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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **1a** | Two from:* Each bolt is either faulty or not faulty.
* The probability of a bolt being faulty (or not) may be assumed constant.
* Whether one bolt is faulty (or not) may be assumed to be independent (or does not affect the probability of) whether another bolt is faulty (or not).
* There is a fixed number (50) of bolts.
* A random sample.
 | **B2** | 1.21.2 | 5thUnderstand the binomial distribution (and its notation) and its use as a model. |
|  | **(2)** |  |  |
| **1b** | Let *X* represent the number of faulty bolts.*X*~B(50, 0.25)P(*X* ⩽ 6) = 0.0194P(*X* ⩽ 7) = 0.0453P(*X* ⩾ 19) = 0.0287P(*X* ⩾ 20) = 0.0139 | **M1****M1dep** | 3.41.1b | 5thFind critical values and critical regions for a binomial distribution. |
| Critical Region is *X* ⩽ 6 ∪ *X* ⩾ 20 | **A2** | 1.1b1.1b |
|  | **(4)** |  |  |
| (6 marks) |
| Notes1aEach comment must be in context for its mark. |

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| Q | Scheme | Marks | AOs | Pearson Progression Step and Progress descriptor |
| **2a** | The set of **values** of the test statistic for which the **null****hypothesis is rejected** in a hypothesis test.  | **B2** | 1.21.2 | 5thUnderstand the language of hypothesis testing. |
|  | **(2)** |  |  |
| **2b** | P(*X* ⩾ 15) = 1− 0.9831 = 0.0169P (X ⩾ 16) = 1 – 09936 = 0.0064 | **M1** | 1.1b | 5thFind critical values and critical regions for a binomial distribution. |
| Critical region is 16 ⩽ *X* (⩽ 30) | **A1** | 1.1b |
| Probability of rejection is 0.0064 | **A1** | 1.1b |
|  | **(3)** |  |  |
| **2c** | Not in critical region therefore insufficient evidence to reject H0. | **B1** | 2.2b | 6thInterpret the results of a binomial distribution test in context. |
| There is insufficient evidence at the 1% level to suggest that the value of *p* is bigger than 0.3. | **B1** | 3.2a |
|  | **(2)** |  |  |
| (7 marks) |
| Notes**2c**Conclusion must be in context (i.e. use *p*), mention the significance level and be non-assertive. |

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| **Q** | **Scheme** | **Marks** | **AOs** | **Pearson Progression Step and Progress descriptor** |
| **3a** | P(*X* ⩽ 1) = 0.0076 and P (*X* ⩽ 2) = 0.0355 | **M1** | 1.1b | 5thFind critical values and critical regions for a binomial distribution. |
| P(*X* ⩾ 10) = 1 – 0.9520 = 0.0480 andP(*X* ⩾ 11) = 1 – 0.9829 = 0.0171 | **A1** | 1.1b |
| Critical region is *X* ⩽ 1 ∪ 11 ⩽ *X* (⩽ 20) | **A1** | 1.1b |
|  | **(3)** |  |  |
| **3b** | Significance level = 0.0076 + 0.0171= 0.0247 or 2.47% | **B1** | 1.1b | 6thCalculate actual significance levels for a binomial distribution test. |
|  | **(1)** |  |  |
| **3c** | Not in critical region therefore insufficient evidence to reject H0. | **B1** | 2.2b | 6thInterpret the results of a binomial distribution test in context. |
| There is insufficient evidence at the 5% level to suggest that the value of *p* is not 0.3.  | **B1** | 3.2a |
|  | **(2)** |  |  |
| (**6 marks**) |
| **Notes****3c**Conclusion must contain context and non-assertive for first B1. |

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| **Q** | **Scheme** | **Marks** | **AOs** | **Pearson Progression Step and Progress descriptor** |
| **4a** | *X*~B(28, 0.37) | **M1** | 3.4 | 5thFind critical values and critical regions for a binomial distribution |
| P(*X* ⩾ 15) = 1 – 0.9454 = 0.0546 andP(*X* ⩾ 16) = 1 – 0.9762 = 0.0238 | **M1dep** | 1.1b |
| Critical region is *X* ⩾ 16 | **A1** | 1.1b |
|  | **(3)** |  |  |
| **4b** | In critical region therefore sufficient evidence to reject H0 | **B1** | 2.2b | 6thInterpret the results of a binomial distribution test in context. |
| There is sufficient evidence at the 5% level to suggest that the value of *p* is bigger than 0.37. | **B1** | 3.2a |
|  | **(2)** |  |  |
| (**5 marks**) |
| **Notes****4a**First M1 for correct distribution seen or implied. Second M1 (dependent on first) for evidence that correct probabilities for either critical value examined.**4b**Conclusion must contain context and non-assertive for first B1. |

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| **Q** | **Scheme** | **Marks** | **AOs** | **Pearson Progression Step and Progress descriptor** |
| **5a** | H0: *p* = 0.2H1: *p* > 0.2 | **B1** | 2.5 | 5thCarry out 1-tail tests for the binomial distribution. |
| Let *X* represent the number of times the taxi is late.*X*~B(5, 0.2) seen or implied. | **M1** | 3.3 |
| EitherP(*X* ⩾ 3) = 1 – P(*X* ⩽ 2) = 1 – 0.9421= 0.05790.0579 > 0.05There is insufficient evidence at the 5% significance level that there is an increase in the number of times **the taxi/driver is late**.OrP(*X* ⩾ 3) = 1 – P(*X* ⩽ 2) = 0.0579P(*X* ⩾ 4) = 1 – P(*X* ⩽ 3) = 0.0067So critical region is *X* ⩾ 43 < 4 or 3 is not in the critical regionSo there is insufficient evidence at the 5% significance level that there is an increase in the number of times the taxi/driver is late. | **M1****A1****B1****B1****M1****A1****B1****B1** | 1.1b1.1b1.1b3.2a1.1b1.1b1.1b3.2a |
|  | **(6)** |  |  |
| **5b** | Two sensible reasons. For example,* Different time of the day Linda travels to work.
* More traffic on different days (e.g. Monday morning, Friday afternoon).
* Weather conditions.
* Road works.
 | **B2** | 2.2b2.2b | 5thUnderstand the binomial distribution (and its notation) and its use as a model. |
|  | **(2)** |  |  |
| **(8 marks)**  |
| **Notes**Conclusion must be non-assertive. |

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| **Q** | **Scheme** | **Marks** | **AOs** | **Pearson Progression Step and Progress descriptor** |
| **6a** | Let *X* represent the number of bowls with minor defects (seen or implied).*X*B(25, 0.2) may be impliedP(*X* ⩽ l) = 0.0274P(*X* = 0) = 0.0038 P*(X* ⩽ 8) = 0.9532  P(*X* ⩾ 9) = 0.0468P(*X* ⩽ 9) = 0.9827  P(*X* ⩾ 10) = 0.0173 Critical region is *X* = 0 ∪ *X* ⩾ 10 | **M1****M1dep****A1****M1****A2** | 3.41.1b1.1b1.1b1.1b 1.1b | 5thFind critical values and critical regions for a binomial distribution. |
|  | **(6)** |  |  |
| **6b** | Significance level = 0.0038 + 0.0173= 0.0211 or 2.11% | **B1** | 1.2 | 6thCalculate actual significance levels for a binomial distribution test. |
|  | **(1)** |  |  |
| **6c** | H0: *p* = 0.2; H1: *p* < 0.2 | **B1**  | 2.5  | 5thCarry out 1-tail tests for the binomial distribution. |
| Let *Y* represent number of bowls with minor defects(Under H0) *Y*~B(20, 0.2) (may be implied) | **M1** | 3.4 |
| EitherP(*Y* ⩽ 2) = 0.20610.2061 > 0.1 (or 10%)Insufficient evidence at the 10% level to suggest that the proportion of defective bowls has decreased.OrP(*Y* ⩽ 2) = 0.2061P(*Y* ⩽ 1) = 0.0692 so critical region is *Y* ⩽ 1Insufficient evidence at the 10% level to suggest that the proportion of defective bowls has decreased.0.2061 > 0.10 or 0.7939 < 0.9  | **B1****M1****A1****B1****M1****A1** | 1.1b1.1b3.2b1.1b1.1b3.2a |
|  | **(5)** |  |  |
| **(12 marks)**  |
| **Notes****6a**M1 for examining probabilities for on both sides for either critical value, A1 for each correct pair.**6c**Conclusion must be non-assertive. |

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| **Q** | **Scheme** | **Marks** | **AOs** | **Pearson Progression Step and Progress descriptor** |
| **7** | H0: *p* = 0.25, H1: *p*> 0.25 | **B1** | 2.5 | 5thCarry out 1-tail tests for the binomial distribution. |
| Let *X* represent the number of seeds that germinate.(Under H0) *X*~B(25, 0.25) | **M1** | 3.4 |
| P(*X* ⩾ 10) = 1 – P(*X* ⩽ 9) = 0.0713 | **M1** | 1.1b |
| > 0.05 | **A1** | 1.1b |
| 10 is not in critical region therefore insufficient evidence to reject H0. | **B1** | 2.2b  |
| There is insufficient evidence at the 5% level to suggest that the book has underestimated the probability. (o.e.) | **B1** | 3.2a |
| **(6 marks)**  |
| **Notes** |