Pearson Edexcel

Mark Scheme (Topic Test)

Critical Regions and p-values

Pearson Edexcel GCE
In Statistics (9ST0)

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General Marking Guidance

Total marks

The total number of marks for the paper is 25.

Mark types

The Edexcel Statistics mark schemes use the following types of marks:

- **M** **Method** marks,
  awarded for 'knowing a method and attempting to apply it',
  unless otherwise indicated.
- **A** **Accuracy** marks can only be awarded if the relevant method (M) marks have been earned.
- **B** **Unconditional accuracy** marks are independent of M marks
- **E** **Explanation** marks

NOTE: Marks should not be subdivided.

Abbreviations

These are some of the marking abbreviations that will appear in the mark schemes.

- ft follow through
- PI possibly implied
- cao correct answer only
- cso correct solution only
  (There must be no errors in this part of the question)
- awrt answers which round to
- awfw answers which fall within (a given range)
- SC special case
- nms no method shown
- oe or equivalent
- dep dependent (on a given mark or objective)
- dp decimal places
- sf significant figures
- ✱ The answer is printed on the paper

Further notes

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied **positively**. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is **no ceiling** on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- All A marks are 'correct answer only' (cao), unless shown, for example, as A1ft to indicate that previous wrong working is to be followed through.
- All M marks are 'possibly implied' (PI) unless specifically stated otherwise in the 'Notes' column.
- After a **misread**, the subsequent A marks affected are treated as A1ft, but manifestly absurd answers should never be awarded A marks.
- **Crossed out** work should be marked UNLESS the candidate has replaced it with an alternative response.
- If **two solutions** are given, each should be marked, and the resultant mark should be the mean of the two marks, rounded down to the nearest integer if needed.

Question	Scheme	Marks	AO	Notes
1(a)	The set of values which the test statistic can take which would lead to rejecting H_0	E1	1.3	Must refer to values and the rejection of the null hypothesis
1(b)	[X = the number of days with a mean daily temperature of below 5 ºC]			
	H_0: $\pi = 0.215$ H_1: $\pi < 0.215$	B1	1.3	Both oe Allow p
	B(12, 0.215)	M1	1.3	Must be seen
	$P(X \leq 1) = 0.2347$	A1	1.3	awrt 0.235
	> 0.05 Do not reject H_0	M1	2.1b	Comparison with 0.05 and correct decision made based on their probability
	There is insufficient evidence to suggest the proportion of days with a mean daily temperature of below 5 ºC has decreased	E1dep	2.1a	Must not be definite Must be in context Must refer to proportion/percentage Dep on correct p-value and significance level
				NOTE: Critical region method can score max B1M1A0M0E0
1(c)(i)	$P(X \leq 0) = 0.0548$	B1	1.3	
	> 0.05 Therefore no critical region exists / the critical region is empty	E1dep	1.3	Dep on previous B1
1(c)(ii)	**Possible advantages (not exhaustive)**			
	The lack of a critical region indicates the sample size is too small			
	The lack of a critical region shows the test will never be significant			
	Critical regions may be used to find the minimum sample size required for the possibility of a significant result			
		E1	3.1a	Any sensible answer relating to a lack of a critical region
	Possible justifications (not exhaustive)			
	The p-value method cannot indicate information about the sample size			
	If you know the sample size is too small / the test will not be significant this will save time/cost collecting data which cannot be used			
	It improves the design of the research and saves waste on the selection of small samples			
		E1dep	3.1a	Any sensible justification of their advantage Dep on previous E1
	Total	**10**		

Question	Scheme	Marks	AO	Notes
2(a)	[X = the shipment weight of HIV test kits]			
	H_0: $\mu = 1001$ H_1: $\mu \neq 1001$	B1	1.3	Both oe
	Method 1: Using $\overline{X} \sim N\left(1001, \frac{953^2}{7}\right)$			
	Test statistic: $\overline{x} = 2348.571$ ...	B1	1.3	awrt 2350
	CV = 1707 (or 295)	B1	1.3	$\frac{953^2}{7}$ seen or implied
		B1	1.3	awrt 1707
	"2349" > "1707" Reject H_0	M1	2.1b	Correct comparison and decision based off their TS and CV
	Method 2: Using $Z \sim N(0, 1)$			
	Test statistic: $\frac{2348.571-1001}{\frac{953}{\sqrt{7}}}$	(B1)		Sample mean awrt 2350
	$= 3.74$	(B1)		awfw 3.74~3.75
	CV = $(\pm)$ 1.96	(B1)		
	"3.74" > "1.96" Reject H_0	(M1)		Correct comparison and decision based off their TS and CV
	There is significant evidence to suggest the mean weight of HIV test kits has changed from 1001 kg (between 2008 and 2024)	E1dep	2.1a	Must not be definite Must be in context Must refer to mean / average Dep on correct TS and CV
				Note: *p*-value method scores max B1B1B0B0M0E0
2(b)	P($\overline{X} \geq$ "2348.571") or P($Z \geq$ "3.74") $(= 0.0000916)$	M1	1.3	FT their TS
	$0.0000916 \times 2 = 0.000183$	A1	1.3	awfw 0.000180~0.000184
2(c)	There is a "0.000183" / "0.0183%" chance of observing a sample mean of "2350" or more extreme if the mean shipment weight of HIV test kits is 1001 kg	E1	1.3	Definition of *p*-value FT their *p*-value and sample mean Allow e.g. "or worse" in place of "more extreme" Condone no context for this mark
		E1	2.1a	In full context
	Total	**10**		

Question	Scheme	Marks	AO	Notes
3(a)	There is insufficient evidence to suggest an association between the match result and whether the game was played at home or away	E1	2.1a	Must not be definite Must be in context
	There is insufficient evidence to suggest the number of goals scored in home matches is higher than the number of goals scored in away matches	E1	2.1a	Must not be definite Must be in context
	There is significant evidence to suggest the win rate for the 2024/25 season is lower than the win rate for the 2023/24 season	E1	2.1a	Must not be definite Must be in context
		E1	2.1b	Style appropriate No technical/statistical terminology
3(b)	**<u>Possible reasons (Not exhaustive)</u>**			
	p-values are a standard measure of significance across all hypothesis tests			
	You don't need to know how the tests work to interpret the results			
	p-values are quicker and easier to interpret			
	Most statistical software packages only report *p*-values			
		E1	2.1b	Any sensible reason
	Total	**5**		