Mark Scheme (Results)

Summer 2018

Pearson Edexcel GCE Further Mathematics
AS Further Statistics S2 Paper 8FM0_24

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the last candidate in exactly the same way as they mark the first.
- 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.
- 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/indicative content will not be exhaustive.

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.

Question	Scheme	Marks	AOs
1(a)	$[S_{pp} = 4748 - \frac{254^2}{16} = 715.75]$ $r = \frac{1115}{\sqrt{1846 \times ("715.75")}}$	M1	1.1b
	$r = 0.970014...$ awrt **<u>0.970</u>**	A1	1.1b
		(2)	
(b)	$b = \frac{1115}{1846}$ [= 0.6040….]	M1	3.3
	$a = \frac{254}{16} - "b" \frac{392}{16}$ [=1.076…]	M1	1.1b
	$p = 1.08 + 0.604m$	A1	1.1b
		(3)	
(c)	RSS = $"715.75" - \frac{1115^2}{1846}$ <u>or</u> RSS = $"715.75"(1 - "0.970"^2)$	M1	1.1b
	RSS = 42.28033... awrt **<u>42.3</u>**	A1	1.1b
		(2)	
(d)	p = 1.08 + 0.604(30) + residual	M1	3.4
	p = **<u>18</u>**	A1ft	1.1b
		(2)	
(e)	|residual| is large/may be an outlier	B1	3.5b
		(1)	
(f)	New r should be closer to 1 than part (a) since the remaining points are likely to be closer to the new regression line.	B1	2.2b
		(1)	
			(11 marks)

Notes	
(a)	M1 for a complete correct method for finding r A1 for awrt 0.970 (allow 0.97 from correct working)
(b)	1st M1 for use of a correct model i.e. a correct expression for b 2nd M1 for use of a correct model i.e. a correct (ft) expression for a A1 for correct model $p = 1.08 + 0.604m$ with awrt 1.08 and awrt 0.604 No fractions and must be in terms of p and m
(c)	M1 for a correct expression for RSS A1 for awrt 42.3
(d)	M1 for substitution of m = 30 into the regression equation and adding the residual A1ft for 18
(e)	B1 for identifying this point's residual is far from 0/it may be an outlier/anomaly/ does not fit the trend
(f)	B1 for closer to 1 than part (a) / increase oe and correct supporting reason about the relative strength of correlation (condone outlier removed)

Question	Scheme	Marks	AOs
2(a)	(Continuous) uniform or rectangular	B1	1.2
		(1)	
(b)	[P($Y > 0$) = P($5 - 2X > 0$) =] P($X < 2.5$) $\quad$ f$(y) = \begin{cases} \frac{1}{16} & -13 \le y \le 3 \end{cases}$	M1	1.1b
	$\frac{2.5-1}{8} = \underline{\frac{3}{16}}$ $\quad$ $\frac{3-0}{16} = \underline{\frac{3}{16}}$	A1	1.1b
		(2)	
(c)	E(Y) = $5 - 2$E(X) [$=5 - 2(\frac{1+9}{2})$] $\quad$ E$(Y) = \frac{-13+3}{2}$	M1	1.1b
	$= \underline{\mathbf{-5}}$	A1	1.1b
		(2)	
(d)	[P($Y < 0$) | ($X < 7.5$)] = $\frac{\text{P}(2.5 < X < 7.5)}{\text{P}(X < 7.5)}$	M1	3.1a
	$= \frac{\frac{7.5-2.5}{8}}{\frac{7.5-1}{8}} \left[= \frac{0.625}{0.8125} \right]$	M1	1.1b
	$= \underline{\frac{10}{13}}$	A1	1.1b
		(3)	
			(8 marks)

Notes	
(a)	B1 for (Continuous) uniform or rectangular Discrete uniform is B0
(b)	M1 for using the distribution of X to obtain P($X < 2.5$) <u>or</u> for finding the distribution of Y in the range $-13 \le y \le 3$ A1 for $\frac{3}{16}$ or 0.1875
(c)	M1 for use of E($aX + b$) <u>or</u> for use of $\frac{a+b}{2}$ from the distribution of Y A1 for –5
(d)	1st M1 for a correct ratio expression 2nd M1 for a correct numerical expression A1 for $\frac{10}{13}$ SC: If M0M0A0 scored, then a correct numerator or correct denominator scores M0M1A0

<table>
<tr><th>Question</th><th>Scheme</th><th>Marks</th><th>AOs</th></tr>
<tr><td>3(a)</td><td>
<table>
<tr><td>Competitor</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td></tr>
<tr><td>High jump ranks</td><td>1</td><td>5</td><td>2.5</td><td>4</td><td>6</td><td>2.5</td></tr>
<tr><td>Long jump ranks</td><td>2</td><td>5</td><td>1</td><td>4</td><td>6</td><td>3</td></tr>
</table>
</td><td>M1
M1</td><td>1.1b
1.1b</td></tr>
<tr><td></td><td>$[\sum h^2 = 90.5 \quad \sum l^2 = 91 \quad \sum hl = 89]$</td><td></td><td></td></tr>
<tr><td></td><td>Use of pmcc $\qquad r_s = \dfrac{89 - \frac{21\times 21}{6}}{\sqrt{(90.5 - \frac{21^2}{6})(91 - \frac{21^2}{6})}}$</td><td>M1</td><td>1.1b</td></tr>
<tr><td></td><td>r = awrt <u>0.899</u></td><td>A1</td><td>1.1b</td></tr>
<tr><td></td><td></td><td>(4)</td><td></td></tr>
<tr><td>(b)</td><td>H_0: $\rho_s = 0$ $\qquad$ H_1: $\rho_s > 0$</td><td>B1</td><td>2.5</td></tr>
<tr><td></td><td>Critical value $\rho_s = 0.8286$</td><td>B1</td><td>1.1b</td></tr>
<tr><td></td><td>$r_s = 0.899$ lies in the critical region/reject H_0</td><td>M1</td><td>2.1</td></tr>
<tr><td></td><td>There is <u>positive</u> rank correlation between <u>high jump</u> and <u>long jump</u> results.</td><td>A1ft</td><td>2.2b</td></tr>
<tr><td></td><td></td><td>(4)</td><td></td></tr>
<tr><td>(c)</td><td>[H_0: $\rho = 0$ $\qquad$ H_1: $\rho > 0$]
0.678 < Critical value $\rho = 0.7293$</td><td>M1</td><td>2.1</td></tr>
<tr><td></td><td>There is no evidence of (positive) correlation (between high jump and long jump).</td><td>A1</td><td>2.2b</td></tr>
<tr><td></td><td></td><td>(2)</td><td></td></tr>
<tr><td>(d)</td><td>The test in part (c) requires the data to come from a bivariate normal distribution.</td><td>B1</td><td>2.3</td></tr>
<tr><td></td><td></td><td>(1)</td><td></td></tr>
<tr><td>(e)</td><td>Although there is evidence of a positive correlation between the ranks, the data does not appear to fit a linear pattern.</td><td>B1</td><td>2.4</td></tr>
<tr><td></td><td></td><td>(1)</td><td></td></tr>
<tr><td colspan="4">(12 marks)</td></tr>
<tr><td colspan="4">Notes</td></tr>
<tr><td>(a)</td><td colspan="3">1st M1 for an attempt to rank first row using tied ranks (at least 4 correct)
2nd M1 for an attempt to rank second row (at least 4 correct)
3rd M1 for use of pmcc with tied ranks
A1 for awrt 0.899
SC: Use of Spearman with Σd^2 for their ranks may score M1M1M1A0</td></tr>
<tr><td>(b)</td><td colspan="3">1st B1 both hypotheses stated in terms of ρ_s or ρ
2nd B1 for correct critical value
M1 for comparing their ‘0.8286’ with their ‘0.899’
A1ft for a correct contextual conclusion (may ft their r_s)</td></tr>
<tr><td>(c)</td><td colspan="3">M1 for comparing 0.7293 with 0.678
A1 for a correct conclusion</td></tr>
<tr><td>(d)</td><td colspan="3">B1 for explaining the required condition for the pmcc test to be used.</td></tr>
<tr><td>(e)</td><td colspan="3">B1 for comparing what each coefficient shows</td></tr>
</table>

Question	Scheme		Marks	AOs
4(a)	F(3) = 0 or F(9) = 1		M1	3.1a
	$c-4.5(3^n)=0$ and $c-4.5(9^n)=1$		A1	1.1b
	Eliminating c $1+4.5(9^n)=4.5(3^n)$	Eliminating n $\frac{\log\left(\frac{c-1}{4.5}\right)}{\log(9)}=\frac{\log\left(\frac{c}{4.5}\right)}{\log(3)}$	M1	1.1b
	Forming a 3 term quadratic $4.5(3^{2n})-4.5(3^n)+1=0$	Forming a 3 term quadratic $4.5c^2-20.25c+20.25=0$	M1	3.1a
	Solving 3TQ leading to a value for n $3^n=\frac{1}{3}\rightarrow n=\ldots$ or $3^n=\frac{2}{3}\rightarrow n=\ldots$	Solving 3TQ leading to a value for c $c=1.5$ or $c=3$	M1	1.1b
	$n=-1$ only (reject other solution as n is an integer)		A1	2.3
	$c=1.5$ only		A1ft	1.1b
			(7)	
(b)	[Let q = lower quartile] "1.5" – 4.5("q^{-1}") = 0.25		M1	1.1b
	$q=3.6$		A1ft	1.1b
			(2)	
				(9 marks)
Notes				
(a)	1st M1 for use of either F(3) = 0 or F(9) = 1 1st A1 for two correct equations in c and n 2nd M1 for eliminating one variable 3rd M1 for realising that a quadratic formula is required to solve 4th M1 for solving the quadratic formula leading to at least one value of c or n 2nd A1 for $n=-1$ only 3rd A1ft for $c=1.5$ only (ft their n in a correct equation and dep on 1st M1)			
(b)	M1 for use of F(q) = 0.25 A1ft for $q=3.6$ (allow follow through on their integer value of n)			