



Mark Scheme (Results)

Summer 2025

Pearson Edexcel GCE
In Further Mathematics (8FM0)
Paper 23 Further Statistics 1

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General Marking Guidance

- 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.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 40.
2. The Edexcel Mathematics mark schemes use the following types of marks:
 - **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
 - **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
 - **B** marks are unconditional accuracy marks (independent of M marks)
 - Marks should not be subdivided.

3. Abbreviations

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

- bod – benefit of doubt
 - ft – follow through
 - the symbol $\checkmark$ will be used for correct ft
 - cao – correct answer only
 - cso - correct solution only. There must be no errors in this part of the question to obtain this mark
 - isw – ignore subsequent working
 - awrt – answers which round to
 - SC: special case
 - oe – or equivalent (and appropriate)
 - dep – dependent
 - indep – independent
 - dp decimal places
 - sf significant figures
 - * The answer is printed on the paper
 - $\square$ The second mark is dependent on gaining the first mark
4. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.
 5. Where a candidate has made multiple responses and indicates which response they wish to submit, examiners should mark this response.
If there are several attempts at a question which have not been crossed out, examiners should mark the final answer which is the answer that is the most complete.
 6. Ignore wrong working or incorrect statements following a correct answer.

7. Mark schemes will firstly show the solution judged to be the most common response expected from candidates. Where appropriate, alternatives answers are provided in the notes. If examiners are not sure if an answer is acceptable, they will check the mark scheme to see if an alternative answer is given for the method used.

Question	Scheme		Marks	AOs
1(a)	H ₀ : There is no association between age and preferred method of shopping . H ₁ : There is an association between age and preferred method of shopping .		B1	3.4
			(1)	
(b)(i)	Online 18 – 30	or 27	B1	2.2a
(ii)	[(50 × 105) / 300 =] 17.5		B1	1.1b
			(2)	
(c)	$\frac{('27' - '17.5')^2}{'17.5'} + 5.060$		M1	1.1b
	= 10.217.... awrt 10.2		A1	1.1b
	df [= (4 – 1)(2 – 1)] = 3		B1	1.1b
	[10.2 >] $\chi^2_{3,(0.05)} = 7.815$		B1ft	3.1b
	[Reject H ₀] There is evidence of an association between age and preferred method of shopping .		B1ft	2.2b
			(5)	
(d)	χ^2 CV is now 11.345 [> 10.2]...		M1	1.1b
	... H ₀ is not rejected/conclusion is reversed		A1ft	2.2b
			(2)	
(10 marks)				
Notes:				
(a)	B1:	For both hypotheses in terms of "association" or “independence” Must mention age and shopping in at least one and be connected correctly to H ₀ and H ₁ Use of link, relationship, correlation or connection is B0 here. Hypotheses must be given in part (a).		
(b)(i)	B1:	both Online <u>and</u> 18 – 30 or 27		
(ii)	B1:	17.5 oe		
(c)	M1:	For use of $\frac{(O - E)^2}{E}$ with their cell + 5.060 (this mark may be implied by awrt 10.2) Watch out for $\frac{(O - E)^2}{O} + 5.060$ which is M0		
	A1:	awrt 10.2 (ignore <i>p</i> -value if given)		
	B1:	3 cao		
	B1ft:	Using the degrees of freedom to find the χ^2 CV for the appropriate model 7.815 or better ft their df 1→3.841, 2→5.991, 4→9.488, 5→11.070, 6→12.592, 7→14.067, 8→15.507		
	B1ft:	Correct conclusion or ft conclusion based on their values in (c), in context (age and shopping). Must be consistent with their CV and test statistic. Independent of their hypotheses. i.e. test statistic > CV → there is association... test statistic < CV → there is no association... Allow relationship, link, connection BUT do not accept correlation or contradictory statements		
(d)	M1:	Obtaining new χ^2 CV 11.345 or awrt 11.3 Condone <i>p</i> = awrt 0.017 [> 0.01] for this mark ft their df (all awrt 3sf) 1→6.64, 2→9.21, 4→13.3, 5→15.1, 6→16.8, 7→18.5, 8→20.1		
	A1ft:	ft deduction which must be consistent with their 1% CV and their test statistic (need not be in context). Do not allow contradictory statements.		

Question	Scheme	Marks	AOs
2(a)	$E(X) = 2 \times 0.6 + 5 \times 0.3 + 9 \times 0.1 [= 3.6]$	M1	1.1b
	$E(X^2) = 2^2 \times 0.6 + 5^2 \times 0.3 + 9^2 \times 0.1 [= 18]$	M1	1.1b
	$\text{Var}(X) = 18 - 3.6^2$	M1	1.1b
	$= \underline{5.04}$	A1	1.1b
		(4)	
(b)	$[P(T = 14) =] 2 \times 0.3 \times 0.1 = 0.06^*$	B1cso*	1.1b
		(1)	
(c)	Possible point totals: [0,] 7, 11, [14]	M1	3.1b
	$[P(T = 0) = 0.6^2 + 0.3^2 + 0.1^2 [= 0.46]]$ $P(T = 7) = 2 \times 0.6 \times 0.3 [= 0.36]$ $P(T = 11) = 2 \times 0.6 \times 0.1 [= 0.12]$ $[P(T = 14) = 2 \times 0.3 \times 0.1 = 0.06]$	M1	1.1b
	$[E(T) = 0 \times 0.46] + 7 \times 0.36 + 11 \times 0.12 + 14 \times 0.06$	M1	1.1b
	$= \underline{4.68}$	A1	1.1b
		(4)	
(d)	$Y \sim B(150, 0.06)$	M1	3.3
	$\approx \text{Po}(9)$	M1	1.1b
	$P(Y = 4) \approx 0.0337$	A1	3.4
		(3)	
(12 marks)			
Notes:			
(a)	M1:	Attempt at $E(X)$ with at least two correct products (must be seen in part (a))	
	M1:	Attempt at $E(X^2)$ with at least two correct products	
	M1:	Use of " $E(X^2)$ " – " $[E(X)]^2$ " with their values	
	A1:	5.04 oe Working must be shown Correct answer on its own with no working scores 0 marks.	
	SC:	$18 - 3.6^2 = 5.04$ on its own scores M0M0M1A1	
(b)	B1*:	Correct calculation oe and given answer (allow $0.3 \times 0.1 + 0.1 \times 0.3 = 0.06^*$)	
(c)	M1:	Realising $T = 7, 11$ (and 14) are needed If extra incorrect totals are stated, then M0	
	M1:	Attempting $P(T = 7)$ and $P(T = 11)$ (at least one correct or both with missing $\times 2$) May be embedded in the calculation for $E(T)$, eg $7 \times 2 \times 0.6 \times 0.3 + 11 \times 2 \times 0.6 \times 0.1 + \dots$	
	M1:	Attempting $E(T)$ for their values with at least 2 non-zero products for two of the T values correct or correct ft eg $7 \times 0.18 + 7 \times 0.18$ only counts as 1 product Must be for their totals, simply calculating $E(X) = 2 \times 0.6 + 5 \times 0.3 + 9 \times 0.1$ here is M0	
	A1:	4.68 oe Correct answer with no obvious incorrect working scores 4 out of 4	
(d)	M1:	Selecting the correct binomial model (may be implied by sight of $\text{Po}(9)$)	
	M1:	Writing or using $\text{Po}(9)$ allow ft $\text{Po}(np)$ from their stated binomial distribution	
	A1:	awrt 0.0337	
	SC:	awrt 0.0313 from exact binomial scores M1M0A0	

Question	Scheme		Marks	AOs
3(a)(i)	$P(X = 6) = 0.11432\dots$ awrt 0.114		B1	1.1b
			(1)	
(ii)	$Y \sim \text{Po}(0.7)$		M1	3.3
	$P(Y = 1) = 0.34760\dots$ awrt 0.348		A1	1.1b
			(2)	
(b)	$H_0: \lambda = 4.2 \quad H_1: \lambda \neq 4.2 \quad (\text{allow } 16.8)$		B1	2.5
	$R \sim \text{Po}(16.8)$		M1	3.3
	$P(R \leq 9) = 0.02896\dots$ $P(R > 25) [= 1 - P(R \leq 25) = 1 - 0.97769\dots] = 0.02230\dots$		A1	3.4
	Actual level of significance $[= 0.02896\dots + 0.02230\dots] =$ awrt 0.0513		A1	1.1b
			(4)	
(c)	$P(S \leq 3) = 0.6025\dots$		B1	1.1b
	$J \sim B(4, \text{“}0.6025\dots\text{”}) \quad \text{or} \quad 6 \times (\text{“}0.6025\text{”})^2(1 - \text{“}0.6025\text{”})^2$		M1	3.3
	$P(J = 2) = 0.34413\dots$ awrt 0.344		A1	1.1b
			(3)	
(d)	Only valid if they are <u>catching butterflies independently</u> of each other		B1	3.5b
			(1)	
(11 marks)				
Notes:				
(a)(i)	B1:	awrt 0.114		
(ii)	M1:	Writing or using Po(0.7) model		
	A1:	awrt 0.348 correct answer scores 2 out of 2		
(b)	B1:	Both hypotheses correct in terms of λ or μ Allow 4.2 or 16.8		
	M1:	Writing or using a Po(16.8) model (may be implied by awrt 0.029 or awrt 0.022 or awrt 0.98)		
	A1:	Either correct tail probability awrt 0.029 or awrt 0.022		
	A1:	Correct level of significance awrt 0.0513 (allow equivalent percentage but isw once a correct answer is seen)		
(c)	B1:	awrt 0.603 (may be implied by a correct answer awrt 0.344)		
	M1:	Writing or using B(4, “0.6025...” where “their 0.6025...” must be a probability		
	A1:	awrt 0.344		
(d)	B1:	A correct comment in context on the validity of the model which must include underlined words or equivalent Ignore extraneous non-contradictory comments.		

Question	Scheme	Marks	AOs
4(a)	$\text{mean} = \frac{[15 \times 0 +] 23 \times 1 + 31 \times 2 + 9 \times 3 + 4 \times 2 [+5 \times 0]}{80} [= 1.5]$	M1	1.1b
	$p = \frac{1.5}{5} = 0.3^*$	A1*	1.1b
		(2)	
(b)	$[X \sim B(5, 0.3)] \quad P(X = 1) = 0.36015 \quad \text{or} \quad P(X = 2) = 0.3087$	M1	1.1b
	$r = 80 \times 0.36015 = 28.8\ldots$ awrt 28.8	A1	1.1b
	$s = 80 \times 0.3087 = 24.69\ldots$ awrt 24.7	A1	1.1b
		(3)	
(c)	Need to combine last 3 columns since E_i are < 5	B1	2.4
	Therefore 4 – 2 degrees of freedom since proportion for Binomial estimated from O_i	B1	2.4
		(2)	
(7 marks)			
Notes:			
(a)	M1:	Attempt to find the mean with at least 3 correct products	
	A1*:	cso fully correct solution leading to given answer 0.3	
	A1*:	May be done in a single calculation for M1A1 $\frac{[15 \times 0 +] 23 \times 1 + 31 \times 2 + 9 \times 3 + 4 \times 2 [+5 \times 0]}{400} = 0.3$	
(b)	M1:	Either correct probability awrt 0.36 or awrt 0.31 (may be implied by a correct value of r or a correct value of s)	
	A1:	awrt 28.8	
	A1:	awrt 24.7	
(c)	B1 :	For explaining need to pool last 3 columns/cells and $E_i < 5$ allow 4 cells remaining after pooling for need to pool last 3 columns/cells must be referencing expected frequencies (not observed frequencies)	
	B1:	For proportion/parameter/ p /mean/0.3 calculated/estimated (from data/ O_i) and 2 constraints or $4 - 2$ or $4 - 1 - 1$ which must come from correct reasoning	

