GCE AS MARKING SCHEME

SUMMER 2025

AS
FURTHER MATHEMATICS
UNIT 2 FURTHER STATISTICS A
2305U20-1

About this marking scheme

The purpose of this marking scheme is to provide teachers, learners, and other interested parties, with an understanding of the assessment criteria used to assess this specific assessment.

This marking scheme reflects the criteria by which this assessment was marked in a live series and was finalised following detailed discussion at an examiners' conference. A team of qualified examiners were trained specifically in the application of this marking scheme. The aim of the conference was to ensure that the marking scheme was interpreted and applied in the same way by all examiners. It may not be possible, or appropriate, to capture every variation that a candidate may present in their responses within this marking scheme. However, during the training conference, examiners were guided in using their professional judgement to credit alternative valid responses as instructed by the document, and through reviewing exemplar responses.

Without the benefit of participation in the examiners' conference, teachers, learners and other users, may have different views on certain matters of detail or interpretation. Therefore, it is strongly recommended that this marking scheme is used alongside other guidance, such as published exemplar materials or Guidance for Teaching. This marking scheme is final and will not be changed, unless in the event that a clear error is identified, as it reflects the criteria used to assess candidate responses during the live series.

WJEC GCE AS FURTHER MATHEMATICS

UNIT 2 FURTHER STATISTICS A

SUMMER 2025 MARK SCHEME

Q1	Solution	Mark	Notes
(a)	$np = 4$	B1	si
	$\mathrm{E}(X^2) = \mathrm{Var}(X) + [\mathrm{E}(X)]^2$	M1	Use of.
	$\mathrm{Var}(X) = np(1-p)$	B1	Use of. si
			OR $2.4 = npq$
	$18.4 = 4(1-p) + 4^2$ $2.4 = 4(1-p)$	m1	Forming equation in p or n or q. e.g. $2.4 = n \times \frac{4}{n}\left(1 - \frac{4}{n}\right)$ oe OR $2.4 = 4q$
	$p = 0.4$	A1	cao
	$n = 10$	A1	cao
		[6]	
(b)	X and Y are independent, so $\mathrm{E}(XY) = \mathrm{E}(X) \times \mathrm{E}(Y)$		
	$\mathrm{E}(3XY) = 3 \times \mathrm{E}(X) \times \mathrm{E}(Y)$	M1	used
	$\mathrm{E}(3XY) = 3 \times 4 \times 12 \times 0.3$		At least 2 of '3', '4'and '12×0.3'
	$\mathrm{E}(3XY) = 43.2$	A1	cao
		[2]	
(c)	$\mathrm{Var}(6X - 5Y + 1) = 6^2\mathrm{Var}(X) + 5^2\mathrm{Var}(Y)$	M1	si
	$(\mathrm{Var}(X) = 10 \times 0.4 \times 0.6 = 2.4)$ $\mathrm{Var}(Y) = (12 \times 0.3 \times 0.7) = 2.52$	B1	FT their $\mathrm{E}(Y)$ from (b)
	$\mathrm{Var}(6X - 5Y + 1) = 36 \times "2.4" + 25 \times "2.52"$ $= 149.4$	A1	cao
		[3]	
	Total for Question 1	**11**	

Q2	Solution	Mark	Notes
(a)	$b = \frac{S_{xy}}{S_{xx}} = \frac{934655}{12916820}$	M1	Used
	$b = 0.072359\ldots$	A1	Must be 2sf. Award when seen even if subsequently rounded to 1 sf.
	$a = \frac{1330}{14} - 0.072359\ldots \times \frac{17738}{14}$	M1	FT their b for M1.
	$a = 3.32\ldots$	A1	Must be 2sf.
	$y = 3.32 + 0.0724x$	A1 **[5]**	Provided M1M1 awarded. FT their a and b even from A0A0 provided 2sf. SC1 for regression line of x on y. Must be fully correct. $x = 122.03 + 12.05y$
(b)	$y = 3.32 + 0.0724 \times 1200$ $y = £90.20$	B1	Correct substitution and evaluation into their equation from (a). Condone £90 from correct working.
	Valid comment e.g. Reliable because 1200 is within the data range. e.g. Reliable but likely to be something like £89.99 rather than £90.20 e.g. Reliable as the data seems pretty linear according to the scatter graph on the other page. e.g. Reliable as it does not require extrapolation. e.g. Reliable because it requires interpolation.	E1 **[2]**	Do not accept comments saying £90.15 (ie referring to y values) is within the range.
	Total for Question 2	**7**	

Q3	Solution	Mark	Notes
(a) (i)	$\mathrm{P}(X=7)=\mathrm{P}(\text{score is } 8)=\frac{1}{4}\times\frac{1}{4}=\frac{1}{16}=0.0625,$ $\mathrm{P}(X=5)=\mathrm{P}(\text{score is } 6))=3\times\frac{1}{16}=\frac{3}{16}=0.1875,$ $\mathrm{P}(X=-3)=\mathrm{P}(\text{a spiner lands on } 1)=7\times\frac{1}{16}=\frac{7}{16}$ $=0.4375$ $(\mathrm{P}(X=0)=\mathrm{P}(\text{other value})=5\times\frac{1}{16}=\frac{5}{16})$	M1 A2	Correct method for one probability. si by one correct probability. A2 all three correct ($\mathrm{P}(X=0)$ not required) A1 for two correct probabilities. Does not have to be associated with correct value of X.
	X | -3 | 5 | 7 $P(X=x)$ | $\frac{7}{16}$ | $\frac{3}{16}$ | $\frac{1}{16}$		
	$\mathrm{E}(X)=-3\times\frac{7}{16}+5\times\frac{3}{16}+7\times\frac{1}{16}\left(+0\times\frac{5}{16}\right)$	M1	Must be $-3, 5$ and 7. FT their probabilities for M1 only.
	$\mathrm{E}(X)=\frac{1}{16}$	A1	cao. oe $\mathrm{E}(X)=0.0625$ or 6.25 pence. Condone answers to the nearest penny. $\mathrm{E}(X)=0.06$ or 6 pence.
	ALTERNATIVE using prize money $\mathrm{E}(W)=\left(0\times\frac{7}{16}\right)+8\times\frac{3}{16}+10\times\frac{1}{16}+3\times\frac{5}{16}$ $\mathrm{E}(W)=\frac{49}{16}=3.0625$ $\mathrm{E}(X)=\frac{1}{16}=0.0625$	(M1) (A1)	Only award if A1 follows.
(ii)	Valid comment Eg. It's not good for the charity because they're expected to lose money. e.g. The fundraising event loses, on average, 6.25 pence each time the game is played. e.g. Expected profit for the player is 6 pence per play.	E1	FT their $\mathrm{E}(X)$
(iii)	$\mathrm{Var}(X)=(-3)^2\times\frac{7}{16}+5^2\times\frac{3}{16}+7^2\times\frac{1}{16}-\left(\frac{1}{16}\right)^2$ $\mathrm{Var}(X)=\frac{2991}{256}=11.683\ldots$	M1 A1 **[8]**	FT their probabilities, their values of X, and $\mathrm{E}(X)$ from (a) cao
(b)	£9	B1 **[1]**	cao
	Total for Question 3	**9**	

<table>
<tr><th>Q4</th><th>Solution</th><th>Mark</th><th>Notes</th></tr>
<tr><td>(a)</td><td>H_0: There is no association between the height of the athlete and distance jumped.

H_1: There is an association between the height of the athlete and distance jumped.</td><td>B1

[1]</td><td>Must engage with the variables.
i.e. H_0: There is no association with H_1: There is an association earns B0
B0 for ‘correlation’</td></tr>
<tr><td>(b)</td><td>The ranks are
<table>
<tr><td>Athlete</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td></tr>
<tr><td>Height
Rank</td><td>3
(5)</td><td>2
(6)</td><td>7
(1)</td><td>6
(2)</td><td>5
(3)</td><td>4
(4)</td><td>1
(7)</td></tr>
<tr><td>Dist
Rank</td><td>7
(1)</td><td>2
(6)</td><td>3
(5)</td><td>4
(4)</td><td>1
(7)</td><td>6
(2)</td><td>5
(3)</td></tr>
<tr><td>d^2</td><td>16</td><td>0</td><td>16</td><td>4</td><td>16</td><td>4</td><td>16</td></tr>
</table>
$\sum d^2 = 72$

$r_s = 1 - \frac{6\times72}{7\times48}$

$r_s = -0.2857$ or $-\frac{2}{7}$</td><td>B1

B1

B1

M1

A1

[5]</td><td>Correct values for first row.

Correct values for second row.
Accept reverse ranks.

si

cao Correct to at least 3sf</td></tr>
<tr><td>(c)
(i)</td><td>5% 2-tailed CV = -0.7857

Since $-0.2857 > -0.7857$ there is insufficient evidence to reject H_0.

There is insufficient evidence to suggest there’s an association between height and distance jumped for athletes at this competition.</td><td>B1

B1

E1

[3]</td><td>Other CVs:
20% 2-tailed CV = -0.5714
10% 2-tailed CV = -0.6786
1% 2-tailed CV = -0.8929
2% 2-tailed CV = -0.8571
Allow $\pm$ for first B1
B0 if one-tail is explicitly stated.

FT their r_s from (b)
Condone correct comparison of two positive values.
Provided two previous B marks awarded and correct hypotheses in (a).</td></tr>
<tr><td>(ii)</td><td>Valid comment.
e.g. It may not be true for this sample, but being tall may be an advantage in triple jump.
e.g. Judge’s comment may not be reliable because tall people are more likely to be triple jumpers.
e.g. There might be association if you pick a bigger range of heights.</td><td>E1

[1]</td><td>E0 for sample size too small.</td></tr>
<tr><td>(d)</td><td>B or E</td><td>B1
[1]</td><td>Accept either or both</td></tr>
<tr><td colspan="2">Total for Question 4</td><td>11</td><td></td></tr>
</table>

<table>
<tr><th>Q5</th><th>Solution</th><th>Mark</th><th>Notes</th></tr>
<tr><td>(a)
(i)</td><td>The p-value is extremely small.</td><td>E1</td><td>No not condone ‘less than 5%’
E0 for ‘p-value is a negative number.’</td></tr>
<tr><td>(ii)</td><td>The comparatively small values in the last two columns are likely to give rise to small expected values.

This may call into question the validity of any conclusions drawn.</td><td>E1

E1
[3]</td><td>Allow ‘likely to give rise to expected values <5 ∴ need to combine classes’
Do not allow ‘lots of the numbers are less than 5 so we need to combine classes.’</td></tr>
<tr><td>(b)</td><td>Table of expected values
<table><tr><th>Gender</th><th>Outlasting</th><th>Timing Out</th></tr><tr><td>Men</td><td>1379.073</td><td>1835.927</td></tr><tr><td>Women</td><td>241.927</td><td>322.073</td></tr></table>
Use of $\frac{(O-E)^2}{E}$ or $\sum\frac{O^2}{E}-N$.

TS= $1545.67\ldots+1677.63\ldots+107.14\ldots+504.26\ldots-3779$

Table of chi-squared contributions
<table><tr><th>Gender</th><th>Outlasting</th><th>Timing Out</th></tr><tr><td>Men</td><td>4.749</td><td>3.567</td></tr><tr><td>Women</td><td>27.071
or (27.096)</td><td>20.335
or (20.334)</td></tr></table>
TS $= 4.749 + 3.567 + 27.071 + 20.335$

$= 55.722\ldots$

DF = 1
5% CV = 3.841

Since $55.722 > 3.841$ there is sufficient evidence to reject H_0.

There is evidence to suggest gender affects manner of victory.</td><td>M1

A2

M1

A2

m1

A1

B1
B1

m1

A1

[12]</td><td>M1 Attempt at calculating an expected value.

A2 Fully correct table.
A1 At least two correct.

FT their expected values for M1A2

A2 fully correct table (or all contributions correct.) (at least1dp)
A1 At least two correct (at least1dp)

FT their χ^2 contributions

FT their DF

FT their TS and CV
Allow comparing individual values that are > 3.841 for m1
cso</td></tr>
<tr><td>(c)</td><td>Women most affect the outcome due to the large values in the chi-squared contributions table for Outlasting and Timing Out in the Women row.

Valid comment comparing expected and observed.
e.g. There are fewer Outlasting victories than expected and more Timing Out victories than expected.</td><td>B1

E1

[2]</td><td></td></tr>
<tr><td colspan="2">Total for Question 5</td><td>17</td><td></td></tr>
</table>

Q6	Solution	Mark	Notes
(a) (i)	Exponential	B1 **[1]**	Allow negative exponential.
(ii)	$\int_0^x k\mathrm{e}^{-kt}\mathrm{d}t = [-\mathrm{e}^{-kt}]_0^x$ $= -\mathrm{e}^{-kx} - (-1)$ $= 1 - \mathrm{e}^{-kx}$ ag	M1 A1	Convincing
(iii)	$F(x) = \begin{cases} 1 - \mathrm{e}^{-kx}, & x \geq 0 \\ 0, & x < 0 \end{cases}$	B1 **[3]**	oe 'otherwise'
(iv)	$0.75 = 1 - \mathrm{e}^{-kQ_3}$ $Q_3 = \dfrac{\ln\left(\frac{1}{4}\right)}{-k}$ $Q_3 = \dfrac{1}{k}\ln 4$	M1 m1	m1 for attempt to solve either eqn following M1 must use logs.
	$0.25 = 1 - \mathrm{e}^{-kQ_1}$ $Q_1 = \dfrac{\ln\left(\frac{3}{4}\right)}{-k}$ $Q_1 = \dfrac{1}{k}\ln\left(\frac{4}{3}\right)$	M1 (m1)	If not previously awarded.
	$IQR = Q_3 - Q_1$ $IQR = \frac{1}{k}\ln 4 - \frac{1}{k}\ln\left(\frac{4}{3}\right)$ $IQR = \frac{1}{k}\ln 3$	m1 A1 **[5]**	Use of. i.e. subtractions of their expressions in k. oe provided single log term eg. $-\frac{1}{k}\ln\frac{1}{3}$.
(b) (i)	$F(1200) - F(600) =$ $\left(1 - \mathrm{e}^{-\frac{1200}{800}}\right) - \left(1 - \mathrm{e}^{-\frac{600}{800}}\right) = \mathrm{e}^{-\frac{600}{800}} - \mathrm{e}^{-\frac{1200}{800}}$ $= 0.2492$	M1 A1 **[2]**	M1 for either expression. 3 sf
(ii)	$\mathrm{P}(Y > 200) = \mathrm{e}^{-\frac{200}{800}}$ $= 0.7788$ $\mathrm{P}(\text{No punctures}) = 0.7788^3$ $= 0.4724$	M1 A1 M1 A1 **[4]**	FT their probability cao
	ALTERNATIVE METHOD – Poisson Let the random variable A be the number of punctures for the trip. $A \sim \mathrm{Po}(0.75)$ $\mathrm{P}(X = 0)$ $= 0.4724$	 (M1) (A1) (M1) (A1)	M1A1 for correct distribution with correct parameter. M1 for $\mathrm{Po}(\lambda)$ with either $\lambda = 0.25$ or $\lambda = 0.00125$ or $\lambda = 0.75$. si si Could be from use of formula or variables listed for calculator.
	Total for Question 6	**15**	