OCR
Oxford Cambridge and RSA

GCE

Mathematics (MEI)

Unit **4766**: Statistics 1

Advanced Subsidiary GCE

Mark Scheme for June 2014

1. Annotations and abbreviations

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

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

a Annotations should be used whenever appropriate during your marking.

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

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

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

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

c The following types of marks are available.

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

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

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

E

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

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

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

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

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

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

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

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

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

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

g Rules for replaced work

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

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

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

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

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

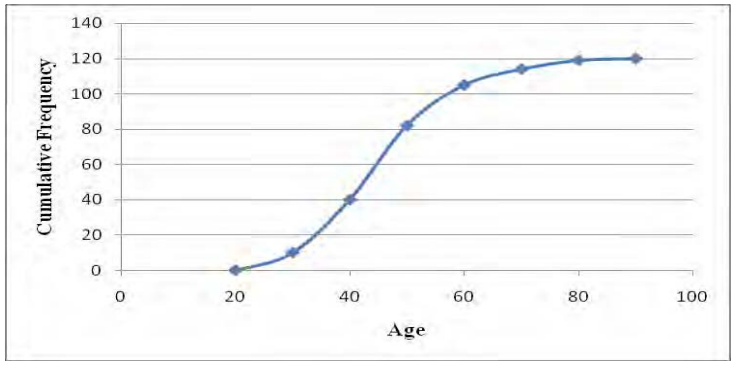
A misread should normally attract *some* penalty, though this would often be only 1 mark and should rarely if ever be more than 2. Commonly in sections of questions where there is a numerical answer either at the end of the section or to be obtained and commented on (eg the value of a test statistic),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

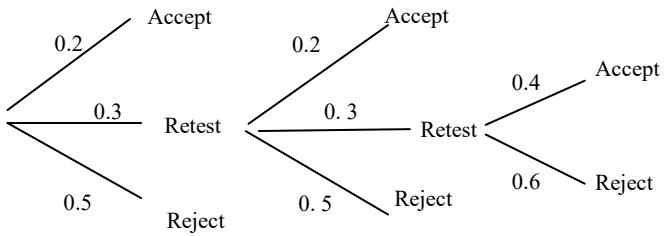
On the other hand, we commonly allow "fresh starts" within a question or part of question. For example, a follow-through of the candidate's value of a test statistic is generally allowed (and often explicitly stated as such within the marking scheme), so that the candidate may exhibit knowledge of how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

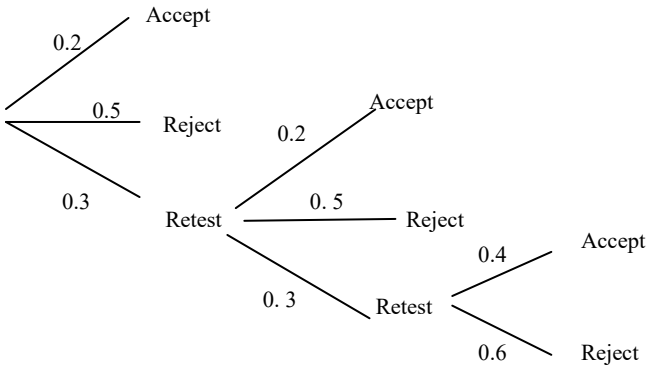
A misread may be of a symbol rather than a number – for example, an algebraic symbol in a mathematical expression. Such misreads are more likely to bring about a considerable change in the object and/or difficulty of the question; but, if they do not, they should be treated as far as possible in the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

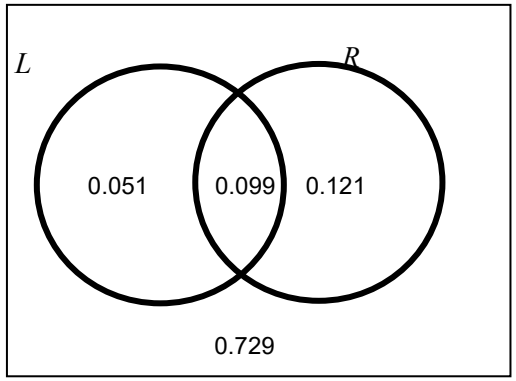
The situation regarding any particular cases that arise while you are marking for which you feel you need detailed guidance should be discussed with your Team Leader.

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

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

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

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

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

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

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

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

$k = 0.09$

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

A1

B1

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

NB Answer Given

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

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

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

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

= 1.78</td><td>M1

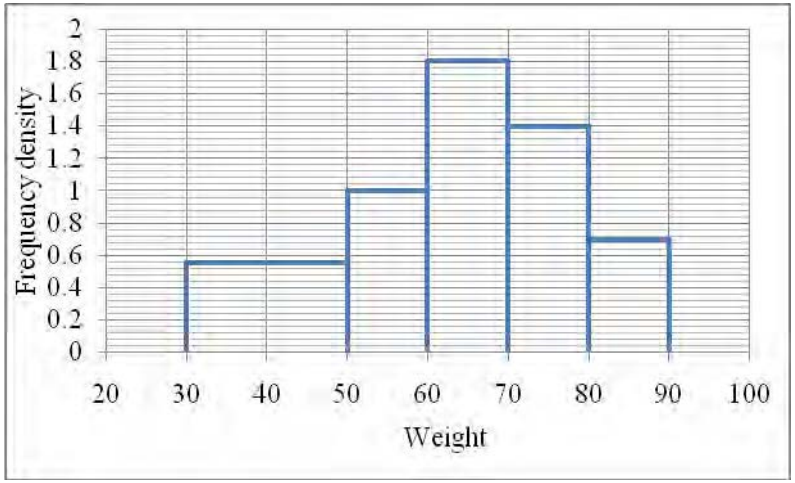
A1
M1*

M1* dep

A1

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

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

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

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

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

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

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

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

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