Pearson Edexcel

Mark Scheme

Summer 2023

Pearson Edexcel GCE

AS Mathematics (8MA0)

Paper 21 Statistics

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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 30.

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)	$61\times(2\times3),\quad 63\times(2\times12),\quad 65\times(2\times8),\quad 67\times(2\times2)$	M1	2.1
	$\dfrac{61\times(2\times3)+63\times(2\times12)+65\times(2\times8)+67\times(2\times2)}{50}=63.72*$	A1*cso	1.1b
		(2)	
(b)	$\sqrt{\dfrac{61^2\times6+63^2\times24+65^2\times16+67^2\times4}{50}-63.72^2}$	M1	1.1b
	$=\sqrt{2.5216}=1.58795...$ = awrt **1.59**	A1	1.1b
		(2)	
(c)	No effect (oe) since…e.g. • since addition/subtraction does not affect the standard deviation (only multiplication and division do) • the weights will have the same spread • the distance of each weight from the mean will not have changed • they all change by the same amount	B1	2.4
		(1)	
			(5 marks)

Notes	
(a)	**M1:** at least 3 correct products seen (oe) Allow any 3 from 366, 1512, 1040, 268 **A1*cso:** correct expression for mean (which may be seen in stages) and given answer. $\frac{3186}{50}=63.72$ on its own is M0A0, but $\frac{3186}{50}=63.72$ following all 4 correct products seen can score M1A1
SC:	**B2:** $\dfrac{61\times3+63\times12+65\times8+67\times2}{25}=63.72*$ scores M1A1 on epen
(b)	**M1:** correct expression for the standard deviation including root Allow equivalent complete methods e.g. $\sqrt{\dfrac{6(61-63.72)^2+24(63-63.72)^2+16(65-63.72)^2+4(67-63.72)^2}{50}}$ NB: $\sum fx^2=203138$ **A1:** awrt 1.59 (allow s = awrt 1.60) Correct answer with no incorrect working scores 2 out of 2
SC:	**B2:** $\sqrt{\dfrac{61^2\times3+63^2\times12+65^2\times8+67^2\times2}{25}-63.72^2}$ = awrt 1.59 scores M1A1 on epen
(c)	**B1:** correct statement and correct explanation

Question	Scheme	Marks	AOs
2(a)	No (correlation)/weak (correlation)	B1	1.1b
		(1)	
(b)	(Negative correlation…) As p(ressure) increases, t(emperature) decreases.	B1	2.2b
		(1)	
(c)	990 to 1040 (hPa)	B1	3.4 LDS
		(1)	
(d)	Daily mean wind speed (Beaufort) is a qualitative variable.	B1	2.4 LDS
		(1)	
			(4 marks)

Notes	
(a)	**B1:** correct description of correlation (oe) (ignore reference to positive/negative) condone neutral
(b)	**B1:** correct inference, allow equivalent statements. Negative correlation on its own is B0. Inversely proportional on its own is B0.
(c)	**B1:** an answer in the range 990 to 1040 inclusive (ignore units)
(d)	**B1:** correct explanation that in the LDS, wind speed (Beaufort) is qualitative/not quantitative Allow e.g. ‘categorical’, e.g. ‘given in words’, e.g. ‘wind speed is (always) light’ Do not allow ‘not continuous’ on its own.

Que.	Scheme	Marks	AOs
3(a)	$45 - 25 = 20$ or e.g. '$25 \leqslant 13 + 12 + y \leqslant 45$'	M1	2.1
	$12 \leqslant x \leqslant 32$	A1	1.1b
		(2)	
(b)	To be independent $\mathrm{P}(A) \times \mathrm{P}(M) = \mathrm{P}(A \text{ and } M)$	M1	1.1a
	$\mathrm{P}(M) = \dfrac{\mathrm{P}(A \text{ and } M)}{\mathrm{P}(A)} = \dfrac{\frac{12}{45}}{\frac{25}{45}} = \dfrac{12}{25}$ or $\dfrac{25}{45} \times \mathrm{P}(M) = \dfrac{12}{45}$ or $\dfrac{25}{45} \times \dfrac{x}{45} = \dfrac{12}{45}$ or $\dfrac{25}{45} \times \dfrac{12+y}{45} = \dfrac{12}{45}$	A1	2.1
	The number of students taking part in music would be $\dfrac{12}{25} \times 45 = 21.6$ / The number of students taking part in music but not art would be $y = 9.6$	A1	1.1b
	…so it is not possible for A and M to be independent (since it must be a whole number).	A1	2.2a
		(4)	
			(6 marks)

Notes

(a)	**M1:** for attempting to find range for x or attempt to find the largest/smallest number of students that could study Music only May be implied by one correct end point. Also may be implied with 20 given as an end point **A1:** oe allow $12 - 32$ or $x \geqslant 12$ and $x \leqslant 32$ $12 < x < 32$ or $x \geqslant 12$ or $x \leqslant 32$ or $x \geqslant 12, x \leqslant 32$ all score M1A0
(b)	**M1:** writing the definition of independence, must use A and M Allow any rearrangement Allow all three probabilities labelled followed by a correct equation/definition $\mathrm{P}(A) = \dfrac{25}{45}$, $\mathrm{P}(A \text{ and } M) = \dfrac{12}{45}$, $\mathrm{P}(M) = \dfrac{x}{45}$ or $\dfrac{12+y}{45}$ **A1:** $\mathrm{P}(M) = 0.48$ oe **or** correct equation for $\mathrm{P}(M)$, or x or y (allow any letter for y) Do not award this mark if working with numbers e.g. $\mathrm{P}(A \text{ and } M) = 12$ **A1:** (dependent on M1 only and does not imply first A1) 21.6 oe (also allow $\dfrac{21.6}{45}$) **or** 9.6 oe **A1:** (dependent on all previous marks being scored) correct deduction from correct working. Ignore any reference to the range of values found in part (a).
SC:	If M0 scored, allow access to 1st and 2nd A1 (to score maximum M0A1A1A0)

Que.	Scheme	Marks	AOs
4(a)	[H_1 :] $p \neq 0.25$	B1	2.5
		(1)	
(b)	X~B(50, 0.25)	B1	3.3
	[P($X \leqslant 6$) =]0.0194 or [P($X \leqslant 18$) =]0.9713 or [P($X \geqslant 19$) =]0.0287 or $X \leqslant 6$ or $X \geqslant 19$	M1	3.4
	[P($X \leqslant 6$) =]awrt 0.0194 and [P($X \geqslant 19$) =]awrt 0.0287	A1	1.1b
	CR: $X \leqslant 6$ or $X \geqslant 19$	A1	1.1b
		(4)	
(c)	[0.0194 + 0.0287 =] awrt 0.048	B1ft	1.1b
		(1)	
(d)	(Do not reject H_0,) there is insufficient evidence to suggest that the **proportion** of those with the **allergy** differs from 25%/**Rylan's belief** not supported	B1	2.2b
		(1)	
			(7 marks)

Notes	
(a)	**B1:** correct alternative hypothesis may be stated in terms of p or π Ignore null hypothesis if stated
	Mark part (b) and part (c) together
(b)	**B1:** setting up a Binomial model with $n = 50$ and $p = 0.25$ (allow if seen previously) May be implied by M mark **M1:** use of Binomial (50, 0.25) to find a tail probability or a CR tail May be implied by a relevant probability e.g. $P(X \leqslant 7) = 0.0453$, $P(X \leqslant 19) = 0.986$, $P(X \geqslant 20) = 0.0139$ For this mark allow 2sf or better. Watch out for $P(X = 6) = 0.0123$, $P(X = 7) = 0.02586$, $P(X = 18) = 0.0262$ which on their own score M0 as these are not tail probabilities. **A1:** both correct probabilities **seen** (condone awrt 0.0193 and awrt 0.0288) **A1:** correct CR oe e.g. $X < 7, X > 18$ Condone $X \leqslant 6$ and $X \geqslant 19$
(c)	**B1ft:** awrt 0.048 or ft their two-tailed CR from B(50, p) to 2sf accuracy Each tail probability must be < 0.05
(d)	**B1:** correct inference in context. Do not allow contradictory non-contextual statement e.g. 'Reject H_0' or '10 is in CR' Allow 'proportion' or 'probability' or 'percent(age)/%' but not 'number'. 'Rylan's hypothesis is not supported' is B1, but 'Rylan's hypothesis test is not supported' is B0.

Que.	Scheme	Marks	AOs
5(a)	$X = 0, 1, 2$ only	B1	3.1b
	$[\mathrm{P}(X=0)=]\frac{6}{8}\times\frac{5}{7}\times\frac{4}{6}$	M1	1.1b
	$[\mathrm{P}(X=1)=]3\times\frac{2}{8}\times\frac{6}{7}\times\frac{5}{6}$ or $[\mathrm{P}(X=2)=]3\times\frac{2}{8}\times\frac{1}{7}\times\frac{6}{6}$	M1	2.1
	x | 0 | 1 | 2 $\mathrm{P}(X=x)$ | $\frac{5}{14}$ | $\frac{15}{28}$ | $\frac{3}{28}$	A1 A1	1.1b 1.1b
		(5)	
(b)	$J \sim \mathrm{B}(10, \frac{1}{9})$	M1	3.1b
	$\mathrm{P}(J\geqslant 4)=1-\mathrm{P}(J\leqslant 3)$ or $\mathrm{P}(J\geqslant 4)=\mathrm{P}(J=4)+\mathrm{P}(J=5)+...+\mathrm{P}(J=10)$ or $1-0.981(57...)$	M1	3.4
	$=$ awrt 0.0184	A1	1.1b
		(3)	
			(8 marks)

Notes

(a)

B1: identifying that X can only take on the values 0, 1 and 2 (may be seen at end of tree diagram). If other values stated, they must be associated with a probability of 0.

M1: correct expression for $\mathrm{P}(X=0)$

M1: correct expression for either $\mathrm{P}(X=1)$ or $\mathrm{P}(X=2)$

A1: one correct probability

Watch out for $\frac{6}{8}\times\frac{5}{7}=\frac{15}{28}$ which is an incorrect attempt at $\mathrm{P}(X=0)$ and scores M0A0

A1: complete probability distribution, need not be in a table, but each value of x must be associated with its probability.

Allow awrt 0.357, awrt 0.536, awrt 0.107

(b)

M1: identifying that the B(inomial) distribution with $n = 10$ is appropriate here.

If distribution not stated, may be implied by use of $(10\mathrm{C}r)p^r(1-p)^{10-r}$ or $0.981(57...)$

M1: writing or using a correct probability statement

A1: awrt 0.0184

Correct answer scores 3 out of 3

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