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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **1a** | *X* ~ Po(5) | **B1** | 3.3 | 3rd  Use the Poisson distribution to model real-world situations |
|  | **(1)** |  |  |
| **1b** | H0: *λ* = 5 | **B1** | 2.5 | 3rd  Understand the language of hypothesis testing |
| H1: *λ* < 5 | **B1** | 2.5 |
|  | **(2)** |  |  |
| **1c** | P(*X* ⩽ 2) | **M1** | 1.1b | 4th  Carry out one-tailed tests for the mean of a Poisson distribution |
| = 0.1247 | **A1** | 1.1b |
| 0.1247 > 0.05 so do not reject H0. There is no evidence at the 5% level of significance that the number of drivers caught speeding has reduced. | **A1** | 2.2b |
|  | **(3)** |  |  |
| (6 marks) | | | | |
| Notes  **1a** **B1** for *X* ~ Po(5) (Do not allow *λ* = 5 on its own)  **1b** **B1** for *λ* = 5 (accept *μ* = 5)  **B1** for *λ* < 5 (accept *μ* < 5)  **1c** **M1** for writing or using P(*X* ⩽ 2) or an attempt to find the critical region  **A1** for awrt 0.125 or critical region *X* ⩽ 1  **A1** for a correct conclusion in context | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **2a** | *X* ~ Po(0.25) | **B1** | 3.3 | 3rd  Use the Poisson distribution to model real-world situations |
|  | **(1)** |  |  |
| **2b** | Distribution is *Y* ~ Po(1) | **B1** | 3.3 | 5th  Carry out two-tailed tests for the mean of a Poisson distribution |
| H0: *λ* = 0.25; H1: *λ* ≠ 0.25 | **B1** | 2.5 |
| P(at least 4 breakdowns) = 1 – P(*Y* ⩽ 3) | **M1** | 1.1b |
| = 0.0190 | **A1** | 1.1b |
| 0.0190 < 0.025 therefore reject H0. There is evidence to suggest that the figure quoted on the website is incorrect. | **A1** | 2.2b |
|  | **(5)** |  |  |
| (6 marks) | | | | |
| Notes  **2a B1** for *X* ~ Po(0.25) (Do not allow *λ* = 0.25 on its own)  **2b** **B1** for stating or implying new distribution with *λ* = 1  **B1** for *λ* = 0.25 (accept *μ* = 0.25 and parameter of 1) and for *λ* < 5 (accept *μ* < 5 and parameter of 1)  **M1** for writing or using P(*Y* ⩽ 3) or an attempt to find the critical region  **A1** for awrt 0.019 or critical region *Y* ⩾ 4  **A1** for a correct conclusion in context | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **3a** | *Y* ~ Po(200 × 0.2) = *Y* ~ Po(4) | **B1**  **B1** | 3.3  2.5 | 6th  Use the Poisson distribution as an approximation to the binomial distribution |
| Suitable since *n* is large and *p* is small. | **B1** | 2.4 |
|  | **(3)** |  |  |
| **3bi** | P(*Y* = 3) = 0.1954 | **B1** | 1.1b | 2nd  Understand the basics of the Poisson distribution |
|  | **(1)** |  |  |
| **3bii** | P(*Y* ⩾ 6) = 1 – P(*Y* ⩽ 5) | **M1** | 1.1b | 2nd  Understand the basics of the Poisson distribution |
| = 0.2149 | **A1** | 1.1b |
|  | **(2)** |  |  |
| **3c** | H0: *λ* = 4; H1: *λ* > 4 | **B1** | 2.5 | 4th  Carry out one-tailed tests for the mean of a Poisson distribution |
| 0.2149 > 0.1 | **M1** | 1.1b |
| Therefore do not reject H0. There is no evidence to suggest that the change in supplier has increased the number of imperfections. | **A1** | 2.2b |
|  | **(3)** |  |  |
| (9 marks) | | | | |

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| Notes  **3a** **B1** for ‘Poisson’ and **B1** for correct *λ* and correct format, accept any letter for the random variable  **B1** for reason that must include both parts  **3bi** **B1** for awrt 0.195 (**ft** *their* *λ*)  **3bii** **M1** for writing or using P(*Y* ⩾ 6)  **A1** for awrt 0.215 (**ft** *their* *λ*)  **3c** **B1** for *λ* = 4 (accept *μ* = 4) and for *λ* > 4 (accept *μ* > 4) (**ft** *their* *λ*)  **M1A1ft** *their* **3bii** if consistent and conclusion correct and in context |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **4a** | Distribution is *X* ~ Po(7.5) | **B1** | 3.3 | 4th  Carry out one-tailed tests for the mean of a Poisson distribution |
| P(*X* ⩽ 2) = 0.0203  P(*X* ⩽ 3) = 0.0591 | **M1** | 1.1b |
| Hence critical region is *X* ⩽ 3 faults. | **A1** | 2.2b |
|  | **(3)** |  |  |
| **4b** | Actual significance level is 5.91% | **B1** | 2.2b | 3rd  Understand the language of hypothesis testing |
|  | **(1)** |  |  |
| **4c** | 2 lies in the critical region… | **M1** | 1.1a | 4th  Carry out one-tailed tests for the mean of a Poisson distribution |
| …therefore evidence to suggest average fault rate is less than 0.15 per metre. | **A1** | 2.2b |
|  | **(2)** |  |  |
| (6 marks) | | | | |
| Notes  **4a B1** for *λ* = 7.5, seen or implied  **M1** for either probability correct for *their* *λ*  **A1** awarded with *evidence*, i.e. both probabilities calculated  **4b** **B1ft** *their* **4a** if consistent and A1 awarded  **4c** **M1A1ft** *their* critical region if consistent and conclusion correct and in context | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **5** | From tables:  P(*Y* ⩽ 3) = 0.0424 when *λ* = 8  P(*Y* ⩽ 3) = 0.0212 when *λ* = 9 | **M1** | 1.1b | 5th  Carry out two-tailed tests for the mean of a Poisson distribution |
| Hence *λ* = 9 | **A1** | 2.2b |
| P(*Y* ⩾ 16) = 0.0220 | **M1** | 1.1a |
| 0.0212 + 0.0220 | **M1** | 1.1b |
| = 0.0432 | **A1** | 1.1b |
| (5 marks) | | | | |
| Notes  1st **M1** for either value found correctly from tables  **A1** awarded if *evidence*, i.e. both values found  2nd **M1** for attempt to find P(*Y* ⩾ 16) for *their λ*  3rd **M1** (indep) for adding *their* probabilities  **A1ft** *their* two probabilities if consistent, added and both less than 0.025 | | | | |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **6a** | *X* ~ Geo(0.3) | **B1** | 3.3 | 5th  Use the geometric distribution to model real-world situations |
| The probability of success is constant; the attempts are independent (both required). | **B1** | 3.5b |
|  | **(2)** |  |  |
| **6bi** | P(*X* = 5) = 0.3 × 0.74 | **M1** | 1.1b | 4th  Understand the basics of the geometric distribution |
| =0.0720 | **A1** | 1.1b |
|  | **(2)** |  |  |
| **6bii** | P(*X* ⩽ 6) = 1 – (0.7)6 | **M1** | 1.1b | 4th  Understand the basics of the geometric distribution |
| = 0.8824 | **A1** | 1.1b |
|  | **(2)** |  |  |
| **6c** | H0: *p* = 0.45; H1: *p* < 0.45 | **B1** | 2.5 | 8th  Carry out hypothesis tests for the parameter *p* of the geometric distribution |
| Assume *X* ~ Geo(0.45) | **M1** | 3.3 |
| P(*X* ⩾ 8) = 0.557 | **M1** | 1.1b |
| = 0.0152 | **A1** | 1.1b |
| 0.0152 < 0.05 therefore reject H0. There is evidence he is overstating the probability of success. | **A1** | 2.2b |
|  | **(5)** |  |  |
| (11 marks) | | | | |

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| Notes  **6a** **B1** for Geo(0.3) and **B1** for reasons (both required)  **6bi** **M1** for attempt to find P(*X* = 5) using *their* *p*  **A1** awrt 0.072  **6bii** **M1** for attempt to find P(*X* ⩽ 6) using *their* *p*  **A1** awrt 0.882  **6c** **B1** for both hypotheses stated correctly  **M1** for Geo(0.45), seen or implied  **M1** (indep) for attempt to find P(*X* ⩾ 8)  **A1** awrt 0.015  **A1ft** for correct conclusion in context (ft *their* probability if both M marks awarded) |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress Descriptor |
| **7a** | Distribution is Geo(0.25) | **B1** | 3.3 | 8th  Carry out hypothesis tests for the parameter *p* of the geometric distribution |
|  | Require P(*X* ⩾ *c*) < 0.1 | **M1** | 3.1a |  |
|  | 0.75*c* – 1 < 0.1 | **M1** | 1.1a |  |
|  |  | **M1** | 1.1b |  |
|  | Hence *c* > 9.0039… giving c.r. as *X* ⩾ 10 | **A1** | 2.2b |  |
|  |  | **(5)** |  |  |
| **7b** | P(*X* ⩾ 10) = (0.75)9 | **M1** | 1.1b | 3rd  Understand the language of hypothesis testing |
|  | = 0.0751 | **A1** | 1.1b |  |
|  |  | **(2)** |  |  |
| (7 marks) | | | | |
| Notes  **7a** **B1** for correct distribution, seen or implied  1st **M1** for probability statement < 0.1  2nd **M1** for use of correct formula with index *c* – 1 or ‘*k*’  3rd **M1** (indep) for attempt to solve equation using logs  **A1** (cao) critical region must be an integer  **7b** **M1** for attempt to find P(*X* ⩾ *their* critical value)  **A1ft** *their* critical value | | | | |