

Mark Scheme (Result)

November 2021

Pearson Edexcel GCE Mathematics

Advanced Subsidiary Level in Mathematics

Statistics Paper 21

8MA0/21

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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 75.

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. 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. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

Qu	Scheme	Marks	AO
1 (a)	[$p = 1 - (0.2 + 0.2 + 0.1 + 0.2)$] = **<u>0.3</u>**	B1 **(1)**	1.1b
(b)	A and C are mutually exclusive. [NOT P(A) and P(C)]	B1 **(1)**	1.2
		(2 marks)	

	Notes
(a)	B1 for
(b)	B1 for A and C [NB $A \cap C$ or $A \cap C = \varnothing$ is B0] If more than one case given they must <u>all</u> be correct e.g. $A \cap B$ and C

Qu	Scheme	Marks	AO
2. (a)	From [5,20) fd = 3 or 1 large square = 2.5 passengers o.e.	M1	2.2a
	Correct bar above [0, 5)	A1	1.1b
	Correct bar above [20, 40)	A1	1.1b
		(3)	
(b)	For [40, 65) **130** passengers or for [65, 80) **60** passengers	M1	2.1
	For attempt to find total number of passengers = **331**	A1ft	1.1b
	[Median =] $40+\frac{\frac{1}{2}("331")-140}{"130"}\times 25$ or $65-\frac{270-\frac{1}{2}("331")}{"130"}\times 25$ (o.e.)	M1	1.1b
	= 44.9038… = awrt **44.9**	A1	1.1b
		(4)	
(c)	Upper outlier limit = 58.9 + 1.5 × (58.9 – 27.3) = 106 (.3) > 90	M1	2.4
	So oldest passenger is not an outlier	A1	2.2a
		(2)	
		(9 marks)	

	Notes
(a)	M1 for attempt at fd or a suitable method to deduce the scale for the histogram May be implied by one correct bar. 1st A1 for first bar [0, 5) with fd = 1 or 2 large squares high 2nd A1 for third bar with fd = 4.5 or 9 large squares high
(b)	1st M1 for an attempt using their fd to find the missing frequencies. May be in table 1st A1ft for a clear attempt to find the total number of passengers (ft their 130 and 60) 2nd M1 for any expression/equation leading to correct Q_2 Must be using 40-65 class 2nd A1 for awrt 44.9 (allow $(n + 1)$ leading to 45)
(c)	M1 for finding the upper outlier limit (expression or awrt 106) and stating or implying > 90 A1 dep on M1 seen for deducing NOT an outlier

Qu	Scheme	Marks	AO
3. (a)	Systematic (sampling)	B1 **(1)**	1.2
(b)(i)	[Daily Mean] Wind Speed	B1	2.2a
(ii)	Light	B1 **(2)**	1.2
(c)	Variable *A* occurs most (around 80~90%) of the time	B1 **(1)** **(4 marks)**	2.2b

	Notes
(a)	B1 for identifying the correct sampling technique Allow slight misspelling e.g. "sysmatic", "sytmatic" Do NOT allow "systemic"
(b)(i)	B1 for identifying appropriate qualitative variable. {LDS mark} Allow "Wind speed" or "Wind strength" but NOT just "wind" or "wind direction"
(ii)	B1 for realising that modal wind speed is "Light" {LDS mark} Allow just "light" or "most light"
NB	These two B marks are independent so can score B0B1 for e.g. "rainfall" and "light"
(c)	B1 for inferring that frequency of *A* can be estimated fairly reliably: {underestimates *B* and over estimates *C*} e.g. "*A* is the most frequent" [can then ignore comments about *B* and *C*]

Qu	Scheme	Marks		AO
4. (a)	[R = no. of red beads in Aliya's bracelet] $R \sim B(18, 0.14)$	B1 **(1)**		3.3
(b)(i)	P($R = 1$) = 0.19403… awrt **0.194**	B1		1.1b
(ii)	P($R \geqslant 4$) = 1 – P($R \leqslant 3$) = 1 – [0.76184…]	M1		3.4
	= 0.2381588… awrt **0.238**	A1 **(3)**		1.1b
(c)	Requires $p = 0.14$ to be constant so need a large number of beads in the sack to ensure that removing 18 beads does not appreciably affect this probability, then it could be suitable.	B1 **(1)**		3.5b
(d)	$H_0 : p = 0.14$ $H_1 : p \neq 0.14$	B1		2.5
	[X = number of red beads in the sample] $X \sim B(75, 0.14)$	M1		3.3
	P($X \leqslant 4$) = 0.01506… or if B(75, 0.14) seen awrt 0.02	A1		3.4
	{0.02 < 0.025 so significant or reject H_0 } There is evidence that the proportion of red beads has changed	A1 **(4)**		2.2b
(e)	p-value is 2×"0.01506..." = 0.030123... = awrt 0.03	B1ft **(1)**		1.1b
		(10 marks)		

	Notes
(a)	B1 for B(18, 0.14) accept in words e.g. binomial with $n = 18$ and $p = 0.14$
(b)(i)	B1 for awrt 0.194
(ii)	M1 for interpreting "at least 4" Need 1 – P($R \leqslant 3$) and 1 – p [$0 < p < 1$] P($R = 3$) = 0.233.. OK
	A1 for awrt 0.238
(c)	B1 for mention of large number of beads and need for $p = 0.14$ to be constant for it to be suitable. Do NOT accept e.g. "events are independent"
(d)	B1 for both hypotheses correct with use of p or π
	M1 for selecting a suitable model: sight or correct use of B(75, 0.14) May be implied by sight of 0.015 or better or [P($X > 4$) =] 0.9849… i.e. 0.985 or better
	1st A1 for use of the correct model awrt 0.015 (accept awrt 0.02 following a correct expression) Allow 1st A1 for awrt 0.985 only if correct comparison with 0.975 is seen. Sight of B(75, 0.14) and P($X \leqslant 4$) = awrt 0.02 scores M1A1
	No sight of B(75, 0.14) but sight of awrt 0.015 scores M1($\Rightarrow$)A1[Condone P($X = 4$) =..]
	2nd A1 (**dep on M1A1)** for a correct conclusion in context mentioning "proportion", "red" and "changed"
	If there is a statement about H_0 or significance it must be compatible.
NB	May see CR i.e. $X \leqslant 4$ (mark when prob seen) and $X \geqslant 18$ (prob = 0.01406..) Ignore upper limit
	NB for information P($X = 4$) = 0.0104… and can only score M1A0A0 if B(75, 0.14) seen
(e)	B1ft for awrt 0.03 Allow ft of their probability in (d) provided at least 3sf used
	NB an answer of 0.02 in (d) leading to 0.04 in (e) is B0
SC	Use of CR will give significance level of 0.01506…+ 0.01406… = 0.029… score B1 **no ft**

Qu	Scheme	Marks	AO
5	Must end up with 3 of each colour or 4 of each colour	M1	3.1b
	***n* = 2** requires 1st red and 2nd green or red from **A** and green from **B**	M1	2.2a
	P(1st red and 2nd green) = $\frac{4}{9}\times\frac{1}{10}=\frac{4}{90}$ or $\frac{2}{45}$ $\quad p = \underline{\underline{\frac{2}{45}}}$	A1	1.1b
	***n* = 5** requires 1st green and 2nd yellow or green from **A** and yellow from **B**	M1	2.2a
	P(1st green and 2nd yellow) = $\frac{5}{12}\times\frac{3}{10}=\frac{15}{120}$ or $\frac{1}{8}$ $\quad p = \underline{\underline{\frac{1}{8}}}$	A1	1.1b
		(5)	
		(5 marks)	

	Notes
	1st M1 for an overall strategy realising there are 2 options. Award when evidence of both cases (3 of each colour or 4 of each colour) seen.
	2nd M1 for $n = 2$ and attempt at 1st red and 2nd green May be implied by e.g. $\frac{4}{9}\times\frac{1}{9}$
	1st A1 for $p = \underline{\underline{\frac{2}{45}}}$ or exact equivalent
	3rd M1 for $n = 5$ and attempt at 1st green and 2nd yellow May be implied by e.g. $\frac{5}{12}\times\frac{3}{9}$
	2nd A1 for $p = \underline{\underline{\frac{1}{8}}}$ or exact equivalent
NB	If both correct values of p are found and then added (get $\frac{61}{360}$) , deduct final A1 only (i.e. 4/5)

Greg Attwood 23rd Oct 2021