

GCE

Further Mathematics A

Y532/01: Statistics

AS Level

Mark Scheme for June 2025

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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.

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MARKING INSTRUCTIONS

PREPARATION FOR MARKING

RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Online Training: OCR Essential Guide to Marking*.
2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are available in RM Assessor
3. Log-in to RM Assessor and mark the **required number** of practice responses (“scripts”) and the **required number** of standardisation responses.

MARKING

1. Mark strictly to the mark scheme.
2. Marks awarded must relate directly to the marking criteria.
3. The schedule of dates is very important. It is essential that you meet the RM Assessor 50% and 100% (traditional 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the RM Assessor messaging system.
5. **Crossed-Out Responses**
Where a candidate has crossed out a response and provided a clear alternative then the crossed-out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed-out response where legible.

Rubric Error Responses – Optional Questions

Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM Assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

Multiple-Choice Question Responses

When a multiple-choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).

When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses

When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only one mark per response)

Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. *(The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)*

Short Answer Questions (requiring a more developed response, worth two or more marks)

If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space).

Longer Answer Questions (requiring a developed response)

Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there, then add the annotation 'SEEN' to confirm that the work has been seen and mark any responses using the annotations in section 11.
7. There is a NR (**No Response**) option. Award NR (No Response):
 - if there is nothing written at all in the answer space
 - 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) which is not an attempt at the question.

Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).
8. The RM Assessor **comments box** is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.
10. For answers marked by levels of response: Not applicable in F501
To determine the level – start at the highest level and work down until you reach the level that matches the answer
To determine the mark within the level, consider the following

Descriptor	Award mark
On the borderline of this level and the one below	At bottom of level
Just enough achievement on balance for this level	Above bottom and either below middle or at middle of level (depending on number of marks available)
Meets the criteria but with some slight inconsistency	Above middle and either below top of level or at middle of level (depending on number of marks available)
Consistently meets the criteria for this level	At top of level

11. Annotations

Annotation	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.

Subject Specific Marking Instructions

- 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	Answer	Marks	AO	Guidance
1(a)	H ₀ : probabilities of each score in the ratio 1:1:1:1:2, H ₁ : they are not	B1 [1]	2.5	Allow H ₀ : “outcomes in/expected frequencies in/follow ratio ...”, “belief is correct”, “each side equally likely”, “dice is unbiased”, “ $p = 1/6$ ” (with p defined) etc. Not H ₀ : “scores/data/results/dice/they are in ratio ...”, “there is evidence that ...”, “data fits/is a good fit for ...”, etc Can be recovered if written correctly in part (b) .
1(b)	Expected frequencies 10, 10, 10, 10, 20 $\Sigma X^2 = (0.9 + 0.9 + 0.1 + 2.5 + 1.8) = 6.2$ 6.2 < 9.488 Do not reject H ₀ . Insufficient evidence that the probabilities are not in the ratio 1:1:1:1:2.	B1 M1* A1 A1 depM1 A1FT [6]	1.1 3.3 3.4 1.1 1.1 2.2b	Stated or implied Evidence of correct method for ΣX^2 , e.g. 3 or more correct, or right answer Seen correct anywhere (NB: 8.0 is common, from final $O_E = 10$) Compare <i>their</i> 6.2 with 9.488 (or 9.49) FT on <i>their</i> 6.2 if M1 gained, but <i>not</i> on wrong CV Contextualised, not too assertive, double negative needed (e.g. <i>not</i> “significant evidence that probabilities are in the ratio ...”). Can award FT even if conclusion reversed. Do not award if hypotheses reversed.

Question		Answer	Marks	AO	Guidance
2	(a)	Helicopters pass within sight independently of one another ...	B1	2.4	Need at least one statement to be contextualised for any marks at all here. Allow “singly” or “randomly”. <i>Not</i> “one day independent of another”, <i>not</i> “helicopters independent of aeroplanes”.
		... and at constant average rate (uniform rate)	B1 [2]	2.4	<i>Not</i> “constant rate”, “average constant rate” etc. Allow “for each equal time interval the probability of seeing a helicopter is constant”, but <i>not just</i> “probability of seeing a helicopter is constant”.
	(b)	$P(\leq 4) - P(\leq 1)$ from $Po(1.8)$ ($= 0.9639 - 0.4628$)	M1	1.1	Allow M1 for 0.233, or sum of formula for $r = 2, 3, 4$, with or without 1
		$= 0.5008$ or 0.501	A1 [2]	1.1	Awrt 0.501
	(c)	$e^{-0.15t} = 0.95$	M1	1.1	Equation of the form $e^{-\lambda t} = 0.95$ stated, or implied by later working (<i>not</i> $e^{-\lambda/t}$, though this can get M0M1: $e^{-k} = 0.95$, $k = 0.0513$, $1.8/t = 0.0513$, $t = 1.8/0.0513$: M0M1A0). <i>Not just</i> $e^{-t} = 0.95$.
		$-0.15t = \ln(0.95)$	M1	2.1	Solve using logs (and with numerical λ if used), or by other method if answer or 0.0513 correct, allow from $e^{-t} = 0.95$ (giving $t = 0.0513$)
		$t = 0.342$ (hours)	A1 [3]	2.2a	Awrt 0.342 (hours). Allow 20.5 mins or better.
	(d)	Not necessarily as this could happen by chance	B1 [1]	3.5a	No with any clear relevant reason, e.g. conclusions based on a short time interval may not be reliable, <i>or</i> “yes as probability of 2 or more is very small/less than 0.05”. (“Yes” answers must be as specific as this.)
	(e)	No, aeroplanes do not pass the point randomly/independently <i>or</i> no because rate is constant/fixed.	B1 [1]	2.3	OE, needs context. <i>Not</i> “mean/average is fixed”. <i>Not</i> “ <u>unlikely</u> that they pass independently”
	(f)	$12 \times 15 + 1.8 = 181.8$	B1 [1]	1.1	Or 182. Allow for just $180 + 1.8$, or this seen but added incorrectly. SC: “181.8 in 12 hours so 363.6 in 24 hours”: B1 ISW

Question		Answer								Marks	AO	Guidance																	
3	(a)	“Association” can mean any form of (monotonic) relationship, not just linear, <i>or</i> “pmcc test may not be valid as distribution not known to be bivariate normal/elliptical shape”								B1 [1]	1.2	OE, e.g. “relationship may not be linear”, “testing for association, not <u>linear</u> correlation”, or “if data arbitrary”, no wrong statements. <i>Not</i> “ <u>data</u> may not be linearly related”, <i>not</i> “data is ranked”, nothing to do with average/spread, <i>not</i> “outliers”. Not <i>just</i> “bivariate” or “normal”																	
	(b)(i)	<table><tr><td>Book</td><td>P</td><td>Q</td><td>R</td><td>S</td><td>T</td><td>U</td><td>V</td></tr><tr><td>Reader A</td><td>(1)</td><td>(2)</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr><tr><td>Reader B</td><td>7</td><td>5</td><td>6</td><td>4</td><td>1</td><td>2</td><td>3</td></tr></table>	Book	P	Q	R	S	T	U	V	Reader A	(1)	(2)	3	4	5	6	7	Reader B	7	5	6	4	1	2	3	B2 [2]	1.1 1.1	All ranks correct SC: (1 or) 2 errors, <i>or</i> Reader B ranks reversed (1 3 2 4 7 6 5): B1
Book	P	Q	R	S	T	U	V																						
Reader A	(1)	(2)	3	4	5	6	7																						
Reader B	7	5	6	4	1	2	3																						
	(b)(ii)	$H_0: \rho_s = 0, H_1: \rho_s \neq 0$ where ρ_s is the population SRCC (for rankings of books by these readers) $(6^2 + 3^2 + 3^2 + 0^2 + 4^2 + 4^2 + 4^2)$ $1 - 6 \times 102 / (7 \times (7^2 - 1))$ $= -0.8214$ or $-\frac{23}{28}$ $-0.8214 < -0.7857$ ($r_s > \rho_s$) Reject H_0. Significant evidence of association between readers’ ratings.								B2 M1* A1 A1 depM1 A1ft [7]	1.1 1.2 1.1 1.1 1.1 1.1 2.2b	No need to mention population if ρ or ρ_s used. Allow “correlation” instead of “association” throughout. One error, e.g. ρ_s not defined: B1. Verbal: “ H_0 : no association between ratings, H_1 : association”, or “ H_0 : ratings independent, H_1 : ratings not independent”: B1, but “negative association/correlation”, B0. Do not distinguish between “rankings/ranks” and “ratings”. Correct formula, <i>their</i> Σd^2 (correct method for d^2 stated or implied) -0.821 or better, or $-\frac{23}{28}$ or exact equivalent fraction, allow 0.821 from ranks reversed Compare their -0.821 with -0.786 or better, signs consistent (e.g. $0.8214 > 0.7857$) FT on their r_s and/or on $CV = (-)0.7143$ if previous M1 gained. Needs context and not too assertive, e.g. <i>not</i> “there is association ...”, though allow “Sig evidence to reject H_0 , there is association ...”, A1. Allow “Significant evidence of negative association ...” Hypotheses reversed: can get M1A0. Inconsistent first conclusion: M0A0																	

Exemplars for 3(a)

α	One set may all be higher/more spread out than the other	B0
β	If ranks are arbitrarily chosen	B0
γ	Spearman tests for association, not correlation	B0
δ	Better if relationship is squared	B1
ε	Correlation may not be linear	B1

Exemplars for 3(b)(ii) hypotheses

α	$H_0: \rho_s = 0, H_1: \rho_s < 0$, where ρ_s is the rank correlation coefficient	B1
β	$H_0: \rho_s = 0, H_1: \rho_s \neq 0$	B1
γ	$H_0: r = 0, H_1: r \neq 0$, where r is the rank correlation coefficient	B1
δ	$H_0: \rho_s = 0, H_1: \rho_s \neq 0$, where ρ_s is the rank correlation coefficient	B2
ε	H_0 : no association between population ratings, H_1 : association	B1

Question			Answer	Marks	AO	Guidance
4	(a)		0.992(152)	B2 [2]	1.1 1.1	If B0, give B1 for any two of 972.996, 185.625 and 421.65 (or two of 97.2996, 18.5625, 42.165) seen, allow correct to 3 SF
	(b)		W is independent/controlled	B1	1.1	Stated, or implied by choosing v on w
			$v = 2.2715w - 2.255$ or $v = \frac{1874}{825}w - \frac{1861}{825}$	B2ft	1.1 1.1	Fully correct including letters, b awrt 2.27, a in range $[-2.25, -2.26]$. Or (from w on v) b awrt 0.433, a in range $[1.11, 1.12]$
			$w = 0.4334v + 1.1143$ or $\frac{70275}{162166}v + \frac{180707}{162166}$	[3]		If B0, allow B1 for gradient correct.
	(c)	(i)	20.5	B1 [1]	1.1	In range $[20.4, 20.5]$ or (from w on v) in range $[5.44, 5.45]$ NB: <i>Not</i> from rearranging equation, e.g. solving $10 = 0.433v + 1.114$ gives $v = 20.5$ (because $r \approx 1$) but this gets B0.
	(c)	(ii)	Mean 8.75, SD 4.31, so 10 is probably within range of data ... as 10 is within 1 SD of mean	M1 A1 [2]	1.1 2.2b	Correct method for correct mean and SD, and <i>either</i> state “(probably) within range” oe, <i>or</i> calculation, e.g. “10 is within 1 SD of mean” seen. Allow from w on v : Mean 17.62, SD 9.86. Correct mean and SD, <i>and</i> reason involving mean and sd, e.g. “ $8.75 \pm 2 \times 4.31$ includes 10 so ...” Same is true if w on v used correctly, e.g. $17.62 \pm 2 \times 9.86$ includes 10 <i>Not</i> “20.5/5.45 within range”. <i>Not</i> “ <u>may</u> be within range”
	(c)	(iii)	10 likely to be within range and pmcc close to 1/strong correlation oe so very probably/should be reliable	B1* depB1 [2]	2.2b 2.4	One of these reasons, and “(probably) reliable” stated. The other reason, and single conclusion, e.g. “yes”. Can be unnuanced (e.g. “reliable”) for correct r and (c)(ii) . Allow “From (c)(ii) ...” FT on their answer to (c)(i) provided $-1 < r < 1$, and (c)(ii) , but may need nuance, e.g. from $r = 0.2$: “Although within data range, r is not close to 1 so not very reliable”: B2 (Needs nuance if r in range -0.8 to 0.8 .) Separate conclusions, e.g. “Reliable as likely to be within range. Also reliable as r is close to 1”: max B1 <i>Not</i> “reliable as standard deviation quite low”. Ignore sample size.
	(d)		The choice of coefficients for the line minimises the sum of squares of the vertical deviations from the line.	B1 [1]	1.2	Needs “minimises”, “sum”, “squares”, and some indication (not wrong) of which deviations are involved, allow “residuals” (allow horizontal <i>or</i> vertical) but not “shortest distance”. Allow “minimises $\sum d_i^2$ ” with diagram illustrating correct meaning of d_i .

Question		Answer	Marks	AO	Guidance
5	(a)	0.2	B1 [1]	1.1	
	(b)	$E(U) = 0.3 + 2p + 1.5 - 3p$ $= 1.8 - p$ $E(U^2) = 0.3 + 4p + 4.5 - 9p$ $= 4.8 - 5p$ $\text{Var}(U) = 4.8 - 5p - (1.8 - p)^2$ $= 1.56 - 1.4p - p^2$ $= 2.05 - (p + 0.7)^2$	B1 B1 M1 A1 [4]	1.1 1.1 1.1 1.1	Needn't be simplified Needn't be simplified <i>Or:</i> Find $\Sigma(u - 1.8 + p)^2 P(u)$ M1 <i>Their</i> $E(U)$ – <i>their</i> $E(U^2)$. If $\Sigma(u - 1.8 + p)^2 P(u)$ used, award this M1 for simplified quadratic Or $a = 2.05$, $b = 0.7$ ($a = 1.07$ is a common mistake)
	(c)	Smallest variance is obtained when $(p + 0.7)^2$ is as large as possible $p \leq 0.5$ So minimum variance is $2.05 - 1.2^2$ $= 0.61$	M1 B1 A1 [3]	3.1a 2.2a 3.2a	Stated or clearly implied, e.g. by substituting $p = 0.5$ into $a - (p + b)^2$ with $b > 0$, or $p = 0$ when $b < 0$, or correct answer. Allow “when $p(1.4 + p)$ is maximised.” Stated or used, e.g. by substituting $p = 0.5$ SC no justification for using 0.5 (e.g. not from form given): M0B1B1
	(d)	1.3	B1 [1]	1.1	1.3 only

Question		Answer	Marks	AO	Guidance
6	(a)	Geometric stated or implied $1 - 0.8^9$ $= 0.865(782)$	B1	1.1	In any part of question, e.g. by 0.8^9 , or by 0.866, 0.832 or 0.893.
			M1	3.3	$1 - 0.8^n$ for $n = 8, 9$ or 10 . Can be implied by 0.866, 0.832 or 0.893.
			A1 [3]	3.4	Awrt 0.866. SC: 0.865 with insufficient working: B1M1A0.
	(b)	$E(X) = 5$ $\text{Var}(X) = (1 - 0.2)/0.2^2 \quad (= 20)$ $E(X^2) = \text{Var}(X) + E(X)^2$ $= 45$	B1 M1* depM1 A1 [4]	1.1 1.1 3.1a 1.1	Can be implied, e.g. by " $E(X^2) = 25$ ", but not from " $E(X^2) = 1/p^2 = 25$ " Attempt to calculate $\text{Var}(X)$ using correct formula Use $E(X^2) = \text{Var}(X) + [E(X)]^2$ with <i>their</i> values SC: $E(X^2) = (2 - p)/p^2$: $(1 - p)/p^2$ used M1* Add $1/p^2$ depM1 $(2 - p)/p^2$ OE, needn't be simplified: A1 45 A1 SC: direct calculation: B2 for anything greater than 44 (needs 33 terms!)
	(c)	DR $0.2 \times 0.8^{n-1} = 0.041943$ $\Rightarrow n - 1 = \log(0.209715) \div \log(0.8)$ or $\log_{0.8}(0.209715)$ $n = 8$ $Y \sim B(8, 0.2)$ $npq = 1.28$	M1 M1 A1 B1 M1 A1 [6]	3.1b 2.1 1.1 1.1 3.1b 3.2a	$0.2 \times 0.8^n = 0.041943$: M1 Use logs to solve. Allow solving $0.8^n = 0.209715$ (giving $n = 7$) Fully correct equation, 0.210 or better Integer only, but allow "8.00" (not e.g. 8.001). Can award from other methods, e.g. no logs (see SC) Binomial distribution stated or implied for Y , any n, p (but <i>not</i> $p = 0.041943$), e.g. by npq used, needn't be numerical for this mark Needs integer n , (so not from "8.00" unsimplified). SC: Correct answer with insufficient working: can award M1 M0A0 B1 M1A1 (4/6 max)

APPENDIX

Exemplar responses for Q3(b)

Response	Mark

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