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**	1.2 1.2	5th Understand the binomial distribution (and its notation) and its use as a model.
		(2)		
1b	Let X represent the number of faulty bolts. $X \sim B(50, 0.25)$ $P(X \leqslant 6) = 0.0194$ $P(X \leqslant 7) = 0.0453$ $P(X \geqslant 19) = 0.0287$ $P(X \geqslant 20) = 0.0139$	**M1** **M1dep**	3.4 1.1b	5th Find critical values and critical regions for a binomial distribution.
	Critical Region is $X \leqslant 6 \cup X \geqslant 20$	**A2**	1.1b 1.1b	
		(4)		
				(6 marks)

Notes

1a

Each comment must be in context for its mark.

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**	1.2 1.2	5th Understand the language of hypothesis testing.
		(2)		
2b	$P(X \geqslant 15) = 1 - 0.9831 = 0.0169$ $P(X \geqslant 16) = 1 - 09936 = 0.0064$	**M1**	1.1b	5th Find critical values and critical regions for a binomial distribution.
	Critical region is $16 \leqslant X (\leqslant 30)$	**A1**	1.1b	
	Probability of rejection is 0.0064	**A1**	1.1b	
		(3)		
2c	Not in critical region therefore insufficient evidence to reject H_0.	**B1**	2.2b	6th Interpret 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.

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
3a	$P(X \leqslant 1) = 0.0076$ and $P(X \leqslant 2) = 0.0355$	M1	1.1b	5th Find critical values and critical regions for a binomial distribution.
	$P(X \geqslant 10) = 1 - 0.9520 = 0.0480$ and $P(X \geqslant 11) = 1 - 0.9829 = 0.0171$	A1	1.1b	
	Critical region is $X \leqslant 1 \cup 11 \leqslant X (\leqslant 20)$	A1	1.1b	
		(3)		
3b	Significance level = 0.0076 + 0.0171 = 0.0247 or 2.47%	B1	1.1b	6th Calculate actual significance levels for a binomial distribution test.
		(1)		
3c	Not in critical region therefore insufficient evidence to reject H_0.	B1	2.2b	6th Interpret 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.

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
4a	X~B(28, 0.37)	**M1**	3.4	5th Find critical values and critical regions for a binomial distribution
	P($X \geqslant$ 15) = 1 – 0.9454 = 0.0546 and P($X \geqslant$ 16) = 1 – 0.9762 = 0.0238	**M1dep**	1.1b	
	Critical region is $X \geqslant 16$	**A1**	1.1b	
		(3)		
4b	In critical region therefore sufficient evidence to reject H_0	**B1**	2.2b	6th Interpret 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.

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
5a	H_0: $p = 0.2$ H_1: $p > 0.2$	**B1**	2.5	5th Carry 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	
	<u>Either</u> $P(X \geqslant 3) = 1 - P(X \leqslant 2) = 1 - 0.9421$ $= 0.0579$ $0.0579 > 0.05$ There is insufficient evidence at the 5% significance level that there is an increase in the number of times **the taxi/driver is late**. <u>Or</u> $P(X \geqslant 3) = 1 - P(X \leqslant 2) = 0.0579$ $P(X \geqslant 4) = 1 - P(X \leqslant 3) = 0.0067$ So critical region is $X \geqslant 4$ $3 < 4$ or 3 is not in the critical region So 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**	1.1b 1.1b 1.1b 3.2a 1.1b 1.1b 1.1b 3.2a	
		(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**	2.2b 2.2b	5th Understand the binomial distribution (and its notation) and its use as a model.
		(2)		
				(8 marks)

Notes

Conclusion must be non-assertive.

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
6a	Let X represent the number of bowls with minor defects (seen or implied). $X \sim B(25, 0.2)$ $P(X \leqslant 1) = 0.0274$ $P(X = 0) = 0.0038$ $P(X \leqslant 8) = 0.9532 \Rightarrow P(X \geqslant 9) = 0.0468$ $P(X \leqslant 9) = 0.9827 \Rightarrow P(X \geqslant 10) = 0.0173$ Critical region is $X = 0 \cup X \geqslant 10$	M1 M1dep A1 M1 A2	3.4 1.1b 1.1b 1.1b 1.1b 1.1b	5th Find 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	6th Calculate actual significance levels for a binomial distribution test.
		(1)		
6c	H_0: $p = 0.2$; H_1: $p < 0.2$	B1	2.5	5th Carry out 1-tail tests for the binomial distribution.
	Let Y represent number of bowls with minor defects (Under H_0) $Y \sim B(20, 0.2)$ (may be implied)	M1	3.4	
	Either $P(Y \leqslant 2) = 0.2061$ $0.2061 > 0.1$ (or 10%) Insufficient evidence at the 10% level to suggest that the proportion of defective bowls has decreased. Or $P(Y \leqslant 2) = 0.2061$ $P(Y \leqslant 1) = 0.0692$ so critical region is $Y \leqslant 1$ Insufficient 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	 1.1b 1.1b 3.2b 1.1b 1.1b 3.2a	
		(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.

Q	Scheme	Marks	AOs	Pearson Progression Step and Progress descriptor
7	H_0: $p = 0.25$, H_1: $p > 0.25$	**B1**	2.5	5th Carry out 1-tail tests for the binomial distribution.
	Let X represent the number of seeds that germinate. (Under H_0) $X \sim B(25, 0.25)$	**M1**	3.4	
	$P(X \geqslant 10) = 1 - P(X \leqslant 9) = 0.0713$	**M1**	1.1b	
	> 0.05	**A1**	1.1b	
	10 is not in critical region therefore insufficient evidence to reject H_0.	**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