GCE

Quantitative Methods (MEI)

Unit **G245**: Statistics 1

Advanced Subsidiary GCE

Mark Scheme for June 2015

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 = $\dfrac{59972}{40}$ = 1499 Condone full answer of 1499.3 (despite over-specification rule) Sxx = $\dfrac{96767028 - \dfrac{59972^2}{40}}{40}$ = 6851008 s = $\sqrt{\dfrac{6851008}{39}}$ = $\sqrt{175667}$ = 419 NB Full answer is 419. 1263 (but only allow to 4sf due to over-specification rule)	B1 M1 A1 **[3]**	CAO Ignore units For Sxx CAO ignore units	NB Allow 1500 NB Answer must be decimal M1 for 96767028 - 40 × their mean^2 BUT NOTE M0 if their S_{xx} < 0 For s^2 of 176000 (or better) allow M1A0 with or without working For RMSD of 414 (or better) allow M1A0 provided working seen For RMSD^2 of 171000 (or better) allow M1A0 provided working seen For use of 1499: Sxx = 6886988, s^2 = 176589, s = 420.225, RMSD = 414.9 For use of 1500: Sxx = 6767028, s^2 = 173513.5, s = 416.549, RMSD = 411.3 Give same credit to answers as for correct answers
1	(ii)		New mean = (0.163 × 1499) + 14.5 = £258.84 (No penalty for giving to 5sf as this is an exact sum of money) New sd = 0.163 × 419 = £68.30	B1 M1 A1 **[3]**	FT their mean provided answer is positive FT their sd for M1 and A1 Allow £68.29 to £68.32 Allow 68.3	If candidate 'starts again' only award marks for CAO Allow £259 or £259.00 from 1500 or £258.89 from 1499.3 Condone 258.8 and 258.9 Accept answers rounded to 3 sf or more eg £258.80, £258.90 Or for 0.163×419.1 oe Do not penalise lack of units in mean or sd Deduct at most 1 mark overall in whole question for over-specification of either mean or SD or both

Question			Answer	Marks	Guidance	
2	(i)	(A)	P(Watched cyc but not fb) = $\dfrac{15}{250} = \dfrac{3}{50}$ = 0.06	B1 **[1]**	CAO (aef)	
2	(i)	(B)	P(Watched one or two) = $\dfrac{33+12+21+14+3+65}{250}$	M1	OR: $\dfrac{250-(64+38)}{250} = \dfrac{148}{250} = 0.592$	For M1 terms must be added with no extra terms (added or subtracted)
			$= \dfrac{148}{250} = \dfrac{74}{125}$ = 0.592	A1 **[2]**	CAO (aef)	
2	(ii)		P(Not watched fb|watched cyc) = $\dfrac{15}{67}$ = 0.224 (0.223880597…)	M1		For denominator of either 67 or 67/250 or 0.268
				A1 **[2]**	CAO (aef)	Allow 0.22 with working
3	(i)		P(Neither is an ace) = $\left(1-\dfrac{4}{52}\right)^2$	M1	For 48/52 oe seen	
			$= \dfrac{2304}{2704} = \dfrac{144}{169} = 0.852$ (0.8572071…)	A1 **[2]**	CAO	Allow 0.85 with working
3	(ii)		Expected number = 10 × 0.852 = 8.52	B1 **[1]**	FT their (i) if seen	Do not allow whole number final answer even if 8.52 seen first. Allow fractional answer
4	(i)		$\dbinom{25}{15}$ = 3268760	M1 A1 **[2]**		Accept $^{25}C_{15}$ or $^{25!}/_{(15!10!)}$ or equivalent for M1 No marks for permutations Exact answer required

Question			Answer	Marks	Guidance	
4	(ii)		$\begin{pmatrix}13\\8\end{pmatrix} \times \begin{pmatrix}12\\7\end{pmatrix}$ = 1287 × 792 = 1019304	M1 A1 **[2]**	For product of both correct combinations CAO	No marks for permutations Exact answer required
4	(iii)		1019304/3268760 = 0.312 (0.311832) Allow fully simplified fraction11583/37145	M1 A1 FT **[2]**	For their (ii) divided by their (i)	 Allow 0.31 with working
			OR			
			$\begin{pmatrix}15\\8\end{pmatrix} \times \frac{13}{25} \times \frac{12}{24} \times \frac{11}{23} \times \frac{10}{22} \times \frac{9}{21} \times \frac{8}{20} \times \frac{7}{19} \times \frac{6}{18} \times \frac{12}{17} \times \frac{11}{16} \times \frac{10}{15} \times \frac{9}{14} \times \frac{8}{13} \times \frac{7}{12} \times \frac{6}{11}$	(M1)	For product of fractions with coefficient	SC1 for $\begin{pmatrix}15\\8\end{pmatrix} \times \left(\frac{13}{25}\right)^8 \times \left(\frac{12}{25}\right)^7$ Allow $\begin{pmatrix}15\\8\end{pmatrix}$ or $\begin{pmatrix}15\\7\end{pmatrix}$
			= 0.312	(A1)		
5	(i)		<pre> 0 │ 6
1 │ 5   8
2 │ 1   5   8
3 │ 1   1   3   5   8   9
Key 1 │ 8 represents 18 people</pre>	G1 G1 G1 **[3]**	Stem (in either order) and leaves Sorted and aligned Key	Do not allow leaves 21 ,25, 28 etc Ignore commas between leaves Allow stem 0, 10, 20, 30 Allow errors in leaves if sorted and aligned**.** 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 then deem this as non-alignment. Highlight this error

Question			Answer	Marks	Guidance	Question
5	(ii)		Negative	B1 **[1]**		Allow -ve but NOT skewed to the left Do not allow 'negative correlation'

5	(iii)		Median = 29.5
			
			 Mean = 26.7 (26.6666) or $26^2/_3$ or $^{80}/_3$ or $26.\dot{6}$
			
			 Mode = 31
			 The mode is not at all useful as it is just by chance that it is 31.
			 Mark awarded for stating not useful and
			    -not representative of data
			    -does not represent Central Tendency
			    -happened by chance (or similar)
			    -comment about not appearing significantly more (only one repetition/only twice/ etc)
			
			 No mark for stating it would be useful
			 OR NOT USEFUL because of
			    -spread/range
			    -sample size
			    -negatively skewed
			    -unaffected by outliers
			    -isn't close to mean and median
			
			 [4]
				B1
				 B1
				
				 B1
				 E1
					CAO
					 CAO
					
					 CAO
					 Allow any reasonable comment
						Do not allow 27
						 but condone 26.6 www

6	(i)		$P(X = 6) = 1 - P(X < 6) = 1 - \left(\dfrac{5}{6}\right)^3 = 1 - \dfrac{125}{216}$ $= \dfrac{91}{216}$ **[3]**	M1 M1 A1	For $\left(\dfrac{5}{6}\right)^3$ For $1 - \left(\dfrac{5}{6}\right)^3$ **NB ANSWER GIVEN**	

Question	Answer	Marks	Guidance	Question
	OR: $= \left(\dfrac{1}{6}\right)^3 + 3 \times \left(\dfrac{5}{6}\right) \times \left(\dfrac{1}{6}\right)^2 + 3 \times \left(\dfrac{5}{6}\right)^2 \times \left(\dfrac{1}{6}\right)$	M1	For second or third product term	Correct, including ×3 or probabilities seen on correct tree diagram
		M1	For attempt at three terms	With no extras, but allow omission of ×3
	$= \dfrac{91}{216}$	A1	**NB ANSWER GIVEN**	NB Zero for 1 – (sum of probs given in part (ii))
	OR: 1 + 15 + 75	M1	for 15 or 75 seen	
	$= \dfrac{1+15+75}{216}$	M1		
	$= \dfrac{91}{216}$	A1	**NB ANSWER GIVEN**	

Question			Answer	Marks	Guidance	Question
6	(ii)		$E(X) =$ $\left(1\times\frac{1}{216}\right)+\left(2\times\frac{7}{216}\right)+\left(3\times\frac{19}{216}\right)+\left(4\times\frac{37}{216}\right)+\left(5\times\frac{61}{216}\right)+\left(6\times\frac{91}{216}\right)$	M1	For Σrp (at least 3 terms correct)	
			$= \dfrac{1071}{216} = \dfrac{119}{24} = 4.96$ (exact answer 4.9583333) $E(X^2) =$ $\left(1\times\frac{1}{216}\right)+\left(4\times\frac{7}{216}\right)+\left(9\times\frac{19}{216}\right)+\left(16\times\frac{37}{216}\right)+\left(25\times\frac{61}{216}\right)+\left(36\times\frac{91}{216}\right)$	A1	CAO	Accept fractional answers Do not allow answer of 5 unless more accurate answer given first Use of $E(X-\mu)^2$ gets M1 for attempt at $(x-\mu)^2$ should see $(-3.96)^2$, $(-2.96)^2$, $(-1.96)^2$, $(-0.96)^2$ 0.04^2, 1.04^2, (if E(X) wrong FT their E(X)) (all 6 correct for M1), then M1 for $\Sigma p(x-\mu)^2$ (at least 3 terms correct) Division by 6 or other spurious value at end and/or rooting final answer gives max M1A1M1M1A0, or M1A0M1M1A0 if E(X) also divided by 6.
				M1*	For Σr^2p (at least 3 terms correct)	
			$= \dfrac{5593}{216} = 25.89$ $Var(X) = 25.89.. - 4.958...^2$	M1* dep	for – their $(E(X))^2$	
			$= 1.31$ Accept answers in range 1.28 to 1.31 with correct working or 2261/1728 (Exact answer 1.308449…)	A1	FT their E(X) provided Var(X) > 0	Do not FT E(X) = 5 if full marks given for E(X) Deduct at most 1 mark for over-specification of either mean or variance or both Unsupported correct answers get 5 marks (Probably from calculator)
				[5]		

Question			Answer	Marks	Guidance	Question
7	(i)	(A)	$X \sim$ B(20, 0.78) P(Exactly 19 cured) = $\dbinom{20}{19} \times 0.78^{19} \times 0.22^{1}$	M1	For $0.78^{19} \times 0.22^{1}$	Allow M2A0 for linear interpolation from tables leading to 0.9918 – 0.9488 = 0.0430 But zero for use of tables with 0.8 leading to 0.9885 - 0.9308 = 0.0577
				M1	For $\dbinom{20}{19} \times p^{19} \times q^{1}$	With $p + q = 1$ Also for 20×0.00196
			= 0.0392 (0.039197)	A1	CAO	Allow 0.039 or better Condone 0.03919 but not 0.0391
				[3]		
7	(i)	(B)	$\dbinom{20}{20} \times 0.78^{20} \times 0.22^{0}$ P(Exactly 20 cured) = = 0.0069	M1	For 0.78^{20} oe	Allow M2 for 0.9488 for linear interpolation from tables or M1 for $1 - 0.9918 = 0.0082$ and second M1 for correct FT using answer to (i)(A) Zero for use of $p = 0.8$ here
			P(At most 18 cured) = 1 – (0.0069 + 0.0392)	M1	For P(19) + P(20)	Not necessarily correct, but both attempts at binomial, including coefficient in (i) and no extra terms (such as P(X=18)) Condone use of $p = 0.8$
			= 0.954 (0.95385)	A1	CAO	Allow 0.95 with working
				[3]		
7	(i)	(C)	E(X) = $np = 20 \times 0.78 = 15.6$	B1	CAO	Do not allow final answer of 15 or 16 even if correct 15.6 given earlier
				[1]		

Question			Answer	Marks	Guidance	Question
7	**(ii)**		Let $X \sim$ B(20, 0.78)			
			Let p = probability of a patient being cured (for population)	B1	For definition of p	In context
						See below for additional notes
			H$_0$: p = 0.78	B1	For H$_0$	
			H$_1$: p > 0.78	B1	For H$_1$	
						No further marks if point probabilities used
			P($X \geq$ 19) = 0.0392 + 0. 0069	B1	For **NOTATION** P($X \geq$ 19) or P(X > 18) or 1– P(X $\leq$ 18) or 1– P(X < 19)	Notation P(X = 19) scores B0. If they have the correct P($X \geq$ 19) then give B1 and ignore any further incorrect notation.
			= 0.0461	B1*	CAO For 0.0461 allow 0.0462	
						FT answer to (i)B for following three marks provided based on 1 – (P(19) + P(20))
			0.0461 > 1%	M1* dep	For comparison with 1%	Dep on sensible attempt at P($X \geq$ 19)
			So not significant.	A1		Allow 'accept H$_0$' or 'reject H$_1$'
			Conclude that there is not enough evidence to suggest that the new drug is more effective than the old one.	E1		Must include 'insufficient evidence' or something similar such as 'to suggest that' 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 cured is 0.78' or similar <u>99% method:</u> P(X≤18) = 0.9539 B1B1* CAO 0.9539 < 99% M1* then as per scheme
				[8]		

Question			Answer	Marks	Guidance	Question
			ALTERNATIVE METHOD FOR FINAL 5 MARKS		If combination of methods used, mark both and give higher mark.	No further marks if point probabilities used
			$P(X \geq 19) = 0.0461 > 1\%$	B1	For either probability	Do not insist on correct notation as candidates have to work out two probabilities for full marks.
			$P(X \geq 20) = 0.0069 < 1\%$	M1	For at least one comparison with 1%	Allow comparison in form of statement 'critical region at 1% level is …'
			So critical region is {20}	B1*	CAO dep on the two correct probabilities	No marks if CR not justified Condone $X \geq 20$, $X = 20$, oe but not $P(X \geq 20,)$ etc
			(19 not in CR so) not significant. Conclude that there is not enough evidence to suggest that the new drug is more effective than the old one.	A1* dep E1* dep	Dep on correct CR Ignore any work on lower critical region	Allow 'accept H_0' or 'reject H_1'
7	(iii)		With a 5% significance level rather than a 1% level, the null hypothesis would have been rejected. OR: 'there would be enough evidence to suggest that the new drug is more effective than the old one.'	B1*	oe	FT their probability from (ii) but NO marks if point probabilities used There must be a sensible attempt to use $P(X = 19) + P(X = 20)$ or must have correct CR.
			This is because $0.0461 < 5\%$	B1* dep	oe	Dep on correct answer of 0.0461 compared with 5% or 0.9539 compared with 95% or correct CR.
				[2]		

Question			Answer	Marks	Guidance	Question
8	(i)		Inter-quartile range = 18.1 – 17.8 = 0.3	B1		
			Lower limit 17.8 – (1.5 × 0.3) (= 17.35)	M1		FT their IQR for M marks only
			No outliers at lower end.	A1	dep on 17.35	Allow 'No values below 17.35 for first A1
						Allow 'Lower limit = 17.35 so no outliers (at lower end)'
						Watch for use of median giving 17.45 which gets M0A0
						You must be convinced that comments about no outliers refer to lower tail only.
			Upper limit 18.1 + (1.5 × 0.3) (= 18.55)	M1		
			(Max is 18.6) so at least one outlier at upper end.	A1	dep on 18.55	Allow 'At least one value above 18.55' for second A1
						Allow 'any value above 18.55 is an outlier' so at least one outlier.
						Do not allow 'There MAY be one outlier' oe
						Condone 'one outlier'
						Condone 'there are outliers'
						Watch for use of median giving 18.35 which gets M0A0
						You must be convinced that comments about some outliers refer to upper tail only.
				[5]		

Question			Answer	Marks	Guidance	Question
8	**(ii)**		$P(A) = P(\text{All 3 have orange centres}) = \dfrac{7}{20} \times \dfrac{6}{19} \times \dfrac{5}{18} = \dfrac{7}{228}$	M1	For 7/20×	Allow final answer of 0.031 with working
				M1	For product of correct three fractions Without extra terms	ALTERNATIVE SCHEME $^{7}C_3/^{20}C_3$ = 35/1140 = 7/228 = 0.0307 M1 for either term in correct position in a fraction M1 for correct fraction A1 CAO
			= 0.0307 (0.030702)	A1	CAO Allow full marks for fully simplified fractional answers	
			$P(B) = P(\text{All 3 have same centres}) =$ $\left(\dfrac{7}{20} \times \dfrac{6}{19} \times \dfrac{5}{18}\right) + \left(\dfrac{6}{20} \times \dfrac{5}{19} \times \dfrac{4}{18}\right) + \left(\dfrac{4}{20} \times \dfrac{3}{19} \times \dfrac{2}{18}\right) + \left(\dfrac{3}{20} \times \dfrac{2}{19} \times \dfrac{1}{18}\right) =$ $= 0.0307 + 0.0175 + 0.0035 + 0.0009$	M1	For at least two correct triple products or fractions or decimals	ALTERNATIVE SCHEME $^{7}C_3/^{20}C_3$ + $^{6}C_3/^{20}C_3$ + $^{4}C_3/^{20}C_3$ + $^{3}C_3/^{20}C_3$ M1 for at least two correct terms
				M1	For sum of all four correct	M1 for sum of all four (all correct) either as combinations or decimals
			$= 0.0526 \quad = \dfrac{1}{19} \quad (0.052632)$	A1	CAO	A1 CAO
			$\left(= \dfrac{7}{228} + \dfrac{1}{57} + \dfrac{1}{285} + \dfrac{1}{1140} \right)$	**[6]**	Allow 0.053 or anything which rounds up to 0.053 with working	**Please check all of the answer space for this part**

Question			Answer	Marks	Guidance	Question
8	(iii)		$P(A\mid B) = \dfrac{0.0307..}{0.0526..}$	M1	For their 'A' divided by their 'B'	$\dfrac{0.0307}{0.0526}$ Allow 0.584 from
			= 0.583 (= 0.58333)	A1	FT their answers to (ii) provided answer < 1	Allow $\dfrac{7}{12}$
			$P(B\mid A) = 1$	B1	CAO	
				[3]		
8	(iv)		P(All have orange centres) = $0.0307^2 = 0.00094$ or $= \dfrac{49}{51984}$ = (0.00094260)	M1	For their 0.0307^2	Allow 9.4×10^{-4} condone 0.0009 or 9×10^{-4}
				A1 **[2]**	FT	

Question			Answer	Marks	Guidance	Question
8	(v)		P(Has to select > 2) = 1 - P(Has to select ≤ 2)	M1	For $\left(\dfrac{6}{20}\times\dfrac{14}{19}\right)$	For any of the methods below allow SC2 for 1 – 0.079 = 0.921 or 1 – 3/38 = 35/38 o.e. as final answer
			$= 1-\left(\dfrac{14}{20}+\left(\dfrac{6}{20}\times\dfrac{14}{19}\right)\right)=1-(0.7+0.221)=1-0.921$			
				M1	For 1 – sum of both	This is 1 – P(C' + CC')
			= 0.079 (=0.078947)	A1 **[3]**	CAO	
			OR	M2	For whole product	Without extra terms added M1 if multiplied by k/18 only where 0<k<18 (seen as a triple product only)
			P(Has to select > 2) = P(First 2 both cherry) = $\left(\dfrac{6}{20}\times\dfrac{5}{19}\right)$			
			$= \dfrac{3}{38}$	A1	CAO	This is P(CC).
			= 0.079			
			OR			
			1 – (P(0 cherries) + P(1 cherry))=	M1	For any term	
			$1-\left(\dfrac{14}{20}\times\dfrac{13}{19}+\left(\dfrac{6}{20}\times\dfrac{14}{19}\right)+\left(\dfrac{14}{20}\times\dfrac{6}{19}\right)\right)$	M1	For 1 – sum of all three	This is 1 – P(C'C' + CC' + C'C)
			$=1-(0.4789+0.2211+0.2211)=1-0.9209$			
			= 0.079	A1	CAO	
			OR			
			$\left(\tfrac{6}{20}\times\tfrac{5}{19}\times\tfrac{14}{18}\right)+\left(\tfrac{6}{20}\times\tfrac{5}{19}\times\tfrac{4}{18}\times\tfrac{14}{17}\right)+\left(\tfrac{6}{20}\times\tfrac{5}{19}\times\tfrac{4}{18}\times\tfrac{3}{17}\times\tfrac{14}{16}\right)+\left(\tfrac{6}{20}\times\tfrac{5}{19}\times\tfrac{4}{18}\times\tfrac{3}{17}\times\tfrac{2}{16}\times\tfrac{14}{15}\right)+\left(\tfrac{6}{20}\times\tfrac{5}{19}\times\tfrac{4}{18}\times\tfrac{3}{17}\times\tfrac{2}{16}\times\tfrac{1}{15}\times\tfrac{14}{14}\right)$	M1	For any term	This is P(CCC' + CCCC' + CCCCC' + CCCCCC' + CCCCCCC')
			$=\dfrac{7}{114}+\dfrac{14}{969}+\dfrac{7}{2584}+\dfrac{7}{19380}+\dfrac{1}{38760}$	M1	For sum of all five terms (all correct)	
			= 0.079	A1	CAO	

NOTE RE OVER-SPECIFICATION OF ANSWERS

If answers are grossly over-specified, deduct the final answer mark (max once per question). 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 and also non alignment in question 5(i)

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 – Use BP symbol
Other rules for annotation: In the 10 standardisation scripts annotate everything that gets anything other than zero or full marks. After this, annotate down the right hand side in Q7(ii), up to where marks stop being scored, in the order given in the mark scheme. Annotate anywhere else where necessary to clarify how you have awarded the marks.

Additional notes re Q7 part ii (first three marks)

Minimum needed for B1 is p = probability of being cured.
Allow p = P(patient being cured)
Definition of p must include word probability (or chance or proportion or percentage or likelihood but NOT possibility, number or amount).
Preferably given as a separate comment. However can be at end of H_0 as long as it is a clear definition 'p = the probability of patient being cured.'
Do NOT allow 'p = probability of patient in the sample being cured'
Do NOT allow 'p = the probability of patient being cured is different'
Allow $p=78\%$, allow only p or θ or π or ρ. However allow any single symbol if defined (including x)
Allow $H_0 = p=0.78$, Allow $H_0 : p=^{39}/_{50}$ or $p=^{78}/_{100}$
Allow NH and AH in place of H_0 and H_1
Do not allow $H_0 : P(X=x) = 0.78$
Do not allow $H_0: =0.78, =78\%, P(0.78), p(x)=0.78, x=0.78$ (unless x correctly defined as a probability)
Do not allow H_0 and H_1 reversed
For hypotheses given in words allow Maximum B0B1B1
Hypotheses in words must include probability (or chance or proportion or percentage) and the figure 0.78 oe
Thus eg $H_0 : P(\text{patient being cured}) = 0.78$, $H_1 : P(\text{patient being cured}) > 0.78$ gets B0B1B1
Do not allow if H_1 wrong

Additional notes re Q7 part ii

Smallest critical region method:
Smallest critical region that 19 could fall into is {19, 20} and has size 0.0461 gets B1,   This is > 1% gets M1, B1, A1, E1 as per scheme
NB These marks only awarded if 19 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.

Lower tailed test done with H_1: p<0.78
Hyp gets max B1B1B0
If compare with 1% give SC2 for $P(X \leq 19) = 1 - 0.0069 = 0.9931 > 1\%$ and SC1 for final conclusion, otherwise give zero.

Two-tailed test done with H_1: $p \neq 0.78$
Provided compare with 0.5% give SC2 for $P(X \geq 19) = 0.0461 > 0.5\%$ and SC1 for final conclusion

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