



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 \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. 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.

Qu	Answer	Marks	AO
1	$H_0 : \rho = 0$ $H_1 : \rho > 0$ 5% one-tail cv for r is: 0.3598 Significant result so there is evidence to support the agent's belief	B1 M1 A1	2.5 1.1b 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)	<table border="1" style="display: inline-table; margin-right: 20px;"> <tr><td>Cake</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td><td>H</td><td>I</td></tr> <tr><td>Mary</td><td>3</td><td>4</td><td>1</td><td>8</td><td>2</td><td>5</td><td>7</td><td>9</td><td>6</td></tr> <tr><td>Jahil</td><td>2</td><td>5</td><td>3</td><td>9</td><td>1</td><td>4</td><td>6</td><td>8</td><td>7</td></tr> </table> $\sum d^2 = 1+1+4+1+1+1+1+1+1 \quad [= 12]$ $r_s = 1 - \frac{6 \times "12"}{9 \times 80}$ $= \underline{\underline{0.9}}$	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 M1 M1 A1	1.1b 1.1b 1.1b 1.1b
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																								
(b)	<table border="1" style="display: inline-table; margin-right: 20px;"> <tr><td>Cake</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td><td>H</td><td>I</td></tr> <tr><td>Jahil</td><td>2</td><td>5</td><td>3</td><td>9</td><td>1</td><td>4</td><td>6</td><td>8</td><td>7</td></tr> <tr><td>Dawn</td><td>7.5</td><td>6</td><td>9</td><td>2</td><td>7.5</td><td>3</td><td>4.5</td><td>1</td><td>4.5</td></tr> </table> $S_{JJ} = 60 \quad S_{DD} = 59 \quad S_{JD} = 176 - \frac{45^2}{9} = -49 \quad (\text{o.e.})$ $r_s = 0 - 0.823558... \quad \text{awrt } \underline{\underline{-0.824}}$	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 A1	1.1b 1.1b
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																								
(c)	Mary and Jahil gave points for good features <u>or</u> high score is good 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 B1	2.4 2.4																														
(9 marks)																																	
Notes																																	
(a)	1 st M1 an attempt to rank both – one row with at least 6 correct 2 nd dM1 (dep on an attempt at finding ranks) for an attempt to find $\sum d^2$ (some correct d values found and sum attempted) 3 rd M1 for using their $\sum d^2$ in formula for r_s with $n = 9$ (Independent of ranking) 2 nd 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)	1 st M1 for ranking Dawn's results and dealing with tied ranks 2 nd 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)	1 st B1 for idea that M and J gave points for good features but D for bad features 2 nd B1 for explaining that since both correlations are strong, one +, one – they agree																																

Qu	Answer	Marks	AO
3	(a) $F(4) = 0 \Rightarrow 4p - 2k = 0$ or $F(9) = 1 \Rightarrow 9p - 3k = 1$ Solving e.g. sub $k = 2p \Rightarrow 9p - 6p = 1$ $p = \frac{1}{3} \quad k = \frac{2}{3}$	M1	2.1
		A1	1.1b
		M1	1.1b
		A1	1.1b
	(b) Find $f(x)$: $f(x) = F'(x) = \frac{1}{3} - \frac{2}{3} \times \frac{1}{2} x^{-\frac{1}{2}} = \frac{1}{3} (1 - x^{-\frac{1}{2}})$ $E(X^2) = \frac{1}{3} \int_4^9 x^2 (1 - x^{-\frac{1}{2}}) dx$ or $\frac{1}{3} \int_4^9 (x^2 - x^{\frac{3}{2}}) dx$ $= \frac{1}{3} \left[\frac{x^3}{3} - \frac{2x^{\frac{5}{2}}}{5} \right]_4^9$ or $\frac{1}{3} \left[\left(\frac{9^3}{3} - \frac{2 \times 3^5}{5} \right) - \left(\frac{64}{3} - \frac{2 \times 2^5}{5} \right) \right] = \frac{2059}{45}$ $\text{Var}(X) = \frac{2059}{45} - \left(\frac{119}{18} \right)^2$ $= 2.048765... = 2.05$ (3sf) (*)	M1	3.1a
	M1	2.1	
	M1	1.1b	
	A1	1.1b	
	M1	1.1b	
	A1*	1.1b	
	(c) $[f(x) = \frac{1}{3} \left(1 - \frac{1}{\sqrt{x}} \right)]$ so max is when x is greatest so] mode = 9	B1	2.2a
	(d) $F(a) = \frac{7}{27} \Rightarrow a - 2\sqrt{a} - \frac{7}{9} = 0$ $y^2 - 2y - \frac{7}{9} = 0 \Rightarrow (y-1)^2 = \frac{16}{9}$ $y = \frac{7}{3}$ or $\left(-\frac{1}{3} \right)$ not valid so $a = \frac{49}{9}$	M1	3.1a
	M1	2.1	
	A1	3.2a	
		(3)	
		(14 marks)	
Notes			
(a)	1 st M1 for selecting a correct approach and getting 1 correct equation 1 st A1 for 2 correct equations in p and k 2 nd M1 for solving two simultaneous equations (based on $F(x)$)– reducing to a linear eqn in 1 var 2 nd A1 for <u>both</u> correct values		
(b)	1 st M1 for realising need to find $f(x)$ first and attempt to differentiate $F(x)$ – some correct 2 nd M1 for attempting $\int x^2 f(x) dx$ ft their $f(x)$ provided different from $F(x)$ 3 rd M1 for some correct integration using their $f(x)$ or a numerical expression for $E(X^2)$ 1 st A1 for a correct value for $E(X^2)$ exact fraction or at least 45.755.... 4 th M1 for a correct method for $\text{Var}(X)$ ft their $E(X^2)$ 2 nd A1* for a fully correct solution		
(c)	B1 for 9		
(d)	1 st M1 for realising the need to use $F(x)$ and forming a correct equation in a (ft their p and k) 2 nd 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	1.1b
(b)	Need to choose model of the form: $w = a + bd$ and have one of a or b correct to 2 sf $w = \underline{21.5d - 17.7}$	(1) M1 A1	3.3 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	3.5a
(d)	$\left\{ S_{ww} = \sum w^2 - \frac{(\sum w)^2}{18} = 45178.68 - \frac{643.6^2}{18} \right\} = 22166.404..$ RSS = $S_{ww} (1 - r^2) = 22166.404... \times (1 - 0.987^2) =$ awrt 570 (g^2)	(1) M1 A1	1.1b 1.1b
(e)	Thicker wire should be stronger and strength is proportional to area (i.e. d^2)	B1	2.4
(f)	$w = cu + f$ where $c = \frac{5721.625}{1482.619} = 3.85913...$ $f \{ = \bar{w} - c\bar{u} \} = \frac{"643.6"}{18} - "3.85913..." \times \frac{157.57}{18} \{ = 1.973... \}$ $w = \underline{1.97 + 3.86u}$	(1) M1 M1 A1	3.3 1.1b 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)	(2) M1, A1	1.1b (x2)
(h)	Robert's model is better since RSS is reduced	B1	2.4
(i)	Use Robert's model: $w \{ = 3.859 \times 3^2 + 1.973 \} =$ awrt 36.7	B1	3.4
		(1)	
		(14 marks)	
Notes			
(a)	1 st 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)	1 st M1 for using correct expression for gradient 2 nd 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)		

