<table>
<tr><th>Q</th><th>Scheme</th><th>Marks</th><th>AOs</th><th>Pearson Progression Step and Progress Descriptor</th></tr>
<tr><td rowspan="2">1a</td><td>H_0: There is no association between sport and gender</td><td>B1</td><td>1.2</td><td>4th
Understand the principle of a goodness of fit test</td></tr>
<tr><td></td><td>(1)</td><td></td><td></td></tr>
<tr><td rowspan="2">1b</td><td>(3 – 1)(2 – 1) = 2</td><td>B1</td><td>1.1b</td><td>5th
Know how to find the number of degrees of freedom of the expected values</td></tr>
<tr><td></td><td>(1)</td><td></td><td></td></tr>
<tr><td rowspan="2">1c</td><td>5.991</td><td>B1</td><td>1.2</td><td>6th
Find critical values for a chi-squared test</td></tr>
<tr><td></td><td>(1)</td><td></td><td></td></tr>
<tr><td rowspan="2">1d</td><td>$\frac{58 \times 39}{120} = 18.85$</td><td>B1</td><td>1.1b</td><td>5th
Show frequencies by means of a contingency table</td></tr>
<tr><td></td><td>(1)</td><td></td><td></td></tr>
<tr><td rowspan="3">1e</td><td><table>
<tr><td></td><td></td><td colspan="3">Sport</td></tr>
<tr><td></td><td></td><td>Hockey</td><td>Cricket</td><td>Rugby</td></tr>
<tr><td rowspan="2">Gender</td><td>Male</td><td>20.78</td><td>18.37</td><td>18.85</td></tr>
<tr><td>Female</td><td>22.22</td><td>19.63</td><td>20.15</td></tr>
</table></td><td>M1</td><td>2.1</td><td rowspan="2">5th
Be able to calculate the chi-squared statistic</td></tr>
<tr><td>$\frac{(25-20.78)^2}{20.78} + \ldots + \frac{(23-20.15)^2}{20.15} = 2.69$</td><td>M1
A1</td><td>1.1b
1.1b</td></tr>
<tr><td></td><td>(3)</td><td></td><td></td></tr>
</table>

1f	2.69 < 5.991 so null hypothesis is not rejected.	**B1**	2.2b	7th Apply chi-squared tests in context and in unfamiliar situations
		(1)		
1g	Still not rejected since 2.69 < new critical value (4.605)	**B1**	2.4	7th Apply chi-squared tests in context and in unfamiliar situations
		(1)		
				(9 marks)

Notes

1e Expected values to 1 d.p. or better and awrt 2.7

1f Must show comparison between test statistic and critical value

1g Must state new critical value

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress Descriptor
2a	$x = 10.84$	B1	1.1b	5th
	$y = 1.01$	B1	1.1b	Show frequencies by means of a contingency table
		(2)		
2b	H_0: The Poisson distribution is a suitable model H_1: The Poisson distribution is not a suitable model	B1	3.4	6th Know how to apply the goodness of fit test to a Poisson distribution
	Cells are combined when expected frequencies < 5 so combine last 3 cells.	M1	2.1	
	$\frac{(9-9.04)^2}{9.04}+...+\frac{(9-10.12)^2}{10.12}=0.248$	M1 A1	1.1b 1.1b	
	Degrees of freedom = 3 – 1 = 2 Do not reject H_0 since 0.248 < 4.605	B1	3.1b	
	The number of cars sold each day follows a Poisson distribution	A1	3.5a	
		(6)		
				(8 marks)

Notes

2a One mark for each number, accept 3 s.f. or better

2b awrt 0.25 for test statistic

Conclusion must be in context for final **A1**

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress Descriptor
3a	(Discrete) uniform distribution	**B1**	1.2	4th Understand the principle of a goodness of fit test
		(1)		
3b	H$_0$: The discrete uniform distribution is a suitable model H$_1$: The discrete uniform distribution is not a suitable model	**B1**	3.4	6th Know how to apply the goodness of fit test to a discrete uniform distribution
	$\frac{2^2+1^2+2^2+3^2+6^2}{16}=3.375$	**M1** **A1**	1.1b 1.1b	
	Degrees of freedom = 5 – 1 = 4	**B1**	3.1b	
	3.375 < 7.779	**M1**	1.1b	
	Do not reject H$_0$: The outcomes can be modelled using a discrete uniform distribution. The spinner is 'fair'.	**A1**	3.5a	
		(6)		
				(7 marks)

Notes

3b Conclusion must be in context for final **A1**

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress Descriptor
4a	Expected values: <table><tr><td>**Number of female kittens**</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>**Expected frequency**</td><td>3.125</td><td>15.625</td><td>31.25</td><td>31.25</td><td>15.625</td><td>3.125</td></tr></table>	**M1** **A1** **A1**	3.4 1.1b	6th Know how to apply the goodness of fit test to a binomial distribution
	H_0: Bin(5, 0.5) is a suitable model H_1: Bin(5, 0.5) is not a suitable model	**B1**	2.5	
	Combine first two and last two groups: Observed: 31, 13; Expected: 18.75 (for both)	**M1**	2.1	
	$v = 4 - 1 = 3$	**B1**	1.1b	
	Critical value: 7.815	**B1**	1.1a	
	Test statistic: $\frac{(31-18.75)^2}{18.75}+\ldots+\frac{(13-18.75)^2}{18.75}=15.63$	**M1** **A1**	1.1b 1.1b	
	In critical region, sufficient evidence to reject H_0, accept H_1 Significant evidence at 5% level to reject model.	**A1**	3.5a	
		(10)		

<table>
<tr><td rowspan="8">4b</td><td>New p value: $\dfrac{0\times12+...+5\times5}{500}=0.414$</td><td>B1</td><td>3.3</td><td rowspan="7">7th
Apply chi-squared tests in context and in unfamiliar situations</td></tr>
<tr><td>Expected values:
<table><tr><td>Number of female kittens</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td></tr><tr><td>Expected frequency</td><td>6.91</td><td>24.41</td><td>34.49</td><td>24.37</td><td>8.61</td><td>1.21</td></tr></table></td><td>M1

A1</td><td>3.4

1.1b</td></tr>
<tr><td>H_0: Binomial is a suitable model
H_1: Binomial is not a suitable model</td><td>B1</td><td>2.5</td></tr>
<tr><td>Combine last two groups:
Observed: 13; Expected: 9.82</td><td>M1</td><td>2.1</td></tr>
<tr><td>$v = 5 - 1 - 1 = 3$</td><td>B1</td><td>1.1b</td></tr>
<tr><td>Test statistic:
$\dfrac{(12-9.61)^2}{9.61}+...+\dfrac{(13-9.82)^2}{9.82}=7.34$</td><td>M1</td><td>1.1b</td></tr>
<tr><td>Critical value: 7.815
Not in critical region, insufficient evidence to reject H_0
No significant evidence at 5% level to reject binomial as a model, therefore binomial is a suitable model.</td><td>A1</td><td>3.5a</td></tr>
<tr><td></td><td>(8)</td><td></td><td></td></tr>
<tr><td colspan="5" align="right">(18 marks)</td></tr>
</table>

Notes

4a Award first **A1** for any four correct expected frequencies, listed or in table form. Award second **A1** for a complete list of correct expected frequencies.

4b Incorrect p value should be followed through – can award 7 out of 8 if completely correct for their p

1st **A1**: All expected frequencies correct to 3 s.f. or better

2nd **A1**: Critical value for *their* v should be stated and conclusion consistent.