OCR
Oxford Cambridge and RSA

Wednesday 23 May 2018 – 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

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**. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- 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 barcodes.
- 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 **8** 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 During a storm in the English Channel, the heights in metres of a random sample of 20 waves were measured. The heights are given below.

9.5	8.8	8.9	8.0	7.3	8.5	7.4	8.6	9.0	7.7
6.9	8.0	6.7	8.8	7.8	9.0	9.2	5.9	8.3	9.3

(i) Construct a sorted stem and leaf diagram to represent these data, taking stem values of 5, 6, 7, 8, 9. **[3]**

(ii) Comment on the skewness of the data. **[1]**

(iii) Write down the median and midrange of the data. **[2]**

(iv) Give one reason why the median is a better measure of central tendency for these data than the midrange. **[1]**

2 Each morning, Peter either cycles or drives to work. For any day, the probability that he drives is 0.25. If he drives, the probability that he arrives late for work is 0.2. The overall probability that he is late for work on any day is 0.08.

For a randomly chosen day,

- D is the event that Peter drives to work,
- L is the event that Peter arrives late for work.

(i) (*A*) Find $P(D \cap L)$. **[2]**

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

(ii) Determine whether or not the events D and L are independent, justifying your answer. **[2]**

3 A wheelchair rugby squad of 12 people has to be chosen from a group of 14 women and 11 men.

(i) How many different squads are possible? **[2]**

(ii) The team coach decides that the squad must consist of equal numbers of women and men.

(*A*) How many different squads are possible now? **[2]**

(*B*) There are 4 players from the squad on the court at any time. Assuming that all possibilities are equally likely, find the probability that all of the players from the squad who are on the court are women. **[3]**

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

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

(i) Show that the value of k is $\frac{1}{220}$ and, using this value of k, show the probability distribution of X in a table, giving the probabilities as exact fractions. **[3]**

(ii) Find E(X) and Var(X). **[5]**

5 The probability of someone who lives in a particular city being a car owner is 0.3. The probability of someone who lives in the countryside surrounding the city being a car owner is 0.75. Two people who live in the city and two people who live in the surrounding countryside are selected at random.

(i) Find the probability that exactly one of these four people is a car owner. **[4]**

(ii) Given that exactly one of the four people is a car owner, find the probability that this person lives in the city. **[3]**

Section B (36 marks)

6 According to a survey 'Drinking Habits Amongst Adults, 2012' by the Office for National Statistics, 50% of males between the ages of 16 and 24 had drunk alcohol in the previous week.

(i) Assuming that the same figure applies now, find the probability that in a random sample of 20 males between the ages of 16 and 24, the number who have drunk alcohol in the previous week is

(*A*) exactly 8, **[2]**

(*B*) at least 8. **[2]**

A student thinks that if a survey were to be carried out now, the figure would be lower than 50%. She selects a random sample of 20 males in this age group and asks each of them whether they have drunk alcohol in the last week. The number of them who say that they have drunk alcohol in the last week is 6.

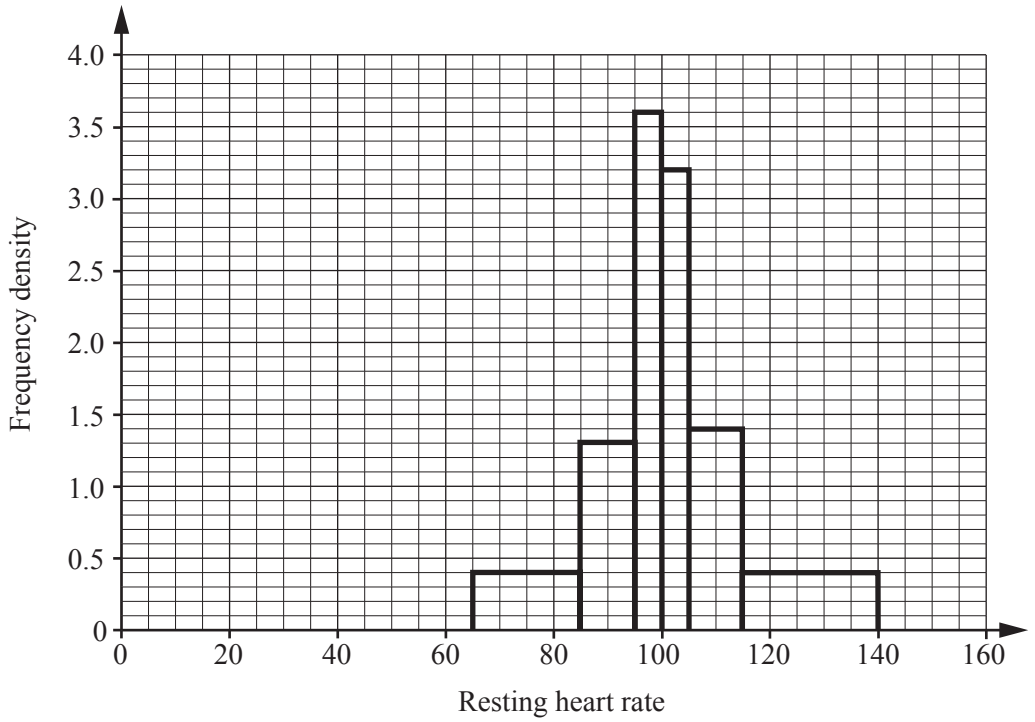
(ii) Carry out a hypothesis test at the 5% significance level to investigate the student's belief. Give a reason for your choice of alternative hypothesis. **[9]**

(iii) A teacher at the school attended by the student suggests that she should have used a larger sample. A new random sample of 100 males between the ages of 16 and 24 is selected. The number of them who say that they have drunk alcohol in the previous week is 41. Using the same hypotheses as in part **(ii)**, carry out another test at the 5% significance level. You may use the information that for $X \sim B(100, 0.5)$,

$P(X = 40) = 0.0108$, $P(X = 41) = 0.0159$, $P(X < 41) = 0.0284$, $P(X \leqslant 41) = 0.0443$. **[4]**

7 The table shows the resting heart rates, x, measured in beats per minute (BPM), of a sample of 4-year-old children. The histogram below illustrates these data.

Resting heart rate	$65 \leqslant x < 85$	$85 \leqslant x < 95$	$95 \leqslant x < 100$	$100 \leqslant x < 105$	$105 \leqslant x < 115$	$115 \leqslant x < 140$
Frequency	8	13	18	16	14	a



(i) Find the value of a. **[1]**

(ii) Previously collected data suggest that the 75th percentile of the resting heart rates of all 4-year-old children is 111. Calculate an estimate of the percentage of children in the sample whose resting heart rate is 111 or below. **[3]**

The table below shows the resting heart rates, y BPM, of a sample of 18-year-olds.

Resting heart rate	$35 \leqslant y < 50$	$50 \leqslant y < 60$	$60 \leqslant y < 70$	$70 \leqslant y < 75$	$75 \leqslant y < 85$	$85 \leqslant y < 105$
Frequency	4	12	30	16	22	16

(iii) Calculate estimates of the mean and standard deviation of these data. **[4]**

(iv) Use your answers to part **(iii)** to investigate whether there may be any outliers. **[4]**

(v) Add a histogram for these data on the copy of the diagram in the answer book. **[4]**

(vi) Use the two histograms to compare the central tendency and variation of the resting heart rates of 4-year-old children and 18-year-olds. **[3]**

END OF QUESTION PAPER

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Wednesday 23 May 2018 – Morning

AS GCE MATHEMATICS (MEI)

4766/01 Statistics 1

PRINTED ANSWER BOOK

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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)	
1 (iv)	

2 (i) (*A*)

2 (i) (*B*)

2 (ii)

3 (i)	
3 (ii) (*A*)	
3 (ii) (*B*)	
4 (i)	

(answer space continued on next page)

4 (i)	**(continued)**
4 (ii)	

5 (i)

5 (ii)

Section B (36 marks)

6 (i) (*A*)	
6 (i) (*B*)	

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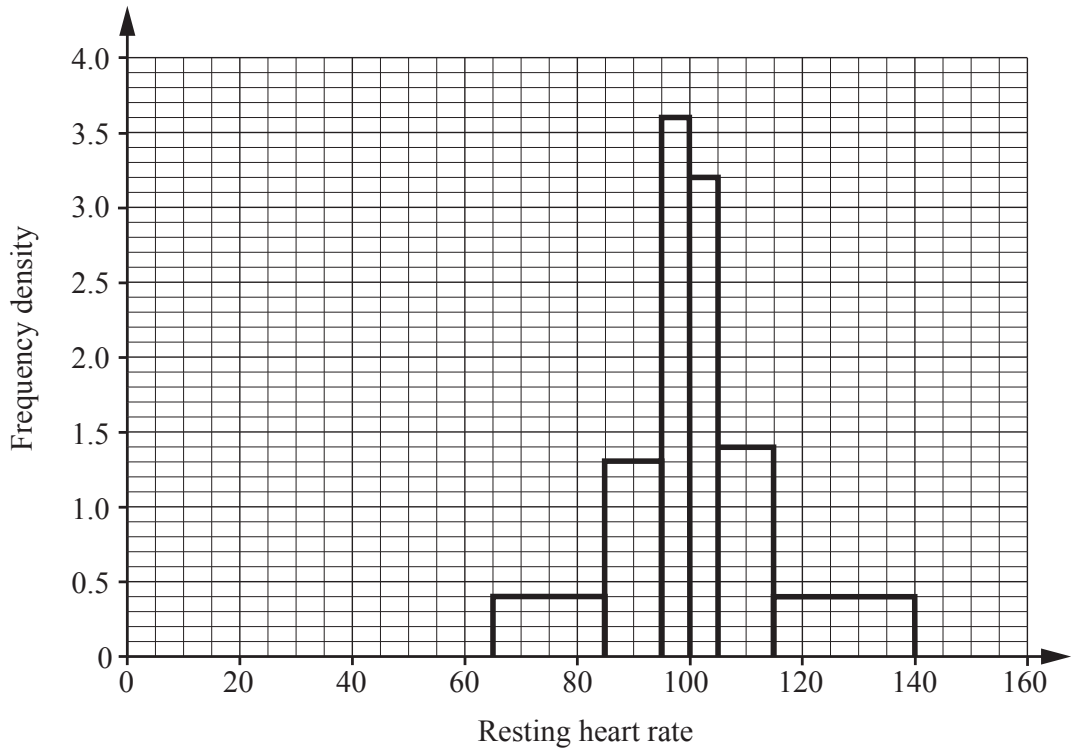
6 (ii)

6 (iii)	
7 (i)	
7 (ii)	

7 (iii)

7 (iv)

7 (v)



7 (vi)

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

OCR
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GCE

Mathematics (MEI)

Unit **4766**: Statistics 1

Advanced Subsidiary GCE

Mark Scheme for June 2018

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, 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.

Annotations and abbreviations

Annotation in scoris	**Meaning**
✓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

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.

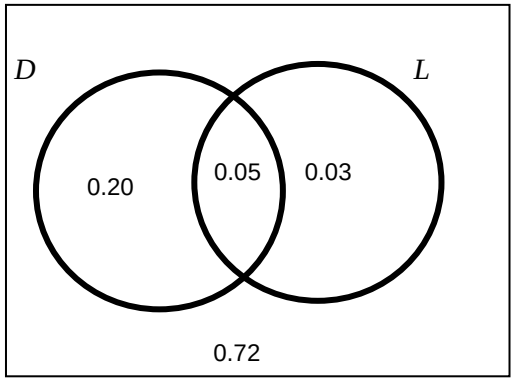
On the other hand, we commonly allow "fresh starts" within a question or part of question. For example, a follow-through of the candidate's value of a test statistic is generally allowed (and often explicitly stated as such within the marking scheme), so that the candidate may exhibit knowledge of how 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)		5 | 9 6 | 7 9 7 | 3 4 7 8 8 | 0 0 3 5 6 8 8 9 9 | 0 0 2 3 5 Key 7 | 3 represents 7.3	B1 B1 B1 **[3]**	Stem (in either order) and leaves Sorted and aligned (**not** dep on first B1) Key For alignment mark if a figure is crossed out but then replaced in the next column then do **not** allow this mark	Do not allow leaves 5.9, 6.7, 6.9, etc Ignore commas between leaves Do not allow decimal points before leaves Use paper test if unsure about alignment – hold a piece of paper vertically and the columns of leaves should all be separate. Alternatively place a pencil vertically over each column. If any figures protrude into the next column then deem this as non-alignment. Highlight this error
1	(ii)		Negative (skewness)	B1 **[1]**		Allow -ve but NOT skewed to the left Do not allow 'negative correlation'
1	(iii)		Median = 8.4 Midrange = 7.7	B1 B1 **[2]**		SC1 if median and midrange both given as 84 and 77
1	(iv)		Because the data are negatively skewed and so the midrange will give a value that is unrepresentative of most of the data.	E1 **[1]**	Must be related to data rather than a general statement EG 'Median better as mid-range affected by the outlier of 5.9' gets E1	Eg 'median is not affected by extreme values' gets E0 Eg 'median is located where the majority of the data is' gets E1 BOD

Question			Answer	Marks	Guidance	
2	(i)	*A*	$P(D \cap L) = P(L\|D) \times P(D) \quad = 0.2 \times 0.25$ $= 0.05$	M1 A1 **[2]**	For 0.2×0.25 CAO	
2	(i)	*B*		G1 G1 G1 **[3]**	For two labelled intersecting circles provided no incorrect labelling For at least 2 correct probabilities. FT their $P(L \cap D)$ provided < 0.08 For remaining probabilities. FT their $P(L \cap D)$	Condone labels such as $P(L)$ etc Allow other shapes in place of circles No need for 'box' In general the four probabilities are $0.25 - x$, x, $0.08 - x$, $0.67 + x$ EG 0.234, 0.016, 0.064, 0.686 EG 0.23, 0.02, 0.06, 0.69
2	(ii)		$P(L\|D) = 0.2$, $P(L) = 0.08$ So $P(L\|D) \neq P(L)$ so *D* and *L* are not independent. *OR* $P(D \cap L) = 0.05$. $P(L) \times P(D) = 0.08 \times 0.25 = 0.02$ So $P(D \cap L) \neq P(L) \times P(D)$ so *D* and *L* are not independent	M1 A1 **[2]**	For second method M1 is for $P(L) \times P(D) = 0.08 \times 0.25$ (must have correct 0.08 and 0.25). For A1 need correct value of $P(D \cap L) = 0.05$.	If no values given for $P(L\|D) \neq P(L)$ or if wrong value given for either give M1A0. (NB allow values given in part (i)) Use vertical highlight to indicate Must be L and D, not A and B (unless defined) For either method A1 only available if mention 'not equal' and 'not indep.' SC1 if two probabilities compared correctly without saying what they are so eg $0.05 \neq 0.02$ and so not independent gets SC1

Question			Answer	Marks	Guidance	
3	(i)		${}^{25}C_{12}$ = 5 200 300	M1 A1 **[2]**	For ${}^{25}C_{12}$ seen CAO	Accept ${}^{25!}/_{(12!13!)}$ or equivalent for M1 No marks for permutation Exact answer required
3	(ii)	*A*	${}^{14}C_6 \times {}^{11}C_6$ = 3003 × 462 = 1 387 386	M1 A1 **[2]**	For product of both correct combinations seen CAO	No marks for permutations Exact answer required
3	(ii)	*B*	$\frac{6}{12}\times\frac{5}{11}\times\frac{4}{10}\times\frac{3}{9}$ $= \frac{1}{33} = 0.0303$ Or: ${}^{6}C_4 / {}^{12}C_4$ = 0.0303	M1 M1 A1 **[3]** M1 M1 A1	For 6/12 or 1/2 × For product of four correct fractions without extra terms CAO If fractional answer only, must be fully simplified For division by ${}^{12}C_4$ For ${}^{6}C_4$ divided by an integer > ${}^{6}C_4$	No marks for binomial even if includes 6/12× but $(1/2)^4$ gets M1M0A0 even if ×${}^{4}C_4$ Allow 0.030 or $0.\dot{0}\dot{3}$ but not 0.03 SC1 for $\frac{14}{25}\times\frac{13}{24}\times\frac{12}{23}\times\frac{11}{22} = \frac{91}{1150} = 0.079$ OR ${}^{14}C_4 / {}^{25}C_4$ =0.079 SC2 if use permutations and fully correct
4	(i)		$k \times 7 + k \times 26 + k \times 63 + k \times 124 = 1$ $(7 + 26 + 63 + 124)k = 1$ $220k = 1$ $k = \frac{1}{220}$ NB $\frac{26}{220} = \frac{13}{110}$ and $\frac{124}{220} = \frac{31}{55}$ r | 2 | 3 | 4 | 5 P($X = r$) | $\frac{7}{220}$ | $\frac{26}{220}$ | $\frac{63}{220}$ | $\frac{124}{220}$	M1 A1 B1 **[3]**	For correct equation including = 1 Need one further intermediate step NB **Answer Given** Complete correct table with exact fractions (not decimals and not in terms of *k*)	Allow substitution of $k = \frac{1}{220}$ to show probabilities add to 1 with convincing working which must be more than just $\frac{1}{220}\times 7 + \frac{1}{220}\times 26 + \frac{1}{220}\times 63 + \frac{1}{220}\times 124 = 1$ This latter gets M1A0 Must be some indication of summation Allow if table given in part (ii) but B0 if no table given anywhere (even if correct probabilities used in part (ii))

Question			Answer	Marks	Guidance	
4	(ii)		$E(X) = (2\times\frac{7}{220})+(3\times\frac{26}{220})+(4\times\frac{63}{220})+(5\times\frac{124}{220})$ $E(X) = \frac{964}{220}=\frac{482}{110}=\frac{241}{55}=4.38(18\ldots)$ $E(X^2) = (4\times\frac{7}{220})+(9\times\frac{26}{220})+(16\times\frac{63}{220})+(25\times\frac{124}{220})$ $=\frac{437}{22}=19.86(36\ldots)$ $Var(X) = \frac{437}{22}-\left(\frac{964}{220}\right)^2=\frac{4013}{6050}=0.663(3\ldots)$	M1 A1 M1* M1* dep A1 **[5]**	For Σrp (at least 3 terms correct) CAO Allow unsimplified fraction. awrt 4.38 Allow 4.4 with working If correct fractional ans then overspec as decimal give A1 ISW For Σr^2p (at least 3 terms correct) for – their $E(X)^2$ FT their $E(X)$ provided $Var(X) > 0$ Allow 0.66 to 0.665 with working	If probs wrong but sum = 1 allow allow max M1A0M1M1A1. If sum ≠ 1 allow max M1A0M1M1A0. Allow max M1A0M1M1A0 if correct answers divided by eg 4 and max M1A0M1M1A1 if only $E(X)$ divided by eg 4 but VAR ok on FT Use of $E(X-\mu)^2$ gets M1 for attempt at $(x-\mu)^2$ should see $(-2.38)^2$, $(-1.38)^2$, $(-0.38)^2$, 0.62^2, (all 4 correct for M1) (if $E(X)$ wrong FT their $E(X)$) then M1 for $\Sigma p(x-\mu)^2$ (at least 3 terms correct with their probabilities)
5	(i)		$0.75\times0.25\times0.7^2 + 0.25\times0.75\times0.7^2 + 0.25^2\times0.3\times0.7 + 0.25^2\times0.7\times0.3$ $= 2\times0.013125 + 2\times0.091875 = 2\times\frac{21}{1600}+2\times\frac{147}{1600}$ $= 0.21$	M1 M1 M1 A1 **[4]**	For one quadruple For one correct quadruple For sum of four quadruples CAO	With at least two correct decimals Not necessarily correct For first and third M marks allow any coefficient, but only give second if there is a correct 2× This answer is exact NB Could use B(2, 0.25) and B(2, 0.7) gives $0.0625\times0.42 + 0.375\times0.49$
5	(ii)		$(0.25^2\times0.3\times0.7 + 0.25^2\times0.7\times0.3)/0.21$ $= 0.02625/0.21$ $= 0.125$	M1 M1 A1 **[3]**	For correct numerator as part of fraction For correct denominator as part of fraction (indep) FT FT their 0.21 (provided answer < 1)	This answer is exact (Do not allow 0.13 unless correct answer given first in which case ISW) Watch for 0.125 from incorrect working

Question			Answer	Marks	Guidance	
6	(i)	*A*	$X \sim B(20, 0.5)$ $P(X = 8) = {}^{20}C_8 \times 0.5^8 \times 0.5^{12} = 0.1201$	M1 A1	For $0.5^8 \times 0.5^{12}$ or 0.5^{20} CAO Allow correct answer from calculator	Allow 0.12 or better with working Check working even if correct answer
			Or: From tables $P(X \leq 8) - P(X \leq 7) = 0.2517 - 0.1316 = 0.1201$	M1 A1 **[2]**	For 0.2517 – 0.1316 CAO	
6	(i)	*B*	$P(X \geq 8) = 1 - P(X \leq 7) = 1 - 0.1316 = 0.8684$	M1 A1 **[2]**	For 0.1316 CAO Allow correct answer from calculator	Accept 0.868 Allow 0.87 with working For $P(X=8) + P(X=9) + P(X=10) + ...$ allow M1A1 for 0.868 or better. Otherwise M0A0
6	(ii)		Let $X \sim B(20, 0.5)$ Let p = probability that a male between the ages of 16 and 24 has drunk alcohol in the last week. (for population) H_0: $p = 0.5$ H_1: $p < 0.5$ The alternative hypothesis has this form as the student thinks that the proportion may now be lower than 50%.	B1 B1 B1 E1	For definition of p (in context) Do not allow '... in sample.' For H_0 For H_1 Dep on < (or ≤) 0.5 used in H_1 E0 for simply stating H_1 in words Condone number instead of proportion in this part.	**See below for additional notes** Do NOT allow number in place of probability. For H_1: $p \leq 0.5$ only deduct this B mark but allow all the rest that are scored. No further marks if point probabilities used
			$P(X \leq 6) = 0.0577$ $0.0577 > 5\%$	B1 B1* *M1 dep	For notation $P(X \leq 6)$ For 0.0577 For comparison with 5% Dep on correct value of 0.0577.	Allow 0.058 For (explicit) comparison with 5% or 0.05 Do NOT FT wrong H_1 but first two marks available
			So not significant. Accept H_0 Conclude that there is not enough evidence to support the student's suggestion.	A1* *E1 dep	Must be in context Do NOT condone 'number' here	Must mention 'insufficient evidence' oe but NOT 'no evidence'

Question			Answer	Marks	Guidance	
			OR 'There is not enough evidence that the probability that a male between the ages of 16 and 24 has drunk alcohol in the last week has decreased.'	**[9]**	Sufficient evidence to suggest that the percentage is lower gets B0 as not in context	Allow SC2 (out of these 5 marks) for clearly indicating use of B(20, 0.5) but with no mention of 0.0577 with convincing reasoning and final answer correct No marks if point probabilities used.
			ALTERNATIVE METHOD FOR 5th TO 9th MARK			
			$P(X \leq 6) = 0.0577 > 5\%$	B1	For either probability	If critical region stated but not justified, allow SC2 (out of these 5 marks) if all correct.
			$P(X \leq 5) = 0.0207 < 5\%$	M1	For at least one comparison with 5%	
			So critical region is {0, 1, 2, 3, 4, 5}	A1*		If unclear which method is being used, or if both, give the better mark of the two.
			So not significant. Accept H_0	*A1*		
			Conclude that there is not enough evidence to support the student's suggestion. oe	*E1 dep	Must be in context Do NOT condone 'number' here	No marks if point probabilities used
6	**(iii)**		$P(X \leq 41) = 0.0443$	B1	For use of $P(X \leq 41)$ only Notation $P(X \leq 41)$ not needed	NB If more than one attempt please mark the final one.
			$0.0443 < 0.05$	M1	For comparison with 5% NB No marks unless using $P(X \leq 41)$	
			So significant. Reject H_0	A1	Dep on first two marks	
			Conclude that there is enough evidence to support the student's suggestion. oe	E1 **[4]**	Do not penalise in this part for 'number' if already penalised in part (ii). Must be in context	
7	**(i)**		$a = 25 \times 0.4 = 10$	B1 **[1]**		
7	**(ii)**		$8 + 13 + 18 + 16 + 6/10 \times 14 = 55 + 8.4 = 63.4$ $63.4/79 = 0.8025$	M1 M1	For $6/10 \times 14$ For any value between 55 and 69 (non-inclusive) divided by	Allow M1 for $4/10 \times 14$ if clearly using upper end Then M1 for (1 – their a - $4/10 \times$

Question			Answer	Marks	Guidance	
			So 80.3%	A1 **[3]**	79 or by 69 + their *a* CAO May round 8.4 to 8 so 63/79 and can get M1M1A1 (Ans 79.7%)	14)/79 or by 69 + their *a* Allow 80% with working Do not allow 0.803
7	**(iii)**		Mean = $\frac{(42.5\times4)+(55\times12)+(65\times30)+(72.5\times16)+(80\times22)+(95\times16)}{100}$ $=\frac{7220}{100}=72.20$	M1 A1	For midpoints (at least 3 correct) (allow 42.25, 54.75 etc leading to answer 71.95 for M1) CAO Correct answers obtained from use of calculator statistical functions gain full marks even if eg wrong *Sxx* given	M0A0M0A0 unless using midpoints Answer must NOT be left as improper fraction as this is an estimate Allow 42, 54.5, 64.5 etc from assuming data is discrete, leading to answer 71.7 for M1A0 but can get M1A1 for sd.
			$\Sigma x^2 f = (42.5^2\times4)+(55^2\times12)+(65^2\times30)+(72.5^2\times16)$ $+(80^2\times22)+(95^2\times16)$ = 7225 +36300 + 126750 + 84100 + 140800 + 144400 = 539575	M1	For attempt at S_{xx} Must include sum of at least 3 correct multiples $fx^2-(\Sigma x)^2/n$	If using $(x-\bar{x})^2$ method, B2 if 13.6 or better, otherwise B0 Or $fx^2-n\times\text{mean}^2$
			$S_{xx}=539575-\frac{7220^2}{100}=18291$ $s=\sqrt{\frac{18291}{99}}=\sqrt{184.76}=13.6\ (13.59...)$	A1 **[4]**	Do not FT their incorrect mean for A1 If both mean and sd over-specified, just deduct one mark	Allow any answer between 13.59 and 13.60 without checking working RMSD = 13.52 gets M0A0 unless working shown
7	**(iv)**		Lower limit = 72.2 – 2 × 13.6 = 45.0	M1 A1*	Method for either FT sensible mean and sd SD must be < 20	No marks 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

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th><th></th></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>writes here ‘limit is $72.2 + 2 \times$ standard deviation’, do NOT award M1</td></tr>
<tr><td></td><td></td><td></td><td>Upper limit = $72.2 + 2 \times 13.6 = 99.4$

So there are probably outliers (at both ends of the distribution)</td><td>A1*

B1* dep on both A
[4]</td><td>FT sensible mean and sd
SD must be < 20

Must include an element of doubt
If one end mentioned then other must also mention other.</td><td>Do not penalise for over-specification.

B1 only if lower limit beween 35 and 50 and upper between 85 and 105
If mention both ends separately must be correct for both.</td></tr>
<tr><td>7</td><td>(v)</td><td></td><td>
<table>
<tr><th>Resting heart rate</th><th>Frequency</th><th>Group width</th><th>Frequency density</th></tr>
<tr><td>$35 \le x < 50$</td><td>4</td><td>15</td><td>0.27</td></tr>
<tr><td>$50 \le x < 60$</td><td>12</td><td>10</td><td>1.2</td></tr>
<tr><td>$60 \le x < 70$</td><td>30</td><td>10</td><td>3</td></tr>
<tr><td>$70 \le x < 75$</td><td>16</td><td>5</td><td>3.2</td></tr>
<tr><td>$75 \le x < 85$</td><td>22</td><td>10</td><td>2.2</td></tr>
<tr><td>$85 \le x < 105$</td><td>16</td><td>20</td><td>0.8</td></tr>
</table>
</td><td>M1

A1

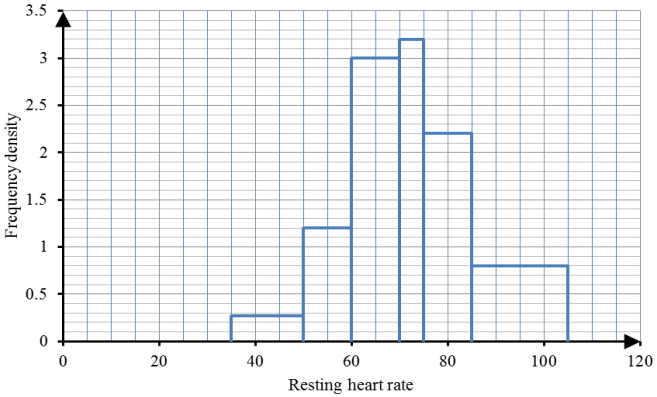
B1

B1</td><td>For fds- at least 4 correct
Accept any suitable unit for fd such as eg freq per beat.
Allow 0.3 in place of 0.27, but not 0.26

Width of bars (Must all be correct)

Height of bars (within half square) .</td><td>M1 can be also be gained from freq per 10 – 2.7, 12, 30, 32, 22,8 (at least 4 correct) or similar.
If fd not explicitly given, M1 A1 can be gained from all heights correct (within ≤ one square) on histogram (and M1A0 if at least 4 correct)

NB Use the template to check</td></tr>
</table>

Question			Answer	Marks	Guidance	
				**[4]**	All correct or otherwise all must agree with calculated values (and at least 3 of these must be correct)	
7	**(vi)**		The central tendency for 4-year-olds is clearly far higher than that for 18-year-olds. The modal class is higher for 4-year-olds. Allow the histogram for 4-year-olds is more 'peaked'. Both groups have roughly the same amount of variation (since the ranges are similar).	E1 E1 E1 **[3]**	Must mention central tendency or mean or median or average If mean and SD used to compare give max SC2 as question says to use histogram	No justification required for first mark Must give some justification to gain any credit for variation if candidate claims it is more for one group than the other such as higher range for 4-year olds or ranges 75 and 70. Allow '4-year olds have a higher range' for B1 (no mention of variation or numbers) 4-year olds have a higher interquartile range gets B0 unless worked out (no mention of variation)

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AS/A LEVEL GCE

Examiners' report

MATHEMATICS (MEI)

3895-3898, 7895-7898

4766/01 Summer 2018 series

Version 1

Contents

Introduction

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

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

Paper 4766/01 series overview

Statistics 1 (4766/01) can be taken as one of three components for AS Level Mathematics or six components for A Level Mathematics. It is an optional component, consisting entirely of statistics. This component develops the statistics studied at GCSE and introduces hypothesis testing based on the binomial distribution. To do well on this paper, candidates need to be very confident with the material studied at GCSE and be able to apply their understanding of new areas, such as the binomial distribution and more advanced probability.

Overall candidates found this an accessible paper, with lower ability candidates able to access most of the questions. It was however rigorous enough to challenge and differentiate the most able candidates, as very few gained full, or very close to full, marks.

The paper gave most candidates sufficient time to fully answer all the questions, although there was evidence of possibly rushed responses at the end of the paper from a small number of candidates.

Over-specification was less of an issue than in previous sessions, however some marks were lost because of premature rounding in calculations (for example in Q4(ii)) or truncating final answers (such as the first frequency density in Q7(v)). Candidates should be advised to ensure that they only round the final answer and that they round correctly.

The use of correct notation was also secure from almost all candidates. However, poor interpretative skills and a lack of accuracy in terminology let down many candidates. They have, in most cases, been well prepared for calculations required in the paper, but less so for analysing or explaining their findings.

Section A

Question 1(i)

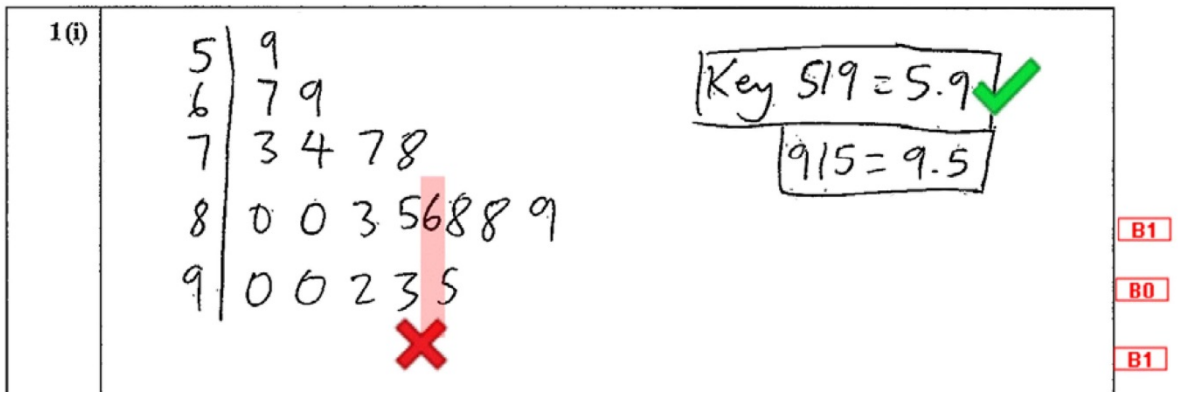
1 During a storm in the English Channel, the heights in metres of a random sample of 20 waves were measured. The heights are given below.

9.5	8.8	8.9	8.0	7.3	8.5	7.4	8.6	9.0	7.7
6.9	8.0	6.7	8.8	7.8	9.0	9.2	5.9	8.3	9.3

(i) Construct a sorted stem and leaf diagram to represent these data, taking stem values of 5, 6, 7, 8, 9. **[3]**

Although almost all candidates were credited at least 2 marks out of the 3 available, many did not align their leaves properly and thus did not gain the final mark. If a candidate misses out one of the data values in their diagram, the diagram needs to be redrawn, rather than inserting the omitted value in between two other values. One way of avoiding this error is for candidates to look at the list of data values and number them in order from lowest to highest, before adding them to the stem and leaf diagram.

Exemplar 1



This exemplar illustrates a situation where a candidate realised that one of the values has been omitted. However, instead of redrawing the diagram, the candidate adds the missing value of 8.6 between 8.5 and 8.8. The diagram is therefore not properly aligned and so the relevant mark cannot be credited.

Question 1(iii)

(iii) Write down the median and midrange of the data. **[2]**

Candidates almost always found the median correctly, although occasionally responses of 8.3 were given instead of 8.4. Many did not know how to find the midrange however, with a wide variety of wrong answers seen (including the range, amongst others).

Question 1(iv)

(iv) Give one reason why the median is a better measure of central tendency for these data than the midrange. **[1]**

The vast majority of candidates did not take into account the instruction 'for these data' and instead gave a general comment that could have related to any data.

Question 2(i)(*A*)

2 Each morning, Peter either cycles or drives to work. For any day, the probability that he drives is 0.25. If he drives, the probability that he arrives late for work is 0.2. The overall probability that he is late for work on any day is 0.08.

For a randomly chosen day,

- D is the event that Peter drives to work,
- L is the event that Peter arrives late for work.

(i) (*A*) Find $P(D \cap L)$. **[2]**

This question required candidates to rearrange the conditional probability formula to $P(D \cap L) = P(L|D) \times P(D)$ and then insert the relevant probabilities. Many were successful, but many others were unable to translate the words in the question into symbols, or used the wrong formula. Common wrong answers were $0.2 \times 0.08 = 0.016$ and $0.25 \times 0.08 = 0.02$.

Question 2(i)(*B*)

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

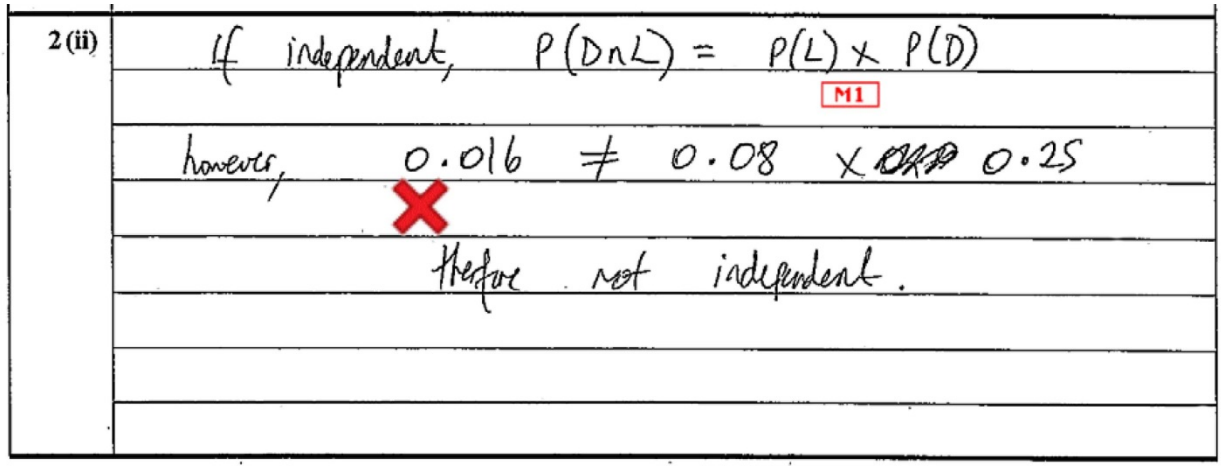
Most candidates answered this question successfully, with many gaining full marks for following through their answer to part (i). Follow through was allowed only if their answer to part (i) was less than 0.08, or in other words less than the value of $P(L|D)$.

Question 2(ii)

(ii) Determine whether or not the events D and L are independent, justifying your answer. **[2]**

This question could be answered very easily by simply stating that $P(L|D)$ is not equal to $P(L)$ and so the events are not independent. Candidates who used this method were only credited 2 marks if they had the correct value of $P(L|D)$ in part (i). However most candidates instead compared $P(D \cap L)$ with $P(D) \times P(L)$. To be credited both marks for this method, candidates had to have the correct value of $P(D \cap L)$ in part (i), which of course many did not have. Some chose to use $P(D|L)$ instead of $P(L|D)$, but this approach was very rarely successful.

Exemplar 2



This candidate's response would be correct if they had found the correct value of 0.05 in part (i). However only 1 mark was credited here since the value of P($L \cap D$) is in fact 0.05. Follow through is sometimes allowed in this type of situation, but not in this particular question. This is because of the fact that, as mentioned above, all that is required is to state that P($L|D$) is not equal to P(L) and so the events are not independent.

Question 3(ii)(*A*)

(ii) The team coach decides that the squad must consist of equal numbers of women and men.

(*A*) How many different squads are possible now? **[2]**

Most candidates gained both marks, but a few added rather than multiplied the two correct combinations and so scored zero.

Question 3(ii)(*B*)

(*B*) There are 4 players from the squad on the court at any time. Assuming that all possibilities are equally likely, find the probability that all of the players from the squad who are on the court are women. **[3]**

More able candidates usually had no problem with this question. However many did not read the question correctly, often not realising that 4 players were needed or from how many players the choice was made. Most candidates attempted a fraction method rather than using combinations, however, many gave an answer of 0.5^4, or multiplied their correct answer by a combination. Others thought that this was a binomial situation. Finally some would have been credited all 3 marks, but then gave their answer either as 0.03 or 0.033. The first of these lost the final mark for lack of accuracy and the second because they missed out a zero.

Question 4(i)

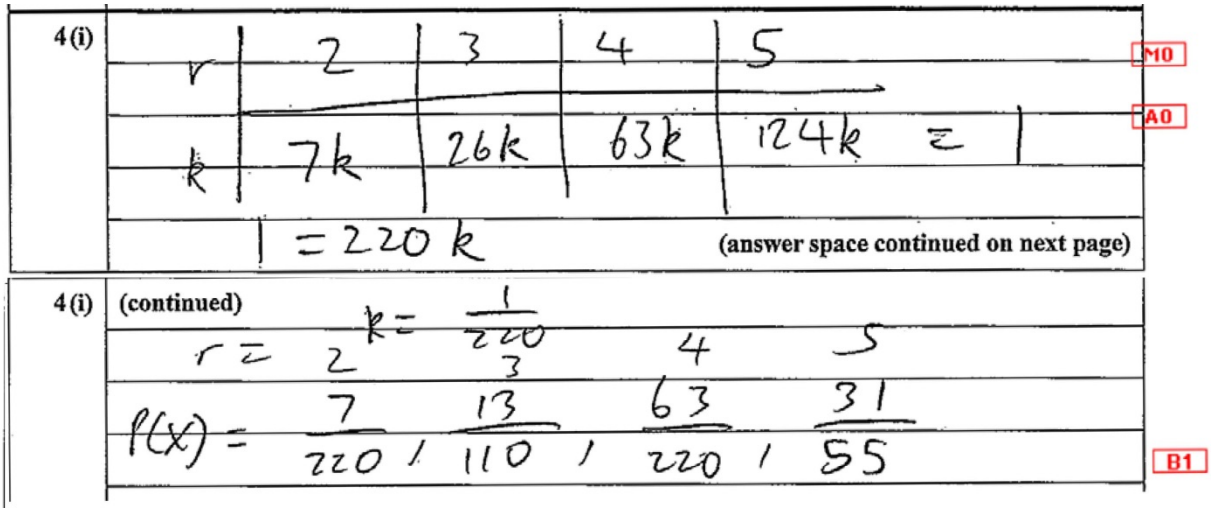
4 The probability distribution of the random variable X is given by the formula

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

(i) Show that the value of k is $\frac{1}{220}$ and, using this value of k, show the probability distribution of X in a table, giving the probabilities as exact fractions. **[3]**

The majority of candidates correctly showed that $k = \frac{1}{220}$ by forming an equation summing the probabilities and making it equal to 1, before stating that $220k = 1$ and then $k = \frac{1}{220}$. Some candidates who tried to use this method did not show that they were adding the probabilities together and so could not gain the two marks for this part of the question. Some candidates instead substituted $k = \frac{1}{220}$ into the probabilities, which was an acceptable method provided that they then showed that the probabilities added to a total of one, but some did not do this convincingly. The table of probabilities gained most candidates the final mark, but a few candidates gave the probabilities as decimals rather than the fractions asked for in the question.

Exemplar 3



Although at first sight this response seems correct, there is no indication that the four probabilities are being added and so neither of the first two marks was credited. The final table was given the mark available, despite the commas and the lack of a box around the table.

Question 4(ii)

(ii) Find E(X) and Var(X). **[5]**

This question was well answered with most candidates being credited all of the 5 marks available. Candidates who lost marks usually lost the final accuracy mark for Var(X) due to using a rounded value for the mean in their calculation of the variance. It was pleasing to see that very few candidates lost a mark for over-specification of their answer. Many of those who did over-specify gave their answer as a fraction before a decimal answer and so still gained full credit.

Question 5(i)

5 The probability of someone who lives in a particular city being a car owner is 0.3. The probability of someone who lives in the countryside surrounding the city being a car owner is 0.75. Two people who live in the city and two people who live in the surrounding countryside are selected at random.

(i) Find the probability that exactly one of these four people is a car owner. **[4]**

There was a very mixed response to this question with approximately half of candidates being credited all 4 marks, some with just a few lines of working out. Others drew tree diagrams and then tried to pick out the correct branches to follow. Others mixed up the probabilities and used 0.7 when they should have used 0.3 and likewise with 0.75 and 0.25. The majority of candidates gained one mark for a quadruple with at least two correct decimals, but many did not get the correct four quadruples. Some got the two different correct quadruples, but either didn't realise that they needed two of both quadruples or multiplied the quadruples by a number other than 2.

Question 5(ii)

(ii) Given that exactly one of the four people is a car owner, find the probability that this person lives in the city. **[3]**

Marks credited for this part were almost equally divided between 0, 1 and 3, with very few candidates scoring 2. Those who scored 1 mark did so because they realised that they had to divide a probability by their answer to part (i), but they used the wrong probability as their numerator.

Section B

Question 6(ii)

A student thinks that if a survey were to be carried out now, the figure would be lower than 50%. She selects a random sample of 20 males in this age group and asks each of them whether they have drunk alcohol in the last week. The number of them who say that they have drunk alcohol in the last week is 6.

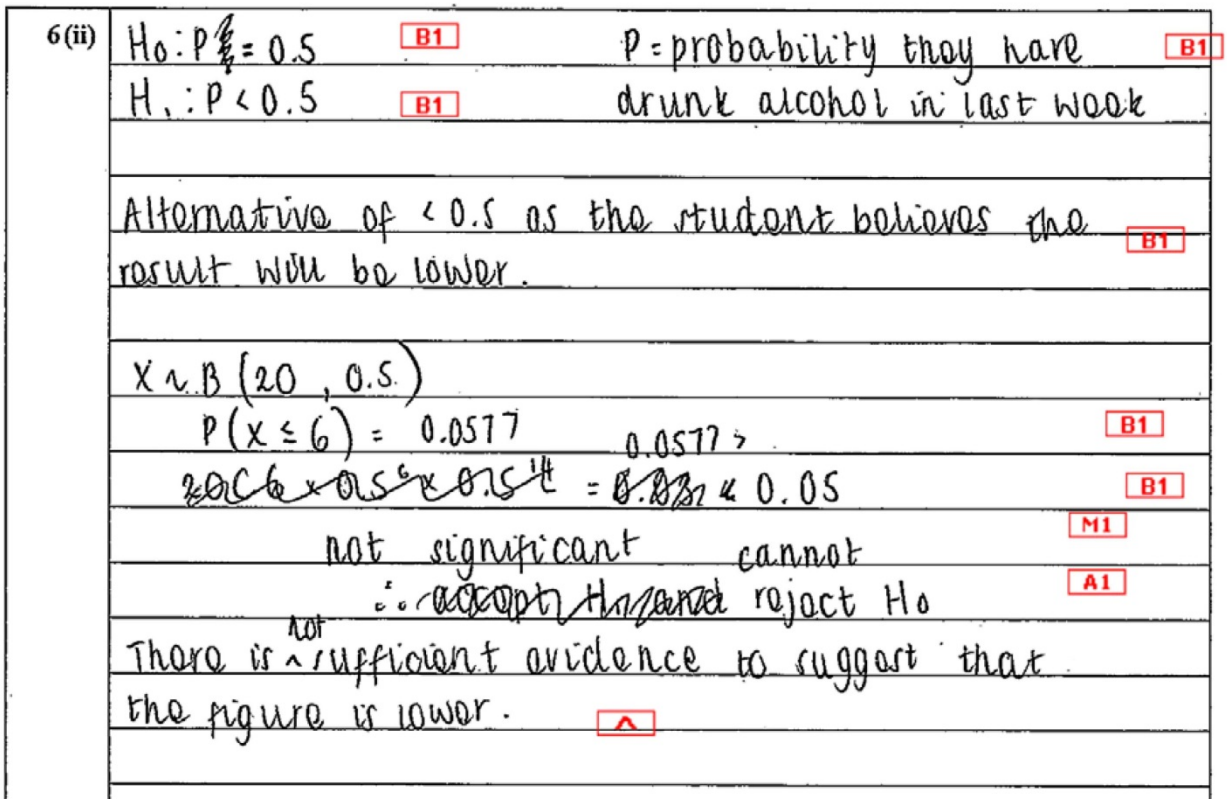
(ii) Carry out a hypothesis test at the 5% significance level to investigate the student's belief. Give a reason for your choice of alternative hypothesis. **[9]**

There were many very pleasing responses to this question, with two thirds of candidates being credited at least 8 marks out of the 9 available. However the first mark for defining *p* still causes difficulty for some candidates; a single letter must be used and the definition must both include the word probability or similar and be in the context of the question. The explanation of the reason for choice of alternative hypothesis should be just that, i.e. not a repeat of the statement of the alternative hypothesis in words rather than symbols. Most candidates correctly found the probability $P(X \leq 6) = 0.0577$, but then some did not explicitly compare it to the significance level. Candidates must actually write $0.0577 > 0.05$.; if they do not do this then they cannot score any of the last 3 marks for the question. A few did write a comparison, but then thought that this meant that the null hypothesis should be rejected.

A small number of candidates used the critical region method. Some of those who tried to find the critical region again missed out comparison with 5% and so again lost the final marks.

Whichever method is used, the final answer should be in the context of the question and should also include an element of doubt. Many candidates, having done everything correctly up to this stage were denied the final mark due to one of these two reasons, or despite putting their answer in context they discussed the 'number' rather than the 'proportion' of young males who had drunk alcohol in the last week.

Exemplar 4



This response is almost perfect and gained 8 marks out of the 9 available. The hypotheses are stated in symbols and the meaning of *p* is defined. The reason for choice of alternative hypothesis is given clearly and concisely. A random variable *X* is defined and then P($X \leq 6$) is found correctly and compared to 0.05. The correct result of 'not significant' is then reached. The candidate then states as part of the final conclusion 'not sufficient evidence to suggest that'. However the final conclusion is not in context and so the final mark was not scored.

Question 6(iii)

(iii) A teacher at the school attended by the student suggests that she should have used a larger sample. A new random sample of 100 males between the ages of 16 and 24 is selected. The number of them who say that they have drunk alcohol in the previous week is 41. Using the same hypotheses as in part **(ii)**, carry out another test at the 5% significance level. You may use the information that for $X \sim \text{B}(100, 0.5)$,

$\text{P}(X = 40) = 0.0108$, $\text{P}(X = 41) = 0.0159$, $\text{P}(X < 41) = 0.0284$, $\text{P}(X \leqslant 41) = 0.0443$. **[4]**

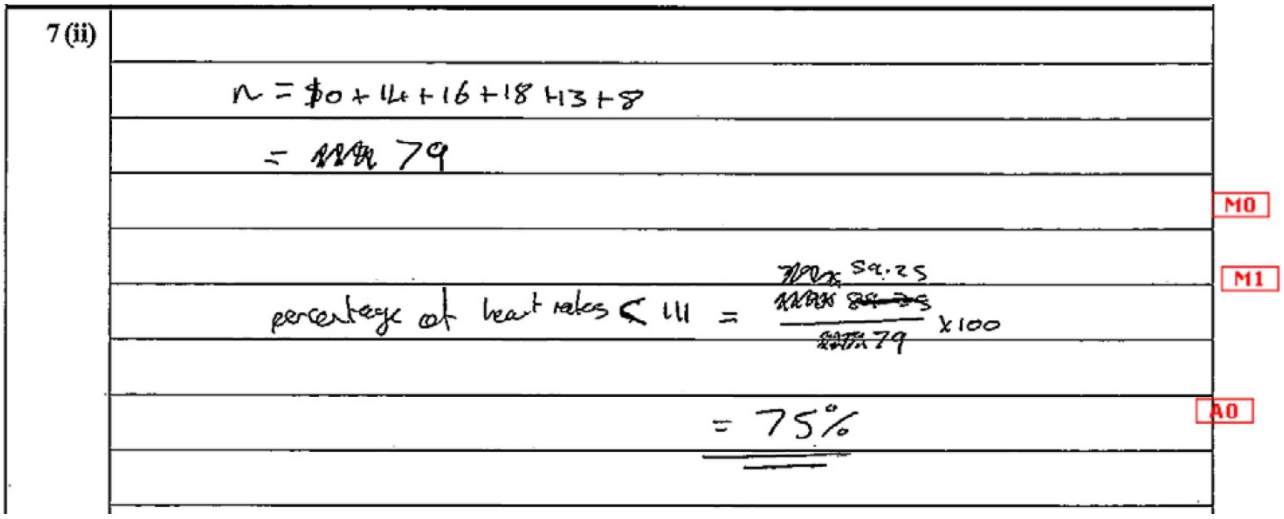
This final part was again generally well done, although again approximately one third of candidates did not give their answer in context. A few chose the wrong probability to compare with 5% or compared all of them with 5% and thus marks were not credited.

Question 7(ii)

(ii) Previously collected data suggest that the 75th percentile of the resting heart rates of all 4-year-old children is 111. Calculate an estimate of the percentage of children in the sample whose resting heart rate is 111 or below. **[3]**

There was a mixed response to this question with just under half of candidates being credited with all 3 marks. Many did not gain the first mark for linear interpolation - several used half way through the group and others divided by 14 and multiplied by 10 rather than the other way around. Others gave no indication of where their numerator came from, although they were dividing by 79 and so scored a method mark. After getting their value some candidates did not work out the percentage (or used 100 instead of 79 as their total). A few candidates tried to subtract from the top end, but those that did often gained all 3 marks

Exemplar 5



This candidate correctly divides by 79 and so gained a method mark. There is however no indication of where their numerator of 59.25 comes from and so they did not gain any further credit.

Question 7(iii)

The table below shows the resting heart rates, y BPM, of a sample of 18-year-olds.

Resting heart rate	$35 \leqslant y < 50$	$50 \leqslant y < 60$	$60 \leqslant y < 70$	$70 \leqslant y < 75$	$75 \leqslant y < 85$	$85 \leqslant y < 105$
Frequency	4	12	30	16	22	16

(iii) Calculate estimates of the mean and standard deviation of these data. **[4]**

The majority of candidates were credited with all 4 marks here. Almost all used correct midpoints, although a few made an error with 42.5 or 80. When calculating S_{xx} some candidates squared the frequencies instead of the midpoint. Candidates who rely on the built in functions of their calculator need to be aware that if they show no method they will not get any marks if they put an incorrect value into their calculator. If candidates do use their calculator for this type of question, they should be encouraged to write down the midpoints that they are using; this will both allow them to score at least one mark if they make an error with one midpoint, and also help them to put them correctly into their calculator. A pleasingly small number of candidates over-specified the value of the standard deviation thus denying themselves the final mark.

Question 7(iv)

(iv) Use your answers to part **(iii)** to investigate whether there may be any outliers. **[4]**

Most candidates used the correct formula for outliers, but some came to an incorrect conclusion – either saying that there were no outliers or that there were definitely outliers. Very few candidates tried to use the median and interquartile range, but some got confused and used 1.5 or 2.5 as the multiplier for the standard deviation.

Question 7(v)

(v) Add a histogram for these data on the copy of the diagram in the answer book. **[4]**

This was well answered although quite a few candidates gave the first frequency density as 0.26, thus denying themselves a mark. A very few lower ability candidates calculated group width divided by frequency. The histogram was drawn more accurately than charts in previous years due to the scales being given on the axes. The first bar was sometimes incorrectly drawn at 2.7 instead of 0.27. Some candidates had the lower boundary of the first bar at 30 instead of 35 or the upper boundary of the final bar at 110 instead of 105.

Question 7(vi)

(vi) Use the two histograms to compare the central tendency and variation of the resting heart rates of 4-year-old children and 18-year-olds. **[3]**

Only a few candidates gained full marks on this question with the most common omission being a comment about the modal class for each group. Many thought there was a difference in the variation but did not back it up with a comment about the range (or other measure of variation). Some candidates showed that they did not understand what central tendency means, seeming to think that it is something to do with variation.

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Unit level raw mark and UMS grade boundaries June 2018 series

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

AS & Advanced GCE Mathematics

				Max Mark	a	b	c	d	e	u
4721	01	C1 Core mathematics 1 (AS)	Raw	72	61	55	50	45	40	0
			UMS	100	80	70	60	50	40	0
4722	01	C2 Core mathematics 2 (AS)	Raw	72	55	49	43	37	31	0
			UMS	100	80	70	60	50	40	0
4723	01	C3 Core mathematics 3 (A2)	Raw	72	55	48	41	34	28	0
			UMS	100	80	70	60	50	40	0
4724	01	C4 Core mathematics 4 (A2)	Raw	72	54	47	40	34	28	0
			UMS	100	80	70	60	50	40	0
4725	01	FP1 Further pure mathematics 1 (AS)	Raw	72	56	50	45	40	35	0
			UMS	100	80	70	60	50	40	0
4726	01	FP2 Further pure mathematics 2 (A2)	Raw	72	59	53	47	41	35	0
			UMS	100	80	70	60	50	40	0
4727	01	FP3 Further pure mathematics 3 (A2)	Raw	72	47	41	36	31	26	0
			UMS	100	80	70	60	50	40	0
4728	01	M1 Mechanics 1 (AS)	Raw	72	60	51	42	34	26	0
			UMS	100	80	70	60	50	40	0
4729	01	M2 Mechanics 2 (A2)	Raw	72	53	46	39	32	26	0
			UMS	100	80	70	60	50	40	0
4730	01	M3 Mechanics 3 (A2)	Raw	72	50	42	34	27	20	0
			UMS	100	80	70	60	50	40	0
4731	01	M4 Mechanics 4 (A2)	Raw	72	59	53	47	42	37	0
			UMS	100	80	70	60	50	40	0
4732	01	S1 – Probability and statistics 1 (AS)	Raw	72	57	50	43	36	29	0
			UMS	100	80	70	60	50	40	0
4733	01	S2 – Probability and statistics 2 (A2)	Raw	72	56	49	42	35	28	0
			UMS	100	80	70	60	50	40	0
4734	01	S3 – Probability and statistics 3 (A2)	Raw	72	59	50	41	32	24	0
			UMS	100	80	70	60	50	40	0
4735	01	S4 – Probability and statistics 4 (A2)	Raw	72	56	49	42	35	28	0
			UMS	100	80	70	60	50	40	0
4736	01	D1 – Decision mathematics 1 (AS)	Raw	72	55	48	42	36	30	0
			UMS	100	80	70	60	50	40	0
4737	01	D2 – Decision mathematics 2 (A2)	Raw	72	58	53	48	44	40	0
			UMS	100	80	70	60	50	40	0

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AS & Advanced GCE Mathematics (MEI)

				Max Mark	a	b	c	d	e	u
4751	01	C1 – Introduction to advanced mathematics (AS)	Raw	72	60	55	50	45	40	0
			UMS	100	80	70	60	50	40	0
4752	01	C2 – Concepts for advanced mathematics (AS)	Raw	72	53	47	41	36	31	0
			UMS	100	80	70	60	50	40	0
4753	01	(C3) Methods for Advanced Mathematics (A2): Written Paper	Raw	72	61	56	51	46	40	0
4753	02	(C3) Methods for Advanced Mathematics (A2): Coursework	Raw	18	15	13	11	9	8	0
4753	82	(C3) Methods for Advanced Mathematics (A2): Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
			UMS	100	80	70	60	50	40	0
4754	01	C4 – Applications of advanced mathematics (A2)	Raw	90	63	56	49	43	37	0
			UMS	100	80	70	60	50	40	0
4755	01	FP1 – Further concepts for advanced mathematics (AS)	Raw	72	55	51	47	43	40	0
			UMS	100	80	70	60	50	40	0
4756	01	FP2 – Further methods for advanced mathematics (A2)	Raw	72	48	42	36	31	26	0
			UMS	100	80	70	60	50	40	0
4757	01	FP3 – Further applications of advanced mathematics (A2)	Raw	72	63	56	49	42	35	0
			UMS	100	80	70	60	50	40	0
4758	01	(DE) Differential Equations (A2): Written Paper	Raw	72	61	54	48	42	35	0
4758	02	(DE) Differential Equations (A2): Coursework	Raw	18	15	13	11	9	8	0
4758	82	(DE) Differential Equations (A2): Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
			UMS	100	80	70	60	50	40	0
4761	01	M1 – Mechanics 1 (AS)	Raw	72	51	44	37	31	25	0
			UMS	100	80	70	60	50	40	0
4762	01	M2 – Mechanics 2 (A2)	Raw	72	59	53	47	41	35	0
			UMS	100	80	70	60	50	40	0
4763	01	M3 – Mechanics 3 (A2)	Raw	72	61	54	48	42	36	0
			UMS	100	80	70	60	50	40	0
4764	01	M4 – Mechanics 4 (A2)	Raw	72	59	51	44	37	30	0
			UMS	100	80	70	60	50	40	0
4766	01	S1 – Statistics 1 (AS)	Raw	72	59	53	47	42	37	0
			UMS	100	80	70	60	50	40	0
4767	01	S2 – Statistics 2 (A2)	Raw	72	54	47	41	35	29	0
			UMS	100	80	70	60	50	40	0
4768	01	S3 – Statistics 3 (A2)	Raw	72	61	54	47	41	35	0
			UMS	100	80	70	60	50	40	0
4769	01	S4 – Statistics 4 (A2)	Raw	72	56	49	42	35	28	0
			UMS	100	80	70	60	50	40	0
4771	01	D1 – Decision mathematics 1 (AS)	Raw	72	50	44	38	32	26	0
			UMS	100	80	70	60	50	40	0
4772	01	D2 – Decision mathematics 2 (A2)	Raw	72	55	51	47	43	39	0
			UMS	100	80	70	60	50	40	0
4773	01	DC – Decision mathematics computation (A2)	Raw	72	46	40	34	29	24	0
			UMS	100	80	70	60	50	40	0
4776	01	(NM) Numerical Methods (AS): Written Paper	Raw	72	57	52	48	44	39	0
4776	02	(NM) Numerical Methods (AS): Coursework	Raw	18	14	12	10	8	7	0
4776	82	(NM) Numerical Methods (AS): Carried Forward Coursework Mark	Raw	18	14	12	10	8	7	0
			UMS	100	80	70	60	50	40	0
4777	01	NC – Numerical computation (A2)	Raw	72	55	47	39	32	25	0
			UMS	100	80	70	60	50	40	0
4798	01	FPT - Further pure mathematics with technology (A2)	Raw	72	57	49	41	33	26	0
			UMS	100	80	70	60	50	40	0

AS GCE Statistics (MEI)

				Max Mark	a	b	c	d	e	u
G241	01	Statistics 1 MEI	Raw	72	No entry in June 2018					
			UMS	100	80	70	60	50	40	0
G242	01	Statistics 2 MEI	Raw	72	No entry in June 2018					
			UMS	100	80	70	60	50	40	0
G243	01	Statistics 3 MEI	Raw	72	No entry in June 2018					
			UMS	100	80	70	60	50	40	0

AS GCE Quantitative Methods (MEI)

				Max Mark	a	b	c	d	e	u
G244	01	Introduction to Quantitative Methods (Written Paper)	Raw	72	58	50	43	36	28	0
G244	02	Introduction to Quantitative Methods (Coursework)	Raw	18	14	12	10	8	7	0
			UMS	100	80	70	60	50	40	0
G245	01	Statistics 1	Raw	72	61	55	49	43	37	0
			UMS	100	80	70	60	50	40	0
G246	01	Decision Mathematics 1	Raw	72	50	44	38	32	26	0
			UMS	100	80	70	60	50	40	0

Level 3 Certificate, Level 3 Extended Project and FSMQ raw mark grade boundaries June 2018 series

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Level 3 Certificate Mathematics - Quantitative Methods (MEI)												
					Max Mark	a	b	c	d	e	u
G244	A	01	Introduction to Quantitative Methods with Coursework (Written Paper)	Raw	72	58	50	43	36	28	0
G244	A	02	Introduction to Quantitative Methods with Coursework (Coursework)	Raw	18	14	12	10	8	7	0
				UMS	100	80	70	60	50	40	0
				Overall	90	72	62	53	44	35	0

Level 3 Certificate Mathematics - Quantitative Reasoning (MEI)											
				Max Mark	a	b	c	d	e	u
H866	01	Introduction to quantitative reasoning	Raw	72	56	49	42	35	28	0
H866	02	Critical maths	Raw	60	44	39	34	29	24	0
		*To create the overall boundaries, component 02 is weighted to give marks out of 72	Overall	144	109	96	83	70	57	0

Level 3 Certificate Mathematics - Quantitative Problem Solving (MEI)										
				Max Mark	a	b	c	d	e	u
H867	01	Introduction to quantitative reasoning	Raw	72	56	49	42	35	28	0
H867	02	Statistical problem solving	Raw	60	40	36	32	28	24	0
		*To create the overall boundaries, component 02 is weighted to give marks out of 72	Overall	144	104	92	80	69	57	0

Advanced Free Standing Mathematics Qualification (FSMQ)										
				Max Mark	a	b	c	d	e	u
6993	01	Additional Mathematics	Raw	100	56	50	44	38	33	0

Intermediate Free Standing Mathematics Qualification (FSMQ)										
				Max Mark	a	b	c	d	e	u
6989	01	Foundations of Advanced Mathematics (MEI)	Raw	40	35	30	25	20	16	0