|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Q** | Scheme | Marks | **AOs** | Pearson Progression Step and Progress Descriptor |
| **1a** | H0: There is no association between sport and gender | **B1** | 1.2 | 4thUnderstand the principle of a goodness of fit test |
|  |  | **(1)** |  |  |
| **1b** | (3 – 1)(2 – 1) = 2 | **B1** | 1.1b | 5thKnow how to find the number of degrees of freedom of the expected values |
|  |  | **(1)** |  |  |
| **1c** | 5.991 | **B1** | 1.2 | 6thFind critical values for a chi-squared test |
|  |  | **(1)** |  |  |
| **1d** |   | **B1** | 1.1b | 5thShow 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 | 5thBe able to calculate the chi-squared statistic |
|  |  | **M1****A1** | 1.1b1.1b |  |
|  |  | **(3)** |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **1f** | 2.69 < 5.991 so null hypothesis is not rejected. | **B1** | 2.2b | 7thApply 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 | 7thApply 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** |    | **B1****B1** | 1.1b1.1b | 5thShow frequencies by means of a contingency table |
|  | **(2)** |  |  |
| **2b** | H0: The Poisson distribution is a suitable modelH1: The Poisson distribution is not a suitable model | **B1** | 3.4 | 6thKnow 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** | 1.1b1.1b |
| Degrees of freedom = 3 – 1 = 2Do 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** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **3a** | (Discrete) uniform distribution | **B1** | 1.2 | 4thUnderstand the principle of a goodness of fit test |
|  | **(1)** |  |  |
| **3b** | H0: The discrete uniform distribution is a suitable modelH1: The discrete uniform distribution is not a suitable model | **B1** | 3.4 | 6thKnow how to apply the goodness of fit test to a discrete uniform distribution |
|  | **M1****A1** | 1.1b1.1b |
| 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** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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** | 3.41.1b | 6thKnow how to apply the goodness of fit test to a binomial distribution |
| H0: Bin(5, 0.5) is a suitable modelH1: 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** | 1.1b1.1b |
| In critical region, sufficient evidence to reject H0, accept H1Significant evidence at 5% level to reject model. | **A1** | 3.5a |
|  | **(10)** |  |  |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **4b** | New *p* value:   | **B1** | 3.3 | 7thApply 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** | 3.41.1b |
| H0: Binomial is a suitable modelH1: 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: 7.815Not in critical region, insufficient evidence to reject H0No 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. |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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** | 3.41.1b | 7thKnow how to apply the goodness of fit test to a geometric distribution |
| H0: Geo(0.6) is a suitable modelH1: 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** | 1.1b1.1b |
| Critical value: 9.348Not in critical region, insufficient evidence to reject H0.Susane’s belief is correct. | **A1** | 3.5a |
|  | **(8)** |  |  |
| (8 marks) |
| NotesCritical value must be stated and conclusion in context for final **A1** |