OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

MATHEMATICS (MEI)

4766

Statistics 1

QUESTION PAPER

Candidates answer on the printed answer book.

OCR supplied materials:
- Printed answer book 4766
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Thursday 26 May 2011
Morning

Duration: 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

These instructions are the same on the printed answer book and the question paper.

- The question paper will be found in the centre of 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. 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.

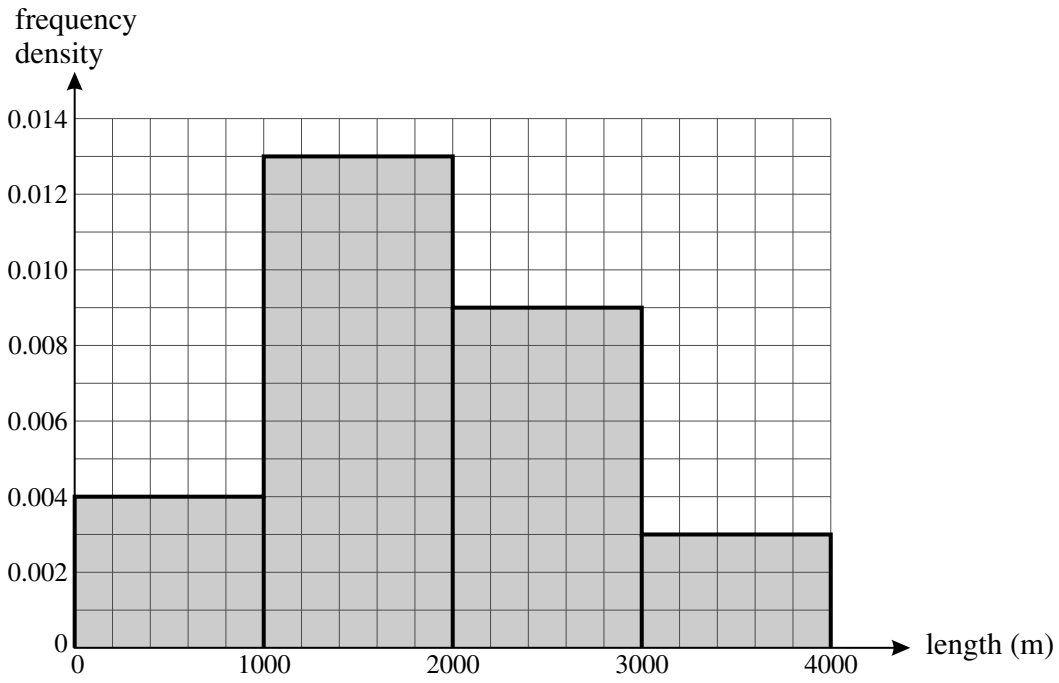
- The number of marks is given in brackets **[ ]** at the end of each question or part question on the question paper.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks 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 destroyed.

Section A (36 marks)

1 In the Paris-Roubaix cycling race, there are a number of sections of cobbled road. The lengths of these sections, measured in metres, are illustrated in the histogram.



(i) Find the number of sections which are between 1000 and 2000 metres in length. **[2]**

(ii) Name the type of skewness suggested by the histogram. **[1]**

(iii) State the minimum and maximum possible values of the midrange. **[2]**

2 I have 5 books, each by a different author. The authors are Austen, Brontë, Clarke, Dickens and Eliot.

(i) If I arrange the books in a random order on my bookshelf, find the probability that the authors are in alphabetical order with Austen on the left. **[2]**

(ii) If I choose two of the books at random, find the probability that I choose the books written by Austen and Brontë. **[3]**

3 25% of the plants of a particular species have red flowers. A random sample of 6 plants is selected.

(i) Find the probability that there are no plants with red flowers in the sample. **[2]**

(ii) If 50 random samples of 6 plants are selected, find the expected number of samples in which there are no plants with red flowers. **[2]**

4 Two fair six-sided dice are thrown. The random variable X denotes the difference between the scores on the two dice. The table shows the probability distribution of X.

r	0	1	2	3	4	5
$\mathrm{P}(X = r)$	$\frac{1}{6}$	$\frac{5}{18}$	$\frac{2}{9}$	$\frac{1}{6}$	$\frac{1}{9}$	$\frac{1}{18}$

(i) Draw a vertical line chart to illustrate the probability distribution. **[2]**

(ii) Use a probability argument to show that

(*A*) $\mathrm{P}(X = 1) = \frac{5}{18}$, **[2]**

(*B*) $\mathrm{P}(X = 0) = \frac{1}{6}$. **[1]**

(iii) Find the mean value of X. **[2]**

5 In a recent survey, a large number of working people were asked whether they worked full-time or part-time, with part-time being defined as less than 25 hours per week. One of the respondents is selected at random.

- W is the event that this person works part-time.
- F is the event that this person is female.

You are given that $\mathrm{P}(W) = 0.14$, $\mathrm{P}(F) = 0.41$ and $\mathrm{P}(W \cap F) = 0.11$.

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

(ii) Determine whether the events W and F are independent. **[2]**

(iii) Find $\mathrm{P}(W \mid F)$ and explain what this probability represents. **[3]**

6 The numbers of eggs laid by a sample of 70 female herring gulls are shown in the table.

Number of eggs	1	2	3	4
Frequency	10	40	15	5

(i) Find the mean and standard deviation of the number of eggs laid per gull. **[5]**

(ii) The sample did not include female herring gulls that laid no eggs. How would the mean and standard deviation change if these gulls were included? **[2]**

Section B (36 marks)

7 Any patient who fails to turn up for an outpatient appointment at a hospital is described as a 'no-show'. At a particular hospital, on average 15% of patients are no-shows. A random sample of 20 patients who have outpatient appointments is selected.

(i) Find the probability that

(*A*) there is exactly 1 no-show in the sample, **[3]**

(*B*) there are at least 2 no-shows in the sample. **[2]**

The hospital management introduces a policy of telephoning patients before appointments. It is hoped that this will reduce the proportion of no-shows. In order to check this, a random sample of n patients is selected. The number of no-shows in the sample is recorded and a hypothesis test is carried out at the 5% level.

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

(iii) In the case that $n = 20$ and the number of no-shows in the sample is 1, carry out the test. **[4]**

(iv) In another case, where n is large, the number of no-shows in the sample is 6 and the critical value for the test is 8. Complete the test. **[3]**

(v) In the case that $n \leqslant 18$, explain why there is no point in carrying out the test at the 5% level. **[2]**

8 The heating quality of the coal in a sample of 50 sacks is measured in suitable units. The data are summarised below.

Heating quality (x)	$9.1 \leqslant x \leqslant 9.3$	$9.3 < x \leqslant 9.5$	$9.5 < x \leqslant 9.7$	$9.7 < x \leqslant 9.9$	$9.9 < x \leqslant 10.1$
Frequency	5	7	15	16	7

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

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

(iii) Show that there are no outliers in the sample. **[3]**

(iv) Three of these 50 sacks are selected at random. Find the probability that

(*A*) in all three, the heating quality x is more than 9.5, **[3]**

(*B*) in at least two, the heating quality x is more than 9.5. **[4]**

OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

MATHEMATICS (MEI) 4766

Statistics 1

PRINTED ANSWER BOOK

Candidates answer on this printed answer book.

OCR supplied materials:
- Question paper 4766 (inserted)
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Thursday 26 May 2011
Morning

Duration: 1 hour 30 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

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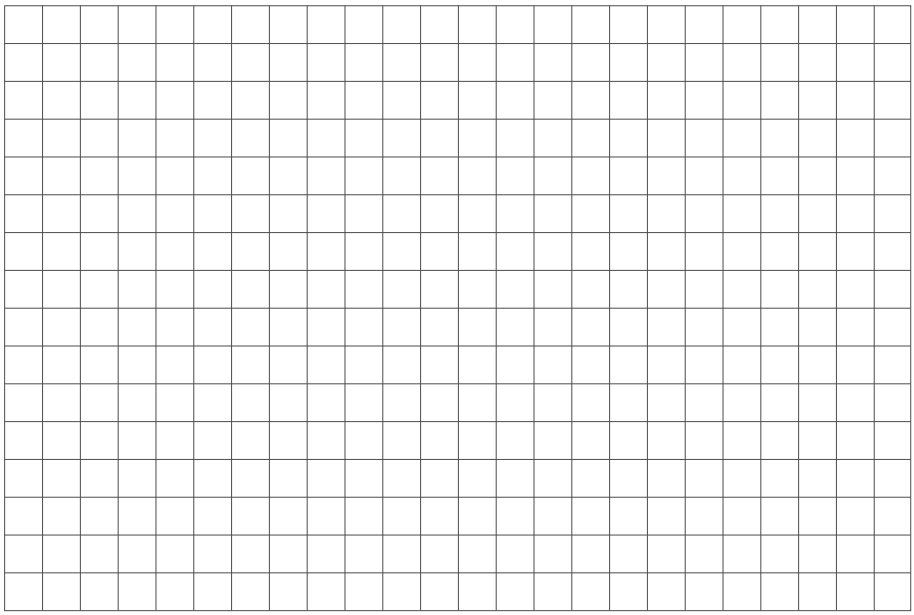
Section A (36 marks)

1 (i)	
1 (ii)	
1 (iii)	
2 (i)	
2 (ii)	

3 (i)	
3 (ii)	

4 (i)



4 (ii) (*A*)

4 (ii) (*B*)

4 (iii)

5 (i)	
5 (ii)	
5 (iii)	

6 (i)

6 (ii)

Section B (36 marks)

7 (i) (*A*)

7 (i) (*B*)

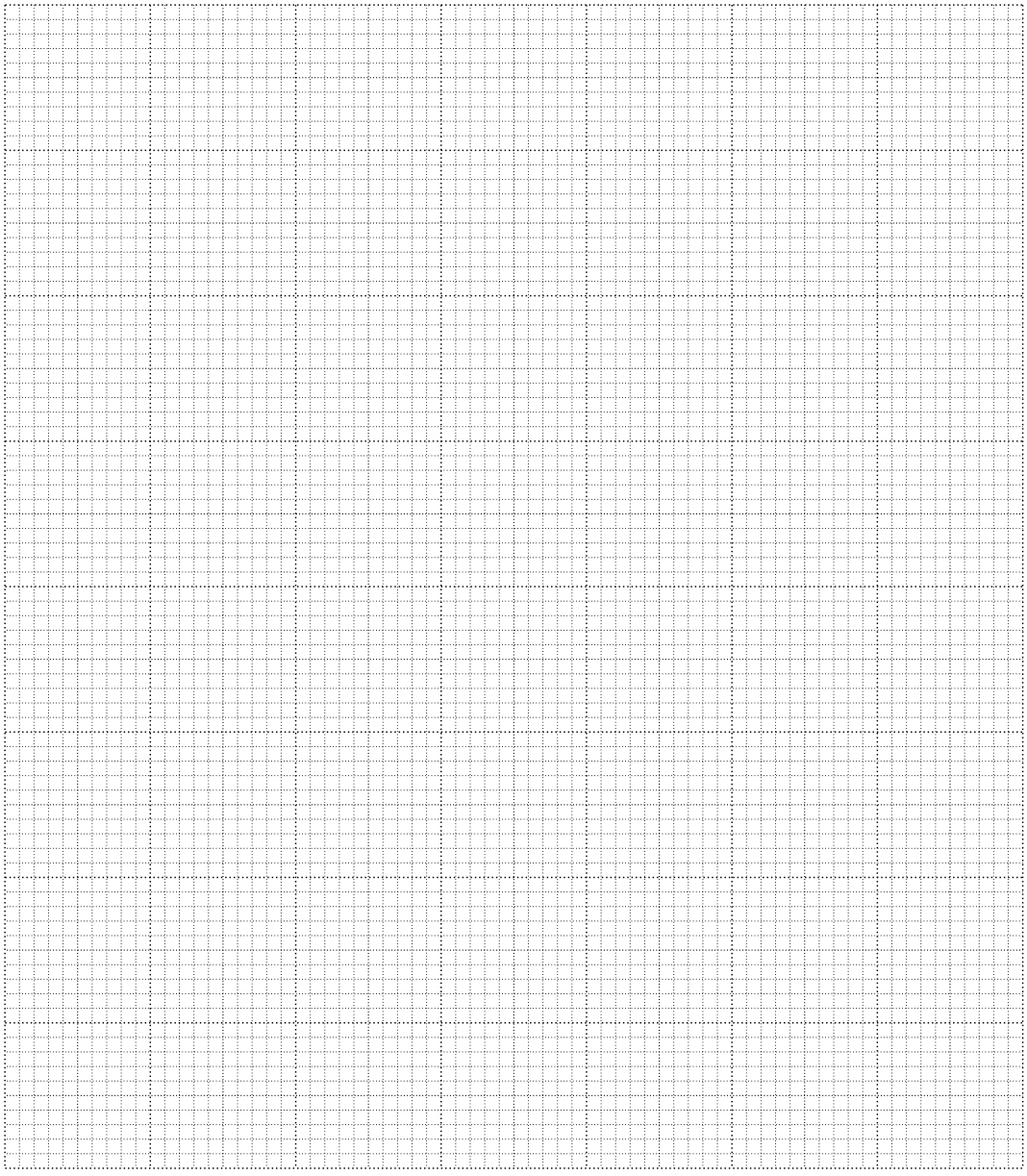
7 (ii)

7 (iii)

7 (iv)

7 (v)

8 (i)



8 (ii)

8 (iii)

8 (iv) (A)

8 (iv) (B)

OCR
RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced Subsidiary GCE

Unit **4766:** Statistics 1

Mark Scheme for June 2011

Oxford Cambridge and RSA Examinations

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of pupils of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, OCR Nationals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

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

Any enquiries about publications should be addressed to:

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E-mail: publications@ocr.org.uk

1. 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.

2. For answers scoring no marks, you must either award NR (no response) or 0, as follows:

   Award NR (no response) if:
   - Nothing is written at all in the answer space
   - There is a comment which does not in any way relate to the question being asked ("can't do", "don't know", etc.)
   - There is any sort of mark that is not an attempt at the question (a dash, a question mark, etc.)

   The hash key [#] on your keyboard will enter NR.

   Award 0 if:
   - There is an attempt that earns no credit. This could, for example, include the candidate copying all or some of the question, or any working that does not earn any marks, whether crossed out or not.

3. The following abbreviations may be used in this mark scheme.

M1	method mark (M2, etc, is also used)
A1	accuracy mark
B1	independent mark
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
ft	follow through
isw	ignore subsequent working
oe	or equivalent
rot	rounded or truncated
sc	special case
soi	seen or implied
www	without wrong working

4. Annotating scripts. The following annotations are available:

✓and ✗

BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working (after correct answer obtained)
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 is also available to highlight any particular points on a script.

5. The comments box will be used by the Principal Examiner to explain his or her marking of the practice scripts for your information. Please refer to these comments when checking your practice scripts.

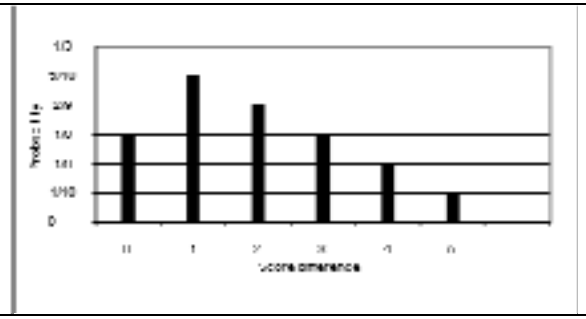
Please do not type in the comments box yourself. Any questions or comments you have for your Team Leader should be communicated by the *scoris* messaging system, e-mail or by telephone.

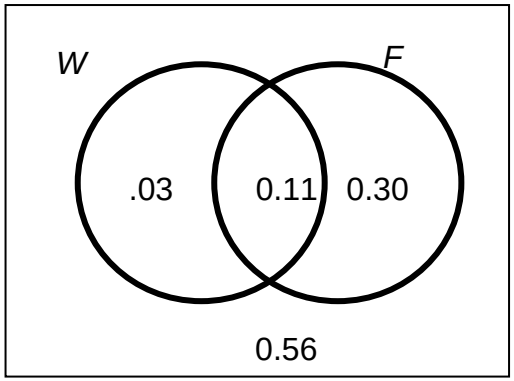
6. Write a brief report on the performance of the candidates. Your Team Leader will tell you when this is required. The Assistant Examiner's Report Form (AERF) can be found on the Cambridge Assessment Support Portal. This should contain notes on particular strengths displayed, as well as common errors or weaknesses. Constructive criticisms of the question paper/mark scheme are also appreciated.

7. Link Additional Objects with work relating to a question to those questions (a chain link appears by the relevant question number) – see scoris assessor Quick Reference Guide page 19-20 for instructions as to how to do this – this guide is on the Cambridge Assessment Support Portal and new users may like to download it with a shortcut on your desktop so you can open it easily! For AOs containing just formulae or rough working not attributed to a question, tick at the top to indicate seen but not linked. When you submit the script, *scoris* asks you to confirm that you have looked at all the additional objects. Please ensure that you have checked all Additional Objects thoroughly.

8. The schedule of dates for the marking of this paper is displayed under 'OCR Subject Specific Details' on the Cambridge Assessment Support Portal. It is vitally important that you meet these requirements. If you experience problems that mean you may not be able to meet the deadline then you must contact your Team Leader without delay.

	SECTION A			
Q1 (i)	$1000 \times 0.013 = 13$ Or $0.2 \times 65 = 13$ Or $0.2 \times 5 \times 13 = 13$	M1 A1 M1 for 0.2×65	**2**	Allow with or without working For MR $1000 \times 0.13 = 130$ Allow M1A0 Allow M1A0 if extra terms added eg 1000×0.004 SC1 for $1000 \times 0.014 = 14$ For whole calculation
(ii)	Positive	B1	**1**	Allow +ve but NOT skewed to the right Do not allow 'positive correlation'
(iii)	Minimum value = 1500 Maximum value = 2500	B1 Without wrong working B1 Without wrong working	**2**	Exact answers only unless good explanation such as eg no road has length zero so min is eg 1501 SC1 for lower answer between 1499 and 1501 and upper between 2499 and 2501 Allow answer given as inequality
		TOTAL	**5**	
Q2 (i)	Either P(alphabetic order) $= \frac{1}{5} \times \frac{1}{4} \times \frac{1}{3} \times \frac{1}{2} \times \frac{1}{1} = \frac{1}{120}$ or P(alphabetic order) $= \frac{1}{5!} = \frac{1}{120} = 0.00833$	M1 for 5! or 120 or ${}^5P_5$ seen or product of correct fractions A1 CAO	**2**	Allow 0.0083 or 1/120 but not 0.008
(ii)	Either P(picks Austen and Bronte) $= \frac{2}{5} \times \frac{1}{4} = \frac{1}{10}$ or P(picks Austen and Bronte) $= \frac{1}{5} \times \frac{1}{4} \times 2 = \frac{1}{10}$ or P(picks Austen and Bronte) $= \frac{1}{\binom{5}{2}} = \frac{1}{10}$	M1 for denominators M1 for $2\times$ *dep on correct denominators* A1 CAO Or M1 for $\binom{5}{2}$ or 10 M1 for $1/\binom{5}{2}$ A1 CAO	**3**	${}^5P_2$ scores M1 also 1/20 oe scores M1 even if followed by further incorrect working $\binom{5}{2}$ seen as part of a binomial expression gets M0M0A0
		TOTAL	**5**	

Q3 (i)	$P(X = 0) = 0.75^6 = 0.178$	M1 for 0.75^6 A1 CAO	**2**	Or from tables 0.1780 Or 729/4096 Allow 0.18 with working
(ii)	$E(X) = np = 50 \times 0.178 = 8.9$	M1 for product A1 FT	**2**	FT their answer to (i) providing it's a probability NB A0 if subsequently rounded
		TOTAL	**4**	
Q4 (i)		G1 labelled linear scales on both axes G1 heights	**2**	Accept *r* or *x* for horizontal label and p or better for vertical including probability distribution Visual check only Allow G1G0 for points rather than lines Bars must not be wider than gaps for second G1 Condone vertical scale 1, 2, 3, 4, 5 and Probability (×) 1/18 as label BOD for height of $r = 0$ on vertical axis
(ii)	(*A*) If $X = 1$, possible scores are (1,2), (2,3), (3,4), (4,5), (5,6) and (2,1), (3,2), (4,3), (5,4), (6,5) (All are equally likely) so probability = $\frac{10}{36} = \frac{5}{18}$	M1 A1	**2**	Also M1 for a clear correct sample space seen with the ten 1's identified by means of circles or ticks oe soi. Must be convincing. No additional values such as 0,1 and 1,0 Do not allow ' just 10 ways you can have a difference of 1 so 10/36' or equivalent SC1 for possible scores are (1,2), (2,3), (3,4), (4,5), (5,6) so probability = 2 × 5 × 1/36 with no explanation for 2 ×
	(*B*) If $X = 0$, possible scores are (1,1), (2,2), (3,3), (4,4), (5,5), (6,6) so probability = $\frac{6}{36} = \frac{1}{6}$	B1	**1**	Also B1 for a clear correct sample space seen with the six 0's identified by means of circles or ticks oe soi. Must be convincing. No additional values. Allow both dice must be the same so probability = 6/36 = 1/6. Allow 1 × 1/6= 1/6 BOD
(iii)	Mean value of $X = 0 \times \frac{1}{6} + 1 \times \frac{5}{18} + 2 \times \frac{2}{9} + 3 \times \frac{1}{6} + 4 \times \frac{1}{9} + 5 \times \frac{1}{18} = 1\frac{17}{18} = 1.94$	M1 for Σrp (at least 3 terms correct) A1 CAO	**2**	Or 35/18 Division by 6 or other spurious factor gets MAX M1A0
		TOTAL	**7**	

Q5 (i)		G1 for two labelled intersecting circles G1 for at least 2 correct probabilities. G1 for remaining correct probabilities	**3**	Allow labels such as P(W) and P(F) Allow other sensible shapes in place of circles
(ii)	P(W) × P(F) = 0.14 × 0.41 = 0.0574 ≠ P($W \cap F$) = 0.11 So not independent.	M1 for 0.41 × 0.14 A1 Condone dependent Must have full method www Must have either P($W \cap F$) or 0.11	**2**	Answer of 0.574 gets Max M1A0 Omission of 0.0574 gets M1A0 Max Or: P(W|F) = 0.11/0.41 = 0.268 ≠ P(W) (= 0.14) M1 for full working P(F|W) = 0.11/0.14 = 0.786 ≠ P(F) (= 0.41) M1 for full working No marks without correct working
(iii)	$P(W \mid F) = \frac{P(W \cap F)}{P(F)} = \frac{0.11}{0.41} = \frac{11}{41} = 0.268$ This is the probability that a randomly selected respondent works (part time), given that the respondent is female.	M1 for correct fraction A1 E1 For E1 must be in context – not just talking about events F and W	**3**	Allow 0.27 with working Allow 11/41 as final answer Condone 'if' or 'when' for 'given that' but not the words 'and' or 'because' or 'due to' for E1. E1 (independent of M1): the order/structure must be correct i.e. no reverse statement Allow 'The probability that a randomly selected female respondent works part time' oe
		TOTAL	**8**	

Q6 (i)	Mean $= \frac{1\times10+2\times40+3\times15+4\times5}{70} = \frac{155}{70} = 2.214$ S_{xx} = $1^2\times10+2^2\times40+3^2\times15+4^2\times5-\frac{155^2}{70} = 385-343.21 = 41.79$ $s = \sqrt{\frac{41.79}{69}} = 0.778$	M1 A1 CAO M1 for Σfx^2 s.o.i. M1 for attempt at S_{xx} Dep on first M1 A1 CAO If 0.778 or better seen ignore previous incorrect working (calculator answer) Allow final answer to 2 sig fig (www)	**5**	For M1 allow sight of at least 3 double pairs seen from $1\times10+2\times40+3\times15+4\times5$ with divisor 70. Allow answer of 155/70 or 2.2 or 2.21 or 31/14 oe For 155/70 = eg 2.3 , allow A1 isw M1 for $1^2\times10+2^2\times40+3^2\times15+4^2\times5$ with at least three correct terms Using exact mean leads to S_{xx} = 41.79 , s=0.778, Using mean 2.214 leads to S_{xx} = 41.87 , s=0.779, Using mean 2.21 leads to S_{xx} = 43.11 and s = 0.790 Using mean 2.2 leads to S_{xx} = 46.2 and s = 0.818 Using mean 2 leads to S_{xx} = 105 and s = 1.233 All the above get M1M1A1 except the last one which gets M1M1A0 RMSD(divisor *n* rather than *n* – 1) =√(41.79/70) = 0.772 gets M1M1A0 Alternative method, award M1for at least 3 terms of and second M1 for all 4 terms of $(1-2.214)^2\times10+(2-2.214)^2\times40+(3-2.214)^2\times15+(4-2.214)^2\times5 (=41.79)$ NB Allow full credit for correct answers without working (calculator used)
(ii)	Mean would decrease Standard deviation would increase	B1 B1	**2**	Do not accept increase/decrease seen on their own – must be linked to mean and SD. Allow eg 'It would skew the mean towards zero' And eg ' It would stretch the SD' SC1 for justified argument that standard deviation might either increase or decrease according to number with no eggs (n≤496 increase, n≥497 decrease)
		TOTAL	**7**	

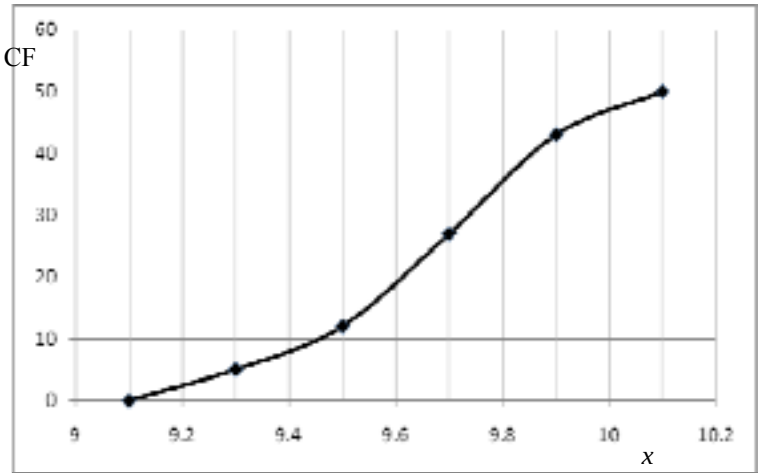
	SECTION B			
Q7 (i)	$X \sim B(20, 0.15)$ **(*A*)** *Either* $P(X = 1) = \binom{20}{1} \times 0.15^1 \times 0.85^{19} = 0.1368$ *or* $P(X = 1) = P(X \le 1) - P(X \le 0)$ $= 0.1756 - 0.0388 = 0.1368$	M1 $0.15^1 \times 0.85^{19}$ M1 $\binom{20}{1} \times p^1 q^{19}$ A1 CAO OR: M2 for $0.1756 - 0.0388$ A1 CAO	**3**	With $p + q = 1$ Allow answer 0.137 with or without working or 0.14 if correct working shown See tables at the website http://www.mei.org.uk/files/pdf/formula_book_mf2.pdf For misread of tables $0.3917 - 0.1216 = 0.2701$ allow M1M1A0 also for $0.1304 - 0.0261 = 0.1043$
	(*B*) $P(X \ge 2) = 1 - P(X \le 1)$ $= 1 - 0.1756 = 0.8244$	M1 for 1 – their 0.1756 A1 CAO	**2**	Provided 0.1756 comes from $P(X=0) + P(X=1)$ Allow answer 0.824 with or without working or 0.82 if correct working shown Point probability method: $P(1) = 0.1368$, $P(0) = 0.0388$ So $1 - P(X \le 1) = 1 - 0.1756$ gets M1 then mark as per scheme M0A0 for $1 - P(X \le 1) = 1 - 0.4049 = 0.5951$ For misread of tables $1 - 0.3917 = 0.6083$ allow M1A1 also for $1 - 0.1304 = 0.8696$ provided consistent with part (*A*) OR M1A0 if formula used in part (*A*)

(ii)	Let $X \sim B(n, p)$ Let p = probability of a 'no-show' (for population) H_0: $p = 0.15$ H_1: $p < 0.15$ H_1 has this form because the hospital management hopes to reduce the proportion of no-shows.	B1 for definition of p B1 for H_0 B1 for H_1 E1 Allow correct answer even if H_1 wrong	**4**	Allow p = P(no-show) for B1 Definition of p must include word probability (or chance or proportion or percentage or likelihood but NOT possibility). Preferably as a separate comment. However can be at end of H_0 as long as it is a clear definition ' p = the probability of no-show, NOT just a sentence 'probability is 0.15' H_0 : p(no-show) = 0.15, H_1 : p(no-show) < 0.15 gets B0B1B1 Allow p=15%, allow θ or π and ρ but not x. However allow any single symbol <u>if defined</u> Allow $H_0 = p$=0.15, Do not allow H_0 : P(X=x) = 0.15, H_1 : P(X=x) < 0.15 Do not allow H_0: =0.15, =15%, P(0.15), p(0.15), p(x)=0.15, x=0.15 (unless x correctly defined as a probability) Do not allow H_1:$p \leq 0.15$, Do not allow H_0 and H_1 reversed for B marks but can still get E1 Allow NH and AH in place of H_0 and H_1 For hypotheses given in words allow Maximum B0B1B1E1 Hypotheses in words must include probability (or chance or proportion or percentage) and the figure 0.15 oe.
(iii)	P($X \leq 1$) = 0.1756 > 5% So not enough evidence to reject H_0. Not significant. Conclude that there is not enough evidence to indicate that the proportion of no-shows has decreased.	M1 for probability seen, but not in calculation for point probability M1 dep for comparison A1	**4**	Zero for use of point prob - P(X = 1) = 0.1368 Do <u>NOT</u> FT wrong H_1 Allow accept H_0, or reject H_1 Full marks only available if 'not enough evidence to…' oe mentioned somewhere Do not allow 'enough evidence to reject H_1' for final mark but can still get 3/4 Upper end comparison: 1 – 0.1756 = 0.8244 < 95% gets

	Note: use of critical region method scores M1 for region {0} M1 for 1 does not lie in critical region, then A1 E1 as per scheme	E1 dep for conclusion in context.		M2 then A1E1 as per scheme Line diagram method M1 for squiggly line between 0 and 1 with arrow pointing to left, M1 0.0388 seen on diagram from squiggly line or from 0, A1E1 for correct conclusion Bar chart method M1 for line clearly on boundary between 0 and 1 and arrow pointing to left, M1 0.0388 seen on diagram from boundary line or from 0, A1E1 for correct conclusion
(iv)	$6 < 8$ So there is sufficient evidence to reject H_0 Conclude that there is enough evidence to indicate that the proportion of no-shows appears to have decreased.	M1 for comparison seen A1 E1 for conclusion in context	**3**	Allow '6 lies in the CR' Do NOT insist on 'not enough evidence' here Do not FT wrong H_1:p>0.15 but may get M1 In part (iv) ignore any interchanged H_0 and H_1 seen in part (ii)
(v)	For $n \leq 18$, $P(X \leq 0) > 0.05$ so the critical region is empty.	E1 for $P(X \leq 0) > 0.05$ E1 indep for critical region is empty	**2**	E1 also for sight of 0.0536 Condone $P(X = 0) > 0.05$ or all probabilities or values, (but not outcomes) in table (for $n \leq 18$) > 0.05 Or 'There is no critical region' For second E1 accept 'H_0 would always be accepted' Do NOT FT wrong H_1 Use professional judgement - allow other convincing answers
		TOTAL	**18**	

Q8 (i)

Upper Bound	9.1	9.3	9.5	9.7	9.9	10.1
Cumulative frequency	0	5	12	27	43	50



B1 for cumulative frequencies

May be implied from graph. Condone omission of 0 at this stage.

G1 for scales

Linear horizontal scale.
Linear vertical scale: 0 to 50
(no inequality scales - Not even <9.1, <9.3, <9.5 …)

G1 for labels

Heating quality or *x* and Cumulative frequency or just CF or similar but not just frequency or fd nor cumulative fd

G1 for points (Provided plotted at correct UCB positions)

5

Plotted as (UCB, their cf). Ignore (9.1,0) at this stage. No midpoint or LCB plots.
Plotted within ½ small square

G1 for joining points

For joining all of 'their points' (line or smooth curve) AND now including (9.1,0) dep on previous G1

All G's dep on attempt at cumulative frequency but not cumulative fx's or other spurious values.

Mid point or LCB plots may score first three marks

Can get up to 3/5 for cum freq bars
Allow full credit if axes reversed correctly

Lines of best fit could attract max 4 out of 5.

(ii) Median = 9.67

B1 FT
Allow answers between 9.66 and 9.68 without checking curve.
Otherwise check curve.

3

Based on 25th to 26th value on a cumulative frequency graph
ft their mid-point plot (not LCB's) approx 9.57 for m.p. plot Allow 9.56 to 9.58 without checking
B0 for interpolation

	Q1 = 9.51 Q3 = 9.83 Inter-quartile range = 9.83 – 9.51 = 0.32	B1 FT for Q3 or Q1 B1 FT for IQR providing both Q1 and Q3 are correct Allow answers between 9.50 and 9.52 and between 9.82 and 9.84 without checking curve. Otherwise check curve.		Based on 12th to 13th and 37th to 38th values on a cumulative frequency graph ft their mid -point plot (not LCB's) approx Q1 = 9.42; Q3 = 9.73 Allow 9.41 to 9.43 and 9.72 to 9.74 without checking B0 for interpolation Allow correct IQR from graph if quartiles not stated Lines of best fit: B0 B0 B0 here.
(iii)	Lower limit 9.51 – 1.5 × 0.32 = 9.03 Upper limit 9.83 + 1.5 × 0.32 = 10.31 Thus there are no outliers in the sample.	B1 FT their Q_1, IQR B1 FT their Q_3, IQR E1 NB E mark dep on both B marks	**3**	Any use of <u>median</u> ± 1.5 IQR scores B0 B0 E0 If FT leads to limits above 9.1 or below 10.1 then E0 No marks for ± 2 or 3 IQR In this part FT their values from (ii) if sensibly obtained (eg from LCB plot) or lines of best fit, but not from location ie 12.5, 37.5 or cumulative fx's or similar. For use of mean ± 2s, Mean = 9.652, s = 0.235, Limits 9.182, 10.122 gets M1 for correct lower limit, M1 for correct upper limit, zero otherwise, but E0 since there could be outliers using this definition
(iv)	(*A*) P(All 3 more than 9.5) = $\frac{38}{50}\times\frac{37}{49}\times\frac{36}{48}=0.4304$ (=50616/117600 = 2109/4900)	M1 for 38/50 × (triple product) M1 for product of remaining fractions A1 CAO	**3**	$(38/50)^3$ which gives answer 0.4389 scores M1M0A0 so watch for this. M0M0A0 for binomial probability including 0.76^{100} but ${}^3C_0\times0.24^0\times0.76^3$ still scores M1 $(k/50)^3$ for values of *k* other than 38 scores M0M0A0 $\frac{k}{50}\times\frac{(k-1)}{49}\times\frac{(k-2)}{48}$ for values of *k* other than 38 scores M1M0A0 Correct working but then multiplied or divided by some factor scores M1M0A0

	(B) P(At least 2 more than 9.5) $= 3\times\frac{38}{50}\times\frac{37}{49}\times\frac{12}{48}+0.4304$ $= 3 \times 0.1435 + 0.4304$ $= 0.4304 + 0.4304$ $= 0.861$ (=101232/117600 = 4218/4900 = 2109/2450) OR P(At least 2 more than 9.5) = 1 – (P(0) + P(1)) $= 1-\left[\left(\frac{12}{50}\times\frac{11}{49}\times\frac{10}{48}\right)+\left(3\times\frac{12}{50}\times\frac{11}{49}\times\frac{38}{48}\right)\right]$ = 1 – [0.01122 + 0.12796] = 1 – 0.13918 = 0.861	M1 for product of 3 correct fractions seen M1 for 3 × a sensible triple or sum of 3 sensible triples M1 indep for + 0.4304 FT (providing it is a probability) A1 CAO M1 for 12/50×11/49×38/48 M1 for 3 × a sensible triple or sum of 3 sensible triples M1 dep on both previous M1's for 1 –[0.01122 + 0.12796] A1 CAO	**4**	Accept 0.43 with working and 0.430 without working Or $\binom{38}{3}/\binom{50}{3}$ = 2109/4900 = 0.4304 Allow unsimplified fraction as final answer 50616/117600 Or $\binom{38}{2}\binom{12}{1}/\binom{50}{3}$=0.4304 gets first two M1M1's SC1 for $3\times\frac{38}{50}\times\frac{38}{50}\times\frac{12}{50}$ or other sensible triple and SC2 if this + their 0.4304 (= 0.8549) Allow 0.86 or 2109/2450 or 4218/4900, but only M3A0 for other unsimplified fractions Use of 1 – method 'with replacement' SC1 for $3\times\frac{12}{50}\times\frac{12}{50}\times\frac{38}{50}$ SC2 for whole of 1 - $3\times\frac{12}{50}\times\frac{12}{50}\times\frac{38}{50}+\frac{12}{50}\times\frac{12}{50}\times\frac{12}{50}$ (= 1 – (0.1313 + 0.0138) = 1 – 0.1451 = 0.8549)
		TOTAL	**18**	

NOTE RE OVER-SPECIFICATION OF ANSWERS

If answers are grossly over-specified (see instruction 8), deduct the final answer mark in every case. Probabilities should also be rounded to a sensible degree of accuracy. In general final non probability answers should not be given to more than 4 significant figures. Allow probabilities given to 5 sig fig. In general accept answers which are correct to 3 significant figures when given to 4 or 5 significant figures.

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4766: Statistics 1

General Comments

The level of difficulty of the paper appeared to be appropriate for the candidates and there was no evidence of candidates being unable to complete the paper in the allocated time. Most candidates appeared to be well prepared for the paper with relatively few unable to gain many marks. Most candidates supported their numerical answers with appropriate explanations and working. Presentation was generally good although, when explanations were required, some candidates made it difficult for us to apply the mark scheme because of poor handwriting and poor use of English. Fortunately 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. Once again many candidates over-specified some of their answers, despite recent Examiner's reports warning against this. Please see the comments about this in the Chief Examiner's report.

The hypothesis testing in question 7 caused problems for many candidates and there was still quite a lot of use of point probabilities in their arguments. Question 6 and the first three parts of question 8 provided valuable sources of marks for most candidates. However question 8(iv)B proved too difficult for all but the most able. There were few correct answers to question 1(iii), suggesting that 'midrange' is a measure of average which receives little attention. In question 4(ii) many candidates failed to understand what is required for a probability argument, despite this phrase having been used in past papers. Candidates should also be reminded to label any graphs that they draw and make sure their scales are uniform. Many lost vital marks by violating these basic requirements.

Comments on Individual Questions

1 In part (i) candidates were able to make a successful start to the paper by realising that the frequency was equal to the frequency density $\times$ class width. Most gained the expected answer of 13 but occasionally the examiners saw 14 (due to a misread of the vertical scale) or 130 (due to not being able to multiply by 1000 correctly).

In part (ii), the vast majority of candidates recognised that the distribution was positively skewed but some still insist on using the unacceptable terms of 'right skew' or 'symmetrical skew'.

Part (iii) defeated many candidates. Whilst many understood the idea of the mid-range, few were able to apply it in the context of the question. Very few appreciated that the maximum mid-range could only be found by averaging the highest value in the last class with highest value in the first class to give (4000 + 1000)/2 = 2500. Many wrote (4000 + 0)/2 = 2000 as their response here. Similarly, the minimum mid- range could only be found by averaging the lowest value in the last class with lowest value of the first class to yield (3000 + 0)/2 = 1500.

2 Part (i) was successfully answered by most candidates.

Many candidates gained only 1 mark out of 3 in part (ii), giving an answer of (1/5) x (1/4) = 1/20, failing to realise that Austen could be picked first followed by Brontë, or vice versa, hence requiring their answer to be multiplied by 2.

3 Part (i) was usually answered correctly, the standard correct response being $(0.75)^6$ = 0.178. However a surprising number of candidates thought that the probability was just 0.75.

In part (ii) the expectation was usually found correctly by multiplication of 0.178 by 50 but occasionally some used 300 instead. Candidates should be reminded not to round their final answer in an expectation calculation. There were too many cases of 8.9 being rounded to 9 which lost the final mark. Candidates who had got the wrong answer to part (i) were allowed a full follow through in part (ii).

4 Part (i) was generally well answered. Candidates who used fractions (in multiples of 1/18) on their probability scale usually scored full marks. Candidates who used decimals made the question more difficult, which often led to inaccurate heights and a loss of one mark. Some candidates lost the first mark due to failure to label both axes.

In part (ii) parts A and B, a significant number of candidates failed to understand the questions by thinking that they had to use the probability distribution given, subtracting the other probabilities from 1, but there was no actual probability argument evident. Those who did begin to identify combinations with a difference of one often did not recognize that the order mattered and then claimed that there were only 18 possible outcomes in order to make the numbers fit the given answer. Most candidates who were successful compiled a two way table of all of the possibilities. A correct numerical method which lacked the essential explanation of where it had come from was fairly commonly seen.

In part (iii), a large majority used a correct method, but a surprising number did not realise that expectation and mean are interchangeable in this context and consequently they divided by 6 or some other number.

5 Many candidates got full marks for their Venn diagram in part (i). A minority failed to subtract 0.11 from 0.41 and 0.14 but even these usually produced two intersecting circles labelled correctly to get the first mark. A few candidates did not work out the probability for the fourth region (0.56).

Part (ii) was answered fairly well and showed that many candidates know how to test for independence, although surprisingly candidates often used the probabilities from their Venn diagram rather than those from the question. Some candidates failed to evaluate 0.14 x 0.41 and consequently lost the accuracy mark. A minority of candidates, having correctly completed the working, then got the conclusion the wrong way round. A small number of candidates used a conditional probability method, not always correctly.

Part (iii) was also answered fairly well, but again a significant number of candidates used the wrong figures from their Venn diagram. An impressively large proportion of candidates did get the correct explanation of what this probability represented but several missed out this mark because they did not explain the conditional probability in the context of the question.

6 In part (i) most candidates found the mean correctly and whilst decimal answers were frequently over-specified candidates gained the mark for giving the answer in fractional form, even if subsequently over-specified. Most candidates made a good attempt at the standard deviation; the main errors were the usual ones - calculating the rmsd instead of the standard deviation, incorrect squaring when calculating $\sum fx^2$ or using n=4 instead of n=70. The number of candidates who simply used the statistical functions on their calculator was fairly small, despite this being the easiest way to do the question.

In part (ii) many candidates found the mean correctly but thought that the standard deviation remained unchanged. Those candidates who understood that standard deviation is a measure of deviation were usually able to see clearly that the deviations would (tend to) be increased. Those who tried to reason their way through the formula usually came to the wrong conclusion. A very few very able candidates correctly said that if the number of gulls laying no eggs was very large (over around 500) then the standard deviation would decrease.

7 Part (i)A was generally answered correctly, although when using the binomial formula, a few candidates forgot to round off sensibly.

Part (i)B was found to be slightly more difficult. Most candidates used tables but some went wrong by calculating $1 - P(X < 1)$ or $1 - P(X \leq 2)$. A reasonable number of candidates first found $P(X = 0)$ and then usually went on to finish off the question correctly.

In part (ii) most candidates correctly stated their hypotheses in terms of p, but then often lost the available mark for defining p. Most were able to give an explanation of the reason for the nature of the alternative hypothesis.

In parts (iii), (iv) and (v), too many candidates forgot to state their conclusions in context. This is required in every exam and so teachers should be careful to instruct their students to do this.

Part (iii) was a relatively easy hypothesis test, since it was a lower tail test. However, many candidates (almost half of the candidature) used point probabilities and thus gained no marks. Of those who gained some credit, most either got full marks, or lost the final mark for conclusion in context.

In part (iv) some candidates wasted a lot of time for these 3 marks, testing out trial distributions for large n. Candidates should appreciate that, with only 3 marks at stake, there must be a more tractable solution. In fact all that was required was a comparison of the test statistic with the critical value, followed by a conclusion in context. In fact, only one third of the candidature gained any marks at all.

Part (v) was expecting candidates to give a valid reason for the critical region being empty. A number of fully correct solutions were seen, and the question was generously marked, so that candidates who got some way to an explanation gained one mark.

8 In part (i) most candidates scored at least three marks. Many did not explicitly write down their calculations for the cumulative frequency, preferring to plot their points directly on the graph, but still gained the mark. Scales were usually correct and sensible but some candidates used a linear horizontal scale starting from zero, which made a very cramped graph. Labels were often forgotten altogether and the vertical scale was often seen as just 'frequency', losing the mark. Points were usually plotted correctly at the right height but far too often were plotted at the mid-points i.e. 9.2, 9.4 etc. losing the final 2 marks. Only a few candidates used the lower class boundaries. Many candidates lost the final mark by not joining (9.3, 5) to (9.1, 0). Cumulative frequency bars were sometimes seen as were lines of best fit. Occasionally no attempt was made at a cumulative frequency graph at all, with some candidates just plotting frequency against midpoints or attempting to find frequency density.

Part (ii) was generally well answered often from a follow through from a 'sensible' graph. Some of the scales used in part (i) meant that it was very difficult to read the figures if they fell outside the allowed ranges. The 12th value was often used instead of the 12.5th value, perhaps because it was easier to read as there was a point plotted there. A few candidates failed to calculate the IQR even though both quartiles were found.

There were many correct answers to part (iii) (or correct ft answers) but many candidates tried to use the median or twice the IQR. A few candidates reverted to calculating and using the mean and standard deviation, gaining up to 2 marks out of 3 although they could not gain the last mark because, with this method, outliers could exist.

In part (iv)(A) only the better candidates obtained the correct answer. Many used $(38/50)^3$ scoring one mark only. Others candidates had more complicated incorrect versions of binomial probabilities. Occasionally the numerators decreased but the denominators did not. Some candidates did not find the correct value of 38 from the table.

Part (iv)(B) was found very challenging and only about ten percent of candidates gained full credit. Many candidates scored one mark for adding their answer from part (A), but otherwise a common incorrect answer of 0.8549 was often seen, which scored SC2. Some candidates thought that they had to multiply only two probabilities when finding the probability of two being more than 9.5. Many candidates did not realise that there were three different ways of getting two more than 9.5. Those candidates who drew tree diagrams fared better here, and in realising that the probabilities diminished. Those candidates attempting 1 - (P(0) + P(1)) were on the whole not as successful, sometimes not including both probabilities or failing to include the factor of 3.

GCE Mathematics (MEI)

			Max Mark	a	b	c	d	e	u
4751/01	(C1) MEI Introduction to Advanced Mathematics	Raw	72	55	49	43	37	32	0
		UMS	100	80	70	60	50	40	0
4752/01	(C2) MEI Concepts for Advanced Mathematics	Raw	72	53	46	39	33	27	0
		UMS	100	80	70	60	50	40	0
4753/01	(C3) MEI Methods for Advanced Mathematics with Coursework: Written Paper	Raw	72	54	48	42	36	29	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	63	56	50	44	38	0
		UMS	100	80	70	60	50	40	0
4755/01	(FP1) MEI Further Concepts for Advanced Mathematics	Raw	72	59	52	45	39	33	0
		UMS	100	80	70	60	50	40	0
4756/01	(FP2) MEI Further Methods for Advanced Mathematics	Raw	72	55	48	41	34	27	0
		UMS	100	80	70	60	50	40	0
4757/01	(FP3) MEI Further Applications of Advanced Mathematics	Raw	72	55	48	42	36	30	0
		UMS	100	80	70	60	50	40	0
4758/01	(DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	63	57	51	45	39	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	60	52	44	36	28	0
		UMS	100	80	70	60	50	40	0
4762/01	(M2) MEI Mechanics 2	Raw	72	64	57	51	45	39	0
		UMS	100	80	70	60	50	40	0
4763/01	(M3) MEI Mechanics 3	Raw	72	59	51	43	35	27	0
		UMS	100	80	70	60	50	40	0
4764/01	(M4) MEI Mechanics 4	Raw	72	54	47	40	33	26	0
		UMS	100	80	70	60	50	40	0
4766/01	(S1) MEI Statistics 1	Raw	72	53	45	38	31	24	0
		UMS	100	80	70	60	50	40	0
4767/01	(S2) MEI Statistics 2	Raw	72	60	53	46	39	33	0
		UMS	100	80	70	60	50	40	0
4768/01	(S3) MEI Statistics 3	Raw	72	56	49	42	35	28	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	45	39	33	27	0
		UMS	100	80	70	60	50	40	0
4772/01	(D2) MEI Decision Mathematics 2	Raw	72	58	53	48	43	39	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	62	55	49	43	36	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