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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  $\checkmark$  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. 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)	$[p = 1 - (0.2 + 0.2 + 0.1 + 0.2)] = \underline{0.3}$	B1 (1)	1.1b
(b)	A and C are mutually exclusive. [ NOT P(A) and P(C) ]	B1 (1)	1.2
		<b>(2 marks)</b>	
<b>Notes</b>			
(a)	B1 for		
(b)	B1 for A and C [NB $A \cap C$ or $A \cap C = \emptyset$ 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 <u>or</u> 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) <b>130</b> passengers <u>or</u> for [65, 80) <b>60</b> passengers	M1	2.1
		For attempt to find total number of passengers = <b>331</b>	A1ft	1.1b
		[Median = ] $40 + \frac{\frac{1}{2}("331") - 140}{"130"} \times 25$ <u>or</u> $65 - \frac{270 - \frac{1}{2}("331")}{"130"} \times 25$ (o.e.)	M1	1.1b
		= 44.9038... = awrt <b>44.9</b>	A1	1.1b
			(4)	
	(c)	Upper outlier limit = $58.9 + 1.5 \times (58.9 - 27.3) = 106 (.3) > 90$	M1	2.4
So oldest passenger is <u>not</u> an outlier		A1	2.2a	
			(2)	
		(9 marks)		
<b>Notes</b>				
(a)	M1 for attempt at fd or a suitable method to deduce the scale for the histogram			
	May be implied by one correct bar.			
	1 <sup>st</sup> A1 for first bar [0, 5) with fd = 1 <u>or</u> 2 large squares high			
	2 <sup>nd</sup> A1 for third bar with fd = 4.5 <u>or</u> 9 large squares high			
	(b)	1 <sup>st</sup> M1 for an attempt using their fd to find the missing frequencies. May be in table		
		1 <sup>st</sup> A1ft for a clear attempt to find the total number of passengers (ft their 130 and 60)		
		2 <sup>nd</sup> M1 for any expression/equation leading to correct $Q_2$ Must be using 40-65 class		
	2 <sup>nd</sup> A1 for awrt 44.9 (allow $(n + 1)$ leading to 45)			
	(c)	M1 for finding the upper outlier limit ( expression or awrt 106 ) <u>and</u> 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)	2.2b
<b>Notes</b>			
(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”		
<b>NB</b>	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)	[ $R = \text{no. of red beads in Aliya's bracelet}$ ] $R \sim B(18, 0.14)$	B1 (1)	3.3
(b)(i)	$P(R = 1) = 0.19403\dots$ awrt <b>0.194</b>	B1	1.1b
(ii)	$P(R \geq 4) = 1 - P(R \leq 3) = 1 - [0.76184\dots]$ $= 0.2381588\dots$ awrt <b>0.238</b>	M1 A1 (3)	3.4 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)	$H_0 : p = 0.14$ $H_1 : p \neq 0.14$ [ $X = \text{number of red beads in the sample}$ ] $X \sim B(75, 0.14)$ $P(X \leq 4) = 0.01506\dots$ or if $B(75, 0.14)$ seen awrt 0.02 { $0.02 < 0.025$ so significant <u>or</u> reject $H_0$ } There is evidence that the proportion of red beads has changed	B1 M1 A1 A1 (4)	2.5 3.3 3.4 2.2b
(e)	$p$ -value is $2 \times "0.01506\dots" = 0.030123\dots =$ awrt 0.03	B1ft (1)	1.1b
<b>(10 marks)</b>			
<b>Notes</b>			
(a)	B1 for $B(18, 0.14)$ accept in words e.g. <u>binomial</u> with $n = 18$ and $p = 0.14$		
(b)(i)	B1 for awrt 0.194		
(ii)	M1 for interpreting "at least 4" Need $1 - P(R \leq 3)$ <u>and</u> $1 - p$ [ $0 < p < 1$ ] $P(R = 3) = 0.233\dots$ OK A1 for awrt 0.238		
(c)	B1 for mention of <u>large number of beads</u> and need for <u><math>p = 0.14</math> to be constant</u> for it to be suitable. Do NOT accept e.g. "events are independent"		
(d)	B1 for both hypotheses correct with use of $p$ or $\pi$ 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 <u>or</u> [ $P(X > 4) =$ ] 0.9849... i.e. 0.985 or better 1 <sup>st</sup> A1 for use of the correct model awrt 0.015 (accept awrt 0.02 following a correct expression) Allow 1 <sup>st</sup> A1 for awrt 0.985 <u>only if</u> correct comparison with 0.975 is seen. Sight of $B(75, 0.14)$ and $P(X \leq 4) =$ awrt 0.02 scores M1A1 <u>No sight</u> of $B(75, 0.14)$ <u>but</u> sight of awrt 0.015 scores M1( $\Rightarrow$ )A1[Condone $P(X = 4) = \dots$ ] 2 <sup>nd</sup> A1 ( <b>dep on M1A1</b> ) for a correct conclusion in context mentioning "proportion", "red" and "changed"		
NB	If there is a statement about $H_0$ or significance it must be compatible. May see CR i.e. $X \leq 4$ (mark when prob seen) and $X \geq 18$ (prob = 0.01406...) Ignore upper limit NB for information $P(X = 4) = 0.0104\dots$ 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 $0.01506\dots + 0.01406\dots = 0.029\dots$ score B1 <b>no ft</b>		



Qu	Scheme	Marks	AO
5	Must end up with 3 of each colour or 4 of each colour	M1	3.1b
	<u><math>n = 2</math></u> requires 1 <sup>st</sup> red and 2 <sup>nd</sup> green <u>or</u> red from <b>A</b> and green from <b>B</b>	M1	2.2a
	$P(1^{\text{st}} \text{ red and } 2^{\text{nd}} \text{ green}) = \frac{4}{9} \times \frac{1}{10} = \frac{4}{90} \text{ or } \frac{2}{45} \quad p = \frac{2}{\underline{\underline{45}}}$	A1	1.1b
	<u><math>n = 5</math></u> requires 1 <sup>st</sup> green and 2 <sup>nd</sup> yellow <u>or</u> green from <b>A</b> and yellow from <b>B</b>	M1	2.2a
	$P(1^{\text{st}} \text{ green and } 2^{\text{nd}} \text{ yellow}) = \frac{5}{12} \times \frac{3}{10} = \frac{15}{120} \text{ or } \frac{1}{8} \quad p = \frac{1}{\underline{\underline{8}}}$	A1	1.1b
	(5)	(5 marks)	
<b>Notes</b>			
NB	1 <sup>st</sup> 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.		
	2 <sup>nd</sup> M1 for $n = 2$ <u>and</u> attempt at 1 <sup>st</sup> red and 2 <sup>nd</sup> green May be implied by e.g. $\frac{4}{9} \times \frac{1}{9}$		
	1 <sup>st</sup> A1 for $p = \frac{2}{\underline{\underline{45}}}$ or exact equivalent		
	3 <sup>rd</sup> M1 for $n = 5$ <u>and</u> attempt at 1 <sup>st</sup> green and 2 <sup>nd</sup> yellow May be implied by e.g. $\frac{5}{12} \times \frac{3}{9}$		
	2 <sup>nd</sup> A1 for $p = \frac{1}{\underline{\underline{8}}}$ or exact equivalent		
If both correct values of $p$ are found and then added ( get $\frac{61}{360}$ ), deduct final A1 only (i.e. 4/5)			