GCE

OCR
RECOGNISING ACHIEVEMENT

Mathematics (MEI)

Advanced Subsidiary GCE

Unit **4766:** Statistics 1

Mark Scheme for June 2013

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

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

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

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

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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)		Mean $= \dfrac{24940}{100} = 249.4$g or 249g	B1	Ignore units	CAO NB 249.40 gets B0 for over-specification
			$Sxx = 6240780 - \dfrac{24940^2}{100} = 20744$	M1	For Sxx	M1 for 6240780 - 100 × their mean^2 BUT NOTE M0 if their $S_{xx} < 0$
			$s = \sqrt{\dfrac{20744}{99}} = \sqrt{209.53} = 14.4751 = 14.5$g	A1	CAO ignore units	For s^2 of 210 (or better) allow M1A0 with or without working For RMSD of 14.4 (or better) allow M1A0 provided working seen For RMSD^2 of 207 (or better) allow M1A0 provided working seen Allow 14.48 but NOT 14.47
				[3]		
1	(ii)		New mean = (0.9 × 249.4) – 15 = 209.5g	B1	FT their mean provided answer is positive	If candidate 'starts again' only award marks for CAO Allow 209
			New sd = 0.9 × 14.48 = 13.03g	M1	FT their sd	Or for $0.9^2 \times 14.5^2$ Deduct at most 1 mark overall in whole question for over-specification of Mean and 1 mark overall for SD
				A1	FT Allow 13.0 to 13.1	
				[3]		

Question			Answer	Marks		Guidance
2	(i)		$3 \times \dfrac{5}{10} \times \dfrac{4}{9} \times \dfrac{5}{8} = \dfrac{300}{720} = \dfrac{5}{12} = (0.4167)$	M1	For 5/10 × 4/9	Correct working but then multiplied or divided by some factor scores M1M1M0A0
				M1	For × 5/8	Zero for binomial Allow M2 for equivalent triple such as $\dfrac{5}{10} \times \dfrac{5}{9} \times \dfrac{4}{8}$
				M1	For 3 × triple product	Or 3 separate equal triplets added
				A1	CAO (Fully simplified)	Answer must be a fraction
				[4]		
			Or $\dfrac{\binom{5}{2} \times \binom{5}{1}}{\binom{10}{3}} = \dfrac{10 \times 5}{120} = \dfrac{5}{12}$	M1*	For $\binom{5}{2} \times \binom{5}{1}$	Seen
				M1*	For $\binom{10}{3}$	Seen
				M1* dep	For whole fraction	Correct working but then multiplied or divided by some factor scores M1M1M0A0
				A1	CAO (Fully simplified)	
2	(ii)		$4 \times \dfrac{7}{12} \times \left(\dfrac{5}{12}\right)^3 + \left(\dfrac{5}{12}\right)^4$	M1FT	For first probability	Allow $^4C_3$
				M1FT	For $(5/12)^4$	
				M1FT	For sum of both correct probabilities	Provided sum <1
			$= 0.169 + 0.030 = 0.199$ $\text{Or} = \dfrac{875}{5184} + \dfrac{625}{20736} = \dfrac{1375}{6912}$	A1	CAO Do not allow 0.2, unless fuller answer seen first	Alternative for 1- (P(0)+P(1)+P(2)) allow M1FT for two 'correct' probs, M1 for sum of three 'correct', M1 for 1 – answer, A1 CAO
				[4]		

Question			Answer	Marks		Guidance
3	(i)		$X \sim B(50, 0.1)$ P(5 underweight) $= \binom{50}{5} \times 0.1^5 \times 0.9^{45} = 0.1849$	M1 M1 A1 **[3]**	For $0.1^5 \times 0.9^{45}$ For $\binom{50}{5} \times p^5 \times q^{45}$ CAO	With **p + q = 1** Also for $2118760 \times 8.73 \times 10^{-8}$ Allow 0.185 or better <u>NB 0.18 gets A0</u>
3	(ii)		$X \sim B(20, 0.1)$ $P(X \geq 1) = 1 - P(X = 0)$ $= 1 - 0.1216 = 0.8784$	M1 A1 **[2]**	For 0.1216 CAO	Allow M1 for 0.9^{20} Allow 0.878 or better See tables at the website http://www.mei.org.uk/files/pdf/formula _book_mf2.pdf
3	(iii)		$E(X) = 48 \times 0.8784 = 42.16 \ (= 42.2)$	M1 A1 **[2]**	FT their probability from part (ii)	If any indication of rounding to 42 or 43 or to another integer on FT allow M1A0 SC1 for $48 \times$ their p giving an integer answer. NB 0.6083 in (ii) leads to 29.20

Question			Answer	Marks	Guidance	
4	**(i)**		$P(X = 15) = \dfrac{3}{6} \times \dfrac{2}{5} \times \dfrac{1}{4}$	M1	For product of three correct fractions	
			$= \dfrac{6}{120} = \dfrac{1}{20} = 0.05$	A1	NB ANSWER GIVEN	Full marks for $3! \times \dfrac{1}{6} \times \dfrac{1}{5} \times \dfrac{1}{4} = \dfrac{6}{120} = 0.05$
			Or $\dfrac{1}{_6C_3} = \dfrac{1}{20} = 0.05$		NB $1 - (0.45 + 0.45 + 0.05)$ $= 0.05$ scores M0A0	Allow 3×2 in place of $3!$ SC1 for
			Or $\dfrac{3! \times 3!}{6!} = \dfrac{1}{20} = 0.05$			$6 \times \dfrac{1}{6} \times \dfrac{1}{5} \times \dfrac{1}{4} = \dfrac{6}{120} = 0.05$
				[2]		
4	**(ii)**		$E(X) = (15 \times 0.05) + (1010 \times 0.45) + (2005 \times 0.45) + (3000 \times 0.05)$	M1	For Σrp (at least 3 terms correct)	
			$= 1507.5$ so 1508 (4sf)	A1	CAO	Allow 1507, 1510, 1507.5, 1507.50 or 3015/2
			$E(X^2) = (15^2 \times 0.05) + (1010^2 \times 0.45) + (2005^2 \times 0.45) + (3000^2 \times 0.05)$ $= 2718067.5$	M1	For $\Sigma r^2 p$ (at least 3 terms correct)	Use of $E(X-\mu)^2$ gets M1 for attempt at $(x-\mu)^2$ should see $(-1492.5)^2$, $(-497.5)^2$, 497.5^2, 1492.5^2, (if $E(X)$ wrong FT their $E(X)$) (all 4 correct for M1), then M1 for $\Sigma p(x-\mu)^2$ (at least 3 terms correct with their probabilities) Division by 4 or other spurious value at end gives max M1A1M1M1A0, or M1A0M1M1A0 if $E(X)$ also divided by 4. Unsupported correct answers get 5 marks
			$Var(X) = 2718067.5 - (1507.5)^2$	M1	dep for – their $E(X)^2$	
			$= 445511.25$ so 445500 (4sf)	A1	FT their $E(X)$ provided $Var(X) > 0$ (and of course $E(X^2)$ is correct)	Allow 446000
				[5]		

Question			Answer	Marks		Guidance
5	**(i)**		Because if people cannot make a correct identification, then the probability that they guess correctly will be 0.5	E1	For idea of a guess or 'chosen at random'	NB The question includes the sentence 'She suspects that people do no better than they would by guessing.', so this on its own does not get the mark for the idea of a guess
			For 'equally likely to guess right or wrong' or 'two outcomes with equal probability' or '50:50 chance of success' or 'right one in two occasions on average' or 'two (equally likely) outcomes' etc	E1	For idea of two outcomes	
				[2]		
5	**(ii)**		'Because people may do better than they would by guessing' or similar	B1	For idea of selecting correctly /identifying /knowing	No marks if answer implies that it is because there are over half in the sample who make a correct identification
				[1]		
5	**(iii)**		$P(X \geq 13) = 1 - P(X \leq 12) = 1 - 0.8684 = 0.1316$	M1	For notation $P(X \geq 13)$ or $P(X > 12)$ or $1 - P(X \leq 12)$	Notation $P(X = 13)$ scores M0. If they have the correct $P(X \geq 13)$ then give M1 and ignore any further incorrect notation.
			NB PLEASE ANNOTATE THE TOP AND BOTTOM OF THE EXTRA PAGE IF NOT USED			
				B1*	For 0.1316	Or for $1 - 0.8684$ indep of previous mark
			$0.1316 > 0.05$	M1* dep	For comparison with 5%	
			So not significant	A1*		Allow 'accept H_0' or 'reject H_1'
			There is insufficient evidence to suggest that people can make a correct identification.	E1* dep	NB Point probabilities score zero.	Must include 'insufficient evidence' or something similar such as 'to suggest' ie an element of doubt either in the A or E mark. Must be in context to gain E1 mark. Do not allow 'sufficient evidence to suggest proportion making correct identification is 0.5' or similar

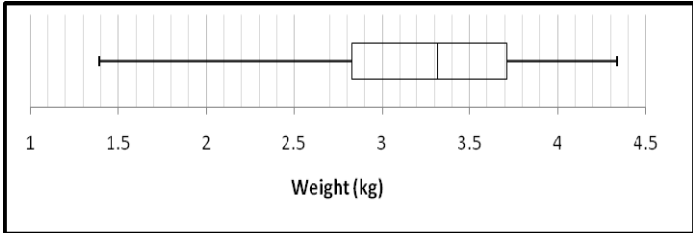| Question	Answer	Marks	Guidance
	ALTERNATIVE METHOD – follow method above unless some mention of CR seen Critical region method UPPER TAIL $P(X \geq 14) = 1 - P(X \leq 13) = 1 - 0.9423 = 0.0577 > 5\%$ $P(X \geq 15) = 1 - P(X \leq 14) = 1 - 0.9793 = 0.0207 < 5\%$ So critical region is {15,16,17,18,19,20} 13 not in CR so not significant There is insufficient evidence to indicate that people can make a correct identification.	 B1 M1* M1* dep A1* E1* dep on A1 **[5]**	Must see some reference to CR to gain any marks For either probability For a correct comparison with 5% cao dep on the two correct probabilities Must include '13 not in CR' Ignore any work on lower critical region	Do not insist on correct notation as candidates have to work out two probabilities for full marks. Allow comparison in form of statement 'critical region at 5% level is …' No marks if CR not justified Condone {15, … 20}, $X \geq 15$, oe but not $P(X \geq 15,)$ etc Allow 'accept H_0' or 'reject H_1' NB If CR found correctly, **then P(X=13) subsequently found,** but cand says '13 not in CR' then allow up to all five marks. If do not say '13 not in CR' allow no marks

Question			Answer	Marks		Guidance
6	**(i)**		Median = 3.32 kg	B1		
			Q1 (= 6.5th value) = 2.83 Q3 (= 19.5th value) = 3.71	B1	For Q1 or Q3	For Q1 allow 2.82 to 2.84
			Inter-quartile range = 3.71 – 2.83 = 0.88	B1	For IQR dep on both quartiles correct	For Q3 allow 3.70 to 3.72 If no quartiles given allow B0B1 for
				[3]		IQR in range 0.86 to 0.90
	(ii)			G1	For reasonably linear scale shown.	Dep on attempt at box and whisker plot with at least a box and one whisker. Condone lack of label.
				G1	For boxes in approximately correct positions, with median just to right of centre	
				G1	For whiskers in approximately correct positions in proportion to the box	Do not award unless RH whisker significantly shorter than LH whisker Allow LH whisker going to 2.5 and outlier marked at 1.39
					FT their median and quartiles if sensible – guidance above is only for correct values	
				[3]		
6	**(iii)**		Lower limit 2.83 – (1.5 × 0.88) = 1.51	B1	For 1.51 FT	Any use of <u>median</u> ± 1.5 × IQR scores B0 B0 E0 No marks for ± 2 or 3 × IQR In this part FT their values from (i)or (ii) if sensibly obtained but not from location ie 6.5, 19.5
			Upper limit 3.71 + (1.5 × 0.88) = 5.03	B1	For 5.03 FT	Do not penalise over-specification as not the final answer
			Exactly one baby weighs less than 1.51 kg and none weigh over 5.03 kg so there is exactly one outlier.	E1*	Dep on their 1.51 and 5.03	Do not allow unless FT leads to upper limit above 4.34 and lower limit between 1.39 and 2.50

Question			Answer	Marks		Guidance
			'Nothing to suggest that this baby is not a genuine data value so she should not be excluded' or 'This baby is premature and therefore should be excluded'.	E1* Dep **[4]**	Any sensible comment in context	For use of mean ± 2sd allow B1 For 3.27 + 2 × 0.62= 4.51 B1 For 3.27 - 2 × 0.62= 2.03 Then E1E1 as per scheme
6	(iv)		Median = 3.5 kg Q1 = 50th value = 3.12 Q3 = 150th value = 3.84 Inter-quartile range = 3.84 – 3.12 = 0.72	B1 B1 B1 **[3]**	For Q1 or Q3 For IQR FT their quartiles	For Q1 allow 3.11 to 3.13 For Q3 allow 3.83 to 3.85 Dep on both quartiles correct If no quartiles given allow B0B1 for IQR in range 0.70 to 0.74
6	(v)		Female babies have lower weight than male babies on the whole Female babies have higher weight variation than male babies	E1 FT E1 FT **[2]**	Allow 'on average' or similar in place of 'on the whole' Allow 'more spread' or similar but not 'higher range' Condone less consistent	Do not allow lower median Do not allow higher IQR, but SC1 for both lower median and higher IQR, making clear which is which
6	(vi)		Male babies must weigh more than 4.34 kg			
			Approx 10 male babies weigh more than this.	M1*	For 10 or 9 or 8	Or 200 – 190, 200 –191 or 200 –192
			Probability $= \dfrac{10}{200} \times \dfrac{9}{199} = \dfrac{90}{39800} = \dfrac{9}{3980} = 0.00226$ or $\dfrac{9}{200} \times \dfrac{8}{199} = \dfrac{72}{39800} = 0.00181$ or $\dfrac{8}{200} \times \dfrac{7}{199} = \dfrac{56}{39800} = \dfrac{7}{4975} = 0.00141$	M1* dep A1 	For first fraction multiplied by any other different fraction (Not a binomial probability) CAO Allow their answer to min of 2 sf	Allow any of these answers For spurious factors, eg 2 × correct answer allow M1M1A0 SC1 for $n/200 \times (n-1)/199$
				[3]		

Question			Answer	Marks		Guidance
7	**(i)**			G1 G1 G1 G1 **[4]**	For first set of branches For second set of branches (indep) For third set of branches (indep) For labels	All probabilities correct All probabilities correct All probabilities correct All correct labels for 'Hit' and 'Miss', 'H' and 'M' etc. Condone omission of First, Second, Third. Do not allow misreads here as all FT
7	**(ii)**	**A**	P(Hits with at least one) = 1 – P(misses with all) = 1 – (0.9 × 0.95 × 0.95) = 1 – 0.81225 = 0.18775 ALTERNATIVE METHOD only if there is an attempt to add 7 probabilities At least three correct triple products Attempt to add 7 triple products FURTHER ALTERNATIVE METHOD 0.1 + 0.9 × 0.05 Above probability + 0.9 × 0.95 × 0.05	M1* M1* dep A1 M1 M1 A1 M1 M1 A1 **[3]**	For 0.9 × 0.95 × 0.95 For 1 – ans CAO CAO CAO	FT their tree for both M marks, provided three terms 0.188 or better. Condone 0.1877 Allow 751/4000 (not necessarily correct triple products)

Question			Answer	Marks		Guidance
7	(ii)	**B**	P(Hits with exactly one) $= (0.1 \times 0.8 \times 0.95) + (0.9 \times 0.05 \times 0.8) + (0.9 \times 0.95 \times 0.05)$ $= 0.076 + 0.036 + 0.04275 = \dfrac{19}{250} + \dfrac{9}{250} + \dfrac{171}{4000}$ $= \dfrac{619}{4000} = 0.15475$	M1 M1 M1 A1 **[4]**	For two correct products For all three correct products For sum of all three correct products CAO	FT their tree for all three M marks, provided three terms Allow 0.155 or better
7	(iii)		P(Hits with exactly one given hits with at least one) $= \dfrac{P\big(\text{Hits with exactly one and hits with at least one}\big)}{P\big(\text{Hits with at least one}\big)}$ $= \dfrac{0.15475}{0.18775}$ $= 0.8242$	 M1 M1 A1 **[3]**	 For numerator FT For denominator FT CAO	If answer to (*B*) > than answer to (*A*) then max M1M0A0 Both must be part of a fraction Allow 0.824 or better or 619/751
7	(iv)		P(Hits three times overall) $=$ $(0.1 \times 0.2 \times 0.2) + (0.9 \times 0.95 \times 0.95 \times 0.05 \times 0.2 \times 0.2)$ $= 0.004 + 0.0016245$ $= 0.0056245$	M1 M1 M1* Dep on both prev M1's A1 **[4]**	For $0.1 \times 0.2 \times 0.2$ or 0.004 or 1/250 For $0.9 \times 0.95 \times 0.95 \times 0.05 \times 0.2 \times 0.2$ For sum of both CAO	FT their tree for all three M marks provided three terms in first product and six in second product. Last three probs must be $0.05 \times 0.2 \times 0.2$ unless they extend their tree With no extras Allow 0.00562 or 0.00563 or 0.0056

NOTE RE OVER-SPECIFICATION OF ANSWERS

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

PLEASE HIGHLIGHT ANY OVER-SPECIFICATION

Please note that there are no G or E marks in scoris, so use B instead

NB PLEASE ANNOTATE EVERY ADDITIONAL ANSWER SHEET EVEN IF FULL MARKS AWARDED OR THE PAGE IS BLANK

Additional notes re Q5 part iii

Comparison with 95% method
If 95% seen anywhere then
M1 for P($X \leq 12$)
B1 for 0.8684
M1* for comparison with 95% dep on second B1
A1* for not significant oe
E1*

Comparison with 95% CR method
If 95% seen anywhere then
B1 for 0.9423 or 0.9793
M1 for correct comparison with 95%
M1dep for correct CR provided both probs correct
then follow mark scheme for CR method

Smallest critical region method:
Smallest critical region that 13 could fall into is $\{13, 14, 15, 16, 17, 18, 19, 20\}$ **gets B1 and has size 0.1316 gets B1,   This is > 5% gets M1*, A1*, E1* as per scheme**
NB These marks only awarded if 13 used, not other values.

Use of k method with no probabilities quoted:
This gets zero marks.

Use of k method with one probability quoted:
Mark as per scheme

Line diagram method and Bar chart method
No marks unless correct probabilities shown on diagram, then mark as per scheme..

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

Education and Learning
Telephone: 01223 553998
Facsimile: 01223 552627
Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

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