

Mark Scheme (Results)

Summer 2025

Pearson Edexcel GCE

In Mathematics (9MA0)

Paper 31 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 50.
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 √ 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.

Special notes for 9MA0-31 exams

Solving a 3-term quadratic (3TQ)

Any method can be used. The solving of the quadratic is a means to an end and not something we are assessing in itself. e.g. for $x^2 + bx + c = 0$ we would not usually worry about the = 0

they could use:

1. Factorisation

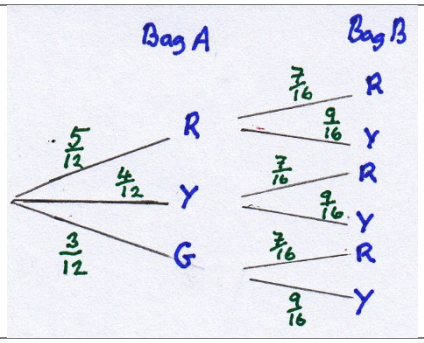
$(x^2 + bx + c) = (x + p)(x + q)$, where $|pq| = |c|$

2. Formula

Attempt to use the correct formula (with values for *b* and *c*)

3. Completing the square

Solving: $x^2 + bx + c = 0 = \left(x \pm \frac{b}{2}\right)^2 \pm q = 0, \quad q \neq 0$

Question	Scheme	Marks	AOs
1(a)(i)	[Let p = probability of yellow from bag **B**] $\mathrm{P}(YY) = \frac{4}{12} \times p$	M1	1.1b
	$\left[\frac{4}{12} \times p = \frac{3}{16}\right]$ so $p = \underline{\underline{\frac{9}{16}}}$ (Allow 0.5625 and condone 0.563)	A1	1.1b
		(2)	
1(a)(ii)		B1	1.1b
		B1ft	1.1b
		(2)	
1(b)	e.g. $\mathrm{P}(RY) + \mathrm{P}(Y) + \mathrm{P}(GY)$ <u>or</u> $1 - \mathrm{P}(RR) - \mathrm{P}(GR)$ <u>or</u> $\mathrm{P}(\ldots Y) + \mathrm{P}(YR)$	M1	2.1
	$\frac{5}{12} \times \frac{"9"}{"16"} + \frac{4}{12} + \frac{3}{12} \times \frac{"9"}{"16"}$ <u>or</u> $1 - \left[\frac{5}{12} \times \frac{"7"}{"16"} + \frac{3}{12} \times \frac{"7"}{"16"}\right]$ or $\frac{"9"}{"16"} + \frac{1}{3} \times \frac{"7"}{"16"}$	A1ft	1.1b
	$= \underline{\underline{\frac{136}{192}}} = \underline{\underline{\frac{17}{24}}} = \underline{\underline{0.708\dot{3}}}$	A1	1.1b
		(3)	
1(c)	$\left[\mathrm{P}(W \mid X) =\right] \frac{\mathrm{P}(W \cap X)}{\mathrm{P}(X)}$ or $\frac{\frac{3}{12} \times \frac{"9"}{"16"}}{"(b)"}$	M1	1.1b
	$= \underline{\underline{\frac{27}{136}}}$	A1	1.1b
		(2)	
			(9 marks)

Notes:

(a)(i)	M1	for a suitable expression (in their p) for the probability both are yellow.
	A1	for correct probability of yellow from **B**. Can be implied by values on tree diagram.
(a)(ii)	B1	for a correct 1st column of tree diagram (probabilities from **A**)
	B1ft	**(dep on M1 in (i))** for correct 2nd column of tree diagram (ft their $\frac{9}{16}$ and $1 - \frac{9}{16}$)
(b)	M1	for selection of <u>all</u> correct cases (including the 1 – if required). Don't need P(… may be implied by correct probability products seen (ft their tree diagram)
	A1ft	for a correct complete probability expression (ft their tree diagram) or awrt 0.708 Must see product pairs (for ft) <u>or</u> implied by correct values e.g. $\frac{15}{64} + \frac{7}{48} + \frac{3}{16} + \frac{9}{64}$ May see $1 - \mathrm{P}\left(\overline{Y}\,\overline{Y}\right)$ (M1) and $1 - \frac{2}{3} \times \frac{"7"}{"16"}$ (A1ft)
	A1	for an exact answer …fraction needn't be simplified but decimal must have … $\dot{3}$
(c)	M1	for a correct ratio of probabilities expression (in symbols) or ft their values seen
	A1	for an exact answer NB an answer of awrt 0.199 (0.198529411…) implies M1
Acc	**If scored 2nd A0 in (b) for 0.708 (or better) then allow A1 in (c) for awrt 0.199**	

Question	Scheme	Marks	AOs
2(a)	$\left[\bar{x} = \frac{6612}{120}\right] =$ **55.1** (seconds)	B1	1.1b
		(1)	
2(b)	$\left[\sigma_x =\right]\sqrt{\frac{364\,902}{120} - ("55.1")^2}$ or $\sqrt{4.84}$	M1	1.1b
	= **2.2** (seconds)	A1	1.1b
		(2)	
2(c)	Coach *B* because standard deviation is greater	M1	2.4
	This means *B* has a greater range **and** therefore more extreme values	A1ft	2.2b
		(2)	
			(5 marks)

Notes:
Ignore units in this question

(a)	B1	for 55.1 or $55\frac{1}{10}$ only (may be seen in the question) ISW e.g. 55.1 followed by 55 etc Do not accept $\frac{551}{10}$ that scores B0
(b)	M1	for a correct expression (values seen not just a formula)(including $\sqrt{\ }$)
	A1	for 2.2 or $\frac{11}{5}$ o.e. (allow $s = 2.209\ldots$ so awrt 2.21) Correct answer is 2 marks
(c)	**Ignore comments about different number of runners. Don't need to state means are the same.** **If there is no answer given for (b) then no marks can be scored in (c)**	
"2.2"<3.6	B1	for coach *B* **and** states s.d. of *B* is greater o.e. Must compare. Allow implied choose *B* e.g. *B* has a greater range or *B*s values are more spread out or $3.6 >$ "2.2" or $\sigma_B >$ "2.2" May say s.d. of *A* is smaller which is equivalent to saying s.d. of *B* is larger
	dB1	(dep on 1st B1 scored) for clear reason why greater s.d. means choose coach *B* Idea of greater range **and** more extreme values (faster times) in *B* e.g. *B* has more (or greater chance of or greater % of) runners at lower times (may compare mean – 1 or 2 or 3 standard deviations to show that *B* has the quicker time) e.g. coach *A* (52.9) > (51.5) coach *B* so coach *B* likely to be quickest
	NB	**"**coach *B* since *B* has greater range /s.d. and so more extreme values" scores B1B1
SC **"2.2">3.6**	**(A0 in (b)** and answer > 3.6)	
	B1	equivalent reasons as above but choose *A*
	dB1	same rules as above but applied to *A*

Question	Scheme	Marks	AOs
3(a)	[Let D = the number of defective components] $D \sim B(36, 0.015)$	M1	3.3
(i)	[$P(D = 2) =$] 0.084792… awrt **0.0848**	A1	1.1b
(ii)	[$P(D > 3) = 1 - P(D \leq 3) = 1 - 0.9979\ldots =$] 0.002032… awrt **0.00203**	A1	1.1b
		(3)	
3(b)	[Let X = the number of defective components] $X \sim B(260, 0.015)$	M1	3.3
	[$P(X \geqslant 8) =$] 0.0441(1…)	A1	1.1b
	[0.04 > 0.025 so not significant] Insufficient evidence that proportion/probability of defective components has changed (o.e.)	A1	2.2b
		(3)	
			(6 marks)

Notes:

(a)	M1	for selecting B(36, 0.015) sight of or use of. Must be B(…) [Implied by sight of Po(0.54)] May be implied by sight of: 0.0848 or awrt 0.085 or 0.00203 or 0.998 or 0.002
(i)	A1	for awrt 0.0848
(ii)	A1	for awrt 0.00203 [Allow 2.03×10^{-3}]
	Use of Poisson Po(0.54) (i) 0.08496 scores A0 (ii) 0.002309… awrt 0.00231 scores A1	
Notation: We do not accept "calculator speak" e.g. $N = 36$, $p = 0.015$ instead of B(36, 0.015)		
(b)	M1	for sight of B(260, 0.015) may be implied by probability of awrt 0.0441 or awrt 0.0264 or awrt 0.956 or correct CR $X = 0$ [or ≤ 0] **and** $X \geq 9$ or $P(X \geq 8) = 0.04$ or better
	A1	for probability of awrt 0.0441 (selected if more probabilities seen) Condone $P(X = 8) = 0.0441\ldots$ If $P(X \geq 8)$ is explicitly seen allow 0.04 or better or for the correct CR $X = 0$ [or ≤ 0] **and** $X \geq 9$. Allow acceptance region [1, 8] (o.e.)
	A1	**dep on M1A1** for a correct conclusion in context. Allow e.g: proportion/probability of defective components has not changed proportion/probability of defective components is still 0.015 Allow "defectives" instead of "components" If a comparison is seen (other than $0.956 < 0.975$) it must be with 0.025 Incorrect comparisons score A0 (condone missing comparison) Do not accept contradictory statements e.g. "significant so insufficient evidence of change in proportion" would score A0 "Insufficient evidence that $p \neq 0.015$" is A0, we need the words.
SC	Poisson Approximation (If you see Po(3.9) or probability 0.0454…)	
	B2 and mark as M0A1A1	
	B1	for probability of awrt 0.0454 or 0.04… if $P(X \geq 8)$ seen or CR as above
	B1	for correct conclusion in context (same rules as above)

Question	Scheme	Marks	AOs
4(a)	Systematic (sampling)	B1	1.2
		(1)	
4(b)	The (Daily Total) Rainfall data may contain "tr" entries (these will need a suitable value substituted before calculations can take place.)	B1	2.4
		(1)	
4(c)(i)	mm/h (o.e.) e.g. mm h^{-1} or mm hrs^{-1} or $\frac{\text{mm}}{\text{hours}}$	B1	1.1b
(ii)	When there is no sun(shine) there is (on average) 0.7(41) (mm) of rain or the amount of rain when there is no sun(shine) (o.e.)	B1	2.4
		(2)	
4(d)	e.g. Not consistent (since); Kay's line says positive correlation **or** gradient **or** regression coefficient **or** regression line **or** 0.199 is positive	B1	2.4
		(1)	
4(e)	$H_0 : \rho = 0$ and $H_1 : \rho < 0$	B1	2.5
	[p-value < 5% so significant result] there is evidence to support the teacher's claim	B1	2.2b
		(2)	
4(f)(i)	The sample is rainfall (y) and sunshine (x) for May~Oct in (Leeming) in 2015	B1	1.1b
(ii)	e.g. (rainfall and sunshine) for: (Leeming) for all of 2015, or Leeming anytime (not just May~Oct) or Leeming for May~October for other years too or May ~Oct in UK etc	B1	3.3
		(2)	
			(9 marks)

Notes:

(a)	B1	for systematic (ignore other non-contradictory descriptions). Condone misspelling. If a clear choice is given e.g. stratified or systematic we take the final answer.
(b)	B1	for mention of "tr" or "trace" entries in rain(fall) [or y] data. Ignore "n/a". Ignore any comment about what to do with trace.
(c)(i)	B1	for mm/h or equivalent in words.
(ii)	B1	for the idea of amount of rain when no sun. "Minimum rain" is B0 Don't need value or units but if given must be correct or consistent with (i)
(d)	B1	for a suitable reason **and** saying not consistent (o.e.) e.g. "false" or "untrue" or "no" Reason only needs to be about the line and may be a description e.g. as x increases y increases or at least 2 values of x substituted and y values evaluated
(e)	B1	for both hypotheses correct in terms of ρ (condone attempt at ρ that looks like p)
	B1	for a correct conclusion in context with no contradiction. Using words "support" and "teacher's claim" **or** "negative correlation" and "sun or x" and "rain or y" [If a comparison is given it must be 0.015 < 0.05]
(f)(i)	B1	for recognising that all the data/days for these variables in LDS for 2015 is the sample. Condone omitting "Leeming" B0 for "sunshine and rainfall for Leeming in 2015" It could be the population.
(ii)	B1	for a suitable attempt to describe a population. The teacher's sample must be a subset.

Question	Scheme	Marks	AOs
5(a)(i)	[Let M be the height of a man from the club, P($M > 186$) =] 0.270187… = awrt **0.270**	B1	1.1b
(ii)	[P($175 < M < 185$) =] 0.6071520… = awrt **0.607**	B1	3.4
		(2)	
5(b)	[Let F be the height of a women from the club]		
	P($F < 170$) = 0.40 $\Rightarrow \frac{170-\mu}{\sigma} = -0.2533$ [calc gives – 0.253347…]	M1	3.1b
	P($F > 175$) = 0.15 $\Rightarrow \frac{175-\mu}{\sigma} = 1.0364$ [calc gives 1.036433…]	M1	3.4
	Solving: $5 = \sigma(1.0364 + 0.2533)$	M1	1.1b
	σ = 3.87687… awrt **3.88**	A1	1.1b
	μ = 170.9820… awrt **171**	A1	3.2b
		(5)	
5(c)	[P($170 < F < 175$) =] 1 – (0.40 + 0.15) = 0.45 (allow awrt 0.45) [P($170 < M < 175$) =] 0.047282… = (allow awrt 0.047)	M1	3.4
	[P($170 < F < 175$) × P($170 < M < 175$) =] "0.45"×"0.047" or 0.021…	A1ft	1.1b
	So P(both) = 0.021277… awrt **0.021**	A1	1.1b
		(3)	
			(10 marks)

Notes:

(a)(i)	B1	for awrt 0.270 (accept just 0.27)
(ii)	B1	for awrt 0.607
(b)	M1	for standardising 170 with μ and σ and set equal to a z value $0 < \lvert z \rvert < 0.3$
	M1	for standardising 175 with μ and σ and set equal to a z value $1 < \lvert z \rvert < 2$
	M1	for solving their 2 linear equations, reducing to a linear equation in one variable This can be implied by two answers that are correct to 2sf.
	To award the A marks they must have scored 1st M1 and 2nd M1	
	A1	for = σ awrt 3.88
	A1	for = μ awrt 171 (Must not be from incorrect working e.g. $\sigma < 0$)
	Ans only	We need to see the linear equations in μ and σ to start awarding marks. If 1st M1 and 2nd M1 are scored and correct answers are seen we can award 5 marks.
	MR	**(15% as 0.015)** 2nd M1 for z = 2.17…, 3rd M1 implied by σ = 2.06… and μ = 170.5 … i.e. Maximum M1M1M1A0A0
(c)	M1	for correct probability for women or correct probability for men or clear intention to multiply P($170 < F < 175$) by P($170 < M < 175$)
	A1ft	for using P($170 < F < 175$) × P($170 < M < 175$) with one probability correct to 2sf
	A1	for awrt 0.021. Correct answer only is 3 marks.
	MR	**(if used in (b))** P($170 < F < 175$) = 0.585 (or awrt 0.58 or 0.59) answer awrt 0.027 or 0.028 All 3 marks can be scored here.

Question	Scheme	Marks	AOs
6(a)	Use sum of probs = 1: $1=\frac{1}{k}(2+4+...+2n)$ Allow $1=\frac{S_r}{k}$ where $S_r=\sum_{r=1}^{n}2r$	M1	3.1a
	Sum e.g. $\frac{n}{2}[4+2(n-1)]$ or $\frac{n}{2}[2+2n]$ or use $\sum_{1}^{n}r=\frac{n(n+1)}{2}$	M1	2.1
	Use sum formula: e.g. $1=\frac{1}{k}\times\frac{n}{2}[4+2(n-1)]$ or $1=\frac{n}{2}\left[\frac{2}{k}+\frac{2n}{k}\right]$	A1	1.1b
	$k=n(n+1)$ *	A1*cso	1.1b
		(4)	
6(b)	Cases: R = 16, 18, 20, 22 and 24	M1	3.4
	Probability = $\left[\frac{16+18+20+22+24}{20\times21}\right]=\underline{\underline{\frac{5}{21}}}$	A1	1.1b
		(2)	
6(c)	[No real roots $\Rightarrow\Delta<0$] so $g^2-4(3g-5)[<0]$	M1	3.1a
	$[g^2-12g+20<0\Rightarrow]$ $(g-10)(g-2)[<0]$	M1	2.1
	So require $2<g<10$ or $4\le g\le8$	M1	1.1b
	So require g = 4, 6, 8 only	dM1	1.1b
	Probability = $\left[\frac{4+6+8}{20\times21}\right]=\underline{\underline{\frac{18}{420}}}=\underline{\underline{\frac{3}{70}}}$	A1	3.2a
		(5)	
			(11 marks)

Notes:		
(a)	M1	for clear attempt/intention to use sum of probs = 1 for n terms. Must see k and "= 1" Condone missing … $\sum_{2}^{2n}r$ is M0 since not n terms
	M1	for using an arithmetic series or Σr to find sum to n terms. No need for k
	A1	(dep on M1M1) for a correct working leading to a correct equation in k and n
	A1*	cso for correct solution with both Ms clearly scored and no incorrect working seen
	SC	Start with $1=\frac{n}{2}\left[\frac{2}{k}+\frac{2n}{k}\right]$ or $1=\frac{1}{k}\times\frac{n}{2}[4+2(n-1)]$ and no mention of a and l or a and d Score **SC B2** (M1M0A1A0) 1st B1 for the start and 2nd B1cso for completing to printed answer.
(b)	M1	for identifying the correct values of R
	A1	for a correct probability (any exact equivalent) Allow $0.\dot{2}38095\dot{2}$ Correct answer with no working scores 2 marks
(c)	M1	for attempt to use discriminant [< 0 not needed here]. Condone g^2-12g
	M1	for attempting to factorise or find critical values for their 3TQ (ignore their < & allow = 0)
	M1	for choosing the correct (inside) region, ft their critical values from a 3TQ with < 0
	dM1	(dep on 3rd M1) for choosing/identifying the appropriate values of g (ft their critical values from 3TQ with < 0 used)
	A1	for an exact probability in any form. Allow $0.0\dot{4}2857\dot{1}$ A correct answer with no incorrect working will score full marks
Acc	**If scored A0 for an answer of awrt 0.238 in (b), allow A1 in (c) for awrt 0.0429**	

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