OCR
RECOGNISING ACHIEVEMENT

GCE

Mathematics

Advanced GCE

Unit **4732:** Probability and Statistics 1

Mark Scheme for January 2012

Oxford Cambridge and RSA Examinations

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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.

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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 (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 awar
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 schem
marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be
alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must
anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect
be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award ma
spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved)
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.
usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate ju
of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, e
relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be giver
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 th
an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working followi ect for Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply t whe 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 sc otherwise; and similarly where there are several B marks allocated. (The notation 'dep *' is used to indicate that a pa on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once g question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when t 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 inco A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks a obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme 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 In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown 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 oth

Candidates are expected to give numerical answers to an appropriate degree of accuracy. 3 significant figures may of but this always needs to be considered in the context of the problem in hand. For example, in quoting probabilities fro generally expect *some* evidence of interpolation and so quotation to 4 decimal places will often be appropriate. But ev apply – quotations of the standard critical points for significance tests such as 1.96, 1.645, 2.576 (maybe even 2.58 – b commonly suffice, especially if the calculated value of a test statistic is nowhere near any of these values. Sensible dis 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 significant figures are expected (either because of an explicit instruction or because the general context of a problem d given, loss of an accuracy ("A") mark is likely to be appropriate; but if 4 significant figures are given, this should not no Likewise, answers which are slightly deviant from what is expected in a very minor manner (for example a Normal prob attempt at interpolation, as 0.6418 whereas 0.6417 was expected) should not be penalised. However, answers which under-specified should normally result in the loss of a mark. This includes cases such as, for example, insistence that statistic is (say) 2.128888446667 merely because that is the value that happened to come off the candidate's calculato to answers that are given as final stages of calculations; intermediate working should usually be carried out, and quote 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 e deta 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 ex candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears (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 diffic considerably changed, it is likely that all the marks for that question, or section of the question, will be lost. However, r 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 leas marks do not. It is difficult to legislate in an overall sense beyond this global statement because misreads, even when difficulty remains unchanged, can vary greatly in their effects. For example, a misread of 1.02 as 10.2 (perhaps as a q mean) may well be catastrophic; whereas a misread of 1.6748 as 1.6746 may have so slight an effect as to be almost candidate's work.

A misread should normally attract *some* penalty, though this would often be only 1 mark and should rarely if ever be m sections of questions where there is a numerical answer either at the end of the section or to be obtained and commer test statistic), this answer will have an "A" mark that may actually be designated as "cao" [correct answer only]. This s *strictly* – if the misread has led to failure to obtain this value, then this "A" mark must be withheld even if all method ma 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-throu value of a test statistic is generally allowed (and often explicitly stated as such within the marking scheme), so that the knowledge of how to compare it with a critical value and draw conclusions. Such "fresh starts" are not affected by any A misread may be of a symbol rather than a number – for example, an algebraic symbol in a mathematical expression. more likely to bring about a considerable change in the object and/or difficulty of the question; but, if they do not, they as possible in the same way as numerical misreads, *mutatis mutandis*. This also applied to misreads of text, which are major problems in fair marking.

The situation regarding any particular cases that arise while you are marking for which you feel you nee d guid 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 sf)" means "answer which rounds to ... to 3 sf". If correct ans seen to ≥ 3sf, ISW for later rounding
Penalise over-rounding only once in paper. NB If marking by question and over-rounding is seen, must mark whole paper.

Question			Answer	Marks	Guidance	
1	(i)		$0.1 + 0.3 + 2p + p = 1$ oe $p = 0.2$	M1 A1 [2]		
1	(ii)		Σxp $= 2.7$ oe	M1 A1f [2]	≥ 2 terms correct, FT p	eg ÷ 4: M0A0
2	(i)		x because values (or depths) are fixed (or controlled or chosen or predetermined or manipulated or given oe) because they can be changed or it is changed or because it is not measured ie not "read off" oe or because we change the values ourselves	 B1 [1]	Allow "because it goes up in intervals" or "because it is taken at set intervals" Ignore all else NB "x is changed" B1, but "x changes" B0	NOT: x, as values are c x, as y depends c x as % sand dep Depth, as not af sand content x, as it is not de x, because y is n x, because it cha y, which is the d
2	(ii)		$S_{xx} = 7344 - \frac{216^2}{9}$ (= 2160) $S_{yy} = 30595 - \frac{512.4^2}{9}$ (= 1422.36) $S_{xy} = 10674 - \frac{216\times512.4}{9}$ (= – 1623.6) $r = \frac{"-1623.6"}{\sqrt{"2160"\times"1422.36"}}$ = –0.926 (3 sfs)	 M1 M1 A1 [3]	 correct subst in any S formula correct subst in all Ss & in r	

Question			Answer	Marks	Guida
2	(iii)	(a)	$b = \frac{"-1623.6"}{"2160"}$ or $-0.75\ldots$ or $-\frac{451}{600}$ $y - \frac{512.4}{9} = "-0.75\ldots"(x - \frac{216}{9})$ $y = -0.75x + 75(.0)$ (2 sf) or $y = -\frac{451}{600}x + \frac{5623}{75}$	M1 M1 A1 [3]	ft S_{xy} & S_{xx} from **(ii)** or $a = \frac{512.4}{9} - 0.75\ldots \times (-\frac{216}{9})$ or $\frac{5623}{75}$ 2 sf is enough Allow $y = -0.75x + (-75)$
2	(iii)	(b)	r close to -1 (or high or strong), $\lvert r\rvert$ close to 1 25 within range of data oe, so reliable 100 outside range of data oe, so unreliable Must give reasons Allow "accurate" instead of "reliable"	B1 B1 B1 [3]	Allow strong or good or high corr'n or rel'nship etc or …. so more reliable or …. so less reliable If (ii) $\lvert r\rvert < 0.7$: poor corr'n oe B1f 25 unreliable B1f 100 unreliable B1f
3	(i)		$(1 - 0.12)^{13}$ or $13\times(1 - 0.12)^{12}\times0.12$ $(1 - 0.12)^{13} + 13\times(1 - 0.12)^{12}\times0.12$ $= 0.526$ (3 sf)	M1 M1 A1[3]	Either seen Fully correct method
3	(ii)		${}^{13}C_2\times0.12^2\times(1 - 0.12)^{11}$ $2 \times$ "0.275275" $\times$ (1 – "0.275275") $= 0.399$ (3 sf)	M1 M1 A1 [3]	or 0.275(…) Correct method except allow omit "2 ×"

Question			Answer	Marks	Guida	
4	(a)		3 5 1 4 2 3 1 5 2 4 1 4 3 5 2 5 2 3 1 4	M1 A1	Attempt ranks for both variables Correct ranks May be implied by $\Sigma d^2 = 10$	If u tic of rank $\Sigma d^2 = 14$ score 2nd & below
			Σd^2 attempted (= 10)	M1	S_{xx} or $S_{yy} = 55 - \frac{15^2}{5}$ (=10) or $S_{xy} = 50 - \frac{15^2}{5}$ (=5)	
			$r_s = 1 - \frac{6\Sigma d^2}{5(5^2-1)}$ dep ≥ M1 gained = 0.5	M1 A1 [5]	$\frac{5}{\sqrt{10\times10}}$	A = 1, B = 2 etc
4	(b)		$n(n^2 - 1)$ greater or increases or becomes $(n+1)((n+1)^2 - 1)$	B1ind	or "denom increases" or "÷ by larger number"or "fraction decreases" or "value taken from 1 decreases" oe	Allow increases NOT just "n inc
			Σd^2 unchanged (or not increase) Allow d^2 unchanged	B1ind	or $d = 0$ or $d^2 = 0$ or the difference is 0	NOT $n(n^2 - 1)$ c NOT "differenc
			r_s greater	B1 [3]	dep ≥ B1 or no explanation "Little diff between rankings so r_s same" or "rankings unchanged" B0B0B0	Use of incorrect "Increases becau
5	(i)	(a)	$(\frac{6}{3} =)\ 2$	B1 [1]	$(\frac{6}{9} \times 3 =)\ 2$	
5	(i)	(b)	$^2/_6 \times 2$ $= {}^2/_3$ oe or 0.667 or 0.67 or 0.7	M1 A1[2]	Allow $^2/_5 \times 2$ or ans 0.8 for M1	Can be implied, Allow 0.66 or 0.

Question			Answer	Marks	Guid	
5	(ii)		(3.5, 6) (0.5, 0) or (6.5, 15)	B1 B1 [2]	Ignore incorrect	(6, 3.
5	(iii)	(a)	$\frac{\Sigma xf}{21}$ = 5.43 (3 sf) or $\frac{114}{21}$ or $\frac{38}{7}$ oe $\frac{\Sigma x^2 f}{21}$ or $\frac{817.5}{21}$ or 38.9… – "5.43"^{2} or = 9.46 or 9.4592…. (√9.4592….) = 3.08 (3 sfs)	M1 A1 M1 M1 A1 [5]	Allow x within classes, incl end pts then ÷5: M0A0 Allow x within class, incl end pt ÷5: M0 dep +ve result; done before √; not $-(\bar{x}^2 \div \ldots)$	≥ 2 non-ze ≥ 2 non-zero t Calc 4 values or (11.8, 0.184 or (70.5, 1.65, $\frac{\Sigma(x-\bar{x})^2 f}{21}$ full
5	(iii)	(b)	Actual values or exact hours unknown oe Don't have raw data. oe or measured to nearest hour oe	B1 [1]	or Data given in classes or grouped oe or Data evenly distributed in classes oe	Mid-points or class boundari

Question			Answer	Marks	Guid	
6	(i)		V because [probs or values or geometric or etc] decreasing or halving or Highest prob is 1st Allow if word "decreasing" or "halving" or "sloping downwards" or any equivalent seen NOT "Positive skew"	B1 B1 [2]	*X* because mode = 1 oe or Highest prob is P(1) oe B2 *Z* because P(0) = 0 or variable can't be 0 oe Allow "Geo distr'n cannot be zero" oe B2 "None of them": Ignore any reason given. B2	Fo V for o V with scores B1 but Z or X or reason or incor In all cases, or scored, ignore
6	(ii)		Y. Peaks at 2 Y. Like normal, peak at 2 Y. Highest prob is middle one (or is at 2) Y. P(X = 2) is max Y. Increase to 2 then decr Y. 1 4 6 4 1 alone or with 0.5^4 × Y. 0.0625, 0.25, 0.375, 0.25, 0.0625 Y. P(1) = P(3) and P(2) is greater/different or equiv of any of the above	B1B1B1	Ignore all else	If values of so 2 to 4 values: Y: For 3rd B1 mu "symmetrical" "peak at 2" or "same shape a
			If none of the above applies: Any implication that values not all equal eg: Not uniform or values increase (then decrease) or there is a peak Symmetrical or mirror image oe or $^4C_0 = {}^4C_4$ or 2nd = 4th or similar or mean = 2, or E(X) = 2, or 2 is hi'est prob, or peak at 2, or peak is middle value Y	 B1 B1 B1 [3]	 $^4C_0$, $^4C_1$, $^4C_2$, etc indep indep indep	

Question			Answer	Marks	Guid	
7	(i)		Geo(0.6) or G(0.6) or Geo with $p = 0.6$ P(woman) const or chance of woman const Each voter has same prob Whether one voter is a woman is indep of whether any other is a woman	B1B1 B1 B1 [4]	Allow Geo(60%) B1B1 or %age of women is constant Allow: "voter(s) independent", "Men & women are independent" "P(woman) is indep" "Each woman is indep"	B.) B comm In cont Allow "vote in In context (EACH comm Ignore all else
7	(ii)		$0.4^3 \times 0.6$ $= {}^{24}/_{625}$ or 0.0384	M1 A1f [2]	ft their Geo(p) from (i) ft their Geo(p) from (i)	Allow $0.3^3 \times$ (eg if $p = 0.4$, a
7	(iii)		0.4^3 alone, or $(0.4^4 + 0.4^3 \times 0.6)$ or $(0.4^4 +$ (ii))	M1	$1-(0.6 + 0.4\times0.6 + 0.4^2\times0.6)$ (allow extra term $0.4^3\times0.6$) ft their Geo(p) from (i)	Allow M1 for M0 for $0.4^r \times$ (
			$= {}^{8}/_{125}$ or 0.064	A1f [2]	ft their Geo(p) from (i)	eg if $p = 0.4$, a
8	(i)		Binomial stated $1 - 0.9648$ $= 0.0352$ (3 sfs) or ${}^{9}/_{256}$	M1 M1 A1 [3]	or implied by $C\times0.5^r$ or use of table or ${}^8C_7\times 0.5^7\times0.5 + 0.5^8$ fully correct method	or $0.5^7\times0.5 +$ $1-(0.5^8+8\times0.$
8	(ii)	(a)	${}^{22}C_{11} \times 0.5^{11} \times 0.5^{11}$ $= 0.168$ (3 sfs)	M1 A1 [2]	Fully correct method. Not ISW	eg 0.168^2 or 2

Question			Answer	Marks	Guidance	
8	(ii)	(b)	1 – "0.168" $^1/_2$(1 – "0.168") = 0.416 (3 sfs)	M1 M1 A1 [3]	or $0.5^{22}(^{22}C_{12} + {}^{22}C_{13} + {}^{22}C_{14} + \ldots + 22 + 1)$ All 11 correct terms seen, or correct ans: M2 or P(X = 12, 13, … 21, 22) stated or implied with $\geq$2 terms shown or one extra term M1	or 1 – a or similar ma
9	(i)	(a)	$^9P_4$ or $^{9!}/_{5!}$ or $^9C_4 \times 4!$ = 3024	M1 A1 [2]	alone	oe eg $^9C_1 \times {}^8C$
9	(i)	(b)	$^8P_3$ or $8 \times 7 \times 6$ oe or $^8C_3 \times 3!$ $\times$ 5 (or $^5C_1$) = 1680	M1 M1 A1 [3]	Allow × …. or ÷ ….. Correct × 5 or $^8C_3 \times 5$ (or $^5C_1$) Not ISW, eg $^{1680}/_{3024}$: M1M1A0	or ($^9P_4$ or "302
					SC: consistent use of with replacement in (i) (or if only (a) or (b) attempted) (ia) M0A0 (ib) 999 × 5 or 4995 M1 M0A0	

Question			Answer	Marks	Guida	
9	(ii)	(a)	${}^5C_3 \times {}^4C_1$ or ${}^5C_4$ oe ${}^5C_3 \times {}^4C_1 + {}^5C_4$ oe correct method so far (= 45) $\div {}^9C_4$ Allow anything $\div {}^9C_4$ $= {}^5/_{14}$ or 0.357 (3 sfs) oe, eg ${}^{35}/_{98}$ or ${}^{45}/_{126}$	M1 M1 M1 A1 [4]	${}^5C_3 \times {}^4C_1 \times 4!$ (or ${}^5P_3 \times 4 \times 4$) or 5! (or ${}^5P_4$) 960 + 120 oe correct method so far $\div {}^9P_4$ [must involve any P or any !] $\div {}^9P_4$ Marks must come from one method, not mixture of two methods	${}^5/_9$ ... × 4 ${}^5/_9 \times {}^4/_8 \times$ ... or: ${}^5/_9 \times {}^4/_8 \times {}^3/_7 \times$ ${}^5/_9 \times {}^4/_8 \times {}^3/_7 \times$ NB ${}^5/_9 \times {}^4/_8 \times$
9	(ii)	(b)	9, 8, 7, 4 or 9, 8, 6, 5 No mark yet 2 $\div {}^9C_4$ oe Must be (1 or 2 or 4) $\div {}^9C_4$ $= {}^1/_{63}$ oe or 0.0159 (3 sfs)	M1 M1 A1 [3]	${}^1/_9 \times {}^1/_8 \times {}^1/_7 \times {}^1/_6$ ⋮ ${}^4/_9 \times {}^3/_8 \times {}^2/_7 \times {}^1/_6$ Allow × or +… × 4! × 2 ⋮ × 2 fully correct method NB Marks from one method only, not mixed methods	4! + 4! or 2 × ... $\div {}^9P_4$ or ÷ (i)(a... Must ${}^2/_9 \times {}^2/_8 \times {}^1/_7 \times {}^1/_6$ × 4!/4 × 2 fu...
					SC: consistent use of with replacement in (ii), (or if only (a) or (b) attempted) (iia) $({}^5/_9)^4$ M1 $+ {}^4C_3({}^5/_9)^3({}^4/_9)$ (= 0.400) M1 M0A0 (iib) $({}^1/_9)^4$ (=0.000152) M1 attempt find no of gps M1A0	$1-(({}^4/_9)^4+4({}^4/_9)$... One term miss...

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