



Mark Scheme (Topic Test)

Goodness of Fit Tests

Pearson Edexcel GCE
In Statistics (9ST0)

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General Marking Guidance

Total marks

The total number of marks for the paper is 50.

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 A1 ft 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 A1 ft, 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	H ₀ : The ratio 5:3:2 is <u>suitable</u> for the <u>colours</u> of Great Mormon <u>butterflies</u> H ₁ : The ratio 5:3:2 is <u>not suitable</u> for the <u>colours</u> of Great Mormon <u>butterflies</u>	B1	1.3	Both oe Must be in context																									
	<table><tr><th>Colour</th><th>Observed</th><th>Probability</th><th>Expected</th><th>$\frac{(O - E)^2}{E}$</th></tr><tr><td>Black/Blue</td><td>82</td><td>0.5</td><td>66</td><td>3.8788</td></tr><tr><td>Black/Red</td><td>19</td><td>0.3</td><td>39.6</td><td>10.7162</td></tr><tr><td>Pale White</td><td>31</td><td>0.2</td><td>26.4</td><td>0.8015</td></tr><tr><td>Total</td><td>132</td><td>1</td><td>132</td><td>15.4</td></tr></table>	Colour	Observed	Probability	Expected	$\frac{(O - E)^2}{E}$	Black/Blue	82	0.5	66	3.8788	Black/Red	19	0.3	39.6	10.7162	Pale White	31	0.2	26.4	0.8015	Total	132	1	132	15.4	B1	1.3	Correct probabilities 0.5, 0.3 and 0.2
		Colour	Observed	Probability	Expected	$\frac{(O - E)^2}{E}$																							
		Black/Blue	82	0.5	66	3.8788																							
		Black/Red	19	0.3	39.6	10.7162																							
		Pale White	31	0.2	26.4	0.8015																							
		Total	132	1	132	15.4																							
		M1	1.3	Attempt to multiply probabilities by 132 May be implied by one correct expected frequency																									
	M1	1.3	Attempt at $\frac{(O-E)^2}{E}$ May be implied by one correct contribution or correct total																										
	M1	1.3	Attempt to sum contributions May be implied by correct total																										
A1	1.3	awfw 15.3~15.5 Correct answer in range scores B1M1M1M1A1																											
Degrees of freedom = 2																													
CV = 5.991	B1	1.3	or $p = 0.000454$																										
“15.4” > “5.991” Reject H ₀	M1	2.1b	Their TS compared with their CV (or p with 0.05) and correct decision made based on that comparison																										
There is <u>significant evidence to suggest</u> that the genetic theory is <u>not</u> a <u>suitable</u> model for the <u>colours of</u> Great Mormon <u>butterflies</u>	E1	2.1a	Dep on correct TS and CV (or correct p and significance level) Must not be definite Must be in context																										
	Total	9																											

Question	Scheme	Marks	AO	Notes
2(a)	$\lambda = 3.26$	B1	1.2	cao
2(b)	$s = 0.1807$ $t = 0.2302$	B1ft	1.2	Both cao FT their λ
	$u = 45.18$ $v = 57.54$	B1ft	1.2	awfw 45.16~45.18 and 57.5~57.55 FT their probabilities
2(c)	H_0 : The <u>Poisson distribution</u> is a <u>suitable</u> model for the <u>number of customer complaints</u> per week	B1	1.3	Both Must be in context B0 if numerical value of λ mentioned
	H_1 : The <u>Poisson distribution</u> is <u>not</u> a <u>suitable</u> model for the <u>number of customer complaints</u> per week			
	Contributions: 1.35, 0.346, 0.490, 0.0364, 0.0733, 2.28	M1	1.3	Attempt at $\frac{(O-E)^2}{E}$ May be implied by one correct contribution or correct total
		M1	1.3	Attempt to sum May be implied by correct total
	$\chi^2 = 4.58$	A1	1.3	awfw 4.5~4.6 Correct answer in range scores M1M1A1
	Degrees of freedom = $6 - 1 - 1 = 4$			
	CV = 9.488	B1	1.3	or $p = 0.333$
	"4.58" < "9.488" Do not reject H_0	M1	2.1b	Their TS compared with their CV (or their p and 0.05) and correct decision made based on that comparison
	There is <u>insufficient evidence</u> to suggest the <u>Poisson distribution</u> is <u>not</u> a <u>suitable</u> model for the <u>number of customer complaints</u> per week	E1	2.1a	Dep on correct TS and CV (or correct p and significance level) Must not be definite Must be in context
Total		10		

Question	Scheme	Marks	AO	Notes																												
3	H_0 : $B(5,0.02)$ is a <u>suitable</u> model for the <u>number of patients</u> who develop post-operative <u>infections</u> H_1 : $B(5,0.02)$ is <u>not</u> a <u>suitable</u> model for the <u>number of patients</u> who develop post-operative <u>infections</u>	B1	1.3	Both oe Must be in context																												
	<table><tr><th>x</th><th>Observed</th><th>Probability</th><th>Expected</th></tr><tr><td>0</td><td>81</td><td>0.904</td><td>92.20</td></tr><tr><td>1</td><td>16</td><td>0.0922</td><td>9.41</td></tr><tr><td>2</td><td>4</td><td>0.00376</td><td>0.38</td></tr><tr><td>3</td><td>1</td><td>0.0000768</td><td>0.01</td></tr><tr><td>4</td><td>0</td><td>0.000000784</td><td>0</td></tr><tr><td>5</td><td>0</td><td>0.0000000032</td><td>0</td></tr></table>	x	Observed	Probability	Expected	0	81	0.904	92.20	1	16	0.0922	9.41	2	4	0.00376	0.38	3	1	0.0000768	0.01	4	0	0.000000784	0	5	0	0.0000000032	0	M1	1.3	Attempt to calculate probabilities from $B(5,0.02)$ May be implied by one correct probability
	x	Observed	Probability	Expected																												
	0	81	0.904	92.20																												
	1	16	0.0922	9.41																												
	2	4	0.00376	0.38																												
	3	1	0.0000768	0.01																												
	4	0	0.000000784	0																												
	5	0	0.0000000032	0																												
		M1	1.3	Attempt to multiply probabilities by 102 May be implied by one correct expected frequency																												
	M1	1.3	Combine classes 1 – 5																													
	M1	1.3	Attempt at $\frac{(O-E)^2}{E}$ May be implied by one correct contribution or correct total																													
	M1	1.3	Attempt to sum their contributions May be implied by correct total																													
	A1	1.3	awrt 14.2 Correct total scores M1M1M1M1M1A1																													
Degrees of freedom = 1			Number of classes – 1																													
CV = 3.841	B1ft	1.3	Or $p = 0.0001 \sim 0.0002$ FT their degrees of freedom if classes not pooled or pooled incorrectly																													
“14.2” > “3.841” Reject H_0	M1	2.1b	Their TS compared with their CV (or their p with 0.05) and correct decision made based on that comparison																													
There is <u>significant</u> evidence to suggest $B(5,0.02)$ is <u>not</u> a <u>suitable</u> model for the <u>number of patients</u> who develop post-operative <u>infections</u>	E1	2.1a	Dep on correct TS and CV (or correct p and significance level) Must not be definite Must be in context																													
	Total	10																														

Question	Scheme	Marks	AO	Notes
4(a)		M1	1.2	Use of $1 - e^{-0.05x}$ with $x = 24$ or 48
	$(1 - e^{-0.05 \times 48}) - (1 - e^{-0.05 \times 24})$ (= 0.2104762586)	M1	1.2	Use of $1 - e^{-0.05x}$ with both $x = 24$ and $x = 48$ and subtracted May be seen as e.g. $e^{-0.05 \times 24} - e^{-0.05 \times 48}$
	"0.2104762586" \times 50 = 10.524	A1	1.2	AG Multiply by 50 and 10.524 given as final answer
4(b)	A "96 or more" class needs to be added because the exponential distribution has no upper limit	E1	1.3	oe e.g. "96+" Reference must be made to the lack of an upper limit.
	The 24 – 48 class, the 48 – 72 class and the 72 – 96 class (and the 96+ class) need to be combined because the expected frequencies are under 5	E1	1.3	oe e.g. "the last three classes" Reference must be made to expected frequencies being under 5
4(c)	H_0 : <u>Exp(0.05)</u> is a <u>suitable</u> model for the <u>time between network outages</u> . H_1 : <u>Exp(0.05)</u> is <u>not</u> a <u>suitable</u> model for the <u>time between network outages</u>	B1	1.3	Both oe Must be in context
	Degrees of freedom = 2			
	CV = 5.991	B1	1.3	
	$0.405 < 5.991$ Do not reject H_0	M1	2.1b	Dep on correct CV
	There is <u>insufficient</u> evidence to <u>suggest</u> that <u>Exp(0.05)</u> is <u>not</u> a <u>suitable</u> model for the <u>time between network outages</u> .	E1	2.1a	Dep on correct CV Must not be definite Must be in context
4(d)	Po(0.05)	B1	1.3	oe
Total		10		

Question	Scheme	Marks	AO	Notes
5(a)	$\mu = 303.65$ $\sigma = 43.07$	B1	1.2	Both cao
5(b)	Use a <u>formula...</u>			
	to <u>add up / sum</u> the values in cells <u>B3 to F3...</u>	E1	1.1	Must see "Formula"
	...and <u>multiply</u> by the value in cell <u>B5</u>	E1	1.1	Must see "Formula"
				=SUM(B3:F3)*B5 oe scores E1E1
5(c)	Cell F5 = 0.168497	B1	1.3	awrt 0.168
	Cell F6 = 66.55633	B1	1.3	awrt 66.6
	Cell F7 = 5.68025	B1	1.3	awrt 5.68
	Cell G7 = 54.36358	B1	1.3	awrt 54.4
5(d)	H ₀ : The <u>normal distribution</u> is a <u>suitable</u> model for the <u>resolution</u> of documents	B1	1.3	Both oe Must be in context B0 if numerical values of parameters mentioned
	H ₁ : The <u>normal distribution</u> is <u>not</u> a <u>suitable</u> model for the <u>resolution</u> of documents			
	Degrees of freedom = 5 – 2 – 1 = 2			Number of classes – Number of estimated parameters – 1
	CV = 5.991	B1	1.3	cao
	“54.4” > “5.991” Reject H ₀	M1	2.1b	Their TS compared with their CV (or $p = 1.57 \times 10^{-12}$ compared with 0.05) and correct decision made based on that comparison
	There is <u>significant evidence</u> to <u>suggest</u> that the <u>normal distribution</u> is <u>not</u> a <u>suitable</u> model for the <u>resolution of documents</u> .	E1	2.1a	Dep on correct TS and CV (or correct p and significance level) Must not be definite Must be in context
Total		11		