**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 frequencies1st A1 352nd M1 Attempting to find  or  may be implied by awrt 13.72nd A1 awrt 13.72nd B1 Degrees of freedom = 6 may be implied by a correct CV3rd B1 awrt 12.63rd 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 required1st B1 Correct expression for 2nd B1 Correct expression for 2nd M1 Equating their expression for Var(*Y*) = 283rd 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 here2nd M1 For correct inequality A1 *n =* 7 cao  |
| **(b)** | M1 Setting up a combined Po model A1 awrt 0.205B1 Understanding that model is only valid if the two parts are independent |
| **(c)** | 1st M1 For using Poisson distribution2nd M1 Setting up binomial distribution3rd M1 For finding 1 – P(*Y* < 1) from binomial2nd A1 awrt 0.055 |

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|  **Question** | **Scheme** | **Marks** | **AOs** |
| **4(a)** | *n* = 2 and *p* = 0.6 | B1B1 | 1.1b1.1b |
|  | **(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 |
|  | M1A1 | 2.11.1b |
|  | M1A1 | 2.11.1b |
|  | M1 | 1.1b |
| \* | A1\*cso | 1.1b |
|  |  | **(7)** |  |
| **(14 marks)** |
| **Notes** |
| **(a)** | 1st B1  *n* = 22nd B1 *p* = 0.6 |
| **(b)(i)****(b)(ii)** | M1 Finding coefficient of *t*A1 0.48oe1st M1 Realising is needed2nd M1 DifferentiationA1 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* > 10094 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 notation1st M1 Realising that the model Geo (0.03) is needed. May be implied by its use2nd M1 Using the model to find an expression for P(*X* > *c*)3rd M1 Finding a valid method to solve the inequalityA1 Correct critical region |
| **(b)** | M1 Using Geo(0.03) model with 100A1 0.049 or awrt 0.0490 |
| **(c)** | M1 Comparing 94 with their critical valueA1 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. | B1B1 | 2.2a2.4 |
|  |  | **(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. | M1A1 | 2.42.2b |
|  | **(2)** |  |
| **(15 marks)** |
| **Notes** |
| **(a)** | B1 0.05oe |
| **(b)** | 1st M1 Selecting correct normal model2nd M1 Using model to standardise and set up inequality1st A1 Correct critical region3rd M1 Correct probability statement to find power2nd A1\*cso awrt 0.68 with no errors seen. |
| **(c)** | B1 Correct deduction about the size of the two testsB1 Correct explanation |

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| **(d)** | 1st M1 Using normal model to find critical region1st 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 powersA1 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 |
|  | M1A1ft | 3.1b1.1b |
| = | 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 successA1 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 binomialA1 awrt 0.873 |
| **(c)** | 1st M1 Realising that both the mean and variance of NB are required1st 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) standardisation3rd A1 awrt 0.882 or 0.883 |