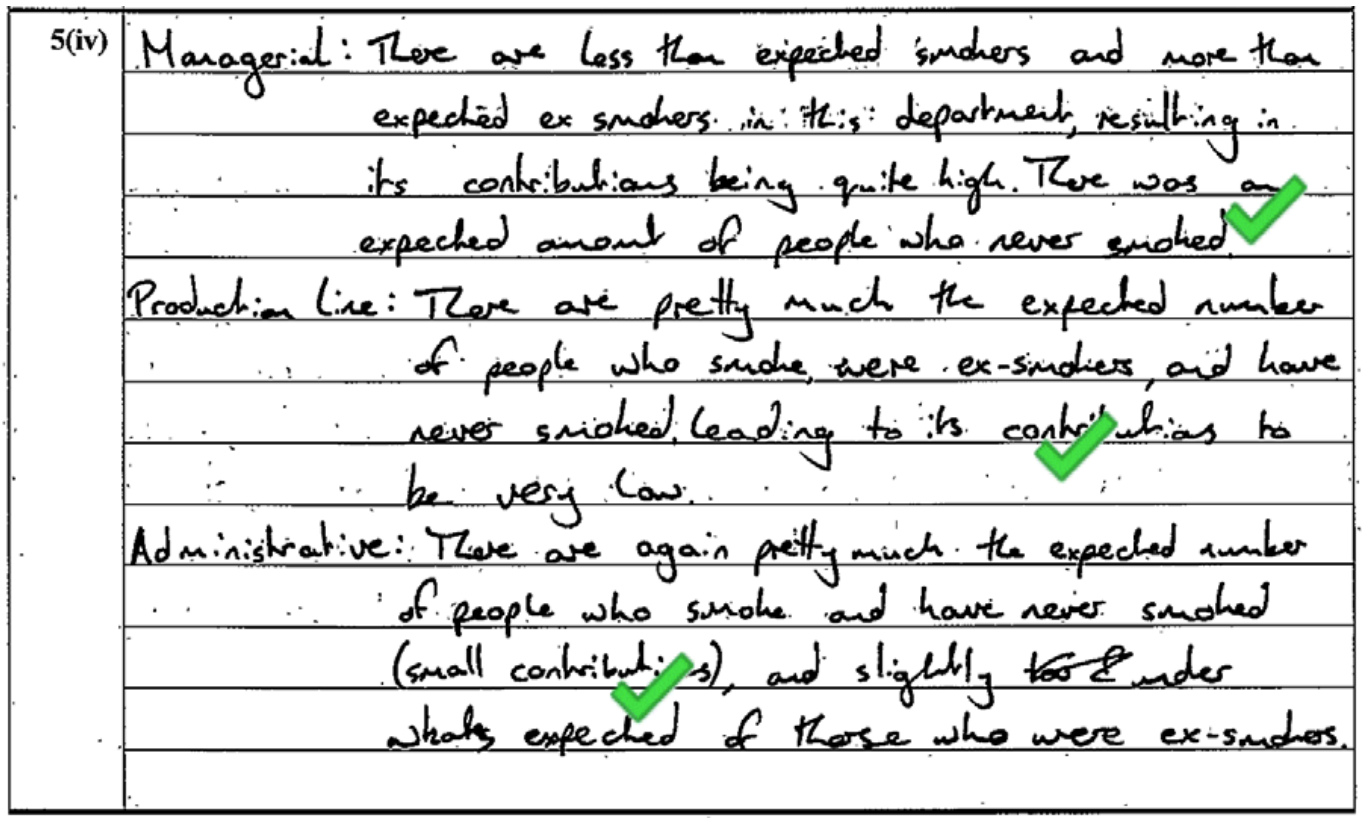
(iv) Discuss briefly what the data suggest about smoking status for different types of workers. You should make a comment for each type of worker. **[3]**

This proved difficult for many candidates. Some correctly identified the large and small contributions to the test statistic and used these observations to make comparisons between the observed and expected frequencies. Some made comparisons without reference to the contributions, which gained less credit. In many cases, candidates just commented on various aspects of the data without making the necessary reference to contributions and observed and expected values.

Exemplar 5



Exemplar 6



Both of these candidates make reference to large and small contributions and provide appropriate interpretations. Their wording is concise yet covers everything necessary.

Question 6(ii)

(ii) Explain how the mean length of frogs with head width 16 mm should be estimated. **[2]**

Many incorrect answers were seen. Commonly, candidates thought that it would suffice to substitute $y = 16$ into the regression line of y on x.

Question 6(iv)

(iv) In the light of the information in the scatter diagram, comment on the goodness of fit of the regression line. **[2]**

Candidates needed to show an understanding that $r^2 = 0.5748$ gives evidence of a moderately good fit which is supported by most of the points lying close to the regression line. Many managed to identify one of these aspects but few identified both.

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