Mark Scheme (Results)

Summer 2022

Pearson Edexcel GCE Mathematics

Advanced Subsidiary Level in Mathematics

Paper 21 8MA0/21 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 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)	Negative (since gradient of regression line is negative)	B1 **(1)**	1.2
(b)	cm/day (o.e. e.g. cm day^{-1})	B1 **(1)**	2.2a
(c)	$3\times[\pm]1.1$ = decrease of 3.3 [cm]	M1 A1 **(2)**	3.4 1.1b
(d)	19 is (well) outside the range [1, 10] or involves extrapolation (o.e.) so (possibly) unreliable/ inaccurate (o.e.)	B1 **(1)**	2.4
		(5 marks)	

	Notes
	Answers may be written within the question.
(a)	B1 for stating "negative". Allow a correct interpretation e.g. as *t* increases then *p* decreases (o.e.) [ignore any values] B0 for contradictory statements e.g. "negative correlation since as *t* increases *p* increases"
(b)	B1 for a correct description of the units (allow fraction, /, or "per" and allow "d" for "day")
(c)	M1 for attempt at a calculation (allow use of $t = x$ and $t = x + 3$ followed by subtraction that should lead to 3.3) A1 for correct description must include word "decrease" (o.e.) and value "3.3" Just seeing: $22-1.1\times3=18.7$ is M0A0 BUT going on to subtract 18.7 from 22 scores M1 Reaching 3.3 and stating "decrease" or "reduced" (o.e.) will score the A1 too An answer of – 3.3 without a word describing decrease (o.e.) will just score M1A0
(d)	B1 for stating "unreliable" (o.e.) **and** giving a suitable reason based on idea of extrapolation Must have **both** statement about reliability **and** suitable reason e.g. $t = 19$ is too big or (Model is based on) *t* between 1 and 10 (only) [since this implies $t = 19$ is too big] Allow e.g. (model) "may not work" because of "extrapolation" Just saying "no" since "extrapolation" is B0 but "unreliable"(o.e.) since "extrapolation" is B1

Qu	Scheme	Mark	AO
2. (a)	[D = number of bags that are damp] $D \sim$ B(35, 0.08) NB 0.08 = $\frac{2}{25}$	M1	3.3
(i)	P(D = 2) = 0.2430497… awrt **0.243**	A1	3.4
(ii)	P(D > 3) = $\left[1-\text{P}(D \text{,,} 3) = 1-0.69397...\right]$ = 0.30602… awrt **0.306**	A1	1.1b
		(3)	
(b)	$H_0 : p = 0.08$ $H_1 : p < 0.08$	B1	2.5
	[$X \sim$] B(70, 0.08)	M1	2.1
	$\left[\text{P}(X \text{,,} 2)\right] = 0.0739756…$ awrt **0.074**	A1	1.1b
	[0.074 < 0.10 so significant, reject H_0 so…]		
	there is evidence to support supplier B's claim (o.e.)	A1	2.2b
		(4)	
		(7 marks)	

	Notes
(a)	M1 for selecting a correct model: sight of or use of B(35, 0.08) [Condone B(0.08, 35)] May be implied by one correct answer or sight of P(D ,, 3) = awrt 0.694 (or allow 0.693) or seeing $\binom{35}{2}0.08^2 \times (1-0.08)^{35-2}$ Saying B(35, 8%) without a correct calculation would score M0
(i)	1st A1 for awrt 0.243
(ii)	2nd A1 for awrt 0.306 (Condone poor use of notation e.g. P(D = 3) = 0.306… i.e. just mark ans)
NB	P(D…3) = 0.539 scores 2nd A0 but would of course score M1
(b)	B1 for both hypotheses correct in terms of p or π [Condone 8% for 0.08] M1 for sight or correct use of B(70, 0.08) [Condone B(0.08, 70)] May be implied by prob of 0.074 or better 1st A1 for final answer awrt 0.074 can condone poor notation e.g. P(X = 2) = awrt 0.074 Can allow this mark for CR of X ,, 2 provided $\left[\text{P}(X \text{,,} 2)\right] = 0.074$ (or better) is seen [Can allow 0.07 if X~B(70, 0.08) and P(X ,, 2) are both seen] 2nd A1 (**dep on** M1A1 but independent of hypotheses) for a correct inference in context Must mention claim or B **and** idea of support for … or proportion/probability (of damp bags) **and** idea of less than 8% or A 2nd A0 for contradictory statements e.g. "accept H_0 so evidence to support B's claim" 2nd A0 if you see 0.0739… < 0.08 so significant/ reject H_0 etc
MR	**0.8 for 0.08** In (a) allow M1 for B(35, 0.8) then A0A0 In (b) allow B1 for Hypotheses and M1 for B(70, 0.8) seen, then A0A0

Qu	Scheme	Mark	AO
3. (a)			
		M1	2.1
		A1	1.1b
	$[Q_2 =](3.5)+\frac{\frac{256}{2}-"125"}{"55"}\times(4.5-3.5)$ <u>or</u> $(4.5)-\frac{"180"-\frac{256}{2}}{"55"}\times 1$	M1	2.1
	$= 3.5545\ldots\ldots$ awrt **<u>3.55</u>**	A1	1.1b
		(4)	
(b)	Need area under curve to be 256 so $\int_{(0)}^{(8)} kx(8-x)\,dx = 256$	M1	3.1a
	$k\left[4x^2-\frac{x^3}{3}\right]_{(0)}^{(8)} = 256$	M1	1.1b
	$\left\{k\left[4\times 8^2-\frac{8}{3}\times 8^2\right]=256\Rightarrow\right\}$ **<u>k = 3</u>**	A1	1.1b
		(3)	
(c)	[By symmetry median =] **<u>4</u>**	B1	2.2a
		(1)	
		(8 marks)	

	Notes
(a)	1st M1 for an attempt to form frequency table (at least 1st 4 rows and freq <u>or</u> cum freq seen must have the frequency of 75 correct and can condone one error/omission in 15, 35, 55) Frequencies or cum freq may be seen on bars of the histogram 1st A1 for identifying class, freq and cum freq (i.e. highlighted values from the table) <u>or</u> sight of 3.5-4.5, freq of 55 and "128" – 125 or 180 – "128" <u>or</u> diagram with 125, "128", 180, 3.5 & 4.5 May be implied by values in 2nd M1expression 2nd M1 for a correct calculation for Q_2 (condone error in end point e.g. 3.45 or 3.49 etc) Can ft their "125" (provided > 100) and their "55" Allow use of $(n + 1)$, usually see 128.5 – … leading to 3.5636… or awrt 3.56 2nd A1 awrt 3.55 but 3.555 is fine (allow 3.56 if $(n + 1)$ being used …need sight of $\frac{257}{2}$ etc) Correct answer with no incorrect working scores 4/4
(b)	1st M1 for identifying the need to find the area under the curve by integrating 2nd M1 for correct integration and = 256 (condone missing limits) A1 for $k = 3$ [May see use of calculator for the integration so score 2nd M1A1 together]
(c)	**NB The answer to part (c) may be written within the question.** B1 for 4 (Independent of their value of k but must be their "x" value) NB when $k = 0.25$ and $x = 4$ gives $y = 4$ so must be clear they intend median = 4 The statement in part (c) "$k = 4$" is B0

	Scheme	Marks	AO

4. (a)	Accept 990 to 1030 inclusive	B1 **(1)**	1.1b
(b)	Any range between 10 and 50 inclusive	B1 **(1)**	1.1b
		(2 marks)	

	Notes
(a)	B1 (Median pressures usually around 1000~1020) [LDS mark]
(b)	B1 Any answer in this range [LDS mark] Allow answers in the form $a \sim b$ where $\lvert b-a \rvert$ is between 10 and 50 Also allow the case where <u>both</u> a and b are in [10, 50]

Qu	Scheme	Mark	AO
5. (a)(i)	Require $R = 3$ and $G = 4$ so probability is $\frac{3}{4}\times\frac{1}{3}$	M1	2.1
	$= \underline{\frac{1}{4}}$ or **<u>0.25</u>**	A1	1.1b
(ii)	[R must be 2 and $G = 1$so $\frac{1}{4}\times\frac{2}{3}$] $= \underline{\frac{1}{6}}$	A1	1.1b
		(3)	
(b)	P($X = 50$) = 0.25 must mean $R = 3$ and $G = 4$	M1	3.1a
	so $3m + 4n = 50$	A1	1.1b
	P($X = 20$) = $\frac{1}{6}$ $\Rightarrow$ $R = 2$, $G = 1$ so $2m + n = 20$	A1	2.1
	Solving: $3m + 4(20 – 2m) = 50$ (o.e.)	M1	1.1b
	<u>$m = 6$</u> and **<u>$n = 8$</u>**	A1	3.2a
		(5)	
		(8 marks)	

Notes

(a)(i) M1 for sight of $\frac{3}{4}\times\frac{1}{3}$ or $\frac{1}{4}\times\frac{2}{3}$ as a single product BUT allow e.g. $\frac{3}{4}\times\frac{1}{3}+\frac{1}{3}\times\frac{3}{4}$ to score M1

However if the products are later added e.g. $\frac{3}{4}\times\frac{1}{3}+\frac{1}{4}\times\frac{2}{3}$ it is M0

May be implied by one correct answer to (i) or (ii)

A1 for $\frac{1}{4}$ or 0.25 or exact equivalent (allow 25%)

(ii) A1 for $\frac{1}{6}$ or exact equivalent

(b) **For the 1st 4 marks condone incorrect labelling e.g. *R* for *m* or *G* for *n* if intention is clear**

1st M1 for identifying either set of cases ($R = 2$, $G = 1$, $X = 20$) or ($R = 3$, $G = 4$, $X = 50$)

Allow 1st M1 for P($X = 20$) = $\frac{1}{4}\times\frac{2}{3}$ **or** P($X = 50$) = $\frac{3}{4}\times\frac{1}{3}$ **NOT** just P($X = 20$) = $\frac{1}{6}$ etc

<u>or</u> $\frac{1}{4}m+\frac{2}{3}n=20$ **or** $\frac{3}{4}m+\frac{1}{3}n=50$ and might score 2nd M1 (answer is $m = 64$, $n = 6$)

<u>or</u> $\frac{1}{4}m+\frac{2}{3}n=\frac{1}{6}$ **or** $\frac{3}{4}m+\frac{1}{3}n=\frac{1}{4}$ and might score 2nd M1 (answer is $m = \frac{4}{15}$, $n = \frac{3}{20}$)

<u>or</u> $2m+n=\frac{1}{6}$ **or** $3m+4n=\frac{1}{4}$ and might score 2nd M1 (answer is $m = \frac{1}{12}$, $n = 0$)

<u>or</u> $2m+n=50$ **and** $3m+4n=20$ and might score 2nd M1 (answer is $m = 36$, $n = -22$)

1st A1 for one correct equation

2nd A1 for **both** correct equations and no incorrect equations, unless they attempt to solve the correct 2 equations only

2nd M1 for attempt to solve <u>their</u> two linear equations in *m* and *n* (reduce to an equation in one variable, condone one sign error). May be implied by $m = 6$ and $n = 8$.

Calc If they use one of the 4 sets of equations for 1st M1 and use a calculator to write down the answer, we will allow this mark for sight of the correct answers to those equations as given above.

3rd A1 $m = 6$ and $n = 8$ only (no incorrect labelling here)

Correct answer by trial can score 5/5 if no incorrect working seen.