Pearson Edexcel

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 $\surd$ 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
- ⌐ 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 **<u>10.2</u>**	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 *p*–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 *p* = 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)	$E(X) = 2\times0.6 + 5\times0.3 + 9\times0.1 [= 3.6]$	M1	1.1b
	$E(X^2) = 2^2\times0.6 + 5^2\times0.3 + 9^2\times0.1 [= 18]$	M1	1.1b
	$Var(X) = 18 - 3.6^2$	M1	1.1b
	= **5.04**	A1	1.1b
		(4)	
(b)	[P(T = 14) =] 2×0.3×0.1 = 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) = 2×0.6×0.3 [= 0.36] P(T = 11) = 2×0.6×0.1 [= 0.12] [P(T = 14) = 2×0.3×0.1 =0.06]	M1	1.1b
	$[E(T) = 0\times0.46] + 7\times0.36 + 11\times0.12 + 14\times0.06$	M1	1.1b
	= **4.68**	A1	1.1b
		(4)	
(d)	Y~B(150, 0.06)	M1	3.3
	≈ Po(9)	M1	1.1b
	P(Y = 4) ≈ 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 0.3×0.1 + 0.1×0.3 = 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 ×2) May be embedded in the calculation for E(T), eg 7×2×0.6×0.3 + 11×2×0.6×0.1 + …
	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 × 0.18 + 7 × 0.18 only counts as 1 product Must be for their totals, simply calculating $E(X) = 2\times0.6 + 5\times0.3 + 9\times0.1$ 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 Po(9))
	M1:	Writing or using Po(9) allow ft 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)	$P(X = 6) = 0.11432....$ awrt **0.114**	B1	1.1b
		(1)	
(ii)	$Y \sim Po(0.7)$	M1	3.3
	$P(Y = 1) = 0.34760....$ awrt **0.348**	A1	1.1b
		(2)	
(b)	H_0: $\lambda = 4.2$ H_1: $\lambda \neq 4.2$ (allow 16.8)	B1	2.5
	$R \sim Po(16.8)$	M1	3.3
	$\boldsymbol{P}(R \leqslant 9) = 0.02896\ldots$ $\boldsymbol{P}(R > 25)[= 1 - \boldsymbol{P}(R \leqslant 25) = 1 - 0.97769\ldots.] = 0.02230\ldots$	A1	3.4
	Actual level of significance [= 0.02896…+ 0.02230…] = awrt **0.0513**	A1	1.1b
		(4)	
(c)	$\boldsymbol{P}(S \leqslant 3) = 0.6025\ldots$	B1	1.1b
	$J \sim B(4, \text{“}0.6025\ldots\text{”})$ or $6 \times (\text{“}0.6025\text{”})^2(1 - \text{“}0.6025\text{”})^2$	M1	3.3
	$P(J = 2) = 0.34413\ldots.$ awrt **0.344**	A1	1.1b
		(3)	
(d)	Only valid if they are catching butterflies independently of each other	B1	3.5b
		(1)	
			(11 marks)

Notes:

(a)(i) (ii)	**B1:**	awrt 0.114
	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)	$[X \sim \text{B}(5, 0.3)]$ $\quad \text{P}(X=1) = 0.36015$ or $\text{P}(X=2) = 0.3087$	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 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

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