GCE

Further Mathematics A

Y542/01: Statistics

A Level

Mark Scheme for June 2022

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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.

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)	(i)	Geo(0.01)	**B1**	1.1	Allow if 0.01 not stated here but used in (ii)	
	(a)	(ii)	$q^m - q^n$ where m = 50, 49, 51, n = 150, 149, 151 $q^{50} - q^{150}$ = 0.384 (0.38355..)	**M1** **A1**	2.1 1.1	e.g. 0.378, 0.386, 0.387, 0.381, 0.390, 0.392. Their q In range [0.383, 0.384], cao	Or $pq^{50} + \ldots + pq^{149} = pq^{50}(1 - q^{100})/(1 - q)$ ± 1 term at either end for M1 M1 needs method for summing GP
	(b)		E(R) = 1/p and correct Var(R) = $(1 - p)/p^2$ $= (1/p)^2 - (1/p) = [E(R)]^2 - E(R)$	**M1** **A1** **[2]**	1.1 2.1	Art least one correct general formulae stated Correctly show required relationship, either way round, don't need conclusion, *not* numerical	
2	(a)		Independent (and no others)	**B1**	2.5	Fully correct only	
	(b)		0.713 **BC**	**B2** **[2]**	1.1 1.1	SC: If B0, give B1 for any 2 of 16.02, 14.24, 10.77, *or* any 2 of 192.25, 170.9, 129.25 seen	e.g. 769/4, 2051/12, 517/4
	(c)	(i)	"More computer failures when temperatures are higher", rather than "number of failures is related to higher or lower temperatures"	**B1** **[1]**	2.4	Oe Allow "Looking for positive correlation", etc	
	(c)	(ii)	H_0: $\rho = 0$, H_1: $\rho > 0$ where ρ is the population PMCC between temperature and number of failures CV = 0.6581 0.713 > 0.6581 Reject H_0. Significant evidence of (positive) correlation between temperature and number of failures	**B2** **B1** **B1ft** **M1ft** **A1ft** **[6]**	1.1 2.5 1.1 1.1 1.1 2.2b	*Treat association and correlation as equivalent* One error, e.g. 2-tail, or ρ not defined: B1 (allow H_0: $\rho \leq 0$). Allow omission of "population" (or "true") *or* of context, but not of both Correct CV, *or* p = 0.00462 Explicit comparison, their r, allow "pmcc > CV" FT on their r, needs 0.6581, 0.6851, 0.7079, 0.4973 or 0.5760; contextualised, not too definite	***See Appendix for exemplars*** Verbal, e.g. H_0: no correlation between temperature and number of failures, H_1: positive correlation: max B1, one error B0 Their CV must be from tables for r or r_s If inconsistent with comparison, M0A0 *Not* "insufficient evidence of no correlation between …"
	(d)		0.713	**B1ft** **[1]**	1.2	Their **(b)**. Allow "unchanged", etc.	
3			**DR** E(V) = q + 0.24 + 0.6 E(V^2) = q + 0.48 + 1.8 q + 0.84 = q + 2.28 – $(q + 0.84)^2$ $(q + 0.84)^2$ = 1.44 so q = –0.84 ± 1.2 Reject q = –2.04 as negative q = 0.36 p = 1 – 0.32 – q = 0.32	**B1** **B1** **M1** **A1** **M1** **B1** **A1** **B1ft** **[8]**	3.1a 1.1 2.1 1.1 1.1 2.3 2.2a 1.1	 Use E(V^2) – [E(V)]^2 Correct simplified quad, eg $q^2 + 1.68q - 0.7344 = 0$ Solve quadratic, valid method seen or implied Explicitly reject invalid solution, with reason 0.36 or exact equivalent seen, e.g. 9/25 p = 0.68 – their q. Withhold if extra solutions seen SC: E(V^2) – E(V): (B1B1) q = 0.6 B1, p = 0.08 B1	*Or:* E(V – E(V))^2: M1 then eliminate p: M1 Or $625q^2 + 1050q - 459 = 0$ Can be implied by one correct root Or reason to take + root of 1.44 E.g. 8/25 Use Poisson: 0/8

Question			Answer	Marks	AO	Guidance	
4	(a)		Punctures must occur at constant average rate throughout the period of 24 hours	**B1** **[1]**	3.3	Constant average rate (*or* uniform rate), with context (*not* events must occur …), no extras	*Not* constant rate, *not* constant probability, *not* average constant rate, *not* singly
	(b)		$\sqrt{2.7} = 1.64(3…)$	**B1**	1.1	Any equivalent answer, e.g. $3\sqrt{30}/10$	
4	(c)		Po(18.9) $1 - P(\leq 21)$ $= 0.267$	**M1** **M1** **A1**	1.1 3.4 1.1	Po(7×2.7) stated or implied Probability from their Po(7×2.7) Awrt 0.267	E.g. $1 - P(\leq 22) = 0.2(0015)$ M1M1A0
	(d)		Po(3.5) $P(> 6) = 0.0653$	**M1** **A1**	1.1 3.4	Stated or implied, e.g. by $1 - 0.858 = 0.142$ Correct calculation, awrt 0.0653	
	(e)		0.0653 is some way from 0.12 so assumptions look doubtful (but possible as 100 days may not be enough evidence)	**B1ft** **B1ft** **[2]**	3.5b 3.5a	Compare 0.12 with answer to **(d)**, or other appropriate calculation and comparison Appropriate assessment, not definite (and correct calculation, if used). FT on their **(d)**	*Or:* B(100, 0.0653), $P(\geq 12) = 0.03$ *or* $E(R) = 6.5$, etc ***See Appendix for exemplars***
5	(a)		$80 + 2X$ $\sim N(246, …$ $… 1440)$ $P(< £235) = 0.386$	**M1** **M1** **A1** **A1** **[4]**	3.1b 1.1 1.1 3.4	Consider distribution of $80 + 2X$ Normal with mean 246 Correct variance Awrt 0.386	*OR:* make X subject M1 $X < 77.5$ (or ≤ 77) A1 $P(X < 77.5)$ from N(83, 360) M1, allow ≤ 77 $P(< £235) = 0.386$ A1 (0.376 A0) *Or* $P(2X < 155)$ where $2X \sim N(166, 1440)$
	(b)		Using costs A_1, A_2, A_3, B_1, B_2: $A_1 = 80 + 2X_1 \sim N(246, 1440)$ $B_1 = 120 + 1.5X_4 \sim N(244.5, 810)$ $A_1 + A_2 + A_3 \sim N(738, 4320)$ $B_1 + B_2 \sim N(489, 1620)$ Difference ~ N(249, 5940) $P(\text{diff} \geq 300) = 0.254$	 **B1** **B1** **B1** **B1** **M1** **A1** **[6]**	 1.1 2.2a 1.1 1.1 3.1b 3.4	 Means 246, 244.5, can be implied by later work Variances 1440, 810, ditto Means 738 & 489, allow 498 & 249 Variances 4320 and 1620 Use normal for difference, add variances Awrt 0.254, allow ±0.02 if cc used	**If in effect using 3*X*, 2*Y*:** Means 246, 244.5 B1 Variances 1440, 810 B1 Means 738, 489 B1 Variances 12960, 3240 B0 N(249, 16200) M1 0.344 A0
		OR	Using distances X_1, X_2, X_3, X_4, X_5: $X_1 + X_2 + X_3 \sim N(249, 1080)$ $X_4 + X_5 \sim N(166, 720)$ A's charge ~ N(738, 4320) B's charge ~ N(489, 1620) Difference ~ N(249, 5940) $P(\text{diff} \geq 300) = 0.254$	 **B1** **B1** **B1** **B1** **M1** **A1**	 	 Means 249, 166, can be implied by later work Variances 1080, 720, ditto Means 738 & 249, allow 498 & 249 Variances 4320 and 1620 Use normal for difference, add variances Awrt 0.254, allow ±0.02 if cc used	**If in effect using 3*X*, 2*Y*:** Means 249, 166 B1 Variances 3240, 1440 B0 Means 738, 489 B1 Variances 12960, 3240 **B1 NB** N(249, 16200) M1 0.344 A0
		OR	Diff in costs is $2(X_1+X_2+X_3) - 1.5(X_4+X_5)$ ~ N(249, 5940) $P(\text{diff} \geq 300) = 0.254$	**M1A1** **M1A2** **A1**		M1 needs attempt to include constants M1 N(249, ...), A2 variance correct, A1 for 16200 Awrt 0.254, allow ±0.02 if cc used	SC: variance formula seen correct but wrongly calculated: (M1)M1 SCM1
			SC1: insufficient working shown			0.254 www gets 6/6; 0.746 www gets 5/6 [A0]	0.344 www gets 4/6 [A0A0]; all else 0/6
			SC2: assume all/both variables equal:	**M1A1**		$3X > 300$ M1 N(249, 3240) or N(±51, 3240) A1	Or N(83, 360) and compare 100: A1 (0.185)

Question			Answer	Marks	AO	Guidance	
6	(a)		Mean 30.7 Biased variance 22.225 (SD 4.714) 22.225 × 128/127 = 22.4 (SD 4.733) 1 – Φ((30.7 – 30)/√(22.4/128) Range is ≥ 0.047 (≥ 4.7%)	**B1** **M1** **M1** **M1** **A1** **[5]**	1.1 1.1 1.2 1.1 2.2a	Seen or implied Calculate variance, allow biased here ×128/127 seen, or implied used Standardise with 128, answer < 0.5 or 50% Allow > or ≥ oe. Awrt 0.047 or 4.7%. CWO. Wrong or no range: A0. Allow = 4.71 so ≥ 5% 0.0464 is probably B1M1M0M1A0	Inequalities can be omitted until final line Independent of previous M1. E.g. 4.6% seen (from no 128/127). *Not* 0.441 No 128/127, or wrong *z*: max 3/5 Insuff working: 4.7% ⇒ 5/5, 4.6% ⇒ 3/5 0 *with some evidence [(√22.4)/128]*: 4/5
6	(b)		128 large enough (for CLT to apply) Hence test not invalidated	**M1** **A1** **[2]**	2.3 2.3	Reason, e.g. sample is large, or $n > 25$ Conclusion, allow "test is valid" or just "no" Wrong extras, eg "all dists approach normal": M0	SC1: CLT applies so not invalidated: B1 SC2: CLT applies as $n >$ (any number other than 25): max B1
7			$\int_0^1 kx^n \mathrm{d}x = 1 \Rightarrow k = n + 1$ $\int_0^{0.8816} kx^n \mathrm{d}x = 0.5$ $k(0.8816)^{n+1}/(n + 1) = 0.5$ and use $k = n + 1$ $0.8816^{n+1} = 0.5$ $n = 4.5$ or $k = 5.5$ $P(X < 0.8) = 0.8^{5.5}$ (= 0.293) E(number < 0.8) = 2.93	**M1** **A1** **M1*** **depM1** **A1** **A1** **M1** **A1ft** **[8]**	2.1 1.1 1.1 3.1a 1.1 3.1a 3.4 2.2a	Equate integral of f(x), upper limit 1, to 1 Correct equation for n and k Equate integral of f(x), upper limit 0.8816, to 0.5 Set up equation in n or k only Correct equation [or $0.8816^k = 0.5$] Correct n or k, awrt 4.5(0) or 5.5(0) Use their ∫f(x), upper limit 0.8, with their n 10×(their p) NB: can get 2.93 from wrong integration	 0.8816 and 0.5 reversed: (M1A1M1) M1A0A0 (M1A1) Not just 3, but ISW if 2.93 rounded to 3
8	(a)		$\mu = 264$ $\frac{1}{4}n(n + 1) = 264$ $\Rightarrow n = 32$ or –33, but $n > 0$ so 32 only **AG**	**B1** **M1** **A1** **[3]**	3.1a 1.1 2.2a	Allow even if no CC used Use formula for mean Solve $n^2 + n – 1056 = 0$ to obtain 32	 Or: 113 + 415 = ½n(n + 1): M2 Can be implied by both 32 and –33 Just verification: SC B1
	(b)		Variance = $\frac{1}{24}n(n+1)(2n+1) = 2860$ Φ(113.5 – 264)/√2860 (= 0.002445) $\Rightarrow r = 2 \times 0.002445 \times 100\%$ = 0.489 (%)	**B1** **M1*** **depM1** **A1** **[4]**	3.3 3.4 3.1b 2.2a	Variance 2860 stated or implied Standardise, their parameters (or use 414.5) Double their p-value ($p < 0.5$), oe 0.49 or better (0.48 is probably from no cc)	 No or wrong cc: (0.503% or 0.518%): B1M1M1A0 Allow 0.50% *only* if correct CC seen
9	(a)		H_0: data consistent with belief, H_1: not Expected frequencies 30, 20, 20, 20, 30 X^2 values 0.1333, 0.8, 0.8, 0.8, 1.2 Total 3.73(333…) (= $\frac{56}{15}$) < 9.488 Do not reject H_0. Insufficient evidence that data inconsistent with head's belief	**B1** **B1** **M1** **A1** **A1** **M1ft** **A1ft** **[7]**	1.1 1.1 3.4 1.1 1.1 1.1 2.2b	OE, e.g. "follows the given ratio" Stated or implied At least two correct, or correct subs in formula Fully correct Compare with 9.488, *or* $p = 0.443 > 0.05$ Consistent first conclusion, FT on their X^2 Contextualised, not over-definite Sufficient evidence that belief is correct: A0	 Can be implied by answer SC: Some cells merged: can get B2M1A0A0 M1A1 Needs CV 9.488 or 11.14 or 7.815 Withhold A1 if hypotheses reversed Insuff evidence to reject H_0, belief correct M1A1

Question			Answer	Marks	AO	Guidance	
	(b)		**"Determine", so needs proper working**				
			$3.73(333\ldots) \times n/120 > 9.488$	**M1**	3.1b	Inequality for n, using TS and CV	3.73 gives 305.2, 3.733… gives 304.97
			$(\Rightarrow 7n/225 > 9.488) \Rightarrow \ n \geq 305$ (3 sf)	**A1**	1.1	$n > 305$ or $n \geq 305$ stated or implied, allow 306	e.g. answer of 305 or 306
			Must be multiple of 30, so least n is 330	**B1ft** **[3]**	3.2a	Next multiple of 30 above *their* 305	Needs reason if rounded up by < 10 or to multiple of 300
		OR	$\frac{\left(\frac{7n}{30}-\frac{3n}{12}\right)^2}{\frac{3n}{12}}+3\times\frac{\left(\frac{4n}{30}-\frac{2n}{12}\right)^2}{\frac{2n}{12}}+\frac{\left(\frac{9n}{30}-\frac{3n}{12}\right)^2}{\frac{3n}{12}}$	**M1**		Inequality for n, using 120, TS and CV, needs n in both O and E terms	*Or* T& I: $n = 300 \rightarrow 9.333$ Any n in range 300 to 360, with Σx^2 in [9.33, 11.2]: M1 $n = 330$ (9.489) A2 ($n = 305 \rightarrow 9.489$ A1)
			$= \frac{1}{900}n+3\times\frac{1}{150}n+\frac{1}{100}n > 9.488$			()	
			$(\Rightarrow 7n/225 > 9.488) \Rightarrow n \geq 305$ (3 sf)	**A1**		$n > 305$ or $n \geq 305$ stated or implied, allow 306	e.g. answer of 305 or 306
			Must be multiple of 30, so least n is 330	**B1ft**		Next multiple of 30 above *their* 305, needs reason	Or $n/120$ must be a multiple of 0.25

APPENDIX

Exemplar responses for **Q2(c)(ii)**

Hypotheses

Verbal statements

A	H_0: no correlation between variables, H_1: positive correlation between variables *[no context]*	B0
B	H_0: no correlation between number of failures and temperature, H_1: correlation between number of failures and temperature *[not one-tailed: needs "positive" in H_1]*	B0
C	H_0: no evidence of correlation between runners' positions, H_1: evidence of positive correlation between number of failures and temperature *["evidence" does not belong in hypotheses; without "evidence of"×2 this would be B1]*	B0

Statements using parameter symbol [mark statements using r in place of ρ identically]

D	H_0: $\rho = 0$, H_1: $\rho \geq 0$ *[two errors: H_1 wrong, no interpretation of ρ]*	B0
E	H_0: $\rho = 0$, H_1: $\rho \neq 0$ *[two errors: H_1 wrong, no interpretation of ρ]*	B0
F	H_0: $r = 0$, H_1: $r > 0$ *[one error: no interpretation of ρ. Allow use of r]*	B1
G	H_0: $\rho = 0$, there is no correlation between number of failures and temperature; H_1: $\rho > 0$, there is positive correlation *[two different answers, either of which would score 1 but neither gains 2 and we don't give 1+1 here]*	B1
H	H_0: $\rho = 0$, H_1: $\rho > 0$, where ρ is the pmcc *[neither "population" nor context]*	B1
I	H_0: $\rho \leq 0$, H_1: $\rho > 0$, where ρ is the population pmcc *OR* H_0: $\rho = 0$, H_1: $\rho > 0$, where ρ is the pmcc between temperature and number of failures	B2

Conclusions *(In general, allow "Accept H_0" as a synonym for "Do not reject H_0", etc.)*

A	Reject H_0. There are more computer failures when temperatures are higher *[too definite]*	M1A0
B	Reject H_0. There is significant evidence of correlation *[no context]*	M1A0
C	Sufficient evidence to reject H_0. There are more computer failures when temperatures are higher *["Evidence" used, albeit in wrong sentence, but BOD]*	M1A1
D	*Wrong but validly obtained TS leading consistently to* Do not reject H_0. There is insufficient evidence that there are more computer failures when temperatures are higher *[standard FT]*	M1A1
E	*Wrong but validly obtained TS leading consistently to* Do not reject H_0. There is evidence that the number of computer failures is not correlated with temperature. *[Non-rejection doesn't give positive evidence that H_0 is correct. When H_0 is not rejected, candidates should aim for a "double negative"]*	M1A0
F	(from correct TS and CV) Do not reject H_0. (+ anything) *[inconsistent]*	M0A0
G	*If H_0, H_1 the wrong way round, but calculations right:* Reject H_0. (+ anything)	M1A0

Exemplar responses for **Q4(e)**

	Response	**Mark**
A	12 is very high so it does cast doubt *[relevant comparison needs to be seen]*	B0B1
B	The probability is so low that 12 is worrying so it does cast doubt *[unclear comparison]*	B0B1
C	0.0653 is not equal to 0.12 so probably not valid *[don't allow "not equal"]*	B1
D	0.0653 is not close to 0.12	B1
E	12 is much higher than 6.53 so it is not valid *[too definite]*	B1B0
F	P(= 12) from B(100, 0.0653) = 0.0166 which is very small so it does cast doubt	B0B1
G	P(> 12) from B(100, 0.0653) = 0.00784 which is very small so it does cast doubt	B0B1
H	P(≥ 12) from B(100, 0.0653) = 0.00784 which is very small so it does cast doubt	B0B1
I	P(≥ 12) from B(100, 0.0653) = 0.0299 which is small so it casts doubt *[0.035 from N(6.53, 6.1036)]*	B1B1
J	Expected number is 100×0.0653 = 6.53 which is very different from 12 so it does cast doubt	B1B1
K	*Wrong p, e.g.:* 0.142 not far from 0.12 so it does not cast doubt (0.142 from Po(≥ 6), 0.0267 from Po(≥ 7)	B1B1ft
L	*Likewise:* Expected number is 14.2 which is not very close to 12 so it does cast doubt	B1B1ft
M	*Likewise:* P(≤ 12) from B(100, 0.142) = 0.319 which is not too low so it does not cast doubt	B1B1ft

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