Pearson Edexcel

Mark Scheme (Results)

October 2020

Pearson Edexcel GCE Further Mathematics Advanced Subsidiary Level in Further Statistics 2 Paper 8FM0_24

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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 40.
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 <u>and indicates which response they wish to submit</u>, examiners should mark this response.
   If there are several attempts at a question <u>which have not been crossed out</u>, examiners should mark the final answer which is the answer that is the <u>most complete</u>.
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.

Qu	Answer	Marks	AO
1	$H_0 : \rho = 0 \quad H_1 : \rho > 0$	B1	2.5
	5% one-tail cv for r is: 0.3598	M1	1.1b
	Significant result so there is evidence to support the agent's belief	A1	2.2b
			(3 marks)
	Notes		
	B1 for both hypotheses correct in terms of ρ M1 for use of tables to find the cv of 0.3598 A1 for a correct conclusion in context mentioning " belief " or description of this		

Qu	Answer	Marks	AO
2 (a)			
	Cake: A B C D E F G H I Mary: 3 4 1 8 2 5 7 9 6 Jahil: 2 5 3 9 1 4 6 8 7	M1	1.1b
	$\sum d^2 = 1+1+4+1+1+1+1+1+1$ [= 12]	M1	1.1b
	$r_s = 1 - \frac{6\times"12"}{9\times 80}$	M1	1.1b
	= **<u>0.9</u>**	A1	1.1b
		(4)	
(b)			
	Cake: A B C D E F G H I Jahil: 2 5 3 9 1 4 6 8 7 Dawn: 7.5 6 9 2 7.5 3 4.5 1 4.5	M1	1.1b
	$S_{JJ} = 60 \quad S_{DD} = 59 \quad S_{JD} = 176 - \frac{45^2}{9} = -49$ (o.e.)	M1	2.1
	$r_s = 0 - 0.823558\ldots$ awrt **<u>– 0.824</u>**	A1	1.1b
		(3)	
(c)	Mary and Jahil gave points for good features <u>or</u> high score is good	B1	2.4
	Dawn gave points for poor features <u>or</u> low score is good Both strong correlation, M&J positive, J&D negative so agree	B1	2.4
		(2)	
			(9 marks)
	Notes		
(a)	1st M1 an attempt to rank both – one row with at least 6 correct		
	2nd dM1 (dep on an attempt at finding ranks) for an attempt to find $\sum d^2$ (some correct d values found and sum attempted)		
	3rd M1 for using their $\sum d^2$ in formula for r_s with $n = 9$ (Independent of ranking)		
	2nd A1 for 0.9 or exact fraction e.g. $\frac{9}{10}$		
NB	No ranking leads to $\sum d^2 = 81$ and $r_s = 0.675$ and (a) M0M0M1A0 (b) M0M0A0		
(b)	1st M1 for ranking Dawn's results and dealing with tied ranks		
	2nd M1 for selecting appropriate method to find r_s sight of 2 of these values or implied by ans		
	A1 for using their calculator to evaluate r_s allow awrt – 0.824		
(c)	1st B1 for idea that M and J gave points for good features but D for bad features		
	2nd B1 for explaining that since both correlations are strong, one +, one – they agree		

Qu	Answer	Marks	AO
3	F(4) = 0 $\Rightarrow$ $4p - 2k = 0$ <u>or</u> F(9) = 1 $\Rightarrow$ $9p - 3k = 1$	M1	2.1
(a)	Both	A1	1.1b
	Solving e.g. sub $k = 2p$ $\Rightarrow$ $9p - 6p = 1$	M1	1.1b
	$\underline{p = \frac{1}{3} \quad k = \frac{2}{3}}$	A1	1.1b
		(4)	
(b)	Find f(x): f(x) = $F'(x) = "\frac{1}{3}" - "\frac{2}{3}" \times \frac{1}{2}x^{-\frac{1}{2}} = \frac{1}{3}\left(1 - x^{-\frac{1}{2}}\right)$	M1	3.1a
	$E\left(X^2\right) = \frac{1}{3}\int_4^9 x^2(1 - x^{-\frac{1}{2}})\,dx$ <u>or</u> $\frac{1}{3}\int_4^9 (x^2 - x^{\frac{3}{2}})\,dx$	M1	2.1
	$= \frac{1}{3}\left[\frac{x^3}{3} - \frac{2x^{\frac{5}{2}}}{5}\right]_4^9$ <u>or</u> $\frac{1}{3}\left[\left(\frac{9^3}{3} - \frac{2\times 3^5}{5}\right) - \left(\frac{64}{3} - \frac{2\times 2^5}{5}\right)\right] = \frac{2059}{45}$	M1 A1	1.1b 1.1b
	Var(X) = $"\frac{2059}{45}" - \left(\frac{119}{18}\right)^2$	M1	1.1b
	= 2.048765… = 2.05 (3sf) **(*)**	A1*	1.1b
		(6)	
(c)	[$f(x) = \frac{1}{3}\left(1 - \frac{1}{\sqrt{x}}\right)$ so max is when x is greatest so] mode = **<u>9</u>**	B1	2.2a
		(1)	
(d)	F(a) = $\frac{7}{27}$ $\Rightarrow$ $a - 2\sqrt{a} - \frac{7}{9} = 0$	M1	3.1a
	$y^2 - 2y - \frac{7}{9} = 0 \Rightarrow (y-1)^2 = \frac{16}{9}$	M1	2.1
	$y = \frac{7}{3}$ or $\left(-\frac{1}{3}\right.$ not valid$\left.\right)$ so $\underline{a = \frac{49}{9}}$	A1	3.2a
		(3)	
		(14 marks)	

Notes

(a)
1st M1 for selecting a correct approach and getting 1 correct equation
1st A1 for 2 correct equations in p and k
2nd M1 for solving two simultaneous equations (based on F(x))– reducing to a linear eqn in 1 var
2nd A1 for <u>both</u> correct values

(b)
1st M1 for realising need to find f(x) first and attempt to differentiate F(x) – some correct
2nd M1 for attempting $\int x^2 f(x)\,dx$ ft their f(x) provided different from F(x)
3rd M1 for some correct integration using their f(x) or a numerical expression for E(X^2)
1st A1 for a correct value for E(X^2) exact fraction or at least 45.755….
4th M1 for a correct method for Var(X) ft their E(X^2)
2nd A1* for a fully correct solution

(c)
B1 for 9

(d)
1st M1 for realising the need to use F(x) and forming a correct equation in a (ft their p and k)
2nd M1 for recognising equation as a quadratic and trying to solve
A1 for exact working and selection of the appropriate value

Qu	Answer	Marks	AO
4(a)	Use overlay. All correct	B1 (1)	1.1b
(b)	Need to choose model of the form: $w = a + bd$ and have one of a or b correct to 2 sf	M1	3.3
	$w = 21.5d - 17.7$	A1 (2)	1.1b
(c)	Not appropriate because eg the line is plotted and not close to the points **or** two lines with different gradients **or** overestimates values in the middle and underestimates the others **or** the points are more curved	B1 (1)	3.5a
(d)	$\left\{ S_{ww} = \sum w^2 - \frac{\left(\sum w\right)^2}{18} = 45178.68 - \frac{643.6^2}{18} \right\} = 22166.404..$	M1	1.1b
	RSS = $S_{ww}\left(1 - r^2\right) = 22166.404\ldots \times (1 - 0.987^2)$ = awrt **570** (g^2)	A1 (2)	1.1b
(e)	Thicker wire should be stronger and strength is proportional to area (i.e. d^2)	B1 (1)	2.4
(f)	$w = cu + f$ where $c = \frac{5721.625}{1482.619} = 3.85913\ldots$	M1	3.3
	$f\{= \bar{w} - c\bar{u}\} = \frac{"643.6"}{18} - "3.8591..." \times \frac{157.57}{18}$ $\{= 1.973\ldots\}$	M1	1.1b
	$w = 1.97 + 3.86u$	A1 (3)	1.1b
(g)	RSS $= S_{ww} \times (1 - r^2)$ or $S_{ww} - \frac{(S_{wu})^2}{S_{uu}}$, = 85.8824… awrt **85.9** (g^2)	M1, A1 (2)	1.1b (x2)
(h)	Robert's model is better since RSS is reduced	B1 (1)	2.4
(i)	Use Robert's model: $w\ \{= 3.859 \times 3^2 + 1.973\}$ = awrt **36.7**	B1 (1)	3.4
		(14 marks)	

Notes

(a) 1st B1 for fully correct scatter diagram

(b) M1 for selecting the appropriate model and one coefficient correct to 2sf
A1 for b = awrt 21.5 and a = awrt – 17.7

(c) B1 for comment suggesting not very good with a suitable reason.

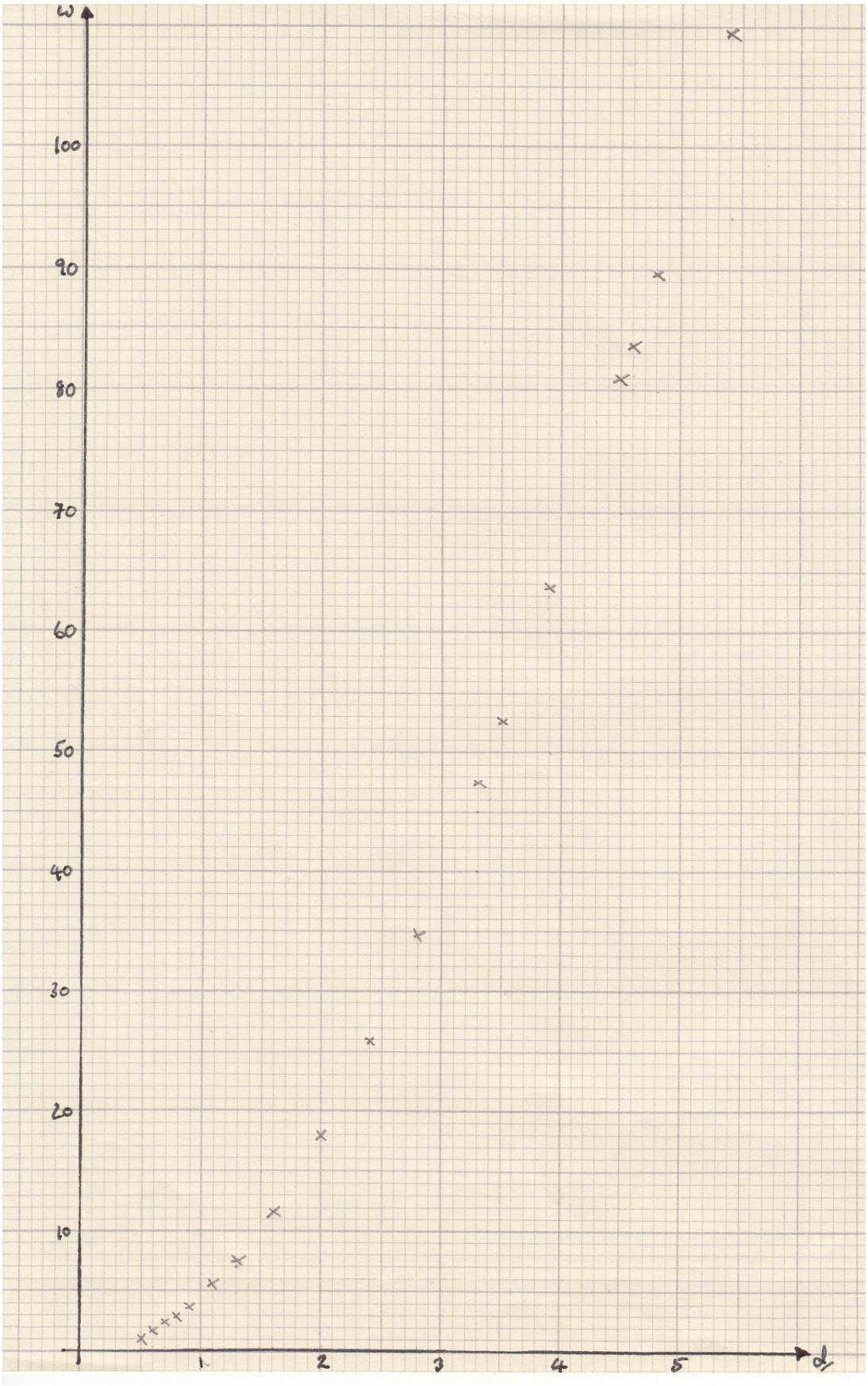
(d) M1 for calculation of S_{ww} or any other terms needed for their calculation
A1 for RSS = 570.3299… i.e. awrt 570

(e) B1 for a comment realising that strength is proportional to d^2 (area)

(f) 1st M1 for using correct expression for gradient
2nd M1 for correct expression for intercept A1 for correct line with coefficients awrt 3 sf

(g) M1 for a correct expression (ft their S_{ww}) [NB r = awrt 0.998]

(h) B1 for comment about reduced RSS (RSS needs to be lower but needn't be correct)



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