Oxford Cambridge and RSA

GCE

Further Mathematics A

Y532/01: Statistics

Advanced Subsidiary GCE

Mark Scheme for November 2020

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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.

Text Instructions

1. Annotations and abbreviations

Annotation in RM assessor	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
BP	Blank Page
Seen	
Highlighting	
Other abbreviations in mark scheme	**Meaning**
dep*	Mark dependent on a previous mark, indicated by *. The * may be omitted if only one previous M mark
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working
AG	Answer given
awrt	Anything which rounds to
BC	By Calculator
DR	This question included the instruction: In this question you must show detailed reasoning.

2. Subject-specific Marking Instructions for A Level Mathematics A

a Annotations must be used during your marking. For a response awarded zero (or full) marks a single appropriate annotation (cross, tick, M0 or ^) is sufficient, but not required.

For responses that are not awarded either 0 or full marks, you must make it clear how you have arrived at the mark you have awarded and all responses must have enough annotation for a reviewer to decide if the mark awarded is correct without having to mark it independently.

It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

Award NR (No Response)

- if there is nothing written at all in the answer space and no attempt elsewhere in the script
- OR if there is a comment which does not in any way relate to the question (e.g. 'can't do', 'don't know')
- OR if there is a mark (e.g. a dash, a question mark, a picture) which isn't an attempt at the question.

Note: Award 0 marks only for an attempt that earns no credit (including copying out the question).

If a candidate uses the answer space for one question to answer another, for example using the space for 8(b) to answer 8(a), then give benefit of doubt unless it is ambiguous for which part it is intended.

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 always 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, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
If you are in any doubt whatsoever 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, e.g. 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 method mark may usually be implied by a correct answer unless the question includes the DR statement, the command words "Determine" or "Show that", or some other indication that the method must be given explicitly.

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.

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, what is acceptable will be detailed in the mark scheme. If this is not the case please, escalate the question to your Team Leader who will decide on a course of action with the Principal Examiner.
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 We are usually quite flexible about the accuracy to which the final answer is expressed; over-specification is usually only penalised where the scheme explicitly says so.

- When a value **is given** in the paper only accept an answer correct to at least as many significant figures as the given value.

- When a value **is not given** in the paper accept any answer that agrees with the correct value to **3 s.f.** unless a different level of accuracy has been asked for in the question, or the mark scheme specifies an acceptable range.
  NB for Specification B (MEI) the rubric is not specific about the level of accuracy required, so this statement reads "2 s.f".

Follow through should be used so that only one mark in any question is lost for each distinct accuracy error.
Candidates using a value of 9.80, 9.81 or 10 for *g* should usually be penalised for any final accuracy marks which do not agree to the value found with 9.8 which is given in the rubric.

g Rules for replaced work and multiple attempts:

- If one attempt is clearly indicated as the one to mark, or only one is left uncrossed out, then mark that attempt and ignore the others.
- If more than one attempt is left not crossed out, then mark the last attempt unless it only repeats part of the first attempt or is substantially less complete.
- if a candidate crosses out all of their attempts, the assessor should attempt to mark the crossed out answer(s) as above and award marks appropriately.

h For a genuine misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A or B mark in the question. Marks designated as cao may be awarded as long as there are no other errors.
If a candidate corrects the misread in a later part, do not continue to follow through. Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

i If a calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers, provided that there is nothing in the wording of the question specifying that analytical methods are required such as the bold "In this question you must show detailed reasoning", or the command words "Show" or "Determine". Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.

j If in any case the scheme operates with considerable unfairness consult your Team Leader.

Question			Solution	Marks	AOs	Guidance	
1	(a)		–0.954 **BC**	**B2** **[2]**	1.1 1.1	SC: If B0, give B1 if two of 7.04, 29.0[4], –13.6[4] (or 35.2, 145[.2], –68.2) seen	
	(b)		Points lie close to a straight line Line has negative gradient	**B1** **B1** **[2]**	2.2b 1.1	Must refer to line, not just "negative correlation"	
	(c)		No, it will be the same as $x \rightarrow a$ is a linear transformation	**B1** **[1]**	2.2a	OE. *Either* "same" with correct reason, *or* "disagree" with correct reason. Allow any clear valid technical term	
2	(a)		$\frac{1}{0.2} = 5$	**M1** **A1** **[2]**	3.3 1.1	Geometric distribution soi 5 (or 5.00…) only	
	(b)		$0.8^2 - 0.8^{10}$ **= 0.533** (0.5326258…)	**M1** **A1** **[2]**	1.1 3.4	Allow for powers 2, 3, 4 and 9, 10, 11. Awrt 0.533, www. [5201424/9765625]	0.506, 0.378, 0.275, 0.405, 0.302, 0.554, 0.426, 0.324 Or $0.2(0.8^2 + \ldots. + 0.8^9)$, ± 1 term at either end
	(c)		P(≥ 10) = 0.8^9 = 0.1342… B(30, 0.1342…) Variance = *npq* **= 3.486…**	**M1** **A1** **M1** **A1ft** **[4]**	3.1b 1.1 3.1b 1.1	Or 0.8^{10}. Can be implied by correct *p* [0.10737… is M1A0 here] Stated or implied, their 0.8^9 or 0.8^{10} In range [3.48, 3.49] 2.875 from 0.8^{10}: M1A0M1A1ft	SC: 0.134(2) oe not properly shown: B2 for correct final answer.

Question			Solution	Marks	AOs	Guidance
3	(a)		Neither	B1 [1]	1.2	
	(b)		$q = 1.13 + 0.620p$	B1B1 B1 [3]	1.1,1.1 1.1	0.62(0) correct; both numbers correct Fully correct answer including letters
	(c)	(i)	2.68	B1ft [1]	1.1	awrt 2.68, ft on their **(b)** if letters correct
	(c)	(ii)	2.5 is within data range, and points (here) are close to line/well correlated	B1 B1 [2]	2.2b 2.2b	At least one reason, allow "no because points not close to line" Full argument, two reasons needed
	(d)		Not much data here/points scattered/ possible outliers So not very reliable	M1 A1 [2]	2.3 1.1	Reason for not very reliable (*not* "extrapolation") Full argument and conclusion, not too assertive (not wholly unreliable!)
4	(a)		Test is for rankings/rankings arbitrary/not bivariate normal etc	B1 [1]	2.4	OE
	(b)		H_0: $\rho_s = 0$, H_1: $\rho_s > 0$, where ρ_s is the population rank correlation coefficient Ranks 5 4 3 6 1 2 5 1 2 6 4 3 $\Sigma d^2 = 20$ $r_s = 1 - \frac{6\times 20}{6\times 35}$ = 3/7 or 0.42857… < 0.9429 Do not reject H_0 Insufficient evidence of association between ranking given by the two categories	B1 B1 M1 A1 B1 M1ft A1ft [7]	1.1 1.1 1.1 1.1 1.1 1.1 2.2b	Allow ρ_s not defined; allow ρ. Allow: H_0: no association between rankings. H_1: positive association (but *not* H_1: association) Exact or awrt 0.429 FT on their Σd^2 only
	(c)		Not dependent on any distributional assumptions	B1 [1]	1.2	Oe (*cf.* Specification, 5.08f)

Question			Solution	Marks	AOs	Guidance
5	(a)		Expected frequency for Middle/25 to 60 is 4.4 which is < 5 so must combine cells	**B1*ft** **depB1** **[2]**	2.4 3.5b	Correctly obtain this F_E, ft on addition errors "< 5" explicit and correct deduction
	(b)		<table><tr><th>Early</th><th>Middle</th><th>Late</th></tr><tr><td>29.4</td><td>23.1</td><td>31.5</td></tr><tr><td>26.6</td><td>20.9</td><td>28.5</td></tr></table> <table><tr><th>Early</th><th>Middle</th><th>Late</th></tr><tr><td>0.9918</td><td>0.4160</td><td>2.2937</td></tr><tr><td>1.0962</td><td>0.4598</td><td>2.5351</td></tr></table>	**B1** **B1** **B1** **[3]**	1.1 1.1 1.1	Both, allow 28.4 for 28.5 awrt 2.29, but allow 2.3 In range [2.53, 2.54]
	(c)		H_0: no association between session and age group. H_1: some association $\Sigma X^2 = 7.793$ $\nu = 2$, $\chi^2(2)_{crit} = 5.991$ Reject H_0. Significant evidence of association between session attended and age group.	**B1** **B1** **B1** **M1ft** **A1ft** **[5]**	1.1 1.1 1.1 1.1 2.2b	Both. Allow "independent" etc Correct value of X^2, awrt 7.79 (allow even if wrong in **(b)**) Correct CV and comparison Correct first conclusion, FT on their TS only Contextualised, not too assertive
	(d)		The two biggest contributions to χ^2 are both for the late session … … when the proportion of younger people is higher, and of older people is lower, than the null hypothesis would suggest.	**M1ft** **A1ft** **[2]**	1.1 2.4	Refer to biggest contribution(s), FT on their answers to **(b)**, needs "reject H_0" Full answer, referring to at least one cell (ignore comments on next highest cells)

Question			Solution	Marks	AOs	Guidance
6	(a)		Failures occur to no fixed pattern/are not predictable	B1 [1]	1.1	OE. *NOT* "independent"
	(b)		Failures occur independently of one another and at constant average rate	B1 B1 [2]	1.1 1.1	Not recoverable from **(a)** if independence not restated here; must be contextualised Ignore "singly". Allow "uniform" rate, not "constant rate" or "constant probability"; must be contextualised
	(c)		Variance (1.6384) ≈ mean So suggests that it is likely to be well modelled	M1 A1 [2]	1.1 3.5a	Compare variance (or SD). Allow square/square-root confusion Correct comparison and conclusion, 1.64 or better seen
	(d)		$e^{-1.61}$	B1 [1]	3.4	Exact needed, allow even if 0! or 1.61^0 or both left in
	(e)		<table><tr><td>1</td><td>≥ 2</td></tr><tr><td>0.322</td><td>0.478</td></tr></table>	B1 B1 [2]	3.4 1.1	One correct e.g. 0.3218 Other correct e.g. 0.4783
	(f)		P(F = 1) will be smaller as single failures are less likely	B1* depB1 [2]	3.5c 3.3	OE. Partial answer: B1

Question			Solution	Marks	AOs	Guidance
7			$\frac{{}^{2m}C_2 \times m}{{}^{3m}C_3}$	**M1**	3.1b	Use ${}^{2m}C_2$ and m
				M1	3.1b	Divide by ${}^{3m}C_3$
			$= \frac{2m(2m-1)}{2} \times m \div \frac{3m(3m-1)(3m-2)}{6}$			
			$= \frac{2m(2m-1)}{(3m-1)(3m-2)}$	**A1**	2.1	Correct expression in terms of m (allow with m not cancelled yet)
			$\frac{2m(2m-1)}{(3m-1)(3m-2)} = \frac{28}{55}$	**M1**	3.1a	Equate to $\frac{28}{55}$ & simplify to three-term quadratic
			$\Rightarrow 16m^2 - 71m + 28 = 0$	**A1**	2.1	Correct simplified quadratic, or (quadratic) × m, = 0, aef
			$m = 4$ **BC**	**M1**	1.1	Solve to get both 4 and $\frac{7}{16}$
			Reject $m = \frac{7}{16}$ as m is an integer	**A1** [7]	3.2a	Explicitly reject $m = \frac{7}{16}$
		OR:	$\frac{2m(2m-1) \times m \times 3!}{3m(3m-1)(3m-2) \times 2}$ then as above			Multiplication method can get full marks, but if no 3 or 3!, max M1M0A0 M1A0M0A0

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