AS Further Mathematics Unit 2: Further Statistics A
General instructions for marking GCE Mathematics

1. The mark scheme should be applied precisely and no departure made from it. Marks should be awarded directly as indicated and no further subdivision made.

2. Marking Abbreviations
The following may be used in marking schemes or in the marking of scripts to indicate reasons for the marks awarded.

cao = correct answer only
MR = misread
PA = premature approximation
bod = benefit of doubt
oe = or equivalent
si = seen or implied
ISW = ignore subsequent working

F.T. = follow through (√ indicates correct working following an error and ✗ indicates a further error has been made)

Anything given in brackets in the marking scheme is expected but, not required, to gain credit.

3. Premature Approximation
A candidate who approximates prematurely and then proceeds correctly to a final answer loses 1 mark as directed by the Principal Examiner.

4. Misreads
When the data of a question is misread in such a way as not to alter the aim or difficulty of a question, follow through the working and allot marks for the candidates' answers as on the scheme using the new data.
This is only applicable if a wrong value, is used consistently throughout a solution; if the correct value appears anywhere, the solution is not classed as MR (but may, of course, still earn other marks).

5. Marking codes

- 'M' marks are awarded for any correct method applied to appropriate working, even though a numerical error may be involved. Once earned they cannot be lost.
- 'm' marks are dependant method marks. They are only given if the relevant previous 'M' mark has been earned.
- 'A' marks are given for a numerically correct stage, for a correct result or for an answer lying within a specified range. They are only given if the relevant M/m mark has been earned either explicitly or by inference from the correct answer.
- 'B' marks are independent of method and are usually awarded for an accurate result or statement.
- 'S' marks are awarded for strategy
- 'E' marks are awarded for explanation
- 'U' marks are awarded for units
- 'P' marks are awarded for plotting points
- 'C' marks are awarded for drawing curves

AS Further Mathematics Unit 2: Further Statistics A
Solutions and Mark Scheme

Qu. No.	Solution	Mark	AO	Notes
1.(a)	$E(W) = E(X)E(Y) = 168$	B1	AO1	
(b)	$E(X^2) = (E(X))^2 + \text{Var}(X)$	M1	AO1	
	$= 221$	A1	AO1	
	$E(Y^2) = 153$	A1	AO1	
	$\text{Var}(W) = E(W^2) - [E(W)]^2$			
	$= E(X^2)E(Y^2) - (E(X)E(Y))^2$	M1	AO3	
	$= 221 \times 153 - 168^2 (= 5589)$	A1	AO1	
	SD = 74.8 (74.75961….)	A1	AO1	
		[7]		
2(a)	$E(T) = \frac{1}{2500}\int_0^{10} t^2(100 - t^2)\,dt$	M1	AO3	
	$= \frac{1}{2500}\left[\frac{100t^3}{3} - \frac{t^5}{5}\right]_0^{10}$	A1	AO1	
	$= 5.33(333\ldots)$	A1	AO1	
(b)(i)	$F(t) = \frac{1}{2500}\int_0^{t} u(100 - u^2)\,du$	M1	AO3	
	$= \frac{1}{2500}\left[50u^2 - \frac{u^4}{4}\right]_0^{t}$	A1	AO1	
	$= \frac{1}{2500}\left(50t^2 - \frac{t^4}{4}\right)$ (for $0 \le t \le 10$)	A1	AO1	
	$= 1$ for $t > 10$	B1	AO1	Allow omission of $t < 0$
	($F(t) = 0$ for $t < 0$)			
(ii)	$P(T > 5) = 1 - F(5)$	M1	AO3	
	$= 0.563$ (0.5625)	A1	AO1	
(iii)	The median m satisfies $F(m) = 0.5$	M1	AO3	
	$m^4 - 200m^2 + 5000 = 0$	A1	AO3	
	$m^2 = \frac{200 \pm \sqrt{40000 - 20000}}{2}$	A1	AO1	
	(= 29.289...)			
	$m = 5.41(1961\ldots)$	A1	AO1	
		[13]		

Qu. No.	Solution	Mark	AO	Notes
3(a)	The ranks are			
	S: A, B, C, D, E, F, G, H H: 3, 6, 1, 8, 7, 2, 4, 5 G: 5, 6, 4, 3, 8, 2, 7, 1	M1 A1 A1	AO3 AO1 AO1	Attempt to find ranks Correct values for 1st row Correct values for 2nd row
	$\sum d^2 = 64$	B1	AO1	
	$r_s = 1 - \frac{6 \times 64}{8 \times 63}$	M1	AO1	
	= 0.238(095238…)	A1	AO1	
(b)	5% 1-tail crit value = 0.6429	B1	AO1	
	This suggests that there is no positive association between marks in History and marks in Geography.	B1	AO3	
(c)	Because the data might not follow a bivariate normal distribution.	B1	AO2	
		[9]		
4(a)	The evidence suggests that good graduate prospects are associated with:			Or The evidence suggests that good graduate prospects are not associated with student satisfaction
	strong research quality	B1	AO2	
	high entry standards.	B1	AO2	
(b)	Gradient			
	$= \frac{122.72}{1.0542}$	M1	AO2	
	= 116.4(105)	A1	AO1	
	Intercept			
	$= \frac{2522}{7} - 116.4105 \times \frac{22.24}{7}$	M1	AO2	
	= -9.5(67)	A1	AO1	Allow for using 116.4 giving -9.5(337)
	y = 116.4(105) x – 9.5(67)	B1	AO1	FT 'their' gradient and intercept
(c)	116.4 × 3 – 9.6	M1	AO3	
	= 339.6	A1	AO1	Accept 358.7(988...) if using exact values throughout
		[9]		

Qu. No.	Solution	Mark	AO	Notes
5(a)	H_0 : The data can be modelled by the Poisson distribution with mean 2. H_1 : The data cannot be modelled by the Poisson distribution with mean 2.	B1	AO3	
(b)	The expected frequencies are Goals scored: 0, 1, 2, 3, 4 or more Obs: 6, 11, 15, 10, 8 Exp: 6.767, 13.534, 13.534, 9.022, 7.144	B1 B1	AO3 AO3	For at least 1 correct For all correct
	Use of χ^2 stat = $\sum \frac{O^2}{E} - N$	M1	AO3	
	= $\frac{6^2}{6.767} + \frac{11^2}{13.534} + \ldots + \frac{8^2}{7.144} - 50$	A1	AO2	
	= 0.93	A1	AO1	
	DF = 4	B1	AO1	
	5% crit val = 9.488	B1	AO1	
	Since 0.93 < 9.488 (Accept H_0)	B1	AO2	
	We conclude that the data can be modelled by the Poisson distribution with mean 2.	B1 **[10]**	AO3	
6(a)	The number of arrivals X is Poi(7.5)	B1	AO3	
	$P(X=5) = \frac{e^{-7.5} \times 7.5^5}{5!}$	M1	AO1	Or straight from the calculator
	$= 0.109(3745\ldots)$	A1	AO1	
(b)(i)	$P(T > t)$ = P(No customers arrive between 11am and t mins after 11am) $= e^{-0.5t}$	B1	AO2	
(ii)	The cumulative distribution function of T is $F(t) = P(T \le t)$	M1	AO3	
	$= 1 - P(T > t) = 1 - e^{-0.5t}$	A1	AO2	
	Let $f(t)$ denote the probability density function of T $f(t) = F'(t)$	M1	AO2	
	$= 0.5e^{-0.5t}$	A1	AO1	
(iii)	This is the exponential distribution.	B1	AO2	
	Therefore mean = standard deviation = 1/0.5 = 2	B1 **[10]**	AO2	

<table>
<tr><th>Qu. No.</th><th>Solution</th><th>Mark</th><th>AO</th><th>Notes</th></tr>
<tr><td>7(a)(i)</td><td>H_0: There is no association between parents knowing their child’s social media passwords and age of child
H_1: There is an association between parents knowing their child’s social media passwords and age of child</td><td>B1</td><td>AO3</td><td>Or H_0: Parents knowing their child's social media passwords is independent of age
H_1: Parents knowing their child's social media passwords is not independent of age</td></tr>
<tr><td>(ii)</td><td>Expected values
<table>
<tr><th></th><th>Age (years)</th><th></th><th></th></tr>
<tr><th>Parent knows password</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>Yes</td><td>62.79</td><td>78.71</td><td>76.50</td></tr>
<tr><td>No</td><td>79.21</td><td>99.29</td><td>96.50</td></tr>
</table>
$142\times\frac{275}{493}=79.21$ OR $275\times\frac{142}{493}=79.21$</td><td>M1
A1</td><td>AO2
AO1</td><td>Or any equivalent correct method</td></tr>
<tr><td>(iii)</td><td>Chi-squared contributions
<table>
<tr><th></th><th>Age (years)</th><th></th><th></th></tr>
<tr><th>Parent knows password</th><th>13</th><th>14</th><th>15</th></tr>
<tr><td>Yes</td><td>2.779</td><td>0.175</td><td>1.180</td></tr>
<tr><td>No</td><td>2.203</td><td>0.139</td><td>0.935</td></tr>
</table></td><td>M1
A1</td><td>AO2
AO1</td><td>M1A0 for one correct χ^2 contribution
FT ‘their observed values’</td></tr>
<tr><td>(iv)</td><td>2 degrees of freedom from $(3 – 1) \times (2 – 1)$</td><td>B1</td><td>AO1</td><td></td></tr>
<tr><td>(v)</td><td>Since p-value < 0.05, Reject H_0

Strong evidence to suggest there is an association between parents knowing their child’s social media passwords and age</td><td>B1
B1

B1
B1</td><td>AO1
AO2

AO2
AO3</td><td>B1 for < 0.05
B1 for Reject H_0

B1 for strong evidence
B1 for relating back to hypothesis</td></tr>
<tr><td>(b)</td><td>Largest contribution for 13-year-olds especially for yes
It seems more parents than expected know passwords for their 13-year-old children.</td><td>E1

E1

[12]</td><td>AO2

AO2</td><td></td></tr>
</table>