OCR

Thursday 22 May 2014 – Morning

AS GCE MATHEMATICS (MEI)

4766/01 Statistics 1

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4766/01
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Duration: 1 hour 30 minutes

1242237314

INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found inside the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book**. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION FOR CANDIDATES

This information is the same on the Printed Answer Book and the Question Paper.

- The number of marks is given in brackets **[ ]** at the end of each question or part question on the Question Paper.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **12** pages. The Question Paper consists of **4** pages. Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER / INVIGILATOR

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

Section A (36 marks)

1 The ages, x years, of the senior members of a running club are summarised in the table below.

Age (x)	$20 \leqslant x < 30$	$30 \leqslant x < 40$	$40 \leqslant x < 50$	$50 \leqslant x < 60$	$60 \leqslant x < 70$	$70 \leqslant x < 80$	$80 \leqslant x < 90$
Frequency	10	30	42	23	9	5	1

(i) Draw a cumulative frequency diagram to illustrate the data. **[5]**

(ii) Use your diagram to estimate the median and interquartile range of the data. **[3]**

2 Candidates applying for jobs in a large company take an aptitude test, as a result of which they are either accepted, rejected or retested, with probabilities 0.2, 0.5 and 0.3 respectively. When a candidate is retested for the first time, the three possible outcomes and their probabilities remain the same as for the original test. When a candidate is retested for the second time there are just two possible outcomes, accepted or rejected, with probabilities 0.4 and 0.6 respectively.

(i) Draw a probability tree diagram to illustrate the outcomes. **[3]**

(ii) Find the probability that a randomly selected candidate is accepted. **[2]**

(iii) Find the probability that a randomly selected candidate is retested at least once, given that this candidate is accepted. **[3]**

3 Each weekday, Marta travels to school by bus. Sometimes she arrives late.

- L is the event that Marta arrives late.
- R is the event that it is raining.

You are given that $\mathrm{P}(L) = 0.15$, $\mathrm{P}(R) = 0.22$ and $\mathrm{P}(L \mid R) = 0.45$.

(i) Use this information to show that the events L and R are not independent. **[1]**

(ii) Find $\mathrm{P}(L \cap R)$. **[2]**

(iii) Draw a Venn diagram showing the events L and R, and fill in the probability corresponding to each of the four regions of your diagram. **[3]**

4 There are 16 girls and 14 boys in a class. Four of them are to be selected to form a quiz team. The team is to be selected at random.

(i) Find the probability that all 4 members of the team will be girls. **[3]**

(ii) Find the probability that the team will contain at least one girl and at least one boy. **[3]**

5 The probability distribution of the random variable X is given by the formula

$$P(X = r) = k + 0.01r^2 \text{ for } r = 1, 2, 3, 4, 5.$$

(i) Show that $k = 0.09$. Using this value of k, display the probability distribution of X in a table. **[3]**

(ii) Find $E(X)$ and $\text{Var}(X)$. **[5]**

Section B (36 marks)

6 The weights, w grams, of a random sample of 60 carrots of variety A are summarised in the table below.

Weight	$30 \leqslant w < 50$	$50 \leqslant w < 60$	$60 \leqslant w < 70$	$70 \leqslant w < 80$	$80 \leqslant w < 90$
Frequency	11	10	18	14	7

(i) Draw a histogram to illustrate these data. **[5]**

(ii) Calculate estimates of the mean and standard deviation of w. **[4]**

(iii) Use your answers to part **(ii)** to investigate whether there are any outliers. **[3]**

The weights, x grams, of a random sample of 50 carrots of variety B are summarised as follows.

$$n = 50 \qquad \Sigma x = 3624.5 \qquad \Sigma x^2 = 265\,416$$

(iv) Calculate the mean and standard deviation of x. **[3]**

(v) Compare the central tendency and variation of the weights of varieties A and B. **[2]**

7 It is known that on average 85% of seeds of a particular variety of tomato will germinate. Ramesh selects 15 of these seeds at random and sows them.

(i) (A) Find the probability that exactly 12 germinate. **[3]**

(B) Find the probability that fewer than 12 germinate. **[2]**

The following year Ramesh finds that he still has many seeds left. Because the seeds are now one year old, he suspects that the germination rate will be lower. He conducts a trial by randomly selecting n of these seeds and sowing them. He then carries out a hypothesis test at the 1% significance level to investigate whether he is correct.

(ii) Write down suitable null and alternative hypotheses for the test. Give a reason for your choice of alternative hypothesis. **[4]**

(iii) In a trial with $n = 20$, Ramesh finds that 13 seeds germinate. Carry out the test. **[4]**

(iv) Suppose instead that Ramesh conducts the trial with $n = 50$, and finds that 33 seeds germinate. Given that the critical value for the test in this case is 35, complete the test. **[3]**

(v) If n is small, there is no point in carrying out the test at the 1% significance level, as the null hypothesis cannot be rejected however many seeds germinate. Find the least value of n for which the null hypothesis can be rejected, quoting appropriate probabilities to justify your answer. **[3]**

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4766/01 Statistics 1

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OCR supplied materials:
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- MEI Examination Formulae and Tables (MF2)

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Duration: 1 hour 30 minutes

* 4 7 6 6 0 1 *

* 1 2 4 2 5 1 9 5 1 9 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

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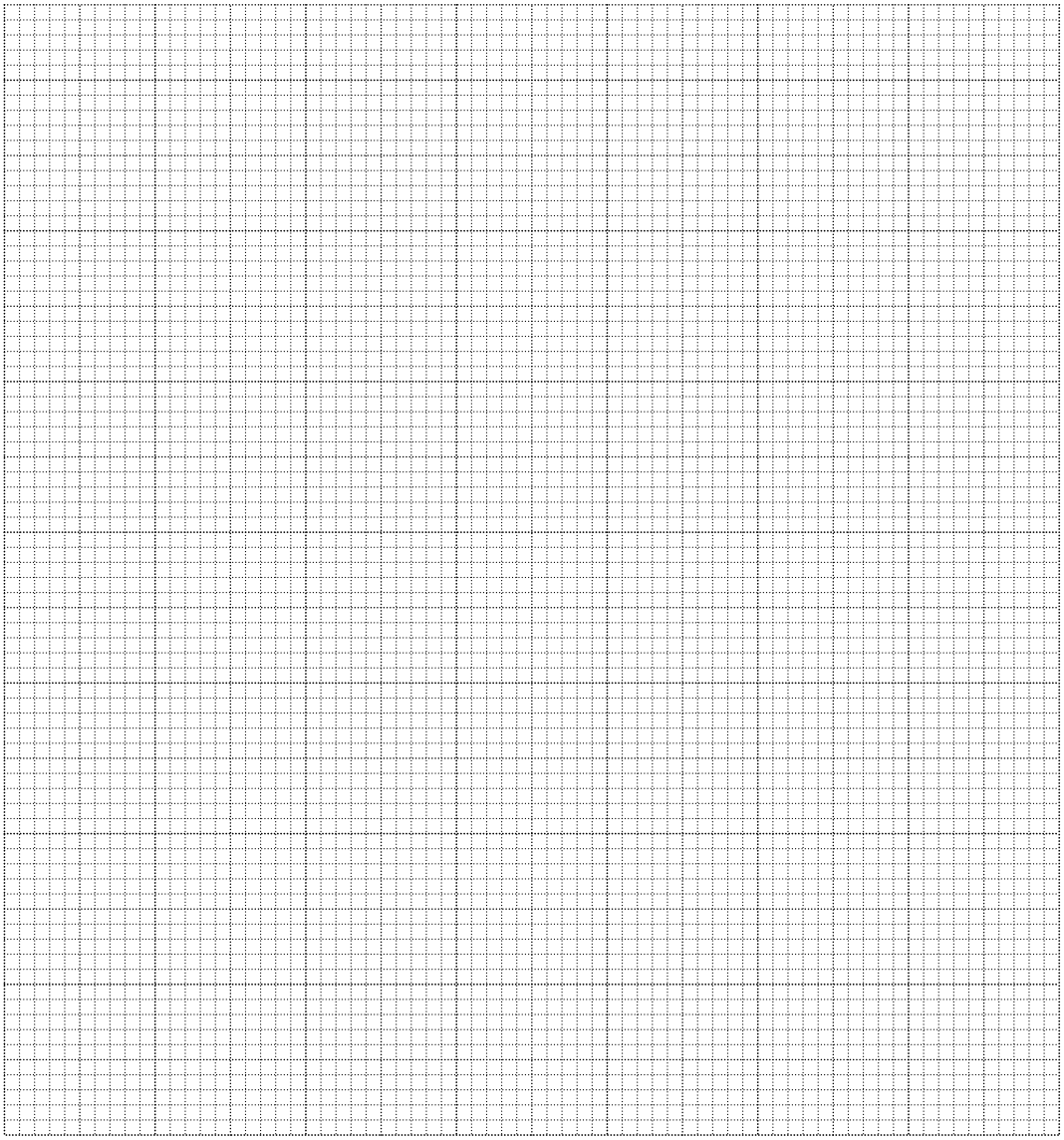
Section A (36 marks)

1 (i) & (ii)



2 (i)

2 (ii)

2 (iii)

3 (i)	
3 (ii)	
3 (iii)	

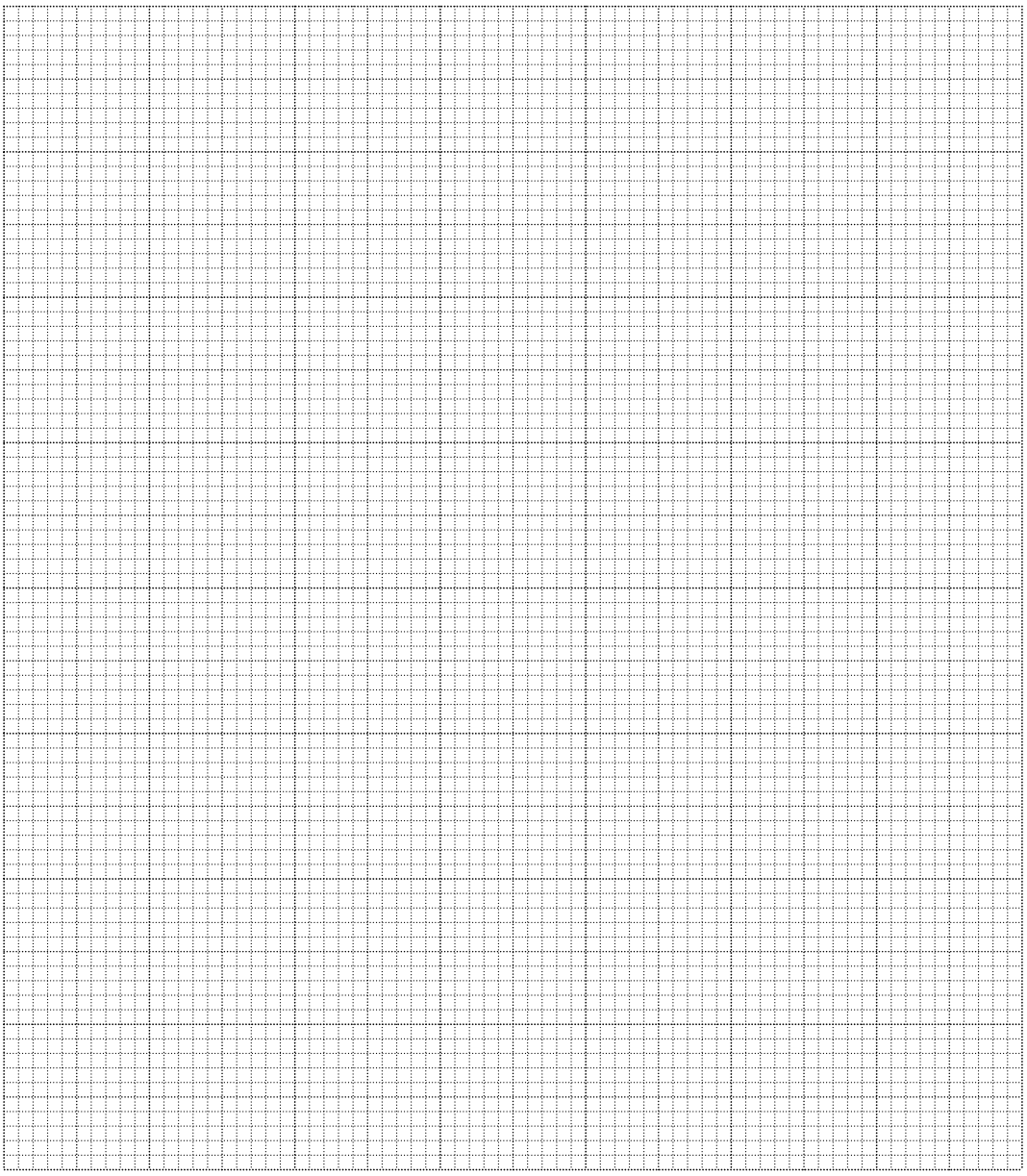
4 (i)

4 (ii)

5 (i) & (ii)	

Section B (36 marks)

6 (i)



6 (ii)

6 (iii)

6 (iv)	
6 (v)	

7 (i) (*A*)

7 (i) (*B*)

7 (ii)

7 (iii)

7 (iv)

7 (v)	

OCR
Oxford Cambridge and RSA

GCE

Mathematics (MEI)

Unit **4766**: Statistics 1

Advanced Subsidiary GCE

Mark Scheme for June 2014

1. Annotations and abbreviations

Annotation in scoris	Meaning
BP	Blank Page – this annotation **must** be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
Highlighting	
Other abbreviations in mark scheme	**Meaning**
E1	Mark for explaining
U1	Mark for correct units
G1	Mark for a correct feature on a graph
M1 dep*	Method mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working

2. Subject-specific Marking Instructions for GCE Mathematics (MEI) Statistics strand

a Annotations should be used whenever appropriate during your marking.

The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

b An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

c The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, eg by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

E

A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep *' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise.

Candidates are expected to give numerical answers to an appropriate degree of accuracy. 3 significant figures may often be the norm for this, but this always needs to be considered in the context of the problem in hand. For example, in quoting probabilities from Normal tables, we generally expect *some* evidence of interpolation and so quotation to 4 decimal places will often be appropriate. But even this does not always apply – quotations of the standard critical points for significance tests such as 1.96, 1.645, 2.576 (maybe even 2.58 – but not 2.57) will commonly suffice, especially if the calculated value of a test statistic is nowhere near any of these values. Sensible discretion *must* be exercised in such cases.

Discretion must also be exercised in the case of small variations in the degree of accuracy to which an answer is given. For example, if 3 significant figures are expected (either because of an explicit instruction or because the general context of a problem demands it) but only 2 are given, loss of an accuracy ("A") mark is likely to be appropriate; but if 4 significant figures are given, this should not normally be penalised. Likewise, answers which are slightly deviant from what is expected in a very minor manner (for example a Normal probability

given, after an attempt at interpolation, as 0.6418 whereas 0.6417 was expected) should not be penalised. However, answers which are *grossly* over- or under-specified should normally result in the loss of a mark. This includes cases such as, for example, insistence that the value of a test statistic is (say) 2.128888446667 merely because that is the value that happened to come off the candidate's calculator. Note that this applies to answers that are given as final stages of calculations; intermediate working should usually be carried out, and quoted, to a greater degree of accuracy to avoid the danger of premature approximation.

The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.

g Rules for replaced work

If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

NB Follow these maths-specific instructions rather than those in the assessor handbook.

h Genuine misreading (of numbers or symbols, occasionally even of text) occurs. If this results in the object and/or difficulty of the question being considerably changed, it is likely that all the marks for that question, or section of the question, will be lost. However, misreads are often such that the object and/or difficulty remain substantially unaltered; these cases are considered below.

The simple rule is that *all* method ("M") marks [and of course all independent ("B") marks] remain accessible but at least some accuracy ("A") marks do not. It is difficult to legislate in an overall sense beyond this global statement because misreads, even when the object and/or difficulty remains unchanged, can vary greatly in their effects. For example, a misread of 1.02 as 10.2 (perhaps as a quoted value of a sample mean) may well be catastrophic; whereas a misread of 1.6748 as 1.6746 may have so slight an effect as to be almost unnoticeable in the candidate's work.

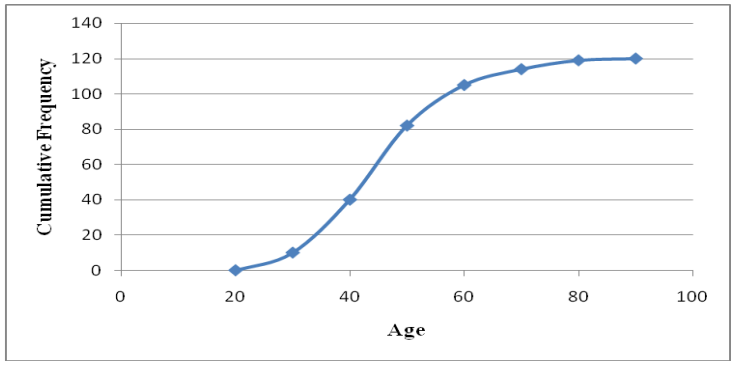
A misread should normally attract *some* penalty, though this would often be only 1 mark and should rarely if ever be more than 2. Commonly in sections of questions where there is a numerical answer either at the end of the section or to be obtained and commented on (eg the value of a test statistic), this answer will have an "A" mark that may actually be designated as "cao" [correct answer only]. This should be interpreted *strictly* – if the misread has led to failure to obtain this value, then this "A" mark must be withheld even if all method marks have been earned. It will also often be the case that such a mark is implicitly "cao" even if not explicitly designated as such.

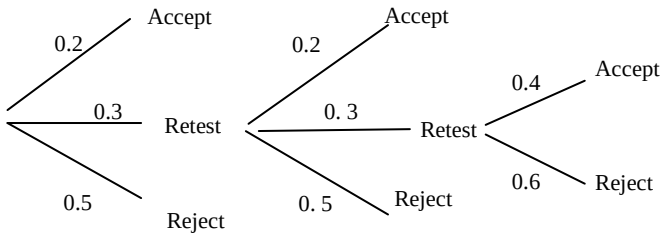
On the other hand, we commonly allow "fresh starts" within a question or part of question. For example, a follow-through of the candidate's value of a test statistic is generally allowed (and often explicitly stated as such within the marking scheme), so that the candidate may exhibit knowledge of how to compare it with a critical value and draw conclusions. Such "fresh starts" are not affected by any earlier misreads.

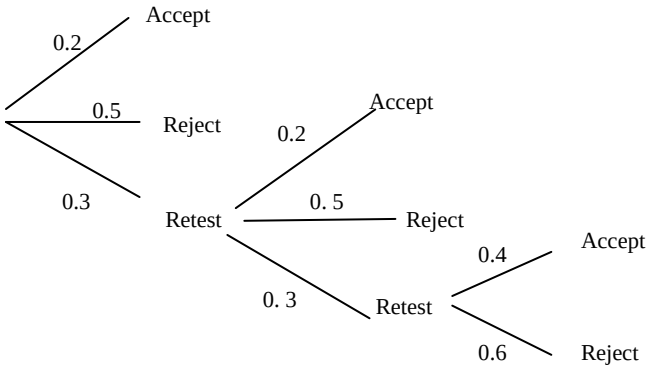
A misread may be of a symbol rather than a number – for example, an algebraic symbol in a mathematical expression. Such misreads are more likely to bring about a considerable change in the object and/or difficulty of the question; but, if they do not, they should be treated as far as possible in the same way as numerical misreads, *mutatis mutandis*. This also applied to misreads of text, which are fairly rare but can cause major problems in fair marking.

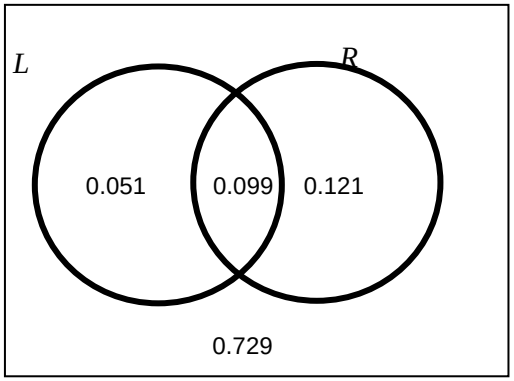
The situation regarding any particular cases that arise while you are marking for which you feel you need detailed guidance should be discussed with your Team Leader.

Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

Question			Answer	Marks	Guidance	
1	(i)		<table><tr><td>Upper Bound</td><td>20</td><td>30</td><td>40</td><td>50</td><td>60</td><td>70</td><td>80</td><td>90</td></tr><tr><td>Cumulative Freq</td><td>0</td><td>10</td><td>40</td><td>82</td><td>105</td><td>114</td><td>119</td><td>120</td></tr></table> 	B1 G1 G1 G1 **[5]**	Cumulative frequencies All correct For plotted points (Provided plotted at correct UCB positions**)** For joining points (within ½ a square) For scales For labels All marks dep on good attempt at cumulative frequency, but not cumulative fx's or other spurious values.	Plotted within ½ small square If cf not given then allow G1 for good attempt at cf. e.g. if they have 0,10,40,72,95,104,109,110

Question			Answer	Marks	Guidance	
1	(ii)		Median = 45	B1	Allow answers between 44 and 46 without checking curve. Otherwise check curve. No marks if not using diagram.	Based on 60th value ft their curve (not LCB's) Allow 40 for m.p. plot without checking graph B0 for interpolation If max value wrong (eg 110) FT their max value for all 3 marks
			Q1 = 37 Q3 = 53	B1	For Q3 or Q1 Allow Q1 between 37 and 38 without checking Allow Q3 between 52 and 54 without checking	Based on 30th and 90th values ft their curve (not LCB's) Allow Q1 = 32; Q3 = 48 without checking graph B0 for interpolation
			Inter-quartile range = 53 – 37 = 16	B1	For IQR providing both Q1 and Q3 are correct	B2 for correct IQR from graph if quartiles not stated but indicated on graph Allow from mid-point plot Must be good attempt at cumulative frequency in part (i) to score any marks here Lines of best fit: B0 B0 B0 here. Also cumulative frequency bars: B0 B0 B0 here
				[3]		
2	(i)				Alternative version of tree diagram for Q2(i)	

Question			Answer	Marks	Guidance	
2	(i)			G1 G1 G1 [3]	Do a vertical scan and give: First column Second column Final column Do not award if first two branches missing Branches two and three should come out of 'retest'	Allow labels such as A, R, F(Fail) etc All probabilities correct All probabilities correct All probabilities correct If any labels missing or incorrect allow max 2/3 Do not allow misreads here as all FT (eg 0.3 and 0.5 reversed)
2	(ii)		P(Accepted) = 0.2 + (0.3 × 0.2) + (0.3 × 0.3 × 0.4) = 0.2 + 0.06 + 0.036 = 0.296	M1 A1 [2]	For second or third product CAO	FT their tree provided correct numbers of terms and correct structure of 3, 3, 2 branches. Allow 37/125 oe
2	(iii)		P(At least one retest given accepted) $= \frac{\text{P(At least one retest and accepted)}}{\text{P(Accepted)}}$ $= \frac{0.3 \times 0.2 + 0.3 \times 0.3 \times 0.4}{0.296} = \frac{0.096}{0.296}$ = 0.324	 M1 M1 A1 [3]	 For numerator For denominator FT their 0.296 and 0.096 Allow 0.32 with working	 FT their tree provided correct numbers of terms and correct structure of 3, 3, 2 branches. for both M1's Both must be part of a fraction Allow 12/125 oe Allow 12/37 oe

Question			Answer	Marks	Guidance	
3	(i)		Because P($L \mid R$) $\neq$ P(L)	E1 **[1]**	If two or more methods given and only one correct, do not award the mark Allow $0.45 \neq 0.15$	Either P($L \cap R$) (= 0.099) $\neq$ P(L) × P(R), provided 0.099 in (ii) or $0.099 \neq 0.15 \times 0.22$ (= 0.033) Look out for complement methods, etc
3	(ii)		P($L \cap R$) = P($L \mid R$) × P(R) = 0.45 × 0.22 = 0.099	M1 A1 **[2]**	For product CAO	Allow if done correctly in part(i) Allow 99/1000
3	(iii)			G1 G1 G1 **[3]**	For two labelled intersecting circles, provided no incorrect labelling. For at least 2 correct probabilities. FT their P($L \cap R$) from part (ii) provided ≤ 0.15 For remaining probabilities. FT their P($L \cap R$) providing probabilities between 0 and 1.	Condone labels such as P(L) etc Allow other shapes in place of circles No need for 'box' FT from 0.033 in (ii) gives 0.117, 0.033, 0.187, 0.663 In general $0.15 - x$, x, $0.22 - x$, $0.63 + x$ May also see 0.0825, 0.0675, 0.1525, 0.6975

Question			Answer	Marks	Guidance	
4	(i)		P(All four are girls) = $\frac{16}{30}\times\frac{15}{29}\times\frac{14}{28}\times\frac{13}{27}$	M1	For $\frac{16}{30}\times$	OR $\binom{16}{4}/\binom{30}{4}=\frac{1820}{27405}=\frac{52}{783}=0.0664$
				M1	For product of other three correct fractions Without extra terms	M1 for either term in correct position in a fraction M1 for correct fraction A1 CAO Allow full marks for unsimplified fractional answers
			= 0.0664	A1	CAO Allow 0.066 with working but not 0.07	SC2 for $\frac{14}{30}\times\frac{13}{29}\times\frac{12}{28}\times\frac{11}{27}=0.0365$
				[3]		SC2 for $\binom{14}{4}/\binom{30}{4}=\frac{143}{3915}=0.0365$

Question			Answer	Marks	Guidance	
4	(ii)		P(All four are boys) = $\frac{14}{30}\times\frac{13}{29}\times\frac{12}{28}\times\frac{11}{27}=0.0365$	M1	For P(All four are boys) Without extra terms	OR $\binom{14}{4}/\binom{30}{4}=\frac{143}{3915}=0.0365$ M1 for this then as per scheme.
			P(At least one girl and at least one boy) = 1 – (0.0664 + 0.0365)	M1	For 1 – (0.0664 + 0.0365) FT their 'sensible' probabilities	
			= 0.897	A1	CAO Allow answer 0.8975 from use of 0.066	NB Watch for (1 – 0.0365)×(1 – 0.0664) = 0.9635×0.9336 = 0.8995 Gets just M1 for 0.0365 Accept 0.90 work working, but not 0.9
				[3]		
			OR			
			P(3b,1g) + P(2b,2g) +P(1b,3g) = $\left(4\times\frac{14}{30}\times\frac{13}{29}\times\frac{12}{28}\times\frac{16}{27}\right)+\left(6\times\frac{14}{30}\times\frac{13}{29}\times\frac{16}{28}\times\frac{15}{27}\right)+$ $\left(4\times\frac{14}{30}\times\frac{16}{29}\times\frac{15}{28}\times\frac{14}{27}\right)=4\times\frac{208}{3915}+6\times\frac{52}{783}+4\times\frac{56}{783}$ $=4\times0.0531+6\times0.0664+4\times0.0715$	M1	For any one product, even if coefficient missing	Or ${}^{14}C_3\times{}^{16}C_1/{}^{30}C_4$ + ${}^{14}C_2\times{}^{16}C_2/{}^{30}C_4$ + ${}^{14}C_1\times{}^{16}C_3/{}^{30}C_4$ = 0.2125 + 0.3985 + 0.2861 = 0.897 M1 for any one term
			= 0.2125 + 0.3985 + 0.2861	M1	For sum of all three (all correct)	M1 for sum of all three (all correct)
			= 0.897 $\left(=\frac{3512}{3915}\right)$	A1	CAO	A1 CAO
				[3]		

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th colspan="2">Guidance</th></tr>
<tr><td>5</td><td>(i)</td><td></td><td>$k + 0.01 + k + 0.04 + k + 0.09 + k + 0.16 + k + 0.25 = 1$
$5k + 0.55 = 1$

$k = 0.09$

<table><tr><td>r</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>P(X= r)</td><td>0.1</td><td>0.13</td><td>0.18</td><td>0.25</td><td>0.34</td></tr></table></td><td>M1

A1

B1

[3]</td><td>For equation in k

NB Answer Given

Complete correct table</td><td>Allow substitution of $k = 0.09$ to show probabilities add to 1 with convincing working

Must tabulate probabilities, though may be seen in part(ii)</td></tr>
<tr><td>5</td><td>(ii)</td><td></td><td>E(X) = $(1\times0.1)+(2\times0.13)+(3\times0.18)+(4\times0.25)+(5\times0.34)$

= 3.6
E(X^2) =
$(1\times0.1)+(4\times0.13)+(9\times0.18)+(16\times0.25)+(25\times0.34)=14.74$

Var(X) = $14.74 - 3.6^2$

= 1.78</td><td>M1

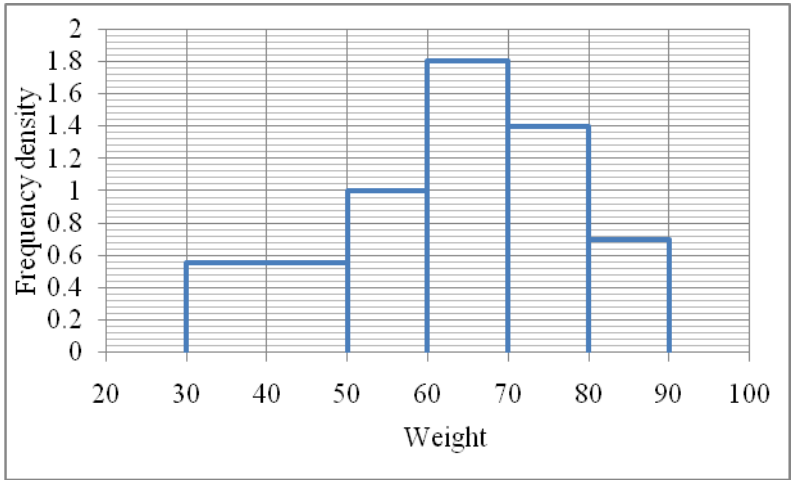
A1
M1*

M1* dep

A1

[5]</td><td>For Σrp (at least 3 terms correct Provided 5 reasonable probabilities seen.
CAO
For Σr^2p (at least 3 terms correct)
for – their (E[X])²
FT their E(X) provided Var(X) > 0

CAO</td><td>If probs wrong but sum = 1 allow max M1A0M1M1A1. If sum ≠ 1 allow max M1A0M1M0A0 (provided all probabilities ≥0 and <1)
No marks if all probs =0.2
.
Use of E$(X-\mu)^2$ gets M1 for attempt at $(x-\mu)^2$ should see $(-2.6)^2$, $(-1.6)^2$, $(-0.6)^2$, 0.4^2, 1.4^2, (if E(X) wrong FT their E(X)) (all 5 correct for M1), then M1 for $\Sigma p(x-\mu)^2$ (at least 3 terms correct with their probabilities)
Division by 5 or other spurious value at end and/or rooting final answer gives max M1A1M1M1A0, or M1A0M1M1A0 if E(X) also divided by 5.
Unsupported correct answers get 5 marks (Probably from calculator)</td></tr>
</table>

Question	Answer	Marks	Guidance	
6 (i)	<table><tr><td>Weight</td><td>Frequency</td><td>Group Width</td><td>Frequency density</td></tr><tr><td>$30 \le w < 50$</td><td>11</td><td>20</td><td>0.55</td></tr><tr><td>$50 \le w < 60$</td><td>10</td><td>10</td><td>1</td></tr><tr><td>$60 \le w < 70$</td><td>18</td><td>10</td><td>1.8</td></tr><tr><td>$70 \le w < 80$</td><td>14</td><td>10</td><td>1.4</td></tr><tr><td>$80 \le w < 90$</td><td>7</td><td>10</td><td>0.7</td></tr></table> 	M1 A1 G1 G1	For fd's - at least 3 correct Accept any suitable unit for fd such as eg freq per 10g. linear scales on both axes and labels Vertical scale starting from zero (not broken - but can get final mark for heights if broken) width of bars	M1 can be also be gained from freq per 10 – 5.5, 10, 18, 14, 7 (at least 3 correct) or similar. If fd not explicitly given, M1 A1 can be gained from all heights correct (within half a square) on histogram (and M1A0 if at least 3 correct) Linear scale and label on vertical axis IN RELATION to first M1 mark ie fd or frequency density or if relevant freq/10, etc (NOT eg fd/10). However allow scale given as fd×10, or similar. Accept f/w or f/cw (freq/width or freq/class width) Ignore horizontal label Can also be gained from an accurate key G0 if correct label but not fd's. Must be drawn at 30, 50 etc NOT 29.5 or 30.5 etc NO GAPS ALLOWED Must have linear scale. No inequality labels on their own such as $30 \le W < 50$, $50 \le W < 60$ etc but allow if 30, 50, 60 etc occur at the correct boundary position. See additional notes. Allow this mark even if not using fd's

Question			Answer	Marks	Guidance	
				G1 **[5]**	height of bars	Height of bars – must be linear vertical scale. FT of heights dep on at least 3 heights correct and all must agree with their fds If fds not given and at least 3 heights correct then max M1A0G1G1G0 Allow restart with correct heights if given fd wrong (for last three marks only)

Question			Answer	Marks	Guidance	
6	(ii)		Mean = $\frac{(40\times11)+(55\times10)+(65\times18)+(75\times14)+(85\times7)}{60}=\frac{3805}{60}$	M1	For midpoints Products are 440, 550, 1170, 1050, 595	For midpoints (at least 3 correct) No marks for mean or sd unless using midpoints Answer must NOT be left as improper fraction as this is an estimate Accept correct answers for mean and sd from calculator even if eg wrong Sxx given
			= 63.4 (or 63.42)	A1	CAO (exact answer 63.41666…)	
			$\Sigma x^2 f = (40^2\times11)+(55^2\times10)+(65^2\times18)+(75^2\times14)+(85^2\times7)$ $=253225$			
			$S_{xx}=253225-\frac{3805^2}{60}=11924.6$	M1	For attempt at S_{xx} Should include sum of at least 3 correct multiples $fx^2 - \Sigma x^2/n$	Allow M1 for anything which rounds to 11900
			$s=\sqrt{\frac{11924.6}{59}}=\sqrt{202.11}=14.2$	A1	At least 1dp required Use of mean 63.4 leading to answer of 14.29199.. with S_{xx} = 12051.4 gets full credit. 63.42 leads to 14.2014… Do not FT their incorrect mean (exact answer14.2166…)	Allow SC1 for RMSD 14.1 (14.0976…) from calculator. Only penalise once in part (ii) for over specification, even if mean and standard deviation both over specified. If using $(x-\bar{x})^2$ method, B2 if 14.2 or better (14.3 if use of 63.4), otherwise B0
				[4]		

Question			Answer	Marks	Guidance	
6	(iii)		$\bar{x} - 2s = 63.4 - (2 \times 14.2) = 35$	M1	For either No marks in (iii) unless using $\bar{x} + 2s$ or $\bar{x} - 2s$	Only follow through numerical values, not variables such as *s*, so if a candidate does not find *s* but then writes here 'limit is 63.4 + 2 × standard deviation', do NOT award M1
			$\bar{x} + 2s = 63.4 + (2 \times 14.2) = 91.8$	A1	For both (FT)	Do not penalise for over-specification
			So there are probably some outliers at the lower end, but none at the upper end	E1 **[3]**	Must include an element of doubt and must mention both ends	Must have correct limits to get this mark
6	(iv)		Mean $= \frac{3624.5}{50} = 72.5$g (or exact answer 72.49g)	B1	CAO Ignore units	
			$S_{xx} = 265416 - \frac{3624.5^2}{50} = 2676$	M1	For S_{xx}	M1 for 265416 - 50 × their mean^2 BUT NOTE M0 if their $S_{xx} < 0$ For s^2 of 54.6 (or better) allow M1A0 with or without working.
			$s = \sqrt{\frac{2676}{49}} = \sqrt{54.61} = 7.39$g	A1 **[3]**	CAO ignore units Allow 7.4 but NOT 7.3 (unless RMSD with working)	For RMSD of 7.3 (or better) allow M1A0 provided working seen For RMSD^2 of 53.5 (or better) allow M1A0 provided working seen

Question			Answer	Marks	Guidance	
6	(v)		Variety A have lower average than Variety B oe	E1	FT their means Do not condone lower central tendency or lower mean	Allow 'on the whole' or similar in place of 'average'.
			Variety A have higher variation than Variety B oe	E1	FT their sd	Allow 'more spread' or similar but not 'higher range' or 'higher variance' Condone less consistent.
				[2]		
7	(i)	(*A*)	$X \sim B(15, 0.85)$	M1	For $0.85^{12} \times 0.15^{3}$	
			P(exactly 12 germinate) = $\binom{15}{12} \times 0.85^{12} \times 0.15^{3}$	M1	For $\binom{15}{12} \times p^{12} \times q^{3}$	
			= 0.2184	A1	CAO	
			OR	**OR**		
			from tables: 0.3958 – 0.1773 = 0.2185	M2 A1 [3]	For 0.3958 – 0.1773 CAO	
7	(i)	(*B*)	P(X <12) = P($X \leq 11$) = 0.1773	M1	For P($X \leq 11$) or P(≤11) (With no extras) CAO (as final answer) May see alternative method: 0.3958 – 0.2185 = 0.1773 0.3958 - their wrong answer to part (i) scores M1A0	
				A1		
				[2]		

Question			Answer	Marks	Guidance	
7	(ii)		Let p = probability of a seed germinating (for the population)	B1	For definition of p	See below for additional notes
			H_0: $p = 0.85$	B1	For H_0	
			H_1: $p < 0.85$	B1	For H_1	
			H_1 has this form because the test is to investigate whether the proportion of seeds which germinate is lower.	E1 **[4]**	Dep on < 0.85 used in H_1 Do not allow just 'Germination rate will be lower' or similar.	For use of 0.15 as P(not germinating), contact team leader E0 for simply stating H_1 in words
7	(iii)		Let $X \sim B(20, 0.85)$ $P(X \leq 13) = 0.0219$	M1*	For probability (provided not as part of finding $P(X = 13)$) Ignore notation	No further marks if point probs used - $P(X = 13) = 0.0160$ DO NOT FT wrong H_1, but see extra notes Allow 'accept H_0' or 'reject H_1' Must include 'sufficient evidence' or something similar such as 'to suggest that' ie an element of doubt either in the A or E mark.
			$0.0219 > 1\%$	M1* dep	For comparison	
			So not enough evidence to reject H_0. Not significant.	A1*	For not significant oe	
			Conclude that there is not enough evidence to indicate that the proportion of seeds which have germinated has decreased.	E1* dep	For conclusion in context Must mention decrease, not just change	
			ALTERNATIVE METHOD – follow method above unless some mention of CR seen Critical region method			No marks if CR not justified Condone $\{0,1,2,\ldots, 12\}$, $X \leq 12$, oe but not $P(X \leq 12)$ etc
			LOWER TAIL $P(X \leq 13) = 0.0219 > 1\%$ $P(X \leq 12) = 0.0059 < 1\%$	M1	For either probability	Could get M1A0A1E1 if poor notation for CR Do not allow just '13 not in CR' - Must say 'not significant' or accept H_0 or similar
			So critical region is $\{0,1,2,3,4,5,6,7,8,9,10,11,12\}$	A1	cao dep on at least one correct comparison with 1%	
			13 not in CR so not significant	A1*		
			There is insufficient evidence to indicate that the proportion of seeds which have germinated has decreased.	E1* dep **[4]**		

Question			Answer	Marks	Guidance	
7	(iv)		33 < 35	M1	For comparison	Allow '33 lies in the CR' Must include 'sufficient evidence' or something similar such as 'to suggest that' ie an element of doubt either in the A or E mark.
			So there is sufficient evidence to reject H_0	A1*		Do not FT wrong H_1: In part (iv) ignore any interchanged H_0 and H_1 seen in part (ii)
			Conclude that there is enough evidence to indicate that the proportion of seeds which have germinated has decreased.	E1* dep **[3]**	For conclusion in context Must mention decrease, not just change	If use a calculator to find $P(X \leq 33) = 0.000661$ and compare with 1% then B2 for $P(X \leq 33) = 0.000661 < 0.01$ so reject H_0 then final E1 as per scheme.
7	(v)		For $n = 3$, $P(X \leq 0) = 0.0034 < 0.01$ For $n = 2$, $P(X \leq 0) = 0.0225 > 0.01$	M1 M1	For $P(X \leq 0) = 0.0034$ For $P(X \leq 0) = 0.0225$	Allow 0.003 Condone just '$n = 3$' for final A mark dep on both M marks
			So the least value of n for which the critical region is not empty and thus H_0 could be rejected is 3.	A1	CAO	If wrong H_1 allow max M2A0 if correct probabilities seen.
			ALTERNATIVE METHOD using logs $0.15^n < 0.01$ $n > \log 0.01 / \log 0.15$ $n > 2.427$ Least $n = 3$	 M1 M1 A1 **[3]**		

4766 Statistics 1

General Comments:

The majority of candidates coped well with this paper. A good number of candidates scored at least 60 marks out of 72 and there were quite a number who achieved full marks. There was no evidence of candidates being unable to complete the paper in the allocated time. As in previous years, 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.

Surprisingly many candidates seemed to cope better on the topics which are not part of GCSE than they did on Question 1, which is was a very standard GCSE topic. Candidates performed rather better on the conditional probability question, than in the past, although this topic still causes difficulties for many. The majority of candidates found Q4(ii) very difficult, with the many scoring at most 1 mark out of 3. In Question 5, many candidates did not provide a convincing explanation of why $k = 0.09$, with quite a number substituting $k = 0.09$ into the given formula and trying to show that the sum of the probabilities was 1. This was only given credit if there was very convincing working. The earlier parts of Question 7 on the binomial distribution and hypothesis testing was fairly well answered, with many candidates defining the hypotheses correctly, and also carrying out the hypothesis test correctly. In the last part of this question, candidates often found $P(X \leq 0)$ for $n = 3$ but omitted $P(X \leq 0)$ for $n = 2$, and so only scored one mark out of three. Most candidates supported their numerical answers with appropriate working, but when written explanations were required, as in Q6(v), the poor handwriting and in some cases the poor use of English of some candidates made it difficult to determine what they were trying to say.

Fortunately, rather fewer candidates lost marks due to over specification of some of their answers, than in past sessions. A number of candidates, did however over specify some of their answers, particularly in Q6(ii), where candidates often gave an answer of 63.416, some adding 'to 3dp', which they thought was appropriate accuracy. Of course it is the number of significant figures rather than the number of decimal places that is important, and giving an estimated mean to 5 significant figures is not sensible and so attracted a penalty.

Comments on Individual Questions:

Question No. 1(i)
Many candidates gained full credit. A common error which resulted in the loss of 2 marks was to plot the correct height but at mid-points. Only a few used the lower class boundaries. Some candidates drew cumulative frequency bars and a small number just plotted frequency against midpoints. Some candidates forgot to label their axes or more often omitted the word "cumulative" on their vertical axis.

Question No. 1 (ii)
This part was very well answered with many candidates picking up the follow through marks for correctly identifying the median and quartiles from their mid-point plotted graph.

Question No. 2 (i)
The vast majority of candidates were able to correctly construct the tree diagram although it did appear that quite a few needed two attempts (it looked as though there may have been some rubbing out under the final version). Only a very small number of candidates omitted any of the required labels or mixed up some of the probabilities, but these candidates were able to gain

follow through marks in subsequent parts of the question. A few candidates omitted the middle set of branches, or added extra sets following 'Accept' or 'Reject'.

Question No. 2 (ii)
This was generally very well answered.

Question No. 2 (iii)
Candidates found this part much more difficult and many gave an answer of 0.096, which is simply the probability that a candidate for the job is retested at least once and accepted, so not a conditional probability at all. This scored zero unless it was as the numerator of a fraction. Other candidates did have a fraction with the correct denominator but their numerator was incorrect.

Question No. 3 (i)
The majority of candidates who scored this mark showed that $P(L \cap R) = 0.099 \neq P(L) \times P(R) = 0.033$. Very few candidates gave the simplest explanation which is that $P(L|R) \neq P(L)$. For the former, candidates had to quote the correct probabilities, but for the latter the symbolic representation was adequate, as the probabilities were given in the question.

Question No. 3 (ii)
There were three common answers here. The majority correctly obtained 0.099, but some candidates multiplied the wrong probabilities together to obtain 0.033 or 0.0675. Brief working was generally given both for the correct and the incorrect answers

Question No. 3 (iii)
Most candidates gained full credit here, often from a follow through of a wrong answer to part (ii). Some candidates failed to subtract $P(L \cap R)$ away from P(L) and P(R) and but were still able to score one mark for the two labelled circles.

Question No. 4 (i)
This was generally well answered but those candidates who did struggle with this question often still managed to score the first mark for $^{16}/_{30}$ multiplied by another probability. There were very few over specified answers seen. A very small minority of candidates mixed up boys and girls but still gained SC2. Rather fewer candidates used the combinations method than the probability method, but those who did were usually successful.

Question No. 4 (ii)
This part was found to be rather difficult. The most successful method was to add together the probabilities of 'no boys' and 'no girls' then take the sum from 1. However, a significant number of candidates took each probability from 1 and then multiplied the resulting answers, which only scored one mark. Those considering the three possibilities 1g3b, 2g2b, 3g1b, often either omitted the coefficients of 4, 6 and 4 altogether or got at least one of them wrong, usually the middle coefficient, replacing 6 with either 4 or 5.

Question No. 5 (i)
A surprising number of candidates could not cope with the algebra required for this part, and whilst credit was given for the substitution method (if all working was shown) it is not a suitable method at this level. A significant number of candidates omitted the summation equal to 1 and so could only gain one mark out of three if their table was correct. A small number of candidates forgot to include the table.

Question No. 5 (ii)
This part was very well answered by the vast majority of candidates with many scoring all 5 marks. Solutions were well laid out, formulae quoted, and correct values for $E(X)$ and $Var(X)$ obtained. It is very pleasing to note that very few candidates made the mistake of dividing by 5,

as was more frequently seen in the past. Fortunately most candidates used the $E(X)^2 - E(X^2)$ method rather than the alternative – these latter often making calculation errors. A number of candidates had wrong probabilities. If their probabilities added to 1 they could still score three marks, but if not only two marks. Candidates should be advised always to check that their probabilities do actually add up to 1 in probability distribution questions.

Question No. 6 (i)
Most candidates found the frequency densities correctly. They usually then went on to draw the axes correctly although a few failed to start the frequency density scale at zero or to label the axes. A few candidates used inequalities on the horizontal axis, which attracted a penalty of one mark. The choice of scales on the vertical axis was not always ideal, and this left some candidates vulnerable to drawing the heights at incorrect positions. In particular the height of the first bar was frequently incorrectly plotted at 0.5 rather than 0.55.

Question No. 6 (ii)
The calculation of the mean of the grouped data was in most cases accurately performed using correct mid-points. The calculation of the standard deviation was less well executed. Whilst there were many correct solutions seen, some forgot to factor in the frequencies and worked with Σx^2 rather than Σfx^2. Over specification of either or both of the answers caused some candidates to lose one mark.

Question No. 6 (iii)
Most candidates scored at least the first two marks. However many omitted the fact that there were definitely no outliers at the top end of the data and/or stated that there were definitely some outliers present at the bottom end, thus missing the final mark.

Question No. 6 (iv)
This was generally very well answered.

Question No. 6 (v)
For this type of question candidates should be taught to discuss 'average' and 'variation'. Simply stating for example that the mean of A is lower than the mean of B does not attract any credit.

Question No. 7(I) a
This was generally very well answered.

Question No. 7(i) b
Although most candidates answered this correctly, some gave $P(X \leq 12)$ rather than $P(X \leq 11)$, and some found the required probability but then subtracted it from 1.

Question No. 7 (ii)
Most candidates wrote down the correct hypotheses using the correct notation. It is encouraging to report that rather more candidates gave a correct definition of p than was the case in previous years.

Question No. 7 (iii)
Those candidates who calculated $P(X \leq 13)$ were generally more successful than those using a critical region method. Those who used the latter method often got the critical region wrong, thereby losing credit. In general conclusions were given more clearly than in previous sessions, although not always in context. There was also rather less use of point probabilities than in the past.

Question No. 7 (iv)
Many candidates, despite having answered the previous part correctly, reverted to point probabilities in this part, using their calculator to find $P(X = 33)$. This of course gained no credit.

Others made a correct comparison (33 < 35) but were not always sure what this meant in the context of the test.

Question No. 7 (v)
Most candidates who knew how to tackle this question wrote down 'for $n = 3$, $P(X = 0) = 0.0034 < 0.01$'. However many did not then justify their answer by writing down $P(X = 0)$ for $n = 2$ and thus only gained one mark. There were very few successful attempts using logarithms.

For a description of how UMS marks are calculated see:
www.ocr.org.uk/learners/ums_results.html

Unit level raw mark and UMS grade boundaries June 2014 series

AS GCE / Advanced GCE / AS GCE Double Award / Advanced GCE Double Award

GCE Mathematics (MEI)

			Max Mark	a	b	c	d	e	u
4751/01	(C1) MEI Introduction to Advanced Mathematics	Raw	72	61	56	51	46	42	0
		UMS	100	80	70	60	50	40	0
4752/01	(C2) MEI Concepts for Advanced Mathematics	Raw	72	57	51	45	39	33	0
		UMS	100	80	70	60	50	40	0
4753/01	(C3) MEI Methods for Advanced Mathematics with Coursework: Written Paper	Raw	72	58	52	47	42	36	0
4753/02	(C3) MEI Methods for Advanced Mathematics with Coursework: Coursework	Raw	18	15	13	11	9	8	0
4753/82	(C3) MEI Methods for Advanced Mathematics with Coursework: Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
4753	(C3) MEI Methods for Advanced Mathematics with Coursework	UMS	100	80	70	60	50	40	0
4754/01	(C4) MEI Applications of Advanced Mathematics	Raw	90	68	61	54	47	41	0
		UMS	100	80	70	60	50	40	0
4755/01	(FP1) MEI Further Concepts for Advanced Mathematics	Raw	72	63	57	51	45	40	0
		UMS	100	80	70	60	50	40	0
4756/01	(FP2) MEI Further Methods for Advanced Mathematics	Raw	72	60	54	48	42	36	0
		UMS	100	80	70	60	50	40	0
4757/01	(FP3) MEI Further Applications of Advanced Mathematics	Raw	72	57	51	45	39	34	0
		UMS	100	80	70	60	50	40	0
4758/01	(DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	63	56	50	44	37	0
4758/02	(DE) MEI Differential Equations with Coursework: Coursework	Raw	18	15	13	11	9	8	0
4758/82	(DE) MEI Differential Equations with Coursework: Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
4758	(DE) MEI Differential Equations with Coursework	UMS	100	80	70	60	50	40	0
4761/01	(M1) MEI Mechanics 1	Raw	72	57	49	41	34	27	0
		UMS	100	80	70	60	50	40	0
4762/01	(M2) MEI Mechanics 2	Raw	72	57	49	41	34	27	0
		UMS	100	80	70	60	50	40	0
4763/01	(M3) MEI Mechanics 3	Raw	72	55	48	42	36	30	0
		UMS	100	80	70	60	50	40	0
4764/01	(M4) MEI Mechanics 4	Raw	72	48	41	34	28	22	0
		UMS	100	80	70	60	50	40	0
4766/01	(S1) MEI Statistics 1	Raw	72	61	53	46	39	32	0
		UMS	100	80	70	60	50	40	0
4767/01	(S2) MEI Statistics 2	Raw	72	60	53	46	40	34	0
		UMS	100	80	70	60	50	40	0
4768/01	(S3) MEI Statistics 3	Raw	72	61	54	47	41	35	0
		UMS	100	80	70	60	50	40	0
4769/01	(S4) MEI Statistics 4	Raw	72	56	49	42	35	28	0
		UMS	100	80	70	60	50	40	0
4771/01	(D1) MEI Decision Mathematics 1	Raw	72	51	46	41	36	31	0
		UMS	100	80	70	60	50	40	0
4772/01	(D2) MEI Decision Mathematics 2	Raw	72	46	41	36	31	26	0
		UMS	100	80	70	60	50	40	0
4773/01	(DC) MEI Decision Mathematics Computation	Raw	72	46	40	34	29	24	0
		UMS	100	80	70	60	50	40	0
4776/01	(NM) MEI Numerical Methods with Coursework: Written Paper	Raw	72	54	48	43	38	32	0
4776/02	(NM) MEI Numerical Methods with Coursework: Coursework	Raw	18	14	12	10	8	7	0
4776/82	(NM) MEI Numerical Methods with Coursework: Carried Forward Coursework Mark	Raw	18	14	12	10	8	7	0
4776	(NM) MEI Numerical Methods with Coursework	UMS	100	80	70	60	50	40	0
4777/01	(NC) MEI Numerical Computation	Raw	72	55	47	39	32	25	0
		UMS	100	80	70	60	50	40	0
4798/01	(FPT) Further Pure Mathematics with Technology	Raw	72	57	49	41	33	26	0
		UMS	100	80	70	60	50	40	0

GCE Statistics (MEI)

			Max Mark	a	b	c	d	e	u
G241/01	(Z1) Statistics 1	Raw	72	61	53	46	39	32	0
		UMS	100	80	70	60	50	40	0
G242/01	(Z2) Statistics 2	Raw	72	55	48	41	34	27	0
		UMS	100	80	70	60	50	40	0
G243/01	(Z3) Statistics 3	Raw	72	56	48	41	34	27	0
		UMS	100	80	70	60	50	40	0