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| **Q** | Scheme | Marks | **AOs** | Pearson Progression Step and Progress Descriptor |
| **1a** | H0: There is no association between sport and gender | **B1** | 1.2 | 4th  Understand the principle of a goodness of fit test |
|  |  | **(1)** |  |  |
| **1b** | (3 – 1)(2 – 1) = 2 | **B1** | 1.1b | 5th  Know how to find the number of degrees of freedom of the expected values |
|  |  | **(1)** |  |  |
| **1c** | 5.991 | **B1** | 1.2 | 6th  Find critical values for a chi-squared test |
|  |  | **(1)** |  |  |
| **1d** |  | **B1** | 1.1b | 5th  Show frequencies by means of a contingency table |
|  |  | **(1)** |  |  |
| **1e** | |  |  |  |  |  | | --- | --- | --- | --- | --- | |  |  | Sport | | | |  |  | Hockey | Cricket | Rugby | | Gender | **Male** | 20.78 | 18.37 | 18.85 | | **Female** | 22.22 | 19.63 | 20.15 | | **M1** | 2.1 | 5th  Be able to calculate the chi-squared statistic |
|  |  | **M1**  **A1** | 1.1b  1.1b |  |
|  |  | **(3)** |  |  |

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| **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 | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **2a** |  | **B1**  **B1** | 1.1b  1.1b | 5th  Show frequencies by means of a contingency table |
|  | **(2)** |  |  |
| **2b** | H0: The Poisson distribution is a suitable model  H1: 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 |
|  | **M1**  **A1** | 1.1b  1.1b |
| Degrees of freedom = 3 – 1 = 2  Do not reject H0 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** | | | | | |

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| 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** | H0: The discrete uniform distribution is a suitable model  H1: 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 |
|  | **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 H0: 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** | | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **4a** | Expected values:   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Number of female kittens | 0 | 1 | 2 | 3 | 4 | 5 | | Expected frequency | 3.125 | 15.625 | 31.25 | 31.25 | 15.625 | 3.125 | | **M1**  **A1**  **A1** | 3.4  1.1b | 6th  Know how to apply the goodness of fit test to a binomial distribution |
| H0: Bin(5, 0.5) is a suitable model  H1: 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: | **M1**  **A1** | 1.1b  1.1b |
| In critical region, sufficient evidence to reject H0, accept H1  Significant evidence at 5% level to reject model. | **A1** | 3.5a |
|  | **(10)** |  |  |

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| **4b** | New *p* value: | **B1** | 3.3 | 7th  Apply chi-squared tests in context and in unfamiliar situations |
| Expected values:   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | Number of female kittens | 0 | 1 | 2 | 3 | 4 | 5 | | Expected frequency | 6.91 | 24.41 | 34.49 | 24.37 | 8.61 | 1.21 | | **M1**  **A1** | 3.4  1.1b |
| H0: Binomial is a suitable model  H1: Binomial is not a suitable model | **B1** | 2.5 |
| Combine last two groups:  Observed: 13; Expected: 9.82 | **M1** | 2.1 |
| *v* = 5 – 1 – 1 = 3 | **B1** | 1.1b |
| Test statistic: | **M1** | 1.1b |
| Critical value: 7.815  Not in critical region, insufficient evidence to reject H0  No significant evidence at 5% level to reject binomial as a model, therefore binomial is a suitable model. | **A1** | 3.5a |
|  | **(8)** |  |  |
| (18 marks) | | | | | |
| 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. | | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **5** | Expected values:   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **Number of pens** | 1 | 2 | 3 | 4 | 5 or more | | **Frequency** | 72 | 28.8 | 11.52 | 4.61 | 3.07 | | **M1**  **A1** | 3.4  1.1b | 7th  Know how to apply the goodness of fit test to a geometric distribution |
| H0: Geo(0.6) is a suitable model  H1: Geo(0.6) is not a suitable model | **B1** | 2.5 |
| Combine last two groups:  Observed: 5; Expected: 7.68 | **M1** | 2.1 |
| *v* = 4 – 1 = 3 | **B1** | 1.1b |
| Test statistic: | **M1**  **A1** | 1.1b  1.1b |
| Critical value: 9.348  Not in critical region, insufficient evidence to reject H0.  Susane’s belief is correct. | **A1** | 3.5a |
|  | **(8)** |  |  |
| (8 marks) | | | | | |
| Notes  Critical value must be stated and conclusion in context for final **A1** | | | | | |