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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 | 4thCarry 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** | 3.32.5 | 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 | 4thCarry 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) = 0.0203P(*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* = 8P(*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) |
| Notes1st **M1** for either value found correctly from tables **A1** awarded if *evidence*, i.e. both values found2nd **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 | 8thCarry 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 implied1st **M1** for probability statement < 0.12nd **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 |