**9FM0/3B: Further Statistics 01 Mark scheme**

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **1** | : Drivers are equally likely to be recorded speeding on any day of the week  : Drivers are not equally likely to be recorded speeding on any day of the week | B1 | 2.1 |
| Expected frequency = | M1 | 3.4 |
| = 35 | A1 | 1.1b |
| Test statistic = | M1 | 1.1b |
| = 13.714… | A1 | 1.1b |
| = 7 – 1 = 6 | B1 | 1.1b |
| = 12.592 | B1 | 1.1a |
| In critical region, sufficient evidence to reject,  Significant evidence at 5% level of significance to reject Jeremy’s belief. | A1 | 3.5a |
| **(8 marks)** | | | |
| **Notes** | | | |
|  | 1st B1 Both hypotheses correct (condone reference to discrete uniform distribution)  1st M1 Using uniform model to calculate expected frequencies  1st A1 35  2nd M1 Attempting to find  or  may be implied by awrt 13.7  2nd A1 awrt 13.7  2nd B1 Degrees of freedom = 6 may be implied by a correct CV  3rd B1 awrt 12.6  3rd A1 Evaluating the outcome of a model by drawing correct inference in context | | |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **2(a)** |  | M1 | 3.1a |
|  | B1 | 1.1b |
|  | B1 | 2.1 |
| 28 = | M1 | 1.1b |
| → *a* = … | M1 | 1.1b |
| *a* = –6 since E(*Y* ) < 0 | A1 | 2.2a |
|  | **(6)** |  |
| **(b)** |  | M1 | 2.1 |
|  | = | A1ft | 1.1b |
|  |  | **(2)** |  |
| **(8 marks)** | | | |
| **Notes** | | | |
| **(a)** | 1st M1 Realising that  is required  1st B1 Correct expression for  2nd B1 Correct expression for  2nd M1 Equating their expression for Var(*Y*) = 28  3rd M1 Solving the equation to find at least 1 value of *a*  A1 –6 only | | |
| **(b)** | M1 Correct expression for E or for finding all values of  A1ft  or awrt 0.306 ft on *a* < – 4 | | |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **3(a)** | *W* ~ Po(0.45*n*) | M1 | 3.1b |
| [P(*W* = 0) =] | M1 | 1.1b |
| *n* > 6.657… |  |  |
| *n* = 7 | A1 | 1.1b |
|  | **(3)** |  |
| **(b)** | *X ~* Po(5×0.45+5×0.2) [Po(3.25)] | M1 | 3.3 |
|  | P(*X* = 2) = 0.20478… awrt **0.205** | A1 | 1.1b |
|  | The model is only valid if Tim and Sue make errors **independently** | B1 | 3.5b |
|  |  | **(3)** |  |
| **(c)** | P(*X* = 0) = 0.03877… | M1 | 3.1b |
| *Y* ~ B(10, ‘0.03877…’) | M1 | 3.3 |
| P(*Y* > 2) = 1 – P(*Y* < 1) | M1 | 1.1b |
| = awrt **0.055** | A1 | 1.1b |
|  |  | **(4)** |  |
| **(10 marks)** | | | |
| **Notes** | | | |
| **(a)** | 1st M1 Understanding that a P(0.45*n*) model is required here  2nd M1 For correct inequality  A1 *n =* 7 cao | | |
| **(b)** | M1 Setting up a combined Po model  A1 awrt 0.205  B1 Understanding that model is only valid if the two parts are independent | | |
| **(c)** | 1st M1 For using Poisson distribution  2nd M1 Setting up binomial distribution  3rd M1 For finding 1 – P(*Y* < 1) from binomial  2nd A1 awrt 0.055 | | |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **4(a)** | *n* = 2 and *p* = 0.6 | B1  B1 | 1.1b  1.1b |
|  | **(2)** |  |
| **(b)(i)** | P(*X* =1) = coefficient of *t* | M1 | 1.1b |
| P(*X* =1) = **0.48** | A1 | 1.1b |
|  | **(2)** |  |
| **(ii)** |  | M1 | 2.1 |
|  | M1 | 1.1b |
|  | A1 | 1.1b |
|  | **(3)** |  |
| **(c)** |  |  |  |
|  | B1 | 3.1a |
|  | M1  A1 | 2.1  1.1b |
|  | M1  A1 | 2.1  1.1b |
|  | M1 | 1.1b |
| \* | A1\*cso | 1.1b |
|  |  | **(7)** |  |
| **(14 marks)** | | | |
| **Notes** | | | |
| **(a)** | 1st B1  *n* = 2  2nd B1 *p* = 0.6 | | |
| **(b)(i)**  **(b)(ii)** | M1 Finding coefficient of *t*  A1 0.48oe  1st M1 Realising is needed  2nd M1 Differentiation  A1 1.2cao | | |
| **(c)** | B1 Correct use of  1st M1 Differentiation to find  1st A1  2nd M1 Differentiation to find  2nd A1  3rd M1 Realising  3rd A1\*cso 6.72 | | |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **5(a)** |  | B1 | 2.5 |
| *X* ~ Geo(0.03) | M1 | 3.3 |
| P(*X* > *c*) < 0.05  (1 – 0.03)*c–*1 < 0.05 | M1 | 3.4 |
| *c –* 1 > | M1 | 1.1b |
| *c* > 99.35…  critical region *X* > 100 | A1 | 2.2a |
|  | **(5)** |  |
| **(b)** | P(*X* > 100) = 0.9799 | M1 | 3.4 |
| = **0.0490** | A1 | 1.1b |
|  | **(2)** |  |
| **(c)** | Critical region *X* > 100  94 is not in the critical region [P(*X* > 94) = 0.0588…> 0.05] | M1 | 1.1b |
| Do not reject There is insufficient evidence at the 5% level of significance that the proportion of visitors making a purchase is less than 0.03 | A1 | 2.2b |
|  | **(2)** |  |
| **(9 marks)** | | | |
| **Notes** | | | |
| **(a)** | B1 Both hypotheses correct using correct notation  1st M1 Realising that the model Geo (0.03) is needed. May be implied by its use  2nd M1 Using the model to find an expression for P(*X* > *c*)  3rd M1 Finding a valid method to solve the inequality  A1 Correct critical region | | |
| **(b)** | M1 Using Geo(0.03) model with 100  A1 0.049 or awrt 0.0490 | | |
| **(c)** | M1 Comparing 94 with their critical value  A1 Fully correct solution and drawing a correct inference in context. | | |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **6(a)** | P(Type I error) = **0.05** | B1 | 1.2 |
|  | **(1)** |  |
| **(b)** |  | M1 | 3.1b |
|  | M1 | 3.4 |
| *c* > 121.56… | A1 | 1.1b |
|  |  |  |
| = | M1 | 2.1 |
| = 0.6786… = 0.68\*(2sf) | A1\*cso | 1.1b |
|  | **(5)** |  |
| **(c)** | Power of Alex’s test is smaller than power of Gizel’s test since the null hypothesis is less likely to be rejected/Type II error has increased. | B1  B1 | 2.2a  2.4 |
|  |  | **(2)** |  |
| **(d)** |  | M1 | 3.4 |
|  | A1 | 1.1b |
|  |  |  |
|  | M1 | 2.1 |
| → | M1 | 1.1b |
| *n* > 19.26… *n* = **20** | A1 | 1.1b |
|  | **(5)** |  |
| **(e)** | (As they both have the same size/Type I error and) Joseph’s test has a higher power,  so Joseph’s test is recommended. | M1  A1 | 2.4  2.2b |
|  | **(2)** |  |
| **(15 marks)** | | | |
| **Notes** | | | |
| **(a)** | B1 0.05oe | | |
| **(b)** | 1st M1 Selecting correct normal model  2nd M1 Using model to standardise and set up inequality  1st A1 Correct critical region  3rd M1 Correct probability statement to find power  2nd A1\*cso awrt 0.68 with no errors seen. | | |
| **(c)** | B1 Correct deduction about the size of the two tests  B1 Correct explanation | | |

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| **(d)** | 1st M1 Using normal model to find critical region  1st A1 Correct critical region in terms of *n*  2nd M1 Setting up comparison with |1.2816| to find *n*  3rd M1 Solving equation to  2nd A1 20cao |
| **(e)** | M1 Comparison of powers  A1 Correct conclusion based on power |

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| **Question** | **Scheme** | **Marks** | **AOs** |
| **7(a)** | [*X* ~ NB(12,)] | M1 | 3.3 |
| = awrt **0.180** | A1 | 1.1b |
|  | **(2)** |  |
| **(b)** | P(*X* >13) = 1 – [P(*X* = 12) + P(*X* = 13)] | B1 | 3.1b |
|  |  | M1 | 1.1b |
|  | = awrt **0.873** | A1 | 1.1b |
|  |  | **(3)** |  |
| **(c)** | E(*X* ) =  = 16 | M1 | 3.1b |
| Var(*X* ) = = | A1 | 1.1b |
|  | M1  A1ft | 3.1b  1.1b |
| = | M1 | 3.4 |
| = P(*Z* > –1.1858…) |  |  |
| = awrt **0.882/0.883** | A1 | 1.1b |
|  | **(6)** |  |
| **(11 marks)** | | | |
| **Notes** | | | |
| **(a)** | M1 Selecting correct model: negative binomial **or** B(14, ) with extra success  A1 0.18 or awrt 0.180 | | |
| **(b)** | B1 Realising that P(*X* >13) = 1 – [P(*X* = 12) + P(*X* = 13)]  M1 Correct form using negative binomial  A1 awrt 0.873 | | |
| **(c)** | 1st M1 Realising that both the mean and variance of NB are required  1st A1 Both mean and variance correct (may be implied by correct standardisation)  2nd M1 Using CLT to model ~ N(‘16’, …)  2nd A1ft Fully correct (or correct ft) normal distribution model for  3rd M1 Using the normal model to find P(>15.5). Can be awarded for correct (ft) standardisation  3rd A1 awrt 0.882 or 0.883 | | |