OCR
RECOGNISING ACHIEVEMENT

GCE

Mathematics

Advanced Subsidiary GCE

Unit **4732:** Probability and Statistics 1

Mark Scheme for June 2013

Oxford Cambridge and RSA Examinations

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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.

1. **Annotations**

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

2. Subject-specific Marking Instructions for GCE Mathematics (OCR) 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, e.g. 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.

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding. Penalise over-rounding only once in paper.

Question			Answer	Marks	Guidance	
1	(i)		2 | 0 4 7 3 | 2 3 4 | 0 5 7 9 5 | 3 5 5 6 8 6 | 2 5 7 9 2 | 4 means 24 or similar	 B1 B1 B1 **[3]**	B1 for stem correct AND (3 branches correct OR 5 branches correct nos but incorrectly ordered) B1 for all correct	Ignore "0" and/or "1" in stem, without leaves Allow incorrect alignment. Allow space instead of line. Allow left–facing diag If all digits are in correct rows and orders, award this mark unless: 4th row is not the longest OR eg a 3rd digit in one row is clearly aligned with a 4th digit in another
1	(ii)		47.6 (3 sf) or $\frac{857}{18}$ or $47\frac{11}{18}$ (cm) oe 51 (cm)	B1 B1ft **[2]**	cao ft wrong diag	eg 857 ÷ 18 = 41.6 B0 but $\frac{857}{18}$ = 41.6 ISW B1
1	(iii)		49 (or 9th no.) becomes 51 or 53 (or 10th no.) becomes 55	B1 B1 **[2]**	No marks for identifying 49 & 53 alone or 51 & 55 alone	NB NO ft from wrong diag NOT eg '51 or higher' Allow embedded answer eg 53 identified as incorrect and state(55+49)÷2=52 scores 2nd B1
2	(i)		5 2 4 1 3 or A B C D E (grades) 3 4 5 2 1 3 1 5 2 4 d^2 4 4 1 1 4 Σd^2 (= 14) $1 - \frac{6\times"14"}{5\times(5^2-1)}$ = 0.3 oe	M1 A1 M1 M1 A1 **[5]**	Attempt ranks Correct ranks; allow both sets reversed Can be implied by eg $\Sigma d^2 = 14$ Attempt Σd^2 dep 1st M1 ft Σd^2 dep 1st M1 If one set reversed, $r_s = -0.3$ M1A0M1M1A0	One set reversed: A0 Use PMCC on ranks: 1st M1A1 as main scheme then: $\Sigma x = \Sigma y = 15$ $\Sigma x^2 = \Sigma y^2 = 55$ $\Sigma xy = 48$ $S_{xx} = S_{yy} = 10$ $S_{xy} = 3$ allow one arith error M1 $r = 3/\sqrt{(10\times10)}$ allow one arith error M1 = 0.3 A1
2	(ii)		$\Sigma d^2 = 8$ or '2 the same and 2 differ by 2' 1 4 3 2	M1 A1 **[2]**	May be implied	Allow $d^2 = 8$ or similar

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Question			Answer	Marks	Guidance	
3	(i)		$1\times0.4 + 3\times0.3 + 5\times0.2 + 7\times0.1$ $= 3$ $1^2\times0.4 + 3^2\times0.3 + 5^2\times0.2 + 7^2\times0.1$ $-$ "3"^{2} $= 4$	M1 A1 M1 M1 A1 **[5]**	≥ 3 terms correct ÷ eg 4 M0 ≥ 3 terms correct ÷ eg 4 M0 Dep +ve result	Use of $\Sigma(x - \bar{x})^2\times p$: $2^2\times0.4 + 0 + 2^2\times0.2 + 4^2\times0.1$ M2 or 2 correct non–zero terms M1
3	(ii)		775, 757, 577 $\frac{2}{3}$ or 0.667 (3 sf)	B1 B1 **[2]**	Must show all three	Allow repeats, eg list of 6 orders Alt method X_1: 5 or 7, X_2: 5 or 7; X_3: 5 or 7 or X_1, X_2, X_3 can be 5 or 7 B1
3	(iii)		Binomial stated, or seen or implied with any n & p $^{11}C_4 \times 0.8^7 \times 0.2^4$ $= 0.111$ (3 sf)	B1 M1 A1 **[3]**	eg by $0.8^r \times 0.2^s$ (r,s>1) not just by ^nC_r Correct method Correct answer, no working M1M1A1	NB 0.0388 scores B1M0A0 as it is $^{11}C_5\times0.8^6\times0.8^5$
4	(i)		5.74 0.13 or 'the same'	B1 B1 **[2]**	NB 0.13 seen within working; B0	eg $\frac{\Sigma x^2}{10}$ – (their mean)^2 = 0.13^2 scores B0 for 0.13
4	(ii)		(10×'5.74' + 15×5.6) ÷ 25oe all correct = 5.656 = 5.66 (3 sf)	M1 A1ft **[2]**	eg $5.74\times\frac{2}{5} + 5.6\times\frac{3}{5}$ ft their 5.74	NB (5.74 + 5.6) ÷ 2 = 5.67 M0A0 NB 5.7 with no wking: M0A0 even if already penalised elsewhere for over–rounding
4	(iii)		1st gp (or one gp) is more consistent (or less spread oe) but less accurate (or mean further from true mean oe)	B1ft B1ft **[2]**	2nd gp (or one gp) more accurate or etc but less consistent or etc If neither B1 scored, but state 'consistency does not imply accuracy' or similar: SC B1 Equiv answers accepted, but no others	1st gp (or one gp) more consistent or etc 2nd gp (or the other gp) more accurate or etc Ignore all other, eg ignore 'Claim false' or 'Claim true' etc even if it contradicts other statements Reference to mean of all 25 does not score Follow through their values for 1st gp: eg if 1st gp sd = 5.13: 1st gp less accurate and less consistent oe B1B1 Similar for other ft.

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Question			Answer	Marks	Guidance	
5	(i)		$S_{xx} = 503.45 - \frac{70.3^2}{10}$ (= 9.241) $S_{yy} = 103.94 - \frac{30.8^2}{10}$ (= 9.076) $S_{xy} = 211.9 - \frac{70.3\times30.8}{10}$ (= -4.624) $r = \frac{"-4.624"}{\sqrt{"9.241"\times"9.076"}}$ = –0.5049…. or –0.505 (3 sfs)	M1 M1 A1 **[3]**	Correct sub in any correct *S* formula Correct sub in any correct *r* formula Correct ans with no wking: M1M1A1	Must be correct sub in all *S*'s & *r* but not nec'y accurate
5	(ii)		Correlation (of UR & CPI) does not imply causation oe or *r* not close to –1	B1 **[1]**	Both (UR & CPI) may depend on another factor or *r* small or poor corr'n oe Ignore all else	Allow One may depend on another factor Allow without context NOT eg UR is independent NOT eg Only for the given years NOT eg Only for certain months
5	(iii)	(a)	$b' = \frac{S_{xy}}{S_{yy}} = \frac{"-4.624"}{"9.076"}$ (= $-\frac{1156}{2269}$ or –0.50948) $x - \frac{70.3}{10} = "-\frac{1156}{2269}"(y - \frac{30.8}{10})$ $x = –0.51y + 8.6$ (2 sfs) or $x = -\frac{1156}{2269}y + 8.6$	M1 M1 A1 **[3]**	ft their *S*'s or $a' = "-\frac{1156}{2269}"\times(-\frac{30.8}{10}) + \frac{70.3}{10}$ NB use b' (= –0.509), not *r*(= –0.5049)	If *y* on *x*: $b = \frac{S_{xy}}{Sxx} = \frac{"-4.624"}{"9.241"}$ (= –0.500) M1 y–3.08="–0.500"×(x–7.03) or a = 3.08+0.5×7.03 M1 y = –0.50x + 6.6 A0
5	(iii)	(b)	x = –0.509 × 4.0 + 8.60 = 6.56 (3 sf) or 6.6 (2 sf)	M1 A1ft **[2]**	Allow sub y = 0.04 for M1 only ft their equn; ans to 2 sf	If *y* on *x* found in **(a)** 4.0 = –0.500x + 6.60 M1 x = 5.2 (2 sf) A1ft
6			In all three parts of q 6, where the right answer is seen following a method which is unclear, award full marks. If the right answer follows from a method that is very clearly incorrect, award M0A0 in (i) & (iii), and in (ii) award M0M0A0 unless there is a partly correct method worth M1.			
6	(i)		$\frac{1}{5}\times\frac{1}{4}\times2$ or $\frac{2}{5}\times\frac{1}{4}$ alone oe = $\frac{1}{10}$ or 0.1 oe	M1 A1 **[2]**	or $\frac{^2C_2}{^5C_2}$ or $\frac{1}{^5C_2}$ or $\frac{^2P_2}{^5P_2}$ Allow $^5C_3$ instead of $^5C_2$	Allow M1 for $\frac{1}{5}\times\frac{1}{4}$, but NOT other methods leading to $\frac{1}{20}$ and NOT $\frac{1}{20}$ with no wking M1 for totally correct method except $\frac{1}{5}\times\frac{1}{4}$ seen: M1 NB $\frac{2}{5}\times\frac{1}{4}\times2$ M0A0; $\frac{2}{^5C_2}$ M0A0; $\frac{2}{5}\times\frac{1}{5}$ M0A0

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding. Penalise over-rounding only once in paper.

Question			Answer	Marks	Guidance	
6	(ii)		$\frac{2}{5}\times\frac{3}{4}\times\frac{2}{3}$ or $\frac{1}{5}\times\frac{3}{4}\times\frac{2}{3}\times 2$ oe or $\frac{1}{5}$ or 0.2 (not from incorrect method) or correct list of 6 comb's with 1 vowel or $\frac{2}{\ldots}\times\frac{3}{\ldots}\times\frac{2}{\ldots}\times 3$ or $\frac{1}{\ldots}\times\frac{3}{\ldots}\times\frac{2}{\ldots}\times 6$	M1	$\frac{2\times {}^3C_2}{\ldots\ldots}$ or $\frac{\ldots\ldots}{{}^5C_3}$ or $\frac{6}{\ldots\ldots}$ or $\frac{2}{5}\times\frac{3}{5}\times\frac{3}{5}$	Only if using complement (ie 1–P(0V or 2V)): $\frac{3}{5}\times\frac{2}{4}\times\frac{1}{3}$ OR $\frac{2}{5}\times\frac{3}{4}\times\frac{1}{3}\times 3$ M1
			$\frac{1}{5}\times\frac{3}{4}\times\frac{2}{3}\times 2\times 3$ oe fully correct method	M1	$\frac{2\times {}^3C_2}{{}^5C_3}$ oe or $6\div 10$ Allow ${}^5C_2$ instead of ${}^5C_3$. Not P's	$1-(\frac{3}{5}\times\frac{2}{4}\times\frac{1}{3}+\frac{2}{5}\times\frac{3}{4}\times\frac{1}{3}\times 3)$ M1 5! or 120 alone is probably an incorrect method in this part
			$=\frac{3}{5}$ or 0.6 oe	A1 **[3]**		See comment before 6(i)
6	(iii)		$1-\frac{1}{{}^5C_4}$ or $1-\frac{1}{5}$ or $\frac{5!-4!}{5!}$ or $\frac{1\times {}^4C_3}{{}^5C_4}$ or $\frac{1}{5}\times 4$	M1	or $(\frac{1}{5}\times\frac{4}{4}\times\frac{3}{3}\times\frac{2}{2})+(\frac{4}{5}\times\frac{1}{4}\times\frac{3}{3}\times\frac{2}{2})$ $+(\frac{4}{5}\times\frac{3}{4}\times\frac{1}{3}\times\frac{2}{2})+(\frac{4}{5}\times\frac{3}{4}\times\frac{2}{3}\times\frac{1}{2})$	or $1-\frac{4}{5}\times\frac{3}{4}\times\frac{2}{3}\times\frac{1}{2}$ or $\frac{24+24+24+24}{5!}$
			$=\frac{4}{5}$ or 0.8 oe	A1 **[2]**		$\frac{4}{5}\times\ldots$ M0A0 eg $\frac{4}{5}\times\frac{1}{5}$ M0A0 See comment before 6(i)
7	(i)	(a)	$X\sim$B(30, 0.05) seen or implied	B1	eg by 0.8122 or 1–0.5535 or $0.95^r\times 0.05^s$ (r , $s>1$) Allow B(30,0.95) or B(30, 0.5) for B1 30×0.05 alone insufficient for B1 ${}^nC_r$ insufficient for B1	If $n=15$: B(15, 0.05) B1
			P($X>2$) = 1 – 0.8122 alone or $1-(0.95^{30}+30\times 0.95^{29}\times 0.05+{}^{30}C_2\times 0.95^{28}\times 0.05^2)$	M1		$1-(0.95^{15}+15\times 0.95^{14}\times 0.05+{}^{15}C_2\times 0.95^{13}\times 0.05^2)$ M1
			= 0. 1878 or 0.188 (3 sfs)	A1 **[3]**		= 0.0362 A0

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding. Penalise over-rounding only once in paper.

Question			Answer	Marks	Guidance	
7	(i)	(b)	Addition method: X~B(30,0.05) & Y~B(15,0.05) stated or implied	B1	NB eg 0.0362 implies B(15, 0.05) see below	Subtraction methods: X~B(30,0.05)&Y~B(15,0.05) stated or impl B1
			$P(X = 2) = (0.8122–0.5535)$ or ${}^{30}C_2\times0.95^{28}\times0.05^2$ or 0.2587/6 OR $P(Y \geq 1) = (1 – 0.95^{15})$ or 0.5367	M1		$P(X=2) = (0.8122–0.5535)$ or ${}^{30}C_2\times0.95^{28}\times0.05^2$ or 0.2587/6 OR $P(Y=0) = 0.95^{15}$ or 0.4633 M1
			"0.2587/6" × "0.5367" or 0.1388	M1	fully correct method for $P(X=2)\times P(Y\geq1)$	fully correct method for $P(X=2)\times P(Y=0)$ "0.2587" × "0.4633" or 0.1199/8 M1
			$P(X > 2) + P(X = 2) \times P(Y \geq 1)$ = "0.1878" + "0.1388" alone	M1	[their (a)+any p] alone, but dep 1st M1	$1 – (P(X = 0,1) + P(X=2)\times P(Y=0))$ = 1 – ("0.5535" + "0.1199") OR $P(X \geq 2) – P(X=2)\times P(Y=0))$ = (1 – "0.5535") – "0.1199" dep 1st M1 M1
			= 0. 327 (3 sf) **AG**	A1		= 0. 327 (3 sf) **AG** A1
			For A1 must see correct wking or 0.3265/6...		If ans 0.327, check whether it comes from a correct method (possibly not in MS) or clearly comes from an incorrect method eg (0.4465 + 0.2587)× 0.4633 = 0.327 (ie $(P(X \geq 2) + P(X = 2)) \times P(Y = 0)$ B1M1M0M0A0	Do not use marks from a mixture of 3rd column and other columns. Decide which column would give most marks and mark according to that method.
				[5]		If n = 15 for both distr's, see next page NB If 0.1392 seen, it comes from given answer – (i)(a) (ie 0.3270 – 0.1878).

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding. Penalise over-rounding only once in paper.

Question			Answer	Marks	Guidance	
7	(i)	**(b)**	Alternative scheme for the case where $n = 15$ is used for both distr's			If $n = 15$ for both distr's: B(15, 0.05) B0 $P(X = 2) = {}^{15}C_2 \times 0.05^2 \times 0.95^{13}$ or 0.1348 OR $P(Y \geq 1) = 1 - 0.95^{15}$ or 0.5367 M1 "0.1348"×"0.5367" or 0.0723 correct method M1 their **(i)(a)** + "0.0732" Dep 1st M1 M1 = 0.1085 A0 NB Also mark subtraction methods if seen.
7	**(ii)**		Any use of 0.327 or their **(i)(b)** for 1st M1 $(1 - 0.327)^3 \times 0.327 + (1 - 0.327)^4 \times 0.327$ Allow "correct" use of their **(i)(a)** or **(i)(b)** for 2nd M1 = 0.167 (3 sf)	M1 M1 A1 **[3]**	$(0.5535 + 0.2586 \times 0.4633)^3 \times 0.327 +$ $(0.5535 + 0.2586 \times 0.4633)^4 \times 0.327$	 $1 - 0.673^5 - (1 - 0.673^3)$ oe Allow any use of their **(i)(b)** for 1st M1 then if "correct" use, also 2nd M1 Allow use of their **(i)(a)** in "correct" method for M0M1A0 No marks for use of 0.95 & 0.05
8	**(i)**		12×10×5 (in numerators or alone) OR any prod of 3 probs×6(or ×3! or ${}^3P_3$) $\frac{12}{27} \times \frac{10}{26} \times \frac{5}{25} \times 6$ or $\frac{12 \times 10 \times 5}{{}^{27}C_3}$ = $\frac{8}{39}$ oe or 0.205 (3 sfs)	M1 M1 A1 **[3]**	or ${}^{12}C_1 \times {}^{10}C_1 \times {}^5C_1$ or 600 (in numerators or alone) or eg $(\frac{12}{27} \times \frac{10}{26} \times \frac{5}{25} + \frac{12}{27} \times \frac{5}{26} \times \frac{10}{25}) \times 3$	 or $\frac{4}{117}$ or 0.0342 oe Fully correct method Examples: $\frac{12}{27} \times \frac{10}{27} \times \frac{5}{27} \times 6$ or $\frac{12}{25} \times \frac{10}{24} \times \frac{5}{23}$ M1M0A0 or $\frac{1}{27} \times \frac{1}{26} \times \frac{1}{25} \times 6$ M1M0A0

Note: "(3 sfs)" means "answer which rounds to ... to 3 sfs". If correct ans seen to ≥ 3sfs, ISW for later rounding. Penalise over-rounding only once in paper.

Question			Answer	Marks	Guidance		
8	(ii)		$0.4 \times \frac{x}{50}$ OR $0.6 \times \frac{50-x}{50}$ oe or $0.4 \times \frac{?}{50}$	M1	$0.4 \times p$ OR $0.6 \times (1-p)$ or similar	$0.4 \times \frac{x}{50}$ or etc	$0.4 \times a$ etc M1
			$0.4 \times \frac{x}{50} + 0.6 \times \frac{50-x}{50} = 0.54$	M1	$0.4 \times p + 0.6 \times (1-p) = 0.54$	$0.4 \times \frac{x}{50} + 0.6 \times \frac{y}{50} = 0.54$ AND $x + y = 50$	$0.4a + 0.6b = 0.54$ AND $a + b = 1$ M1
			$4x = 60$ oe, two terms	A1	$p = 0.3$	$4x = 60$ or $4y = 140$	$a = 0.3$ or $b = 0.7$ A1
			no. of red = 15	A1	no. of red = 15 Allow $x = 15$ as answer, but not if contradicted later	no. of red = 15	no. of red = 15 A1
			T & I: $0.4 \times \frac{x}{50}$ or etc OR one trial ($n \neq 15$) M1 Trial of $n = 15$ M1A1 Answer stated A1	**[4]**	If $x \leftrightarrow (50-x)$ or $p \leftrightarrow (1-p)$: similar mks including 1st A1 for $p = 0.7$ or $x = 35$	Correct answer scores full marks unless clearly from incorrect method.	
9			If 0.8 ↔ 0.2 apparently used consistently in 9(i)(a), (i)(b) & possibly (ii). SC; can score all M–marks in all three parts, and A1 in (ii) but A0 in (i)(a) and A0 (i)(b) This may be implied by their answers without working as follows (i)(a) $0.2^{10} \times 0.8 = 8.19 \times 10^{-8}$; $0.2^{9} \times 0.8 = 4.10 \times 10^{-7}$; $0.2^{11} \times 0.8 = 1.64 \times 10^{-8}$ M1A0 (i)(b) $1 - 0.2^{10} = 0.999999898$ M1M1A0; $1 - 0.2^{9} = 0.999999488$ M0M1A0; $1 - 0.2^{11} = 0.999999979$; $0.2^{10} = 1.024 \times 10^{-7}$ M1M0A0 But if 0.9999…. or similar, unclear precisely which method used so M0M0A0 (ii) $1 \div 0.8 = 1.25$ M1A1 **NB!!!!!** Any other p ($\neq$ 0.2 or 0.8) can score only M1 in (ii) & possibly B1ft in (iii)				
9	(i)	(a)	$0.8^{10} \times 0.2$ = 0.0215 (3 sf)	M1 A1 **[2]**	Allow $0.8^{9} \times 0.2$ or $0.8^{11} \times 0.2$ or 0.0268 or 0.0172	If 0.8 ↔ 0.2, see above	
9	(i)	(b)	0.8^{10} or 0.107…. $1 - 0.8^{10}$ alone = 0.893 (3 sf)	M1 M1 A1 **[3]**	Not $0.8^{10} \times$ …. M0M0 Not just 0.8^{9} or 0.8^{11} M0M0 Allow M1 for $1-0.8^{9}$ or $1-0.8^{11}$ alone or 0.866 or 0.914	$0.2 + 0.8 \times 0.2 + \ldots + 0.8^{9} \times 0.2$ (10 terms) M2 Allow M1 for 1 term omitted or extra Allow use of dots as above, for M1 or M2, so long as their 1st & last and one other term seen If 0.8 ↔ 0.2, see above	

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Question			Answer	Marks	Guidance	
9	(ii)		$\frac{1}{0.2}$ alone = 5	M1 A1 **[2]**	(5, 1) M1A0	Allow 1 ÷ their incorrect *p* used in (i)(a) Ignore eg "E(*X*) =" If 1 ÷ 0.8 = 1.25, see above
9	(iii)		4 Allow (4, 1)	B1ft **[1]**	or (ii) – 1 or (ii) × 0.8	ft (their (ii)–1, 1)

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