Mark Scheme (Results)

Summer 2019

Pearson Edexcel GCE Further Mathematics
AS 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 80.
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)	<table><tr><td>Skater / Judge</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></tr><tr><td>1</td><td>2</td><td>3</td><td>1</td><td>5</td><td>4</td><td>6</td><td>7</td><td>8</td></tr><tr><td>2</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>8</td><td>7</td></tr><tr><td>d^2</td><td>1</td><td>1</td><td>4</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td></tr></table>	M1 dM1	1.1b 1.1b
	$\sum d^2 = 10$		
	$r_s = 1 - \frac{6\times"10"}{8(64-1)}$	M1	1.1b
	$r_s = 0.8809...$ awrt 0.881	A1	1.1b
		(4)	
(b)	$H_0 : \rho = 0$ $H_1 : \rho > 0$	B1	2.5
	Critical Value $\rho = 0.8333$	B1	1.1b
	$r_s = 0.8809$ lies in the critical region/reject H_0/significant	M1	2.1
	There is evidence that the two judges are in agreement.	A1cso	2.2b
		(4)	
(c)	The $\sum d^2$ will decrease since the new rankings given by Judge 1 are now the same as the rankings given by Judge 2 for Skater D and E whereas previously they were different	M1	2.4
	therefore Spearman's rank correlation coefficient will increase	A1	2.2a
		(2)	
			(10 marks)

Notes

(a) **M1:** For an attempt to rank at least one row (at least 4 correct)

dM1: dep on previous M mark being awarded**.** For an attempt at d or d^2 row for their ranks.

M1: for use of $1-\frac{6\times"\text{their }\sum d^2"}{8(64-1)}$ Allow if not ranked $\sum d^2 = 85$

A1: awrt 0.881

(b) **B1:** Both hypotheses stated in terms of ρ

B1: for correct critical value. Allow even if 2 tail test (sign must match their r_s)

M1: for comparing their 0.881 with "their 0.8333"

A1cso: All previous marks awarded. For a correct contextual conclusion with no contradictions seen

(c) **M1:** For a correct explanation to support their answer given.

$\sum d^2$ decreases or d/d^2 decreases for *D* and *E*

and idea of same rankings eg d^2 will reduce by 2 . Do not allow d^2 will reduce by 1

A1: for a correct deduction from the information. Allow closer to 1.

Question	Scheme	Marks	AOs
2(a)	$\int \frac{t}{120}\mathrm{d}t = \frac{t^2}{240}$ and use of F(4) = 0 or F(16) = 1 or limits of t and 4	M1	2.1
	or attempt at area of trapezium allow 1 mistake. $\frac{1}{2}\times(t-4)\left(\frac{4}{120}+\frac{t}{120}\right)$		
	$= \frac{t^2}{240} - \frac{1}{15}$	A1	1.1b
		(2)	
(b)	$\mathrm{F}(10) - \mathrm{F}(5) = \frac{100}{240} - "c" - \frac{25}{240} + "c"$	M1	1.1b
	$= \frac{5}{16}$	A1	1.1b
		(2)	
(c)	$\frac{m^2}{240} - \frac{1}{15} = 0.5$	M1	1.1b
	$m = 11.66....$ awrt 11.7	A1	1.1b
		(2)	
(d)	$\mathrm{F}(k) = \frac{2}{3}\left(1 - \mathrm{F}(k)\right)$ or $\int_4^k \frac{t}{120}\mathrm{d}t = \frac{2}{3}\int_k^{16} \frac{t}{120}\mathrm{d}t$	M1	3.1a
	$\frac{k^2}{240} - "\frac{1}{15}" = \frac{2}{3}\left(1 - \left(\frac{k^2}{240} - "\frac{1}{15}"\right)\right)$ or $\frac{k^2}{240} - \frac{1}{15} = \frac{2}{3}\times\left(\frac{16}{15} - \frac{k^2}{240}\right)$	dM1	1.1b
	$\frac{k^2}{144} = \frac{7}{9}$		
	$k = \sqrt{112}$ or awrt 10.6	A1	1.1b
	Alternative		
	Let $\mathrm{P}(T < k) = p$ then $p = \frac{2}{3}(1-p)$ $\therefore p = \frac{2}{5}$	(M1)	
	$\frac{k^2}{240} - \frac{1}{15} = \frac{2}{5}$	(dM1)	
	$k = \sqrt{112}$ or awrt 10.6	(A1)	
		(3)	
			(9 marks)

Notes

(a) **M1:** for attempting to integrate and a correct method

A1: $= \frac{t^2}{240} - \frac{1}{15}$ or $= \frac{t^2}{240} - 0.0667$

(b) **M1:** writing or using F(10) – F(5)

A1: awrt $\frac{5}{16}$ or 0.3125 or exact equivalent

(c) **M1:** setting their F(t) = 0.5

A1: awrt 11.7 or $2\sqrt{34}$ or exact equivalent

(d) **M1:** Setting up a correct equation to solve the mathematical problem or setting up correct equation to find p and an attempt to solve

dM1: attempted to integrate and limits substituted or using "Their F(k)" = "their p"

A1: $\sqrt{112}$ or awrt 10.6

Question	Scheme	Marks	AOs
3(a)	$\left[S_{ll} = 26.2326 - \frac{16.06^2}{10} = 0.44024\right]$		
	$r = \frac{42.786}{\sqrt{9936.9 \times "0.44024"}}$	M1	1.1b
	$r = 0.64689...$ awrt 0.647	A1	1.1b
		(2)	
(b)	"0.647" coding has no effect on the pmcc	B1ft	1.1b
		(1)	
(c)	$l - 20 = 0.00431(w - 6) - 18.87$	M1	3.1a
	$l = 0.00431w + ...$	M1	1.1b
	$l = 0.00431w + 1.10\,414$	A1	1.1b
		(3)	
(d)	$l = 0.00431 \times 100 + 1.10 = 1.53$	B1ft	3.4
		(1)	
(e)	$\text{RSS} = "0.44024" - \frac{(42.786)^2}{9936.9}$ or $"0.44024"(1 - "0.647"^2)$	M1	1.1b
	RSS = 0.2560	A1	1.1b
		(2)	
(f)	(i) The points appear **randomly** scattered above and below zero giving us no reason to doubt the suitability of the linear model.	B1	3.5a
	(ii) There is a possible outlier that could be removed (and the regression line recalculated).	B1	3.5c
		(2)	
			(11 marks)

Notes
(a) M1: For a complete correct method to find r
A1: for awrt 0.647
(b) B1ft: stating their answer to part (a) and a correct reason
(c) M1: for use of a correct model. i.e. a correct expression for b
M1: for use of a correct model i.e. a correct expression (ft) for a
A1: for correct model $l = 0.00431w + 1.10$ with awrt 0.00431 and awrt 1.10
(d) B1ft: correct answer using their equation and $w = 100$ or using $t = 0.00431s - 18.87$ and $s = 94$ Allow awrt 1.53/1.54
(e) M1: for a correct expression for RSS
A1: awrt 0.256
(f) B1: For explaining why the model may be suitable. Allow randomly scattered around w (x) axis. Do not allow most residuals close to zero or not suitable as not randomly scattered.
B1: For explaining how the fit of the model might be improved.

Question	Scheme	Marks	AOs
4(a)	$\frac{1}{12}(a-5)^2=\frac{27}{4}$	M1	3.1a
	$(a-5)^2=81$		
	$a-5=9$ **or** $a-5=-9$	A1	1.1b
	$\therefore$ since $a>5$ $a=14$*	A1cso*	2.2a
		(3)	
(b)	Correct method for E(Y), E(X) and E(X^2) **or** E(Y) and E(X^2+X)	M1	3.1a
	$\mathrm{E}(Y)=\int_2^6 \frac{1}{20}y(2y-3)\,\mathrm{d}y$	M1	1.1b
	$=\frac{68}{15}$	A1	1.1b
	$\mathrm{E}(X)=\frac{5+14}{2}$ or 9.5 **and** $\frac{27}{4}=\mathrm{E}(X^2)-9.5^2$ or $\int_5^{14}\frac{x^2}{9}\mathrm{d}x$ **or** $\int_5^{14}\left(\frac{x^3}{9}+\frac{x^2}{9}\right)\mathrm{d}x$ or $3\int_5^{14}\left(\frac{x^3}{9}+\frac{x^2}{9}\right)\mathrm{d}x$	M1	1.1b
	$\mathrm{E}(X^2)=97$ and $\mathrm{E}(X)=9.5$ **or** $\mathrm{E}(X^2+X)=106.5$ **or** $3\mathrm{E}(X^2+X)=319.5$	A1	1.1b
	$\mathrm{E}(T)=3\times"97"+3\times"9.5"+2\times\frac{68}{15}$ oe	M1	1.1b
	$\mathrm{E}(T)=\frac{9857}{30}$ *	A1*cso	2.1
		(7)	
			(10 marks)

Notes

(a) **M1:** translating a problem in mathematical contexts into a correct equation. Allow $\frac{a^3-125}{3(a-5)}-\left(\frac{a+5}{2}\right)^2=\frac{27}{4}$

A1: for $a-5=9$ or $a-5=-9$ or $a^2-10a-56=0$ or $a^3-15a^2-6a+280=0$

A1cso*: concluding it is 14 giving a reason why -4 is rejected

(b) **M1**: For a complete method to solve the problem

M1: For an attempt at E(Y)

A1: $=\frac{68}{15}$ or awrt 4.53

M1: For an attempt at E(X) and E(X^2) or $\mathrm{E}(X^2+X)$ or $3\,\mathrm{E}(X^2+X)$ Some sort of working must be seen for E(X^2) eg $\frac{27}{4}$ = E(X^2) – E(X)^2. Allow Var(X) = E(X^2) – E(X)^2 leading to = E(X^2)

A1: 319.5

M1: Method for finding E(T) ft their values

A1*cso: Fully correct solution no errors, must have $\mathrm{E}(T)=\frac{9857}{30}$ *

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